Functional, Technical and Economical Requirements Integration for Additive Manufacturing Design Education

Additive Manufacturing (AM) enables designers to consider the benefits of digital manufacturing from the early stages of design. This may include the use of part integration to combine all required functions, utilizing multiple materials, moving assemblies, different local properties such as colour and texture, etc. Cost analysis can also be factored in throughout the entire value chain, from design to the finishing operations in comparison to traditional processes and conventional ways of working. Therefore, the concept of Design for Additive Manufacturing (DfAM) is more than a geometrical issue on a CAD system, and not limited only to topological optimization or lattice integration.

General information

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Authors: Bernard, A. (Ekstern), Thompson, M. K. (Intern), Moroni, G. (Ekstern), Vaneker, T. (Ekstern), Pei, E. (Ekstern), Barlier, C. (Ekstern)
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Fast and stable gratings inscription in POFs made of different materials with pulsed 248 nm KrF laser

This paper presents fiber Bragg grating (FBG) inscription with a pulsed 248 nm UV KrF laser in polymer optical fibers (POFs) made of different polymers, namely polymethyl methacrylate (PMMA), cyclic-olefin polymer and co-polymer, and Polycarbonate. The inscribed gratings and the corresponding inscription parameters are compared with grating inscribed in POFs made of the aforementioned materials but with the hitherto most used laser for inscription, which is a continuous wave 325 nm UV HeCd laser. Results show a reduction of the inscription time of at least 16 times. The maximum time reduction is more than 130 times. In addition, a reflectivity and a bandwidth close to or higher than the ones with the 325 nm laser were obtained. The polymer optical fiber Bragg gratings (POFBGs) inscribed with the 248 nm laser setup present high stability with small variations in their central wavelength, bandwidth, and reflectivity after 40 days.

General information
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Organisations: Department of Mechanical Engineering, Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Manufacturing Engineering, Universidad Politecnica de Valencia, University of Espirito Santo, Universidade de Aveiro
Authors: Marques, C. A. (Ekstern), Min, R. (Ekstern), Leal, A. (Ekstern), Antunes, P. (Ekstern), Fasano, A. (Intern), Woyessa, G. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Ortega, B. (Ekstern), Bang, O. (Intern)
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Scopus rating (2015): SJR 1.91 SNIP 1.674 CiteScore 3.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.313 SNIP 2.124 CiteScore 4.18
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BFI (2013): BFI-level 2
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ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.562 SNIP 2.108 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
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BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.58 SNIP 2.572 CiteScore 4.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
A 3D numerical study of humidity evolution and condensation risk on a printed circuit board (PCB) exposed to harsh ambient conditions

In many applications, electronics enclosures are exposed to harsh environmental conditions. For a reliable design, it is crucially important to understand the effects of such conditions on the local climate inside the enclosures. In this study, the relative humidity (RH) and temperature inside an electronic enclosure exposed to harsh ambient conditions (relative humidity of 100% and cyclic temperature changes from 10 to 50 °C) are studied by developing a full 3D finite element based CFD model. The RH evolution is studied in three stages: first, in an empty enclosure, then in an enclosure with a PCB, heatsink and a heater, and finally in the case of an internal cyclic heat load. In all three parts, the effect of the opening size of the enclosure is also studied. The numerical simulation results are compared with corresponding experimental results from the literature, and a good agreement is found.

The presence of components inside the enclosure damps the response of the internal climate to the ambient changes and this is especially the case for the aluminum heatsink. In case of exposure to RH of 100%, controlling the moisture concentration appears to be more effective than controlling temperature with the aim of reducing the condensation risk on the PCB.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Shojaee Nasirabadi, P. (Intern), Hattel, J. H. (Intern)
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Additive Manufacturing of Mould Inserts with Mirror-like Surfaces

Selective laser melting (SLM) is often applied in the production of steel moulds with high wear resistance and conformal cooling channels for advanced thermal management. The surface finishing of such moulds is crucial, especially if it is intended for the moulding of plastic parts with aesthetic functionality. The surface quality of such metal 3D printed moulds is typically refined by means of subsequent material removal processes, but this is often hindered by residual porosity and inhomogeneity in the metal structure of the 3D-printed part.

In this paper an indirect tooling process chain for production of mould inserts is proposed. The process chain aims at exploiting the good replication capability of electroformed nickel, to copy mirror-like substrates. The bulky part of the insert
is produced by means of SLM that shows a considerably higher material deposition rate. The thermal input is controlled throughout the process chain to prevent deleterious grains growth in the nickel layer.

The roughness of the nickel surface is measured after the selective etching of the substrate and compared with the substrate roughness before the nickel deposition, showing good replication of the master surface. The proposed process chain overcomes the problems related to the deposition of thick electroformed coatings by coupling electroforming with higher output additive processes such as SLM - that furthermore allows the introduction of cooling channels in close contact with the mould surface.

Additive manufacturing with vat polymerization method for precision polymer micro components production
The direct fabrication of miniaturized polymer components by Additive Manufacturing (AM) processes is a remarkable method at the microdimensional scale. However, the measurement of complex micro products and the evaluation of the related uncertainty are still particularly challenging and necessary in the micro AM field. In the DTU, a proprietary Vat Photopolymerization machine able to produce micro features has been designed, built and validated. This study evaluates the capability of the machine in terms of printed dimensions and the corresponding uncertainty assessment. For this purpose, two test parts with micro features of different geometries and dimensions have been designed and five samples of each test part have been printed. The dimensions of the micro features have been evaluated for quality control capability assessment and to establish procedures for verification of AM machines.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Biondani, F. G. (Intern), Bissacco, G. (Intern), Tang, P. T. (Ekstern), Hansen, H. N. (Intern)
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Additive manufacturing with vat polymerization method for precision polymer micro components production
The direct fabrication of miniaturized polymer components by Additive Manufacturing (AM) processes is a remarkable method at the microdimensional scale. However, the measurement of complex micro products and the evaluation of the related uncertainty are still particularly challenging and necessary in the micro AM field. In the DTU, a proprietary Vat Photopolymerization machine able to produce micro features has been designed, built and validated. This study evaluates the capability of the machine in terms of printed dimensions and the corresponding uncertainty assessment. For this purpose, two test parts with micro features of different geometries and dimensions have been designed and five samples of each test part have been printed. The dimensions of the micro features have been evaluated for quality control capability assessment and to establish procedures for verification of AM machines.

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Scopus rating (2017): CiteScore 1.5 SJR 0.668 SNIP 0.982
Scopus rating (2016): CiteScore 1.6 SNIP 1.374 SJR 0.719
A method for the characterization of the reflectance of anisotropic functional surfaces

The functional properties of micro-structured surfaces have gained increasing interest thanks to many applications such as wetting, adhesion, thermal and/or electrical conductivity. In this study, directional optical properties, i.e. contrast between two regions of a surface, were achieved with an anisotropic microstructure composed of a close array of ridges. The anisotropic surface, designed as a combination of ridges, has been milled on a steel bar and replicated through hot embossing of Acrylonitrile butadiene styrene (ABS) and through replica technology using silicone rubber. The directional reflectance of the surface for a range of design-specific view-illumination configurations was determined using a method that involves a Hirox RH-2000 digital microscope, used as a gonioreflectometer. This method allows the empirical determination of the optimum surface microstructure for maximizing contrast between two horizontally orthogonal views. The results show that even if the uncertainty related to the instrumentation is up to 20% in some cases, this procedure is suitable for the characterization of the surface of both metal and plastic counterpart.

A new design for an extensive benchmarking of additive manufacturing machines

This paper focuses on a new methodology for conducting a comprehensive benchmarking of Additive Manufacturing (AM) technologies. The quality of the built products using AM strongly depends on the machine capabilities, and it is thus essential to develop a proper benchmarking design that would allow their comparative evaluation. The benchmarking presented has been designed with the purpose of conducting a comparison between different AM machines, with a particular focus on metal powder-bed AM. The main scope is to make an extensive evaluation of the technologies from multiple points of view, covering: accuracy and precision of the machine, residual stresses on the parts (particularly important in the case of metal AM), homogeneity (in terms of density and residual porosity), build speed, mechanical properties, surface finish and corrosion resistance. For each evaluation criteria, a specific analysis method is employed. The aim of this work is to analyse the current technology capabilities and limitations, in order to assess what different AM machines can deliver in a net-shape process chain scenario. The benchmark is employed for a statistically designed
series of experiments to study in detail the AM machine’s real limitations and their working process windows. The design also includes features that represent a challenge for the AM machine, and sometimes exceed the machine’s actual capabilities. Furthermore, the benchmark has been developed to be used as a periodic quality control-job for the operational performance of the AM machines.

**General information**

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- **Organisations:** Department of Mechanical Engineering, Manufacturing Engineering
- **Authors:** Moshiri, M. (Intern), Tosello, G. (Intern), Mohanty, S. (Intern)
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- **Additive Manufacturing, Selective Laser Melting, Powder Bed Fusion, Benchmarking, Technology evaluation, Accuracy, Repeatability, Homogeneity**

**Application of modelling tools for precise transfer of nanostructures from silicon wafers to steel injection moulding tool inserts**

Functional nanostructures applied on various consumer products has attracted increasing attention in the industry. Examples of functional nanostructures are well known from nature, where organisms and plants possess optical, adhesive, and self-cleaning capabilities. The aim of the present work is to produce injection moulding tool inserts with the nanostructured functional surfaces as mentioned above. In order to manufacture these structures on the double-curved surfaces of the injection moulding tool inserts, a technology called nanoimprint lithography (NIL) with flexible stamps is applied. However, the resolution limit due to distortion of the stamp when applying the pressure, and complications regarding deformations of the flexible stamp, is a major concern for precise replication of the nanostructures whose functionality might change dramatically with just a few nanometres of distortion. Here, the application of modelling tools is essential in order to predict how the flexible stamp will deform during the transferring process. However, such models are quit complicated since the overall behaviour is non-linear. A review of different manufacturing and simulation cases will be presented and gives an overview of today’s methodologies for transfer of nanostructures to curved surfaces.

**General information**

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- **Organisations:** Department of Mechanical Engineering, Manufacturing Engineering
- **Authors:** Sonne, M. R. (Intern), Hattel, J. H. (Intern)
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- **Main Research Area:** Technical/natural sciences
- **Nanotechnology, Modelling, Injection moulding, Nanoimprint lithography**

**A robustness analysis of the bonding process of joints in wind turbine blades**

In this paper, a numerical model is used to perform a robustness analysis of the bonding process of a joint between the two shells composing a wind turbine blade. The flow behaviour of the bonding adhesive is quantified on a rheometer and the Herschel-Bulkley material model is utilized to approximate the rheological data set. The material model parameters are implemented in the numerical model, which is validated by comparison with experimental results. The robustness analysis is focused on analysing the adhesive position and initial shape as well as the inclination angle’s effect on the squeeze force and final adhesive geometry. The results illustrate that the numerical model can assist in increasing the strength of the joint, decreasing the risk of residual stress induced cracks, and minimizing cost/waste and mass of the blade.

**General information**

- **State:** Accepted/In press
- **Organisations:** Department of Mechanical Engineering, Manufacturing Engineering, Solid Mechanics, LM Wind Power
- **Authors:** Spangenberg, J. (Intern), Uzal, A. (Intern), Nielsen, M. W. (Ekstern), Hattel, J. H. (Intern)
- **Number of pages:** 17
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- **Main Research Area:** Technical/natural sciences

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- **Journal:** International Journal of Adhesion and Adhesives
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- **Ratings:**
A simple model linking surface roughness with friction coefficient and manufacturing cost

A simple theoretical model linking surface micro geometry, friction and manufacturing cost is presented. Combining a basic geometrical relationship of plastic deformation of workpiece surface asperities by a hard tool with an assumption of adhesive friction, the friction coefficient of a soft, rough surface sliding against a hard, smooth tool surface can be calculated, linking surface roughness with friction coefficient. The simple model can also link the cost related to manufacturing with a surface characterized by a given friction coefficient value. Results are presented from tests carried out to verify the simple model. Several test pieces were manufactured by turning, or grooving, an aluminum alloy and
brass using different feeds, tool nose radii, and tool nose angles, achieving different surface profiles. The surfaces were characterized using a stylus profilometer and a digital microscope. The static friction coefficient was determined in terms of angle of repose using a rotary table. The experimentally determined values of the friction coefficient were compared with those predicted from feed, tool radius, and asperity angle. The tests have shown a good reproducibility, and a clear determination of the friction coefficient was possible. However, due to the low normal loads involved in this set up, the influence from the surface roughness was not clear. Further investigations are therefore proposed.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
Authors: De Chiffre, L. (Intern), Kücükyildiz, Ö. C. (Intern), Bay, N. (Intern)
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
ISI indexed (2013): ISI indexed yes
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BFI (2012): BFI-level 1
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Scopus rating (2011): SJR 0.177 SNIP 0.436 CiteScore 0.22
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.184 SNIP 0.296
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.209 SNIP 0.24
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.192 SNIP 0.283
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Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.221 SNIP 0.42
Scopus rating (2005): SJR 0.221 SNIP 0.373
Scopus rating (2004): SJR 0.225 SNIP 0.434
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.218 SNIP 0.32
Assessment of sub-mm features replication capability in injection moulding using a multi-cavity tool produced by additive manufacturing

This research investigates the effect of injection moulding process parameters on photopolymer mould inserts produced with the Digital Light Processing (DLP) additive manufacturing (AM) method. The main motivation of applying AM to produce mould inserts is the potential of reducing lead time and manufacturing cost, as well as achieving a more flexible manufacturing method in case of non-mass produced products such as prototypes. In this research moulds inserts of 20 x 20 x 2.7 mm with mould cavities as small as 5 x 4 mm in dimensions are tested. The parts are analyzed and evaluated by the measurements of different features and the influence of the IM process.

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Additive manufacturing, Digital light processing, Soft tooling, Injection moulding
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instead of air, the obtained surface characteristics were remarkably different, which led to a significant improvement in the metal deposition characteristics using electroless plating. In this work, we try to explain the underlying fundamental mechanisms that contribute to this improvement in surface characteristics through concurrent experimental and modeling research. The observed images of laser modified surfaces suggest that a hemispherical hump is formed in the case of water at lower laser fluences that breakup with an increase in fluence. Such a behavior was not observed when the process was carried out in air. We explain this phenomenon by simulating the temperature profiles in the polymer during the laser heating process in air and water. The results suggest that subsurface heating effects occur when the process is carried out in water. We further argue that this phenomenon is mainly responsible for the formation of the complex structure that was observed in our previous work.

**General information**

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Marla, D. (Intern), Andersen, S. A. (Intern), Zhang, Y. (Intern), Hattel, J. H. (Intern), Spangenberg, J. (Intern)
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Web of Science (2017): Indexed yes
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Scopus rating (2014): SJR 1.025 SNIP 2.013 CiteScore 1.77
Scopus rating (2013): SJR 0.909 SNIP 1.496 CiteScore 1.74
Scopus rating (2012): SJR 0.945 SNIP 1.759 CiteScore 1.72
Scopus rating (2011): SJR 0.602 SNIP 2.232 CiteScore 1.2
Scopus rating (2010): SJR 0.796 SNIP 1.215
Scopus rating (2009): SJR 0.264 SNIP 0.39
Scopus rating (2008): SJR 0.187 SNIP 0.368
Scopus rating (2007): SJR 0.331 SNIP 0.824
Scopus rating (2006): SJR 0.28 SNIP 0.511
Scopus rating (2005): SJR 0.196 SNIP 0.273
Scopus rating (2004): SJR 0.235 SNIP 0.34
Scopus rating (2003): SJR 0.246 SNIP 0.297
Scopus rating (2002): SJR 0.276 SNIP 0.133
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Scopus rating (2000): SJR 0.155 SNIP 1.489
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Laser, Polymers, Subsurface heating, Surface modification, Finite difference method

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**A Study on DLC Tool Coating for Deep Drawing and Ironing of Stainless Steel**

The trend in metal forming tribology is to develop new tribo-systems including new lubricants, tool materials and tool coatings in order to substitute environmentally hazardous lubricants by environmentally friendly tribo-systems. In preliminary testing the limits of lubrication of new tribo-systems for sheet forming production, it is advantageous to use dedicated simulative tribo-tests. This paper studies the influence of tool coatings on deep drawing operations using the Bending Under Tension (BUT) test and also under more severe tribological conditions by adopting the Strip Reduction Test (SRT) to replicate industrial ironing of deep drawn, stainless steel parts. Non-hazardous tribo-systems in form of a double layer Diamond-like coated tool applied under dry condition or with an environmentally friendly lubricant were investigated via emulating industrial process conditions in laboratory tests. Experiments revealed that the double layer coating worked successfully, i.e. with no sign of galling, when it was used with environmentally friendly lubricants, whereas
the results were more prone to galling under dry condition.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Universiti Malaysia Perlis
Authors: Üstünyagiz, E. (Intern), Hafis Sulaiman, M. (Ekstern), Christiansen, P. (Intern), Nielsen, C. V. (Intern), Bay, N. (Intern)
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- Web of Science (2015): Indexed yes
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- Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
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- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
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- ISI indexed (2011): ISI indexed yes
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- Scopus rating (2010): SJR 0.184 SNIP 0.296
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 0.209 SNIP 0.24
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.192 SNIP 0.283
- Scopus rating (2007): SJR 0.194 SNIP 0.366
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 0.221 SNIP 0.42
- Scopus rating (2005): SJR 0.221 SNIP 0.373
- Scopus rating (2004): SJR 0.225 SNIP 0.434
- Web of Science (2004): Indexed yes
- Scopus rating (2003): SJR 0.218 SNIP 0.32
- Web of Science (2003): Indexed yes
- Scopus rating (2002): SJR 0.246 SNIP 0.236
- Scopus rating (2001): SJR 0.265 SNIP 0.399
A Systematic Approach to Analyse Critical Tribological Parameters in an Industrial Case Study of Progressive Die Sequence Production

In a production line that uses sheet metal forming technology, the surface quality of the final part and tool life depend significantly on the lubricant performance. Hazardous chlorinated paraffin oils have been widely used by manufacturers throughout the world for many decades. However, with growing environmental awareness, the trend is to substitute environmentally hazardous oils with environmentally friendly lubricants. Tribological conditions in forming operations depend on several parameters such as process speed, workpiece/tool interface pressure, workpiece/tool interface temperature and surface roughness of the parts. Prior to testing several tribo-systems in the laboratory to determine the limit of lubrication, it is therefore important to identify the tribological parameters in the production process.

This paper describes a generic methodology for such an investigation to determine the tribologically critical parameters in an industrial production line in which a progressive tool sequence is used. The current industrial case is based on multistage deep drawing followed by an ironing operation. Severe reduction in the ironing stage leads to high interface temperature and pressure. As a result, subsequent lubricant film breakdown in the production line occurs. The methodology combines finite element simulations and experimental measurements to determine tribological parameters which will later be used in laboratory testing of possible tribology systems.

Characterization of holding brake friction pad surface after pin-on-plate wear test

This article concerns the metrological characterization of the surface on a holding brake friction material pin after a pin-on-plate (POP) wear test. The POP test induces the formation of surface plateaus that affect brake performances such as wear, friction, noise and heat. Three different materials' surfaces have been characterized after wear from data obtained with a focus variation 3D microscope. A new surface characterization approach with plateau identification is proposed, using the number of plateau on the surface, equivalent diameter, length and breadth as measurands. The identification method is based on determining and imposing ISO 27158-2 lower plateau limit (LPL) in material probability curves; and on applying a combined criterion of height segmentation threshold and equivalent diameter threshold. The method determines the criterion thresholds for each material since LPL appears typical by material. The proposed method has allowed quantifying the surface topography at two different levels of wear. An expanded measurement uncertainty of 3.5 µm for plateau dimensions in the range 50–2000 µm and one of 0.15 µm for plateau heights up to 10 µm have been documented.
Combined numerical and experimental determination of the convective heat transfer coefficient between an AlCrN-coated Vanadis 4 tool and Rhenus oil

Abstract
Regardless of the field of application, the reliability of numerical simulations depends on correct description of boundary conditions. In thermal simulation, determination of heat transfer coefficients is important because it varies with material properties and process conditions. This paper shows a combined experimental and numerical analysis applied for determination of the heat transfer coefficient between an AlCrN-coated Vanadis 4 tool and Rhenus LA722086 oil in an unloaded condition, i.e. without the tool being in contact with a workpiece. It is found that the heat transfer coefficient in unloaded conditions at 80°C oil temperature is 0.1 kW/(m²·K) between the selected stamping tool and mineral oil. A sensitivity analysis of the numerical model was performed to verify the effects of mesh discretization, temperature measurement location and tool geometry. Among these parameters, mesh size and the thermocouple insert depth were identified as the critical parameters that affect the measured and calculated temperatures.

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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.62 SJR 0.733 SNIP 1.566
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.52 SJR 0.727 SNIP 1.685
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.662 SNIP 1.501 CiteScore 2.18
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.676 SNIP 1.7 CiteScore 1.89
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.566 SNIP 1.743 CiteScore 1.8
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Comparison of selected processes for surface microstructuring of complex mould for an implanted device

Polymer products with functional surfaces are applied in many fields such as medical devices and biotechnology. However, most technologies for the fabrication of microstructured functional surfaces are still limited to flat geometries or geometries with constant curvature. This paper describes and compares three approaches for fabricating micro- or nanostructured surfaces; those process chains are suitable for patterning of the surface of 3D shape cavity for injection moulding. The desired surface features have been approved by cell proliferation test. The first approach is to use prefabricated plate with microstructured surface as an insert inside the cavity. The second approach is to directly pattern the surface by a femtosecond laser combined with mask projection technique. The third approach is to produce the cavity part using an anodizing process followed by metal deposition, and in this way, sub-microfeatures were obtained all over the cavity surface. The aim of this paper is to find solutions to implementing the desired features on the entire surfaces of a 3D-shaped ring; this research will also benefit the production of other complex parts with functional micro- or nanostructured surface.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Zhang, Y. (Intern), Hansen, H. N. (Intern), Bissacco, G. (Intern), Biondani, F. G. (Intern)
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Publication information
Journal: International Journal of Advanced Manufacturing Technology
Volume: 97
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ISSN (Print): 0268-3768
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.8 SJR 0.994 SNIP 1.697
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.3 SJR 1.046 SNIP 1.608
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.889 SNIP 1.325 CiteScore 1.8
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.082 SNIP 1.841 CiteScore 2.03
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.134 SNIP 2.131 CiteScore 2.26
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.971 SNIP 2.099 CiteScore 1.75
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.817 SNIP 1.673 CiteScore 1.61
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.785 SNIP 1.445
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.797 SNIP 1.384
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.52 SNIP 1.029
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.441 SNIP 0.747
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.477 SNIP 1.109
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.608 SNIP 0.944
Scopus rating (2004): SJR 0.56 SNIP 0.9
Scopus rating (2003): SJR 0.653 SNIP 0.911
Scopus rating (2002): SJR 0.687 SNIP 1.003
Scopus rating (2001): SJR 0.462 SNIP 1.064
Scopus rating (2000): SJR 0.583 SNIP 0.91
Scopus rating (1999): SJR 0.606 SNIP 0.918

Original language: English
Microstructured surface, Free form, Laser, Nanostructure, 3D product, Injection moulding
DOIs:
10.1007/s00170-018-2152-1
Source: Findit
Source-ID: 2434627103
Publication: Research - peer-review › Journal article – Annual report year: 2018
Comparison of surface extraction techniques performance in computed tomography for 3D complex micro-geometry dimensional measurements

The number of industrial applications of computed tomography (CT) for dimensional metrology in $10^0-10^3$ mm range has been continuously increasing, especially in the last years. Due to its specific characteristics, CT has the potential to be employed as a viable solution for measuring 3D complex micro-geometries as well (i.e., in the sub-mm dimensional range). However, there are different factors that may influence the CT process performance, being one of them the surface extraction technique used. In this paper, two different extraction techniques are applied to measure a complex miniaturized dental file by CT in order to analyze its contribution to the final measurement uncertainty in complex geometries at the mm to sub-mm scales. The first method is based on a similarity analysis: the threshold determination; while the second one is based on a gradient or discontinuity analysis: the 3D Canny algorithm. This algorithm has proven to provide accurate results in parts with simple geometries, but its suitability for 3D complex geometries has not been proven so far. To verify the measurement results and compare both techniques, reference measurements are performed on an optical coordinate measuring machine (OCMM). The systematic errors and uncertainty results obtained show that the 3D Canny adapted method slightly lower systematic deviations and a more robust edge definition than the local threshold method for 3D complex micro-geometry dimensional measurements.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Universidad de Zaragoza, Universidad Autonoma de Baja California, Centro Universitario de la Defensa
Authors: Torralba, M. (Ekstern), Jiménez, R. (Ekstern), Yagüe-Fabra, J. A. (Ekstern), Ontiveros, S. (Ekstern), Tosello, G. (Intern)
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Journal: International Journal of Advanced Manufacturing Technology
Volume: 97
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ISSN (Print): 0268-3768
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.8 SJR 0.994 SNIP 1.697
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.3 SJR 1.046 SNIP 1.608
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.889 SNIP 1.325 CiteScore 1.8
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.082 SNIP 1.841 CiteScore 2.03
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.134 SNIP 2.131 CiteScore 2.26
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.971 SNIP 2.099 CiteScore 1.75
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.817 SNIP 1.673 CiteScore 1.61
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Considerations on numerical modelling for compensation of in-process metrology in manufacturing

The growing demands for quality and flexibility and at the same time production speed challenges conventional metrology. The future tendency is that metrology is an integrated part of the production line and thus is placed in a production environment. This is a challenge since dimensional metrology in a production environment might lead to higher uncertainties due to dynamic variations both in the conditions of the environment and in the conditions produced parts, with all the influencing factors such as temperature, vibrations, forces and humidity etc. that lies outside the requirements from today's standards referring to 20°C and 0 N (zero forces acting on the part). However, many of these effects can be treated as systematic errors if the physical phenomena leading to the deviations can be described. Today, it is very common to compensate for the variations in temperature in a classical 1D manner where a measurand is compensated via the coefficient of thermal expansion (CTE) and the difference from the reference temperature. However, when temperature gradients and very complex part geometries exist the deformation pattern might not at all follow a linear path. Instead, more advanced three-dimensional thermomechanical numerical models should be used for predicting the deformation of the parts due to the thermal effects taking the inherent build-up of residual stresses and warpage into account. The same goes for other effects that might change the dimensions over time such as hygroscopic swelling (for polymer parts), which can be taken into account by considering numerical modelling. In the present work, different academic and industrial parts will be used as cases in order to show the advantages of using numerical simulation tools for compensation of the dynamic changes and further also highlight and discuss where the classical 1D approaches might be sufficient for a desired uncertainty.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
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Main Research Area: Technical/natural sciences
Metrology, Production environment, Numerical modelling, Hygroscopic swelling
Publication: Research - peer-review » Conference abstract for conference – Annual report year: 2018
Correlation of mechanical and electrical properties with processing variables in MWCNT reinforced thermoplastic nanocomposites

The influence of the processing variables and nanotube content on the mechanical and electrical properties of polyamide 6.6-based nanocomposites reinforced with multi-walled carbon nanotubes is investigated. Results show that variation in the processing variables such as compounding method, injection melt temperature, injection speed, mold temperature, and holding pressure varies the properties significantly. In fact, composites containing similar contents of the nanofillers show variations in mechanical properties up to 30.0% and in the electrical properties up to three orders of magnitude. Different processing parameters required for achieving optimal mechanical and electrical performances are also found. Correlation between processing parameters and microstructure within the nanocomposites is studied. Results show that variation of the processing parameters defines the existence or absence of a nanotube network in the nanocomposite structure. Experimental and micromechanical modeling results show that less control over the nanocomposite morphology and nanotube alignment is achievable in higher nanofiller contents. The underlying mechanisms responsible for the modulation in the properties are also discussed using scanning and transmission electron microscopy, rheological and crystallization investigations. The research provides a recipe to manufacture the tailored nanocomposite with the specified properties for various industrial applications.

General information
State: Accepted/In press
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, Solid Mechanics
Authors: Doagou-Rad, S. (Intern), Islam, A. (Intern), Jensen, J. S. (Intern)
Number of pages: 17
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Composite Materials
ISSN (Print): 0021-9983
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.898 SJR 0.555 CiteScore 1.57
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.42 SJR 0.528 SNIP 0.803
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.573 SNIP 0.876 CiteScore 1.4
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.612 SNIP 1.188 CiteScore 1.44
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.625 SNIP 1.186 CiteScore 1.45
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.599 SNIP 1.239 CiteScore 1.21
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.649 SNIP 1.242 CiteScore 1.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.667 SNIP 1.093
Web of Science (2010): Indexed yes
Damping Behavior of Carbon Nanotube Reinforced Nanocomposites: Micromechanical Modeling and Experiments

The damping characteristics of polymeric nanocomposites reinforced with carbon nanotubes is studied using micromechanical modeling and experiments. Two damage dissipation mechanisms namely interfacial and viscoelastic damping contribute to the damping properties of the polymeric nanocomposites. Incorporation of stiff fillers in the structure of the polymeric materials leads to a reduction of viscoelastic damping in the composites. However, inclusion of the nanotubes in the polymeric matrix also introduces a new dissipation mechanism along the interface with the polymeric phase. In order to study the dynamic behavior of the nanocomposites, normal and shear stress distributions along the nanotubes as the function of their orientation to the loading were achieved based on a shear-lag Cox model. Consequently, the slippage of the nanotube surrounded by polymeric phase as function of external loading and orientation of fibers was determined. Contribution of the viscoelastic damping to the nanocomposite behavior as the function of nanotube orientation and content was also studied. The total damping property of the nanocomposites represent the combined action of the two involved mechanisms. Nanocomposite specimens containing 0.5, 1.0, 3.0, 5.0, and 6.0 wt. % of the nanotubes were prepared. The damping and energy dissipation in the produced specimens were studied using dynamic mechanical experiments. Experimental results showed good agreement with the results abstained from the modeling.

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, Solid Mechanics
Authors: Doagou-Rad, S. (Intern), Jensen, J. S. (Intern), Islam, A. (Intern)
Number of pages: 8
Publication date: 2018
Main Research Area: Technical/natural sciences
Polymeric composites, Micromechanics, Damping, Modeling, Carbon nanotubes
Electronic versions:
ECCM18_4_submission_1.pdf
Source: PublicationPreSubmission
Source-ID: 150054275
Publication: Research - peer-review › Paper – Annual report year: 2018

Design for manufacturability of macro and micro products: a case study of heat exchanger design

In this paper, a novel methodology in designing a micro heat exchanger is proposed by modifying a conventional design methodology for macro products with the considerations of differences between design of a micro and a macro product. The methodology starts with the identification of differences in design considerations for micro scale products compared to the macro scale. These design considerations consist of material selection, manufacturing process, physical phenomena and shape and geometry design. Manufacturability criteria are defined and various potential manufacturing processes for fabricating micro heat exchangers are ranked based on the defined criteria. Following the design methodology, primary
design ideas for micro heat exchangers are generated according to the heat transfer principles for macro heat exchangers. Taking micro design considerations into account, the designs from next iteration are created. Finally, the performances of the designs for micro heat exchangers are compared with their macro counterparts. The most appropriate designs for micro heat exchangers are finalized. The micro specific design guidelines obtained by the designer through evaluating the modeling results and the design criteria are formulated in a knowledge-based unit called “Rules To Consider” (RTC). The proposed methodology provides an interactive design process through the RTC unit. The RTC data is used by the designer in the subsequent iterations of the micro-product design as well as can be used by designers/engineers in design of the same category of micro products. Furthermore, through utilization of the proposed methodology by designers/engineers for design of other micro products, the RTC unit can be enriched with micro-oriented design principles and accordingly provide a basic guideline for design of micro products.

**General information**
State: Accepted/In press
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Department of Wind Energy, Wind Turbine Structures and Component Design, Engineering Design and Product Development, National University of Singapore
Authors: Omidvarnia, F. (Intern), Weng Feng, L. (Ekstern), Hansen, H. N. (Intern), Sarhadi, A. (Intern), Lenau, T. A. (Intern), Mortensen, N. H. (Intern)
Number of pages: 12
Publication date: 2018
Main Research Area: Technical/natural sciences

**Publication information**
Journal: International Journal on Interactive Design and Manufacturing
ISSN (Print): 1955-2505
Ratings:
Web of Science (2018): Indexed yes
Scopus rating (2017): SNIP 1.192 SJR 0.426 CiteScore 1.31
Scopus rating (2016): CiteScore 1.15 SNIP 1.07 SJR 0.536
Scopus rating (2015): CiteScore 0.71 SNIP 0.816 SJR 0.349
Scopus rating (2014): CiteScore 0.83 SNIP 0.732 SJR 0.48
Scopus rating (2013): CiteScore 0.88 SNIP 1.425 SJR 0.524
Scopus rating (2012): CiteScore 0.72 SNIP 0.801 SJR 0.349
Scopus rating (2011): CiteScore 0.57 SNIP 0.867 SJR 0.31
Scopus rating (2010): SNIP 1.121 SJR 0.213
Scopus rating (2009): SNIP 1.515 SJR 0.162
Original language: English
Design methodology, Design for manufacturing , Micro manufacturing , Size effect, Heat exchanger
DOIs: 10.1007/s12008-018-0457-9
Source: PublicationPreSubmission
Source-ID: 143697448
Publication: Research - peer-review → Journal article – Annual report year: 2018

**Design for manufacturing and assembly key performance indicators to support high-speed product development**
Design for Manufacturing and Assembly (DFMA) has great potential for minimizing late engineering changes (ECs) that impede high-speed product development and delay time-to-profit. However, our understanding of DFMA and its implementation in industry is still incomplete. This paper presents an industrial case study on late ECs in high-speed product development and compares the results to other examples from the literature. It then proposes a framework with sets of key performance indicators (KPIs) to measure and improve producability and product quality throughout the product development process.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark, Grundfos A/S
Authors: Thompson, M. K. (Intern), Juel Jespersen, I. K. (Ekstern), Kjaergaard, T. (Ekstern)
Pages: 114-119
Publication date: 2018
Conference: 28th CIRP Design Conference, Nantes, France, 23/05/2018 - 23/05/2018
Main Research Area: Technical/natural sciences

**Publication information**
Determination of Viscosity Versus Pressure by Means of a Clearance Seal

This paper describes the construction and testing of a simple, experimental tool setup that enables determination of the pressure–viscosity relationship for high viscosity oils. Comparing the determined pressure–viscosity relationship with a reference rheometer measuring the viscosity at ambient pressure yields reasonable agreement. The computed viscosity at elevated pressures was well represented by the Chu and Cameron model.

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
Authors: Christiansen, P. (Intern), Schmidt Hansen, N. (Ekstern), Lund, M. T. O. (Ekstern), Spangenberg, J. (Intern), Bay, N. O. (Intern)
Number of pages: 3
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information

Journal: Journal of Tribology
Volume: 140
Issue number: 3
Article number: TRIB-17-1253
ISSN (Print): 0742-4787
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.38 SJR 0.767 CiteScore 1.81
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.76 SJR 0.777 SNIP 1.643
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.718 SNIP 1.425 CiteScore 1.27
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.879 SNIP 1.444 CiteScore 1.34
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.905 SNIP 1.373 CiteScore 1.14
ISI indexed (2013): ISI indexed yes
Direct fabrication of bio-inspired gecko-like geometries with vat polymerization additive manufacturing method

Functional surfaces have proven their potential to solve many engineering problems, attracting great interest among the scientific community. Bio-inspired multi-hierarchical micro-structures grant the surfaces with new properties, such as hydrophobicity, adhesion, unique optical properties and so on. The geometry and fabrication of these surfaces are still under research. In this study, the feasibility of using direct fabrication of microscale features by Additive Manufacturing (AM) processes was investigated. The investigation was carried out using a specifically designed vat photopolymerization AM machine-tool suitable for precision manufacturing at the micro dimensional scale which has previously been developed, built and validated at the Technical University of Denmark. It was shown that it was possible to replicate a simplified surface inspired by the Tokay gecko, the geometry was previously designed and replicated by a complex multi-step micromanufacturing method extracted from the literature and used as benchmark. Ultimately, the smallest printed features were analyzed by conducting a sensitivity analysis to obtain the righteous parameters in terms of layer thickness and exposure time. Moreover, two more intricate designs were fabricated with the same parameters to assess the surfaces functionality by its wettability. The surface with increased density and decreased feature size showed a water contact angle (CA) of 124°±0.10°, agreeing with the Cassie-Baxter model. These results indicate the possibility of using precision AM for a rapid, easy and reliable fabrication method for functional surfaces.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology
Number of pages: 10
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
Effect of process parameters on flow length and flash formation in injection moulding of high aspect ratio polymeric micro features

This paper reports an investigation of the effects of process parameters on the quality characteristics of polymeric parts produced by micro injection moulding (µIM) with two different materials. Four injection moulding process parameters (injection velocity, holding pressure, melt temperature and mould temperature) were investigated using Polypropylene (PP) and Acrylonitrile Butadiene Styrene (ABS). Three key characteristics of the mouldings were evaluated with respect to process settings and the material employed: part mass, flow length and flash formation. The experimentation employs a test part with four micro fingers with different aspect ratios (from 21 up to 150) and was carried out according to the Design of Experiments (DOE) statistical technique. The results show that holding pressure and injection velocity are the most influential parameters on part mass with a direct effect for both materials. Both parameters have a similar effect on flow length for both PP and ABS at all aspect ratios and have higher effects as the feature thickness decreased below 300 µm. The study shows that for the investigated materials the injection speed and packing pressure were the most influential parameters for increasing the amount of flash formation, with relative effects consistent for both materials. Higher melt and mould temperatures settings were less influential parameters for increasing the flash amount when moulding with both materials. Of the two investigated materials, PP was the one exhibiting more flash formation as compared with ABS, when corresponding injection moulding process parameters for both materials were considered.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, Mansoura University
Authors: Eladl, A. (Ekstern), Mostafa, R. (Ekstern), Islam, A. (Intern), Loaldi, D. (Intern), Soltan, H. (Ekstern), Hansen, H. N. (Intern), Tosello, G. (Intern)
Number of pages: 19
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Main Research Area: Technical/natural sciences

Publication information
Journal: Micromachines
Volume: 9
Issue number: 2
Article number: 58
ISSN (Print): 2072-666X
Ratings:
Web of Science (2018): Indexed yes
Scopus rating (2017): CiteScore 2.31 SJR 0.493 SNIP 0.987
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 1.83 SJR 0.395 SNIP 0.791
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 0.463 SNIP 0.925 CiteScore 1.78
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 0.625 SNIP 1.341 CiteScore 2.1
Scopus rating (2013): SJR 0.479 SNIP 1.107 CiteScore 1.73
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.472 SNIP 1.285 CiteScore 1.28
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.222 SNIP 0.882
ISI indexed (2011): ISI indexed no
Original language: English
Micro injection moulding, Design of experiments, Part mass, Flow length, Flash formation
Electronic versions:
Effects of micro-injection moulding process parameters on accuracy and precision of thermoplastic elastomer micro rings

Micro-injection moulding (μIM) represents the only technology currently capable of enabling the mass production of polymer micro-components. Although this process is mainly utilized to process rigid thermoplastics, the development of new fields of application asks for the extension of the technology potential to novel types of polymeric materials such as soft thermoplastic elastomers (TPEs). In this work, the authors studied the μIM technology of TPE micro suspension rings for sensor applications. An initial benchmark study, based on microscopy inspections and weld line depth measurements, allowed identifying suitable process parameters settings. Then, the effects of the process parameters on the dimensional variation of the outer and inner diameter of the produced micro rings were quantified. A focus variation microscope was employed for the measurements of both parts and mould cavities. The results of this study showed that the outer ring diameter was mostly affected by mould temperature and holding pressure, while the inner one depended mainly on mould and melt temperature. It was also found that the investigated process parameters had an opposite effect on the outer and inner diameter variations, posing great challenges in the achievement of the part geometry specified in the design.
Evaluation of part consistency with photopolymer inserts in different injection moulding process parameters

Using additive manufacturing (AM) processes for direct fabrication of complex three-dimensional objects in a fewer time
ing comparison to the subtractive method is the advancement of this technology. This study connecting the AM with injection
moulding (IM) process. AM inserts are directly manufactured by photopolymer material and used in IM process. Different
combinations of IM parameters are used in order to find out the influence of various settings on the fabrication of the parts
with soft inserts. The effects of injection moulding parameters are investigated by the use of a design of experiment (DOE)
and optical metrology. DOE analysis concludes that the IM speed and cooling time are significant factors, for the geometry
of the features. The height of bricks and knobs are also measured on the IM parts for assessment of different batches
before any cracks appear on the inserts.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Davoudinejad, A. (Intern), Charalambis, A. (Intern), Zhang, Y. (Intern), Calaon, M. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Evaluation of part consistency with photopolymer inserts in different injection moulding process parameters

Using additive manufacturing (AM) processes for direct fabrication of complex three-dimensional objects in a fewer time in comparison to the subtractive method is the advancement of this technology. This study connecting the AM with injection moulding (IM) process. AM inserts are directly manufactured by photopolymer material and used in IM process. Different combinations of IM parameters are used in order to find out the influence of various settings on the fabrication of the parts with soft inserts. The effects of injection moulding parameters are investigated by the use of a design of experiment (DOE) and optical metrology. DOE analysis concludes that the IM speed and cooling time are significant factors, for the geometry of the features. The height of bricks and knobs are also measured on the IM parts for assessment of different batches before any cracks appear on the inserts.
without small long-waved and centrally located suppression in the surface. The flow properties of the branched polymer melt were defined by a multi mode version of the molecular stress function constitutive equation. A multi mode version based on a Maxwell relaxation spectrum was applied, and the involved parameters were fitted based on previous measured extensional viscosities including the startup, relaxed and reversed flow of the Lupolen 1840D melt. For an ideal cylindrically shaped geometry, at some of the extensional rates, there was a match with the calculated break of strain values, but most were just below the error bars as reported experimentally by Burghelia et al. (J Non-Newton Fluid Mech 166:1198–1209 2011). At low extensional rates, the measurements were considerably above the calculated ones. A very small relative suppression in the surface (0.1%) was required to achieve an agreement with all measurements on average. The largest sensitivity to the surface suppression was at low extensional rates.

**General information**
- State: Published
- Organisations: Department of Mechanical Engineering, Manufacturing Engineering
- Authors: Rasmussen, H. (Intern), Fasano, A. (Intern)
- Pages: 317-325
- Publication date: 2018
- Main Research Area: Technical/natural sciences

**Publication information**
- Journal: Rheologica Acta
- Volume: 57
- Issue number: 4
- ISSN (Print): 0035-4511
- Ratings:
  - BFI (2018): BFI-level 2
  - Web of Science (2018): Indexed yes
  - BFI (2017): BFI-level 2
  - Scopus rating (2017): SNIP 1.063 SJR 0.704 CiteScore 1.9
  - Web of Science (2017): Indexed yes
  - BFI (2016): BFI-level 2
  - Scopus rating (2016): CiteScore 1.9 SJR 0.634 SNIP 1.026
  - Web of Science (2016): Indexed yes
  - BFI (2015): BFI-level 2
  - Scopus rating (2015): SJR 0.876 SNIP 1.272 CiteScore 2.09
  - Web of Science (2015): Indexed yes
  - BFI (2014): BFI-level 2
  - Scopus rating (2014): SJR 0.725 SNIP 1.181 CiteScore 1.72
  - Web of Science (2014): Indexed yes
  - BFI (2013): BFI-level 2
  - Scopus rating (2013): SJR 0.877 SNIP 1.38 CiteScore 2.09
  - ISI indexed (2013): ISI indexed yes
  - BFI (2012): BFI-level 2
  - Scopus rating (2012): SJR 0.898 SNIP 1.36 CiteScore 1.8
  - ISI indexed (2012): ISI indexed yes
  - Web of Science (2012): Indexed yes
  - BFI (2011): BFI-level 2
  - Scopus rating (2011): SJR 1.292 SNIP 1.397 CiteScore 2.22
  - ISI indexed (2011): ISI indexed yes
  - Web of Science (2011): Indexed yes
  - BFI (2010): BFI-level 2
  - Scopus rating (2010): SJR 1.267 SNIP 1.302
  - Web of Science (2010): Indexed yes
  - BFI (2009): BFI-level 2
  - Scopus rating (2009): SJR 1.005 SNIP 1.227
  - Web of Science (2009): Indexed yes
  - BFI (2008): BFI-level 1
  - Scopus rating (2008): SJR 0.899 SNIP 1.312
  - Web of Science (2008): Indexed yes
Flow Characteristics of a Thermoset Fiber Composite Photopolymer Resin in a Vat Polymerization Additive Manufacturing Process

Additive manufacturing vat polymerization has become a leading technology and gained a massive amount of attention in industrial applications such as injection molding inserts. By the use of the thermoset polymerization process inserts have increased their market share. For most industrial applications, strength and stiffness are crucial factors to a successful implementation of cured photopolymer thermosets. Hence, fiber-reinforced polymers have recently been introduced. The behavior and especially orientation of fibers during the vat photopolymerization process has yet not been fully understood. Research indicates an orientation within the manufacturing layer and efforts have been made to achieve a more uniform orientation within the part. A vat polymerization machine consisting of a resin vat and a moving build plate has been simulated using the fluid flow module of Comsol Multiphysics™. A moving mesh with hyper-elastic behavior was utilized to simulate the flow of the photopolymer during the lifting of the build plate after a successful curing of a single layer. The velocity profile can thereafter be used to estimate a prediction for the orientation of the short fibers added to the liquid photopolymer resin. The prediction can be used to identify potential clusters or misalignment of fibers and in the future allow for optimization of the machine design and manufacturing process.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Hofstätter, T. (Intern), Spangenberg, J. (Intern), Pedersen, D. B. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 5
Publication date: 2018
Event: Paper presented at 34th International Conference of the Polymer Processing Society, Taipei, Taiwan, Province of China.
Main Research Area: Technical/natural sciences
Additive Manufacturing, Vat Polymerization, Thermoset, Simulation, Photopolymer
Electronic versions:
201805_PPS34_FlowSimulation_Paper_final_08052018.pdf
Publication: Research - peer-review › Paper – Annual report year: 2018

Friction coefficients in cold forging: A global perspective
Worldwide, at least twenty different tribological tests have been proposed for the empirical determination of friction coefficients in cold forging processes. Due to the varying test setups, means of measurement, and level of abstraction, the comparability of the outcomes is, however, disputable. Within this work, six established test principles are compared using identical tribological systems. Large differences between the empirically determined friction coefficients are observed but can be explained under consideration of the respective tribological loads. Additional investigations of an extrusion process reveal that friction models also have to take into account the varying local thickness of the lubricant film.

General information
Geometrical shape assessment of additively manufactured features by direct light processing vat polymerization method

The importance of Additive Manufacturing (AM) in the field of micro manufacturing is increasing. Vat Polymerization Methods are one of the lead AM technologies to produce polymer micro parts. In the Technical University of Denmark (DTU), a vat photopolymerization AM machine able to print features in a micro scale was developed, build and validated. The work here presented analyses the capability of the machine in terms of geometry, when printing features of different sizes and geometries. For this study, two test parts have been designed, a circular stepped pyramid and a square stepped pyramid, both having micro size steps at the top of the pyramids. Five batches of each test part have been printed to evaluate the variability of the results in a single and in various prints.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Zaragoza
Number of pages: 2
Publication date: 2018
Event: Abstract from 18th International Conference of the europe Society for Precision Engineering and Nanotechnology (euspen 18), Venice, Italy.
Main Research Area: Technical/natural sciences
Additive manufacturing, Vat Polymerization, Micro Manufacturing, Polymer
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2018

Grand Solutions - Augmented Cellular Meat Production (ACMP)
A collaborative robot cell concept as an alternative to the serial production line currently used in major slaughterhouses.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Sonne, M. R. (Intern), Andriollo, T. (Intern), Hattel, J. H. (Intern)
Number of pages: 1
Publication date: 2018
Event: Poster session presented at Institutkonference - DTU Food, Denmark.
Main Research Area: Technical/natural sciences
Publication: Research › Poster – Annual report year: 2018

Humidity build-up in electronic enclosures exposed to different geographical locations by RC modelling and reliability prediction

Electronic devices are exposed to a wide range of climatic conditions. This study shows a reliability prediction of electronic devices exposed to different climates (from arid to humid and cold to hot regions). Temperature and humidity probability distribution functions have been calculated to indicate the change of climate exposure along year. While temperature and relative humidity (RH) are important factors in terms of water diffusion and electronic reliability, the internal climatic condition of 25°C and 60% RH is widely used as threshold for electronic safety. Acceleration factors according to this steady state (25°C and 60% RH) have been calculated for the different climates, and the protection offered by the
enclosures has been estimated under different casing materials and resistor-capacitor (RC) simulation. This method offers a way to predict the average value of failure rate for electronic devices based on climate information and enclosure material.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Materials and Surface Engineering, Manufacturing Engineering
Authors: Conseil-Gudla, H. (Intern), Staliulionis, Z. (Intern), Mohanty, S. (Intern), Jellesen, M. S. (Intern), Hattel, J. H. (Intern), Ambat, R. (Intern)
Pages: 136-146
Publication date: 2018
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Microelectronics Reliability
Volume: 82
ISSN (Print): 0026-2714
Ratings:

BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.907 SJR 0.388 CiteScore 1.52
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.57 SJR 0.447 SNIP 0.991
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.581 SNIP 1.136 CiteScore 1.81
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.572 SNIP 1.376 CiteScore 1.9
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.568 SNIP 1.195 CiteScore 1.55
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.574 SNIP 1.323 CiteScore 1.6
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.607 SNIP 1.327 CiteScore 1.63
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.576 SNIP 1.064
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.686 SNIP 1.127
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.887 SNIP 1.228
Scopus rating (2007): SJR 0.733 SNIP 1.205
Scopus rating (2006): SJR 0.692 SNIP 1.117
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.496 SNIP 0.972
Scopus rating (2004): SJR 0.512 SNIP 0.8
Scopus rating (2003): SJR 0.465 SNIP 0.752
Scopus rating (2002): SJR 0.546 SNIP 0.732
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.413 SNIP 0.681
Scopus rating (2000): SJR 0.178 SNIP 0.378
Scopus rating (1999): SJR 0.209 SNIP 0.539
Inline temperature compensation for dimensional metrology of polymer parts in a production environment based on 3D thermomechanical analysis

Abstract In the present work a new method for thermal compensation in dimensional metrology of polymer parts in a production environment based on 3D thermomechanical simulations is developed. A fixture for measuring the length dimension of a classical polymer part is placed in a production environment and equipped with sensors in terms of thermocouples for temperature measurements of the part and the fixture and a contact probe for measuring the dimension. A 3D thermomechanical model is developed in ABAQUS, emulating the thermoelastic conditions of the polymer part when placed in the fixture. Knowledge from classical heat transfer and elasticity theory is then applied to derive a more generic, yet simple expression for the compensation from the transient 3D temperature and displacement fields, based on dimensionless values, which makes applicable for a wide range of initial and surrounding conditions found in a production environment. The developed expression is then used for length compensation on 24 samples measured inline ten minutes after production. The results reveals a significant improvement in capturing the transient behavior of the part with a reduced error from 13μm to 3μm, applying the developed formula instead of using more classical 1D standard thermal compensation.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Pages: 46-53
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
Journal: Precision Engineering
ISSN (Print): 0141-6359
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.79 SJR 0.98 SNIP 1.874
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.77 SJR 1.072 SNIP 2.178
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.039 SNIP 2.063 CiteScore 2.42
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.227 SNIP 2.409 CiteScore 2.39
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.398 SNIP 2.885 CiteScore 2.54
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 3.193 CiteScore 2.2
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.295 SNIP 2.699 CiteScore 2.03
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
In-situ investigation of the evolution of annealing twins in high purity aluminium

With focus on annealing twins, the microstructural evolution of cold rolled high purity aluminium was characterized in-situ during annealing using the electron backscatter diffraction technique. It was found that annealing twins developed during recrystallization. Many but not all of the twins were gradually removed during grain growth. The grain boundary energies of all the boundaries in a network associated with the twins are estimated and reasons why most twins disappear while a few remain are discussed.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Materials and Surface Engineering, Chongqing University
Authors: He, Q. (Ekstern), Huang, T. (Ekstern), Shuai, L. (Ekstern), Zhang, Y. (Intern), Wu, G. (Ekstern), Huang, X. (Intern), Juul Jensen, D. (Intern)
Pages: 68-72
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
Journal: Scripta Materialia
Volume: 153
ISSN (Print): 1359-6462
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.19 SJR 1.923 SNIP 1.855
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.71 SJR 1.884 SNIP 1.737
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.259 SNIP 1.841 CiteScore 3.54
Aluminium alloy, local mechanical properties, stress strain, material data, Annealing twins, In-situ annealing, EBSD

Electronic versions:
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Publication: Research - peer-review › Journal article – Annual report year: 2018
Interaction of nanofillers in injection-molded graphene/carbon nanotube reinforced PA66 hybrid nanocomposites

Interaction of multi-walled carbon nanotubes and graphene nanoplatelets within injection-molded thermoplastic-based nanocomposites is investigated. The research shows how the nanofillers’ combination ratio and content influence the properties in the semicrystalline thermoplastic-based composites. Three main groups of polyamide-based composite specimens containing either or both of the nanofillers are prepared. Results show that the single inclusion of the nanomaterials improves the mechanical and thermal properties significantly. However, the combined incorporation of both the nanofillers in the polymeric matrix does not lead to the linear combination of the observed behaviors. While the mechanical properties and the degrees of crystallinity improve, the thermal conductivities decrease in the hybrid composites for similar nanofiller contents. Rheological and crystallization investigations also showed the dominant influence of the nanotubes in the structure of the hybrid composites. The underlying mechanisms of modulation in the properties were also investigated in detail.

General information
State: Accepted/In press
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, Solid Mechanics, Technical University of Denmark
Authors: Doagou-Rad, S. (Intern), Islam, A. (Intern), Jensen, J. S. (Intern), Alnasser, A. (Ekstern)
Number of pages: 11
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Polymer Engineering
ISSN (Print): 0334-6447
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.77
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.64
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 0.66
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 0.47
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 0.41
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 0.24
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 0.5
BFI (2010): BFI-level 1
BFI (2009): BFI-level 1
BFI (2008): BFI-level 1
Original language: English
Publication: Research - peer-review » Journal article – Annual report year: 2018

Interlaboratory Comparison of a physical and a virtual assembly measured by CT

In a comparison including 20 laboratories, a physical as well as a virtual assembly provided as two data sets were used to investigate measuring and post-processing approaches in Computed Tomography, CT. Different procedures were used in the comparison including one simulating in-line measurement. The comparison demonstrated that: (i) a tangible improvement in the use of CT compared to previous comparisons; (ii) most of the participants were able to reduce their scanning time by more than 70% without increasing the length measurement errors; and (iii) most of the participants can further reduce their uncertainties, thereby reducing the tolerance size that can be inspected using CT in industry.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Stolfi, A. (Intern), De Chiffre, L. (Intern)
Pages: 263-270
Internal Fiber Structure of a High-Performing, Additively Manufactured Injection Molding Insert

A standard mold is equipped with additively manufactured inserts in a rectangular shape produced with vat photo polymerization. While the lifetime compared to conventional materials such as brass, steel, and aluminum is reduced, the prototyping and design phase can be shortened significantly by using flexible and cost-effective additive manufacturing technologies. Higher production volumes still exceed the capability of additively manufactured inserts, which are overruled by the stronger performance of less-flexible but mechanically advanced materials. In this contribution, the internal structure of a high-performing, fiber-reinforced injection molding insert has been analyzed. The insert reached a statistically proven and reproducible lifetime of 4,500 shots, which significantly outperforms any other previously published additively manufactured inserts. Computer tomography, tensile tests and life cycle analysis have been performed in order to provide an understanding of the internal structure of the fiber-reinforced, additively manufactured injection molding inserts.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Physics, Neutrons and X-rays for Materials Physics, Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics
Number of pages: 6
Publication date: 2018
Event: Paper presented at 34th International Conference of the Polymer Processing Society, Taipei, Taiwan, Province of China.
Main Research Area: Technical/natural sciences
Additive Manufacturing, Injection Molding, Inserts, Computed Tomography, Fiber-Reinforcement
Electronic versions:
201805_PPS34_CTofIMInsert_Paper_v4_2.pdf
Publication: Research - peer-review Paper – Annual report year: 2018

Lubricant influence on the ejection and roughness of in-die electro sinter forged Ti-discs

Electro Sinter Forging (ESF) is a new sintering process based on Joule heating by high electrical current flowing through compacted metal powder under mechanical pressure. The whole process takes about three seconds and is based on a closed-die setup, where the sample is sintered inside a die. A near-net shape component is therefore manufactured. One of the challenges associated with this process is the ejection of the sample after sintering. Due to powder compaction and axial loading during sintering, a radial pressure is generated at the die/sample interface. Consequently, the ejection can be difficult, and the final quality of the sintered component in terms of roughness and surface defects may be affected. In the present work, four different lubricants and non-lubricated conditions were tested to investigate the effects on the final part quality. The sintered sample is a disc made of commercially pure titanium powder. The force was measured while ejecting the samples by using a speed-controlled press. The surface roughness parameter Sa was measured by using a laser confocal microscope.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Cannella, E. (Intern), Nielsen, C. V. (Intern)
Pages: 171-178
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
Journal: Key Engineering Materials
Volume: 767
ISSN (Print): 1013-9826
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.29 SJR 0.18 SNIP 0.303
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
Meso-Scale Process Modelling Strategies for Pultrusion of Unidirectional Profiles

The resin injection pultrusion is an automated composite manufacturing method in which the resin is injected in a chamber. The flow and the thermo chemical mechanical (TCM) models have been studied for the pultrusion process to improve the reliability of the final products. Flow models are needed to understand and describe the fiber impregnation, filling time and presence of dry spots or voids. Also pressure field in the injection chamber can be estimated with flow models. TCM models are needed to predict residual stress distributions and to optimize the process conditions. A non-uniform fiber distribution strongly affects the results of both types of models. In this study, different strategies are carried out to implement non-uniform fiber distributions into the models. The cross-sectional image and fiber distribution of a 19×19 mm glass fiber reinforced polyester unidirectional pultruded composite is used. Non-uniform fiber distribution is observed and implemented into the flow model by means of permeability variations. The results of this study are compared with uniform fiber distribution results. In the TCM model, the non-uniform fiber volume content is implemented within different sized patches. The results show that the non-uniform fiber fraction should be taken into account for the process models of composites in order to capture the local process induced stresses and probability of dry spots or voids due to poor fiber impregnation.
Micro-injection moulding (μIM) is a replication-based process enabling the cost-effective production of complex and net-shaped miniaturized plastic components. The micro-scaled size of such parts poses great challenges in assessing their dimensional quality and often leads to time-consuming and unprofitable off-line measurement procedures. In this work, the authors proposed a novel method to verify the quality of a three-dimensional micro moulded component (nominal volume equal to 0.07 mm³) based on the combination of optical micro metrology and injection moulding process monitoring. The most significant dimensional features of the micro part were measured using a focus variation microscope. Their dependency on the variation of µIM process parameters was studied with a Design of Experiments (DoE) statistical approach. A correlation study allowed the identification of the product fingerprint, i.e., the dimensional characteristic that was most linked to the overall part quality and critical for product functionality. Injection pressure and velocity curves were recorded during each moulding cycle to identify the process fingerprint, i.e., the most sensitive and quality-related process indicator. The results of the study showed that the dimensional quality of the micro component could be effectively controlled in-line by combining the two fingerprints, thus opening the door for future µIM in-line process optimization and quality assessment.
Modeling of nanosecond pulsed laser processing of polymers in air and water: Paper

Laser ablation of polymers in water is known to generate distinct surface characteristics as compared to that in air. In order to understand the role of ambient media during laser ablation of polymers, this paper aims to develop a physics-based model of the process considering the effect of ambient media. Therefore, in the present work, models are developed for laser ablation of polymers in air and water considering all the relevant physical phenomena such as laser–polymer interaction, plasma generation, plasma expansion and plasma shielding. The current work focuses on near-infrared laser radiation ($\lambda = 1064$ nm) of nanosecond pulse duration. The laser–polymer interaction at such wavelengths is purely photo-thermal in nature and the laser–plasma interaction is assumed to occur mainly by inverse-bremsstrahlung photon absorption. The computational model is based on the finite volume method using the Crank–Nicholson scheme. The model predicts that underwater laser ablation results in subsurface heating effect in the polymer and confinement of the laser generated plasma, which makes it different from laser ablation in air. Plasma expansion velocities are much lower in water than in air. This results in an enhanced plasma shielding effect in the case of water. The predicted results of ablation depth versus fluence from the model are in qualitative agreement with those observed in experiments.
In the present study, numerical modelling has been used to assess the influence of non-uniform fibre distribution on the temperature and degree of cure field in Resin Injection Pultrusion. The fibre distribution of an industrial glass-fibre/polyurethane profile with a square cross-section was investigated using the burn-out process and light optical microscopy. Both characterization techniques showed non-uniform fibre distributions. The characterized fibre distribution trends were implemented in a numerical model and compared with the corresponding uniform case. The results show a significant change in the cure behavior from solely outside-in curing in case with a uniform fibre distribution to inside-out curing for the center part of the profiles with non-uniform fibre distribution.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Fiberline Composites A/S
Authors: Rasmussen, F. S. (Intern), Klingaa, C. G. (Intern), Larsen, M. (Ekstern), Sonne, M. R. (Intern), Spangenberg, J. (Intern), Hattel, J. H. (Intern)
Number of pages: 8
Publication date: 2018
Main Research Area: Technical/natural sciences
Pultrusion, Fibre distribution, Curing, Modelling, Materials characterization
Electronic versions:
F.S.Rasmussen_Modelling_the_Effect_of_Non_Uniform_Fibre_Distribution_on_the_Curing_Behaviour_in_Resin_Injection_Pultrusion_1.pdf
Source: PublicationPreSubmission
Source-ID: 150719007
Publication: Research - peer-review › Paper – Annual report year: 2018
Multiphysics modelling of manufacturing processes: A review

Numerical modelling is increasingly supporting the analysis and optimization of manufacturing processes in the production industry. Even if being mostly applied to multistep processes, single process steps may be so complex by nature that the needed models to describe them must include multiphysics. On the other hand, processes which inherently may seem multiphysical by nature might sometimes be modelled by considerably simpler models if the problem at hand can be somehow adequately simplified. In the present article, examples of this will be presented. The cases are chosen with the aim of showing the diversity in the field of modelling of manufacturing processes as regards process, materials, generic disciplines as well as length scales: (1) modelling of tape casting for thin ceramic layers, (2) modelling the flow of polymers in extrusion, (3) modelling the deformation process of flexible stamps for nanoimprint lithography, (4) modelling manufacturing of composite parts and (5) modelling the selective laser melting process. For all five examples, the emphasis is on modelling results as well as describing the models in brief mathematical details. Alongside with relevant references to the original work, proper comparison with experiments is given in some examples for model validation.

Numerical modeling of the strand deposition flow in extrusion-based additive manufacturing

Abstract We propose a numerical model to simulate the extrusion of a strand of semi-molten material on a moving substrate, within the computation fluid dynamics paradigm. According to the literature, the deposition flow of the strands has an impact on the inter-layer bond formation in extrusion-based additive manufacturing, as well as the surface roughness of the fabricated part. Under the assumptions of an isothermal Newtonian fluid and a creeping laminar flow, the deposition flow is controlled by two parameters: the gap distance between the extrusion nozzle and the substrate, and the
velocity ratio of the substrate to the average velocity of the flow inside the nozzle. The numerical simulation fully resolves
the deposition flow and provides the cross-section of the printed strand. For the first time, we have quantified the effect of
the gap distance and the velocity ratio on the size and the shape of the strand. The cross-section of the strand ranges
from being almost cylindrical (for a fast printing and with a large gap) to a flat cuboid with rounded edges (for a slow
printing and with a small gap), which substantially differs from the idealized cross-section typically assumed in the
literature. Finally, we found that the printing force applied by the extruded material on the substrate has a negative linear
relationship with the velocity ratio, for a constant gap.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Comminal, R. (Intern), Serdeczny, M. P. (Intern), Pedersen, D. B. (Intern), Spangenberg, J. (Intern)
Pages: 68-76
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
Journal: Additive Manufacturing
Volume: 20
ISSN (Print): 2214-8604
Ratings:
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Scopus rating (2016): CiteScore 6.38 SNIP 3.636 SJR 1.932
Scopus rating (2015): CiteScore 3.79 SNIP 3.575 SJR 1.09
Original language: English

Extrusion-based additive manufacturing, Fused deposition modeling, Numerical simulation, Deposition flow, Strand cross-
section, Printing force

DOI: 10.1016/j.addma.2017.12.013
Source: RIS
Source-ID: urn:24B20B2A18630930EE45B2890188201B
Publication: Research - peer-review › Journal article – Annual report year: 2018

Numerical Modelling of Mechanical Anisotropy during Low Temperature Nitriding of Stainless Steel
A 3D Finite Element method (FEM) model for investigation of the anisotropic mechanical behaviour of austenitic stainless
steel during nitriding is presented. The model considers the non-linear concentration dependent diffusion of nitrogen
including trapping by chromium, the surface reaction, elastic and plastic anisotropy and influences on thermodynamics
(solubility) and diffusion kinetics. Large differences in the nitrided case thickness have previously been attributed to the
elastic and plastic anisotropy, which in turn affects the diffusion and solubility properties of nitrogen. The two mechanically
distinctive grain orientations <001> and <111> are simulated and the stress, strain and concentration profiles are
discussed and compared to experimental findings.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Materials and Surface Engineering,
Magma Gießereitechnologie GmbH
Authors: Küçükyıldız, Ö. C. (Intern), Sonne, M. R. (Intern), Thorborg, J. (Ekstern), Winther, G. (Intern), Hattel, J. H. (Intern)
, Somers, M. A. J. (Intern)
Number of pages: 7
Publication date: 2018
Main Research Area: Technical/natural sciences
Nitriding, Diffusion, Stresses, Plasticity, Anisotropy

Electronic versions:
271_ECHT2018_3.pdf
Publication: Research - peer-review › Paper – Annual report year: 2018

Numerical simulation of the planar extrudate swell of pseudoplastic and viscoelastic fluids with the streamfunction and the
VOF methods

Abstract We present an Eulerian free-surface flow solver for incompressible pseudoplastic and viscoelastic non-Newtonian
fluids. The free-surface flow solver is based on the streamfunction flow formulation and the volume-of-fluid method. The
streamfunction solver computes the vector potential of a solenoidal velocity field, which ensures by construction the mass
conservation of the solution, and removes the pressure unknown. Pseudoplastic liquids are modelled with a Carreau
model. The viscoelastic fluids are governed by differential constitutive models reformulated with the log-conformation
approach, in order to preserve the positive-definiteness of the conformation tensor, and to circumvent the high
Weissenberg number problem. The volume fraction of the fluid is advected with a geometric conservative unsplit scheme that preserves a sharp interface representation. For the sake of comparison, we also implemented an algebraic advection scheme for the liquid volume fraction. The proposed numerical method is tested by simulating the planar extrudate swell with the Carreau, Oldroyd-B and Giesekus constitutive models. The swell ratio of the extrudates are compared with the data available in the literature, as well as with numerical simulations performed with the open-source rheoTool toolbox in OpenFOAM®. While the simulations of the generalized Newtonian fluids achieved mesh independence for all the methods tested, the flow simulations of the viscoelastic fluids are more sensitive to mesh refinement and the choice of numerical scheme. Moreover, the simulations of Oldroyd-B fluid flows above a critical Weissenberg number are prone to artificial surface instabilities. These numerical artifacts are due to discretization errors within the Eulerian surface-capturing method. However, the numerical issues arise from the stress singularity at the die exit corner, and the unphysical predictions of the Oldroyd-B model in the skin layer of the extrudate after the die exit, where large extensional deformations occur.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Porto
Authors: Comminal, R. (Intern), Pimenta, F. (Ekstern), Hattel, J. H. (Intern), Alves, M. A. (Ekstern), Spangenberg, J. (Intern)
Pages: 1–18
Publication date: 2018
Main Research Area: Technical/natural sciences

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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.509 SJR 1.14 CiteScore 2.44
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.43 SJR 1.145 SNIP 1.604
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.155 SNIP 1.505 CiteScore 2.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.988 SNIP 1.324 CiteScore 1.96
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.024 SNIP 1.606 CiteScore 2.09
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.101 SNIP 1.532 CiteScore 1.93
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.09 SNIP 1.408 CiteScore 1.93
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.232 SNIP 1.743
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.534 SNIP 1.504
Web of Science (2009): Indexed yes
On the Performance of Thin-Walled Crash Boxes Joined by Forming

A new joining by forming process that combines lancing and shearing with sheet-bulk compression is utilized to assemble thin-walled crash boxes utilized as energy absorbers. Process design and fabrication of the new crash boxes are analyzed by finite elements and experimentation. Axial crush tests were performed to compare the overall crashworthiness performance of the new crash boxes against that of conventional crash boxes assembled by resistance spot-welding. Results show that the joining process is a good alternative to resistance spot-welding because the new crash boxes can absorb the same crushing energy, and because the new process helps to overcome typical manufacturing problems of welding.
Prediction of micro-sized flash using micro-injection moulding process simulations

In micro-manufacturing, the accurate prediction of defects affecting the part quality by means of process simulations is of paramount importance. With this purpose, micro-injection moulding process simulations can be fundamental with the aim of strongly reducing experimental and quality assurance efforts. In this study, the usage of process simulations for the prediction of the size of the flash affecting an ultra-small three-dimensional polyoxymethylene (POM) micro component is discussed. A three-dimensional multi-scale mesh was used to discretize a geometry comprising the part and the feed system of the one-cavity micro mould. The venting channel was included into the model in order to simulate the flash formation as a virtual short-shot. Simulation were run with Autodesk Moldflow Insight 2017® and results validated comparing numerical results with experimental observation of the flash size. A state-of-the-art 3D focus variation measurement instrument was used for characterizing the flash on moulded parts. Four injection moulding process parameters were tested using a Design of Experiment (DoE) approach in both real experiments and simulations in order to validate the numerical outputs with respect to process variations. The results showed that flash size was generally overestimated by simulations. However, both real parts measurements and numerical results agreed on the signs and magnitudes of the effects of the investigated process parameters, demonstrating that simulations are an useful tool for process/product optimization.
Probing the structure and mechanical properties of the graphite nodules in ductile cast irons via nano-indentation

Little is known today about the mechanical properties of the graphite nodules, despite the key influence these particles have on the performance of ductile cast irons. To address this issue, nano-indentation tests were performed on the cross-section of a nodule whose sub-surface morphology was characterized via 3D computed tomography. From the recorded load vs. penetration curves, the spatial variation of the maximum indenter penetration $h_{\text{max}}$ and of the reduced Young's modulus $E^*$ was determined. It was observed that the pattern of $h_{\text{max}}$ presents features which, statistically, cannot be explained with the experimental error. Conversely, they can be justified by a model which takes into account the geometrical interaction between the indenter and the local orientation of the graphite platelets forming the nodule. To the authors' best knowledge, this result constitutes the first direct proof of a clear link between internal structure and mechanical properties of the nodules. The existence of a non-negligible mechanical anisotropy implies that the calculated mean value of $E^*$ can only be seen as indicative of a sort of "averaged" elastic stiffness. Caution should then be used when assessing the elastic response of the entire nodule just on the basis of this parameter, as complex anisotropic effects associated with the non-random orientation of the graphite platelets can be foreseen.
Electro-sinter-forging (ESF) is an innovative sintering process based on the principle of electrical Joule heating. The electrical current is flowing through the powder compact, which is under mechanical pressure. As compared to conventional sintering [1] and spark plasma sintering [2], the main advantages are the decreased sintering time and high relative density [3]. Near net-shape components can be manufactured and post-removal processing is limited to surface polishing. The present work is focused on analysing the influence of the main process parameters, namely compacting pressure, sintering time and electrical current density, on the final density of a disc sample made from commercially pure titanium powder. The maximum achieved relative density was 94% of the bulk density of pure titanium. The density estimation was carried out by using both Archimedes’ and 3D scanning.

**General information**

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Cannella, E. (Intern), Nielsen, C. V. (Intern), Bay, N. (Intern)
Number of pages: 1
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Event: Poster session presented at 18th International Conference of the European Society for Precision Engineering and Nanotechnology (euspen 18), Venice, Italy.
Main Research Area: Technical/natural sciences

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Publication: Research - peer-review › Poster – Annual report year: 2018

Electro-sinter-forging (ESF) is an innovative sintering process based on the principle of electrical Joule heating. The electrical current is flowing through the powder compact, which is under mechanical pressure. As compared to conventional sintering [1] and spark plasma sintering [2], the main advantages are the decreased sintering time and high relative density [3]. Near net-shape components can be manufactured and post-removal processing is limited to surface polishing. The present work is focused on analysing the influence of the main process parameters, namely compacting pressure, sintering time and electrical current density, on the final density of a disc sample made from commercially pure titanium powder. The maximum achieved relative density was 94% of the bulk density of pure titanium. The density estimation was carried out by using both Archimedes’ and 3D scanning.
process parameters on the final density of a disc sample made from commercially pure titanium powder. Applying the design of experiments (DoE) approach, the electrical current was seen to be of largest influence. The maximum obtained density was 94% of the bulk density of pure titanium. Density measurements were carried out by measuring the mass and volume separately. The volume was estimated applying two methods, namely the Archimedes' suspension method and 3D scanning to build and measure the volume mesh of the sample. The density calculations proved to be compatible.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Cannella, E. (Intern), Nielsen, C. V. (Intern), Bay, N. (Intern)
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Main Research Area: Technical/natural sciences
Electro-sinter-forging, Titanium powder, Design of experiments, Density measurements
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2018

Qualification and testing of CT systems
This chapter focuses on system verification and conformance to specifications. System qualification is carried out to ensure that the system and its components achieve the best performance—usually corresponding to the specifications made by the manufacturer. Acceptance and re-verification testing are undertaken on the overall integrated system to check whether the system performs as specified.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Physikalisch-Technische Bundesanstalt, University of Padua
Authors: Bartscher, M. (Ekstern), Neuschaefer-Rube, U. (Ekstern), Illemann, J. (Ekstern), Borges de Oliveira, F. (Ekstern), Stolfi, A. (Intern), Carmignato, S. (Ekstern)
Pages: 185-228
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Host publication information
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Publisher: Springer
Editors: Carmignato, S., Dewulf, W., Leach, R.
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Chapter: 6
Main Research Area: Technical/natural sciences
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Source: PublicationPreSubmission
Source-ID: 133642401
Publication: Research - peer-review › Book chapter – Annual report year: 2018

Quantification of local mobilities
A new method for quantification of mobilities of local recrystallization boundary segments is presented. The quantification is based on microstructures characterized using electron microscopy and on determination of migration velocities and driving forces for local boundary segments. Pure aluminium is investigated and the results show that even for a single recrystallization boundary, different boundary segments migrate differently, and the differences can be understood based on variations in mobilities and local deformed microstructures. The present work has important implications for understanding of recrystallization boundary migration, and suggests an experimental way forward for how to determine boundary mobilities during recrystallization.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Materials science and characterization
Authors: Zhang, Y. B. (Intern)
Pages: 286-289
Publication date: 2018
Main Research Area: Technical/natural sciences
Publication information
Recent Developments in Fiber-Reinforced Additive Manufacturing of Injection Molding Inserts
Digitization and industry 4.0 (I4.0) processes have increased the need and possibilities of smart, flexible, and cost efficient production. Scaling down this development to the injection molding (IM) industry, IM inserts manufactured from additive manufacturing (AM) vat photopolymerization (VP) have been developed and increased their market share over the past years. [1]–[3] The inserts comprise the possibility of digital part development at low entry costs and therefore are a technology used for pilot production.

General information
State: Accepted/In press
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Hofstätter, T. (Intern), Pedersen, D. B. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 6
Publication date: 2018
Event: Abstract from 2018 ASPE and euspen Summer Topical Meeting, Berkeley, United States.
Main Research Area: Technical/natural sciences
Additive Manufacturing, Vat Photopolymerization, Fiber-Reinforcement, Injection, Molding, Simulation
Source: PublicationPreSubmission
Source-ID: 149274117
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2018

Residual Stresses around Individual Graphite Nodules in Ductile Iron: Impact on the Tensile Mechanical Properties
Residual stresses in ferritic ductile iron castings have been studied for decades. However, little attention has traditionally been given to the local residual stresses which may arise in the microstructure as a result of the thermal contraction mismatch between the matrix and the graphite nodules during solid-state cooling. Recent synchrotron X-ray measurements performed by the authors have demonstrated that in the ferritic phase these local stresses can be in the order of 100-150 MPa, hence of the same order of magnitude as the material macroscopic yield stress. This suggests that they might have a significant influence on the mechanical properties of ductile iron components. However, no systematic research appears to have been conducted so far to investigate this aspect. The present work takes a first step in this direction by presenting an integrated theoretical analysis which addresses both the formation of these local residual stresses at the microscopic level and their role during mechanical loading at the macro-scale.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Andriollo, T. (Intern), Thorborg, J. (Intern), Tiedje, N. S. (Intern), Hattel, J. H. (Intern)
Pages: 465-472
Publication date: 2018
Main Research Area: Technical/natural sciences

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Volume: 925
ISSN (Print): 0255-5476
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BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.3 SJR 0.18 SNIP 0.317
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.28 SJR 0.188 SNIP 0.302
BFI (2015): BFI-level 1
Residual stress in expanded austenite on stainless steel; origin, measurement, and prediction

Expanded austenite is a supersaturated solid solution of nitrogen/carbon in austenite that forms as a case by the diffusion of nitrogen/carbon into austenitic stainless steel. Expanded austenite has a high level of hardness that provides resistance against galling and wear, superior resistance against localized corrosion, and contributes to improvement of the fatigue
performance. This latter characteristic is a consequence of the huge compressive residual stresses in the expanded austenite case. Such stresses are induced by the high interstitial content in the austenite lattice and are accommodated elasto-plastically. The experimental assessment of the elastic lattice strains is complicated by the presence of steep composition-depth and stress-depth profiles, which necessitate special measurement or correction procedures to unravel the influence of composition and stress on the lattice spacing and avoid artifacts arising from (steep) lattice-spacing gradients. In the present work the sin²Ψ method was combined with grazing incidence X-ray diffraction to keep the information depth during measurement shallow, independent of the (effective) tilt angle Ψ. The plastic strains in the expanded austenite 27 zone were estimated from the lattice rotations, as determined with electron backscatter diffraction. It is demonstrated that the level of elastic lattice strains in expanded austenite can be adjusted by retracting part of the dissolved nitrogen. The experimental results for elastic and plastic strains are compared to those predicted by a comprehensive numerical model that simulates the time-dependent development of composition-depth and stress-depth profiles in expanded austenite. The work described in this manuscript is a combination of a review of previously achieved and published results as well as the newest results of ongoing research activities.

General information
State: Accepted/In press
Organisations: Department of Mechanical Engineering, Materials and Surface Engineering, Manufacturing Engineering, Center for Electron Nanoscopy, Technical University of Denmark
Authors: Somers, M. A. (Intern), Kücükyıldız, Ö. C. (Intern), Ormstrup, C. A. (Ekstern), Alimadadi, H. (Intern), Hattel, J. H. (Intern), Christiansen, T. L. (Intern), Winther, G. (Intern)
Number of pages: 25
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Main Research Area: Technical/natural sciences

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Journal: Materials Performance and Characterization
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Web of Science (2018): Indexed yes
Scopus rating (2017): CiteScore 0.35 SJR 0.21 SNIP 0.475
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 0.42 SJR 0.219 SNIP 0.367
Scopus rating (2015): SNIP 0.286 SJR 0.146 CiteScore 0.24
Scopus rating (2014): SNIP 0.476 SJR 0.139
Scopus rating (2013): SNIP 0.111 SJR 0.103
Original language: English
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Review of friction modeling in metal forming processes
Abstract In metal forming processes, friction between tool and workpiece is an important parameter influencing the material flow, surface quality and tool life. Theoretical models of friction in metal forming are based on analysis of the real contact area in tool-workpiece interfaces. Several research groups have studied and modeled the asperity flattening of workpiece material against tool surface in dry contact or in contact interfaces with only thin layers of lubrication with the aim to improve understanding of friction in metal forming. This paper aims at giving a review of the most important contributions during the last 80 years covering experimental techniques, upper bound solutions, slip-line analyses and numerical simulations. Each of the contributions shed light on the importance of the real contact area and the influencing parameters including the material properties, surface conditions, normal pressure, sliding length and speed, temperature changes, friction on the flattened plateaus and deformation of the underlying material. The review illustrates the development in the understanding ofasperity flattening and the methods of analysis.

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Authors: Nielsen, C. (Intern), Bay, N. (Intern)
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 2.678 SJR 1.695 CiteScore 4.15
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.62 SJR 1.717 SNIP 2.646
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.385 SNIP 2.463 CiteScore 2.9
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.112 SNIP 3.708 CiteScore 3.43
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.702 SNIP 3.455 CiteScore 2.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.712 SNIP 3.726 CiteScore 2.71
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.336 SNIP 3.206 CiteScore 2.52
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.198 SNIP 2.366
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.115 SNIP 1.747
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.985 SNIP 1.74
Scopus rating (2007): SJR 0.793 SNIP 1.55
Scopus rating (2006): SJR 0.769 SNIP 1.372
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.758 SNIP 1.05
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.718 SNIP 1.215
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.627 SNIP 1.046
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.547 SNIP 0.956
Scopus rating (2001): SJR 0.507 SNIP 0.988
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.442 SNIP 0.889
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.426 SNIP 0.746
Original language: English
Statistical investigations into the erosion of material from the tool in micro-electrical discharge machining

This paper presents a statistical study of the erosion of material from the tool electrode in a micro-electrical discharge machining process. The work involves analysis of variance and analysis of means approaches on the results of the tool electrode wear rate obtained based on design of experiments approach. The input factors used in the experiments are discharge current (Id), discharge frequency (fd), and pulse width (wp). The individual effects as well as interactions among the input factors have been considered for the analysis. The results of this investigation show that discharge current (Id) and discharge frequency (fd) control the erosion of material from the tool electrode. The material erosion from the tool electrode (Me) increases linearly with the discharge frequency. As the current index increases from 20 to 35, the Me decreases linearly by 29%, and then increases by of 36%. The current index of 35 gives the minimum material erosion from the tool. It is observed that none of the two-factor interactions are significant in controlling the erosion of the material from the tool.

Structure and strength of sub-100 nm lamellar structures in cold-drawn pearlitic steel wire

Pearlitic steel wire, with a representative sub-100 nm lamellar structure, is the strongest mass-produced steel with an excellent combination of formability and strength. This overview summarises investigations of cold-drawn pearlitic steel wire in the last decades, covering the microstructural evolution and strengthening mechanisms. Based on quantitative structural parameters, this overview covers a quantitative and extensive analysis of structure–strength relationships. By focusing on the structure, challenges and future strategy are outlined to further improve the mechanical behaviour and performance of pearlitic steel wire to widen its use in society.
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes

BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.89 SJR 0.889 SNIP 1.004
Web of Science (2017): Indexed Yes

BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.43 SJR 0.833 SNIP 0.859
Web of Science (2016): Indexed yes

BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.623 SNIP 0.774 CiteScore 1.1
Web of Science (2015): Indexed yes

BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.775 SNIP 0.996 CiteScore 1.1
Web of Science (2014): Indexed yes

BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.631 SNIP 0.846 CiteScore 0.92
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes

BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.683 SNIP 0.965 CiteScore 0.86
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes

BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.667 SNIP 1.047 CiteScore 0.94
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes

BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.635 SNIP 0.776
Web of Science (2010): Indexed yes

BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.882 SNIP 1.076
Web of Science (2009): Indexed yes

BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.776 SNIP 1.036
Web of Science (2008): Indexed yes

Scopus rating (2007): SJR 0.754 SNIP 1.183
Web of Science (2007): Indexed yes

Scopus rating (2006): SJR 0.676 SNIP 0.994
Scopus rating (2005): SJR 0.627 SNIP 0.917
Web of Science (2005): Indexed yes

Scopus rating (2004): SJR 0.678 SNIP 0.878

Scopus rating (2003): SJR 0.776 SNIP 1.201
Scopus rating (2002): SJR 0.916 SNIP 1.146
Scopus rating (2001): SJR 0.72 SNIP 1.235
Web of Science (2001): Indexed yes

Scopus rating (2000): SJR 1.053 SNIP 1.203
Web of Science (2000): Indexed yes

Scopus rating (1999): SJR 1.149 SNIP 1.269
Original language: English
Pearlitic steel wire, Sub-100nm lamellar structure, Strengthening mechanisms, Strength-structure relationship, Sislocation-based plasticity
DOIs:
10.1080/02670836.2018.1440155
Source: FindIt
Synchrotron quantification of graphite nodule evolution during the solidification of cast iron

In cast iron, graphite develops in conjunction with the metallic matrix during solidification. The morphology and distribution of the embedded graphite is pivotal for mechanical properties from yield strength to fatigue. A novel high temperature environmental cell was developed and combined with in situ synchrotron tomography to investigate and quantify microstructural evolution, including graphite nodule nucleation and growth rates in ductile cast iron. The mechanisms of degenerate graphite nodule formation were also revealed. The formation of a coherent primary gamma phase dendritic network before the graphite nucleation is demonstrated. The graphite nodule nucleation rate, mobility and growth rates are compared to classical models, highlighting the limitations in these models. The results provide unique insights to tune the temperature pathways during cast iron solidification to achieve desired uniform rounded graphite morphologies and size distributions.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University College London, Research Complex at Harwell
Authors: Azeem, M. (Ekstern), Bjerre, M. K. (Intern), Atwood, R. (Ekstern), Tiedje, N. (Intern), Lee, P. D. (Ekstern)
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Main Research Area: Technical/natural sciences

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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.18 SJR 3.263 SNIP 2.737
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.67 SJR 3.21 SNIP 2.702
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 3.417 SNIP 2.831 CiteScore 5.22
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.885 SNIP 3.166 CiteScore 5.16
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 3.238 SNIP 2.674 CiteScore 4.37
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.37 SNIP 2.875 CiteScore 4.28
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.215 SNIP 2.768 CiteScore 4.27
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 3.709 SNIP 2.698
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Shape memory polymers (SMP) demonstrate a unique ability to recover to their original shape upon application of the external stimulus after being deformed and fixed into a temporary shape. The SMP part can be produced by injection moulding process but limited work has been done to understand the effects of moulding conditions on the shape memory effect. The aim of this research is to investigate the influence of selected moulding parameters on the shape memory effect (SME). Three moulding process parameters - injection speed, packing pressure and mould temperature were differentiated in order to produce the test parts. The samples were subjected to thermomechanical experiments and their shape before and after the experiments were analysed along with the overall quality of the parts. The results from these analyses are presented in the paper.
Thermal behaviour of additively manufactured injection moulding inserts

General information
State: Accepted/In press
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Applied Mathematics and Computer Science
Authors: Hofstätter, T. (Intern), Pedersen, D. B. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 2
Publication date: 2018

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Publisher: The European Society for Precision Engineering and Nanotechnology
Main Research Area: Technical/natural sciences
Conference: 18th International Conference of the European Society for Precision Engineering and Nanotechnology (euspen 18), Venice, Italy, 04/06/2018 - 04/06/2018
Additive Manufacturing, Injection Moulding, Micro Structures, Inserts, Simulation
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2018

Thermomechanical Modelling of Direct-Drive Friction Welding Applying a Thermal Pseudo Mechanical Model for the Generation of Heat
In the present work a 2D axisymmetric thermomechanical model of the direct-drive friction welding process is developed, taking the temperature dependent shear yield stress into account in the description of the heat generation, utilizing a recent thermal pseudo mechanical model originally developed for the friction stir welding (FSW) process. The model is implemented in ABAQUS/Explicit via a subroutine. The application in this case is joining of austenitic stainless steel rods with an outer diameter of 112 mm, used for manufacturing of exhaust gas valves for large two stroke marine engines. The material properties in terms of the temperature dependent flowstress curves used both in the thermal and the mechanical constitutive description are extracted from compression tests performed between 20 °C and 1200 °C on a Gleeble 1500 thermomechanical simulator. Comparison between measured and simulated transient temperatures shows relatively good agreement and furthermore, the simulated deformations in terms of upsetting length and flash formation are also in good agreement with the observations from the experiment.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Sonne, M. R. (Intern), Hattel, J. H. (Intern)
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Journal: Key Engineering Materials
Volume: 767
ISSN (Print): 1013-9826
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.29 SJR 0.18 SNIP 0.303
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
Three-dimensional grain growth in pure iron. Part I. statistics on the grain level

Grain evolution in pure iron is determined in three dimensions using diffraction contrast tomography at a synchrotron source. During annealing for 75 min at 800°C, the evolution of initially 1327 grains is quantified as a function of 15 time-steps. A comprehensive statistical analysis is provided based on the equivalent radius, the number of faces and the mean width parameters of the grains. We introduce analytical relations between these parameters, validate them, and discuss their physical meaning. While the sample is fully recrystallized, the growth is found not to be self-similar, as evidenced in changes in the distributions of normalized grain size and number of faces per grain. More importantly, a strong decrease in the slope of the growth rate over the mean width of grain faces is observed, indicating a slowdown of grain growth. The data is used to determine the applicability of the isotropic MacPherson-Srolovitz theory to an anisotropic material such as iron. Geometrical properties that are averaged over the entire grain ensemble are well described by the model, but the properties and evolution of the individual grains exhibit substantial scatter.

General information
State: Published
Organisations: Department of Physics, Neutrons and X-rays for Materials Physics, Department of Mechanical Engineering, Manufacturing Engineering, European Synchrotron Radiation Facility, Naval Research Laboratory, Northwestern University
Number of pages: 10
Pages: 76-85
Publication date: 2018
Main Research Area: Technical/natural sciences
Tolerance analysis in manufacturing using process capability ratio with measurement uncertainty

Tolerance analysis provides valuable information regarding performance of manufacturing process. It allows determining the maximum possible variation of a quality feature in production. Previous researches have focused on application of tolerance analysis to the design of mechanical assemblies. In this paper, a new statistical analysis was applied to manufactured products to assess achieved tolerances when the process is known while using capability ratio and expanded uncertainty. The analysis has benefits for process planning, determining actual precision limits, process optimization, troubleshoot malfunctioning existing part. The capability measure is based on a number of measurements performed on part’s quality variable. Since the ratio relies on measurements, elimination of any possible error has notable negative impact on results. Therefore, measurement uncertainty was used in combination with process capability ratio to determine conformity and nonconformity to requirements for quality characteristic of a population of workpieces. A case study of sheared billets was described where proposed technique was implemented. The use of ratio was addressed to draw conclusions about non-conforming billet’s weight expressed in parts per million (ppm) associated with measurement uncertainty and tolerance limits. The results showed significant reduction of conformance zone due to the measurement uncertainty.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Isfahan
Authors: Mahshid, R. (Intern), Mansourvar, Z. (Ekstern), Hansen, H. N. (Intern)
Pages: 201-210
Publication date: 2018
Main Research Area: Technical/natural sciences

Publication information
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Volume: 52
ISSN (Print): 0141-6359
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.79 SJR 0.98 SNIP 1.874
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.77 SJR 1.072 SNIP 2.178
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.039 SNIP 2.063 CiteScore 2.42
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.227 SNIP 2.409 CiteScore 2.39
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.398 SNIP 2.885 CiteScore 2.54
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.331 SNIP 3.193 CiteScore 2.2
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.295 SNIP 2.699 CiteScore 2.03
Tool condition monitoring in strip reduction testing using acoustic emission

The usage of diamond-like-carbon (DLC) tool coatings has previously been found to prolong the tool life of forming tools, while reducing the demands of the lubricants used for different metal forming operations. This allows for a more environmentally friendly production without the use of hazardous lubricants, which were previously deemed necessary due to their unique lubricating ability. While facilitating production without the use of hazardous lubricants, the occurrence of coating deterioration can cause damage to the forming tools and produce components with diminished surface quality.

The present study outlines the possibility to employ measurements of acoustic emission for online tool condition monitoring in a strip reduction test, which emulates industrial production conditions for ironing.

Tool design and materials for electro sinter forging (ESF)

A near net-shape forming process represents a suitable solution to obtain the final product by avoiding secondary machining processes. In this field, electro sinter forging is capable of accomplishing the advantages of sintering in a reduced amount of time. Classified as a high field mode (HFM) process, the main requirement is the electrical current passing through the electrical conducting powder. To obtain this, a closed-die setup with electrical insulating properties was used. Furthermore, the alignment between the compacting punch and die needed to be ensured by pre-aligning or alternatively by using an alignment system. The present work is focused on the designing phase of a tool for the electro sinter forging of a disc, made from titanium powder. By applying a pre-alignment system, the setup resulted suitable for this application. A tool design for sintering rings is also showed.
Tooling for Production of the Green Fiber Bottle

Ever since the invention of plastics, packaging has become extremely cheap and efficient. In recent times, the demand for more ecological packaging is increasing leading back to the roots of using naturally available resources, which are biodegradable. The manufacturing process of the Green Fiber Bottle (GFB) is based on moulding of wood fibers. The process is still at the research stage and not commercialized. Tooling is the most critical element in moulding and should be adapted to quick water removal techniques, such as Impulse Drying Technology. In this work, functional requirements for the development of a robust tooling solution are identified. Tooling alternatives are investigated and compared with the capacity to enable water removal. Characterization and assessment of porous tool materials using computed tomography are also outlined and discussed.

Uncovering the local inelastic interactions during manufacture of ductile cast iron: How the substructure of the graphite particles can induce residual stress concentrations in the matrix

Recent X-ray diffraction (XRD) measurements have revealed that plastic deformation and a residual elastic strain field can be present around the graphite particles in ductile cast iron after manufacturing, probably due to some local mismatch in thermal contraction. However, as only one component of the elastic strain tensor could be obtained from the XRD data, the shape and magnitude of the associated residual stress field have remained unknown. To compensate for this and to provide theoretical insight into this unexplored topic, a combined experimental-numerical approach is presented in this paper. First, a material equivalent to the ductile cast iron matrix is manufactured and subjected to dilatation and high-temperature tensile tests. Subsequently, a two-scale hierarchical top-down model is devised, calibrated, and validated.
collected data and used to simulate the interaction between the graphite particles and the matrix during manufacturing of the industrial part considered in the XRD study. The model indicates that, besides the vis- coplastic deformation of the matrix, the effect of the inelastic deformation of the graphite has to be considered to explain the magnitude of the XRD strain. Moreover, the model shows that the large elastic strain perturbations recorded with XRD close to the graphite–matrix interface are not artifacts due to e.g. sharp gradients in chemical composition, but correspond to residual stress concentrations induced by the conical sectors forming the internal structure of the graphite particles. In contrast to common belief, these results thus suggest that ductile cast iron parts cannot be considered, in general, as stress-free at the microstructural scale.

**General information**

State: Published  
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Jönköping University  
Pages: 333–357  
Publication date: 2018  
Main Research Area: Technical/natural sciences  

**Publication information**

Journal: Journal of the Mechanics and Physics of Solids  
Volume: 111  
ISSN (Print): 0022-5096  
Ratings:  
BFI (2018): BFI-level 2  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 2  
Scopus rating (2017): SNIP 1.83 SJR 1.988 CiteScore 4.03  
Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 2  
Scopus rating (2016): CiteScore 4.33 SJR 2.231 SNIP 2.107  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 2  
Scopus rating (2015): SJR 2.444 SNIP 2.154 CiteScore 4.29  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 2  
Scopus rating (2014): SJR 2.642 SNIP 2.319 CiteScore 4.7  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): SJR 2.604 SNIP 2.256 CiteScore 4.43  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 2  
Scopus rating (2012): SJR 2.229 SNIP 2.054 CiteScore 3.5  
ISI indexed (2012): ISI indexed yes  
BFI (2011): BFI-level 2  
Scopus rating (2011): SJR 2.799 SNIP 2.25 CiteScore 3.6  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 2  
Scopus rating (2010): SJR 3.309 SNIP 2.451  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 2  
Scopus rating (2009): SJR 2.918 SNIP 2.149  
BFI (2008): BFI-level 1  
Scopus rating (2008): SJR 3.557 SNIP 2.578  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 3.618 SNIP 2.635  
Scopus rating (2006): SJR 3.797 SNIP 2.684
GEOMETRICAL CALIBRATION OF X-RAY CT SCANNERS
A method of performing calibration scan and measurement scan in one and the same scanning operation with a calibration object having the fiducial marks arranged in positions spanning a volume enclosing at least a central portion of the measuring object. This avoids the need for one or more separate calibration scans to be performed in addition to the scanning of the measurement object. Considerable time is thereby saved. The fiducial objects are thus distributed, preferably evenly, around the measuring object, whereby homogeneous calibration is ensured. After having performed a scan of the measuring object together with the calibration object and thereby obtained scan data on the measuring object and corresponding scan data on the calibration object the scan data on the fiducial marks of the calibration object are used to calibrate the CT scanner, and the scan data on the measuring object are used to calculate geometric properties of the measuring object.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Stolfi, A. (Intern), De Chiffre, L. (Intern)
Publication date: 26 Jul 2017

Publication information
IPC: G06T 7/60 A 1
Patent number: EP3195802
Date: 26/07/2017
Priority date: 19/01/2016
Priority number: EP20160151878
Original language: English
Electronic versions:
Main Research Area: Technical/natural sciences
Source: espacenet
Source-ID: EP3195802
Publication: Research › Patent – Annual report year: 2017

2D Numerical Modelling of the Resin Injection Pultrusion Process Including Experimental Resin Kinetics and Temperature Validation
In the present study, a two-dimensional (2D) transient Eulerian thermo-chemical analysis of a carbon fibre epoxy thermosetting Resin Injection Pultrusion (RIP) process is carried out. The numerical model is implemented using the well known unconditionally stable Alternating Direction Implicit (ADI) scheme. The total heat of reaction and the cure kinetics of the epoxy thermosetting are determined using Differential Scanning Calorimetry (DSC). A very good agreement is observed between the fitted cure kinetic model and the experimental measurements. The numerical steady state temperature predictions inside the composite profile are validated by comparison with experimental measurements and
good agreement is found.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Fiberline Composites A/S
Authors: Rasmussen, F. S. (Intern), Sonne, M. R. (Intern), Larsen, M. (Ekstern), Spangenberg, J. (Intern), Lilleheden, L. T. (Ekstern), Hattel, J. H. (Intern)
Number of pages: 10
Main Research Area: Technical/natural sciences
Composites, Pultrusion, Curing, Modelling, Characterization
Electronic versions:
Source: PublicationPreSubmission
Source-ID: 137485687
Publication: Research - peer-review › Paper – Annual report year: 2017

3D Finite Element Modelling of Drilling Process of Al2024-T3 Alloy with solid tooling and Experimental Validation
Drilling is an indispensable process for many manufacturing industries due to its importance for assembling components. This study presents a 3D finite element modelling (3D FEM) approach for drilling process of aluminium 2024-T3. The 3D model of drilling tools for two facet HSSCo and four facet HSS were generated including their geometries. The simulations were carried out for both drills under different cutting conditions. The numerically obtained thrust forces were compared against experimental results. The tool stress distribution, chip formation and temperature distribution in the chip area were determined numerically. The results confirm the ability and advantage of 3D FE modelling of the drilling process.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Davoudinejad, A. (Intern), Tosello, G. (Intern)
Number of pages: 3
Publication date: 2017
Host publication information
Title of host publication: Proceedings of the 17th International Conference of the European Society for Precision Engineering and Nanotechnology
Publisher: The European Society for Precision Engineering and Nanotechnology
ISBN (Electronic): 978-0-9957751-0-7
Main Research Area: Technical/natural sciences
Conference: 17th euspen International Conference & Exhibition, Hannover, Germany, 29/05/2017 - 29/05/2017
Finite element modelling, Drilling, Force, Chip, Temperature distribution
Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

3D Finite Element Modelling of Drilling Process of Al2024-T3 Alloy with solid tooling and Experimental Validation
Drilling is an indispensable process for many manufacturing industries due to the importance of the process for assembling components. This study presents a 3D finite element modeling (3D FEM) approach for drilling process of aluminum 2024-T3. The 3D model of drilling tool for two facet HSSCo and four facet HSS were generated based on the details geometry. The simulations were carried out for both drills in different cutting conditions. The numerically obtained thrust forces were compared against experimental results. The tool stress distribution, chip formation and temperature distribution in the chip area were determined numerically. The results confirm the ability and advantage of 3D FE model of the drilling process.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Davoudinejad, A. (Intern), Tosello, G. (Intern)
Number of pages: 1
Publication date: 2017
Event: Poster session presented at 17th euspen International Conference & Exhibition, Hannover, Germany.
Main Research Area: Technical/natural sciences
Electronic versions:
Poster_euspen2017_AliDAV_Final.pdf
Publication: Research - peer-review › Poster – Annual report year: 2017
3D Finite Element Simulation of Micro End-Milling by Considering the Effect of Tool Run-Out
Understanding the micro milling phenomena involved in the process is critical and difficult through physical experiments. This study presents a 3D finite element modeling (3D FEM) approach for the micro end-milling process on Al6082-T6. The proposed model employs a Lagrangian explicit finite element formulation to perform coupled thermo-mechanical transient analyses. FE simulations were performed at different cutting conditions to obtain realistic numerical predictions of chip formation, temperature distribution, and cutting forces by considering the effect of tool run-out in the model. The radial run-out is a significant issue in micro milling processes and influences the cutting stability due to chip load and force variations. The Johnson–Cook (JC) material constitutive model was applied and its constants were determined by an inverse method based on the experimental cutting forces acquired during the micro end-milling tests. The FE model prediction capability was validated by comparing the numerical model results with experimental tests. The maximum tool temperature was predicted in a different angular position of the cutter which is difficult or impossible to obtain in experiments. The predicted results of the model, involving the run-out influence, showed a good correlation with experimental chip formation and the signal shape of cutting forces.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Politecnico di Milano
Authors: Davoudinejad, A. (Intern), Tosello, G. (Intern), Parenti, P. (Ekstern), Annoni, M. (Ekstern)
Number of pages: 20
Publication date: 2017
Main Research Area: Technical/natural sciences

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Journal: Micromachines
Volume: 8
Issue number: 6
Article number: 187
ISSN (Print): 2072-666X

Ratings:
Web of Science (2018): Indexed yes
Scopus rating (2017): CiteScore 2.31 SJR 0.493 SNIP 0.987
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 1.83 SJR 0.395 SNIP 0.791
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 0.463 SNIP 0.925 CiteScore 1.78
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 0.625 SNIP 1.341 CiteScore 2.1
Scopus rating (2013): SJR 0.479 SNIP 1.107 CiteScore 1.73
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.472 SNIP 1.285 CiteScore 1.28
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.222 SNIP 0.882
ISI indexed (2011): ISI indexed no
Original language: English
Micro milling, Finite element, Run-out, Chip formation, Cutting force, Cutting temperature, 3D simulation, Measurement

3D Printing of Bio-inspired surfaces
The ability of the gecko to scurry across smooth or rough surfaces, regardless of inclination (vertical or even upside down), has been traced to the multiscale hierarchical structures of the gecko toe [1 - 3]. Considering all the strategies to manufacture bio-inspired surfaces, the most common is polymer replica molding (REM) [4]. This project will further study the influence of pillar size, shape, aspect ratio, tilting angle and levels of hierarchies in terms of wettability and adhesion, using a cost effective rapid prototyping method with direct light processing (DLP). The aim of this project will be to seek the feasibility to rapid prototype gecko surface geometries. Furthermore, a micromanufacturing method is proposed using DLP and a mask.

3D Printing of Bio-inspired surfaces
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Accurate dimensional measurements in production environment using Dynamic Length Metrology

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Dalla Costa, G. (Intern), De Chiffre, L. (Intern), Hansen, H. N. (Intern)
Publication date: 2017

Publication information
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English
Main Research Area: Technical/natural sciences

Relations
Projects:
Accurate dimensional measurements in production environment using Dynamic Length Metrology
Publication: Research › Ph.D. thesis – Annual report year: 2017

A comparison of reflectance properties on polymer micro-structured functional surface

In this study, a functional micro-structure surface [1] has been developed as a combination of arrays of micro ridges. The scope of the surface is to achieve specific directional optical properties: that is, under constrained lighting, maximizing the reflectance from a certain viewing direction, and minimizing it from the corresponding horizontally orthogonal position, i.e. maximize the contrast between two horizontally orthogonal view positions at the same inclination (Figure 1). The sample is composed of 12 different anisotropic surfaces, that are designed as a combination of ridges defined by their pitch distance and their angle in respect to the surface (Figure 2). The geometry was obtained by precision milling of a tool steel bar and replicated through silicone replica technology [2], and by hot embossing using Acrylonitrile Butadiene Styrene (ABS). A digital microscope has been used as a gonioreflectometer to determine the directional surface reflectance of each surface to varying light and camera positions. The presented results show that the replication processes and the polymeric material have a strong impact on the contrast under constrained lightening. More specifically, the reflectance properties are strongly influenced by the geometry of the structure and by the colour.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Danish Meteorological Institute
Authors: Regi, F. (Intern), Li, D. (Intern), Nielsen, J. B. (Intern), Zhang, Y. (Intern), Tosello, G. (Intern), Madsen, M. H. (Ekstern), Frisvad, J. R. (Intern), Aanæs, H. (Intern)
Number of pages: 1
Publication date: 2017
Event: Poster session presented at 17th euspen International Conference & Exhibition, Hannover, Germany.
Main Research Area: Technical/natural sciences
Electronic versions:
poster_euspen_faregi_final_1.pdf
Publication: Research › peer-review › Poster – Annual report year: 2017

A Contribution to the Understanding of the Combined Effect of Nitrogen and Boron in Grey Cast Iron

Inoculation is an essential part of controlling material properties in grey cast iron. Inoculation practice has for decades been based on the addition of small amounts of elements with a strong affinity to O (and S) just before casting
takes place. This method is proven—both in theory and in practice—to be effective in most cases. But it has the disadvantage that the nucleation effect fades away over time. In particular, in heavy castings (slow cooling) this effect may cause non-uniform and unacceptable material properties in some parts of the casting. Nitrogen is also known to influence grey iron microstructure. Both graphite flake formation and matrix formation are influenced. However, the obtained effects differ considerably between different reported investigations. This investigation deals with the combined effect of nitrogen and boron and how it is possible to utilize this effect to enhance material properties in heavy grey iron castings. It is shown that the controlled additions of nitrogen and boron can be used to control the microstructure of thick section grey iron castings. A plausible theory for the formation of boron nitride nuclei effective for graphite growth is presented.

**General information**

State: Published
Organisations: Department of Energy Conversion and Storage, Mixed Conductors, Department of Mechanical Engineering, Manufacturing Engineering, Dansk Udviklings Formidling ApS
Authors: Strande, K. (Ekstern), Tiedje, N. S. (Intern), Chen, M. (Intern)
Number of pages: 10
Pages: 61-70
Publication date: 2017
Main Research Area: Technical/natural sciences

**Publication information**

Journal: International Journal of Metalcasting
Volume: 11
Issue number: 1
ISSN (Print): 1939-5981
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Web of Science (2018): Indexed yes
Scopus rating (2017): CiteScore 0.66 SJR 0.329 SNIP 0.729
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 0.47 SJR 0.304 SNIP 0.688
Scopus rating (2015): SJR 0.286 SNIP 0.58 CiteScore 0.32
Scopus rating (2014): SJR 0.285 SNIP 0.546 CiteScore 0.37
Scopus rating (2013): SJR 0.21 SNIP 0.33 CiteScore 0.18
ISI indexed (2013): ISI indexed yes
Scopus rating (2012): SJR 0.194 SNIP 0.692 CiteScore 0.31
ISI indexed (2012): ISI indexed yes
Scopus rating (2011): SJR 0.281 SNIP 0.989 CiteScore 0.41
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.256 SNIP 0.857
Web of Science (2010): Indexed yes
Scopus rating (2009): SJR 0.169 SNIP 0.041
Scopus rating (2008): SJR 0.104 SNIP 0
Original language: English
Nitrogen, Boron, Control, Properties, Grey iron, Heavy castings
Electronic versions:
A_Contribution_to_the_Understanding_of_the_Combined_Effect_of_Nitrogen.pdf. Embargo ended: 30/08/2017
DOIs:
10.1007/s40962-016-0079-6
Source: FindIt
Source-ID: 2342425870
Publication: Research - peer-review › Journal article – Annual report year: 2017

**Acoustic emission monitoring of the bending under tension test**
Preliminary investigations have shown that acoustic emission has promising aspects as an online monitoring technique for assessment of tribological conditions during metal forming as regards to determination of the onset of galling. In the present study the acoustic emission measuring technique has been applied for online monitoring of the frictional conditions experienced during Bending Under Tension (BUT) testing. The BUT test emulates the forming conditions experienced when drawing sheet material over a die curvature as in deep drawing processes. Monitoring of the developed acoustic emission in BUT testing has been found to describe the frictional conditions during forming well and to allow for accurate assessment of the limits of lubrication.

**General information**
A FEM based methodology to simulate multiple crack propagation in friction stir welds

In this work a numerical procedure, based on a finite element approach, is proposed to simulate multiple three-dimensional crack propagation in a welded structure. Cracks are introduced in a friction stir welded AA2024-T3 butt joint, affected by a process-induced residual stress scenario. The residual stress field was inferred by a thermo-mechanical FEM simulation of the process, considering temperature dependent elastic-plastic material properties, material softening and isotropic hardening. Afterwards, cracks introduced in the selected location of FEM computational domain allow stress redistribution and fatigue crack growth. The proposed approach has been validated by comparison with numerical outcomes provided by a consolidated FEM-DBEM procedure, available in literature. The discussed procedures are substantially equivalent in terms of SIFs evaluation along the crack front at the cracks insertion, as well as with respect to crack sizes measured in three different points for each propagation step. This FEM-based approach simulates the fatigue crack propagation by considering accurately the residual stress field generated by plastic deformations imposed on a structural component and has general validity.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Salerno, Norwegian University of Science and Technology
Authors: Lepore, M. (Ekstern), Carlone, P. (Ekstern), Berto, F. (Ekstern), Sonne, M. R. (Intern)
Pages: 154-167
Publication date: 2017
Main Research Area: Technical/natural sciences
A methodology for online visualization of the energy flow in a machine tool

The demand of energy efficient machine tools has increased recently due to the awareness for energy efficient production in precision manufacturing. A portion of the energy supplied to machine tools is transferred to thermal losses which influence also the thermal behavior of the precision related machine tools components. Machine cooling and process cooling can prevent thermal machine tool errors. However this further requires considerable amounts of energy. Hence there is a demand to monitor the electric, thermal, fluidic and mechanical energy flows in the machine tool in order to optimize the machining process and by this increasing its energy efficiency. This study intents to propose a method which has the capability of real-time monitoring of the entire energetic flows in a CNC machine tool including motors, pumps and cooling fluid. The structure of this approach is based on categorizing the machine into subsystems and measurements of the consumers (pump, motors, . . . ) power, temperature at the inlet and outlet of the pumps and current as well as the speed of the motors. The visualization is carried out by a 2D Sankey diagram, which makes it easy to understand the energetic flows in the machine tool. The methodology is verified by the rule of energy conversion which confirms the capability of this method on real-time energy monitoring of a machine tool.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Swiss Federal Institute of Technology, inspire AG,
Authors: Mohammadi, A. (Intern), Züst, S. (Ekstern), Mayr, J. (Ekstern), Blaser, P. (Ekstern), Sonne, M. R. (Intern), Hattel, J. H. (Intern), Wegener, K. (Ekstern)
Pages: 138-146
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: CIRP Journal of Manufacturing Science and Technology
Volume: 19
ISSN (Print): 1755-5817
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 2.049 SJR 1.377 CiteScore 2.78
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 2.76 SJR 1.107 SNIP 2.093
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 1.197 SNIP 1.847 CiteScore 2.55
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 1.349 SNIP 1.863 CiteScore 2.46
Scopus rating (2013): SJR 0.992 SNIP 1.771 CiteScore 2.01
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.776 SNIP 1.799 CiteScore 1.69
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.941 SNIP 1.988 CiteScore 1.72
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 1.124 SNIP 2.324
Scopus rating (2009): SJR 0.917 SNIP 1.183
Original language: English
Energy flow model, Machine tools, Sankey diagram, Online monitoring, Energy efficiency
DOIs:
10.1016/j.cirpj.2017.08.003
Source: FindIt
Source-ID: 2373666199
Publication: Research - peer-review › Journal article – Annual report year: 2017

Analysis of the equivalent indenter concept used to extract Young’s modulus from a nano-indentation test: some new insights into the Oliver–Pharr method

In this paper a thorough analysis of the equivalent indenter concept applied to nano-indentation is carried out, motivated by the fact that previous works in the field have not considered the requirement of a consistent relation between contact
depth and projected contact area. Dimensional analysis is initially used to prove that the shape of the axisymmetric equivalent indenter can be regarded as a material property, provided that size-effects are negligible. Subsequently, it is shown that such shape can effectively be employed to describe the nano-indentation unloading stage by means of Sneddon's elastic solution which is formally valid only for indentation into a flat surface. This allows for formulating the problem of extracting Young's modulus from the unloading curve as an optimization problem. However, it is proved that the latter does not have a unique solution, due to the particular mathematical structure of the underlying equations; hence, additional constraints are needed to set restrictions on the admissible equivalent indenter shapes. An example of such constraint is hidden in some apparent inconsistencies of the well-known Oliver–Pharr method, which is demonstrated to be based on an equivalent conical indenter whose semi-apical angle depends on the ratio between residual and total penetration. Specifically, this angle tends to 90° when the material exhibits extensive inelastic deformation, whereas it reduces to the one characteristic of the real indenter for a perfectly elastic material. This provides a new physical explanation for the relatively good accuracy of the method even in presence of a non-negligible residual contact impression on the sample.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Andriollo, T. (Intern), Thorborg, J. (Intern), Hattel, J. H. (Intern)
Number of pages: 22
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Modelling and Simulation in Materials Science and Engineering
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Scopus rating (2016): CiteScore 1.82 SJR 1.076 SNIP 1.05
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.225 SNIP 1.057 CiteScore 1.73
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.305 SNIP 1.157 CiteScore 1.81
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.083 SNIP 1.197 CiteScore 1.25
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.461 SNIP 1.794 CiteScore 2.05
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.151 SNIP 1.362 CiteScore 1.96
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.244 SNIP 1.307
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.16 SNIP 1.165
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
An approach to the modeling study and analysis of tool electrode wear mechanisms in micro electrical discharge milling

**General information**
State: Submitted
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Puthumana, G. (Intern)
Number of pages: 11
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**Publication information**
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Publication: Research - peer-review › Journal article – Annual report year: 2017

An Influence of Parameters of Micro-Electrical Discharge Machining On Wear of Tool Electrode

To achieve better precision of features generated using the micro-electrical dischargemachining (micro-EDM), there is a necessity to minimize the wear of the tool electrode, because a change in the dimensions of the electrode is reflected directly or indirectly on the feature. This paper presents a novel modeling and analysis approach of the tool wear in micro-EDM using a systematic statistical method exemplifying the influences of capacitance, feed rate and voltage on the tool wear ratio. The association between tool wear ratio and the input factors is comprehended by using main effect plots, interaction effects and regression analysis. A maximum variation of four-fold in the tool wear ratio have been observed which indicated that the tool wear ratio varies significantly over the trials. As the capacitance increases from 1 to 10 nF, the increase in tool wear ratio is by 33%. An increase in voltage as well as capacitance would lead to an increase in the number of charged particles, the number of collisions among them, which further enhances the transfer of the proportion of heat energy to the tool surface. Furthermore, to model the tool wear phenomenon, a regression relationship between tool wear ratio and the process inputs has been developed.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
A Novel Integrated Approach for Analysis and Evaluation of Control Factor Effects on Volumetric Tool Wear Rate (Vtwr) in Micro-EDM

General information
State: Submitted
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Puthumana, G. (Intern)
Number of pages: 17
Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
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ISSN (Print): 0354-2025
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Scopus rating (2016): CiteScore 0.66 SJR 0.16 SNIP 0.91
Web of Science (2016): Indexed yes
Original language: English
Source: PublicationPreSubmission
Source-ID: 127264010
Publication: Research - peer-review ▶ Journal article – Annual report year: 2017

A numerical investigation of the effect of ambient conditions on natural convection cooling of electronics

Thermal management is a serious concern in electronic industry. It is important to understand the effects of ambient conditions on cooling of electronics. In this work, the effect of ambient conditions on the thermophysical properties of humid air is estimated in five cities (Copenhagen, Mashhad, Singapore, Las Vegas and Jakarta). Thereafter, the Nu number is calculated for cooling of an isothermal surface in horizontal and vertical orientations. Comparing the results, shows that Pr number is very slightly affected by ambient conditions; however, Gr is following the temperature changes. Among the investigated cities Singapore and Jakarta, the cities with the higher temperature and moisture concentration had the lowest heat transfer coefficients.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Shojaee Nasirabadi, P. (Intern), Hattel, J. H. (Intern)
Pages: 1-4
Publication date: 2017

Host publication information
Title of host publication: 23rd International Workshop on Thermal Investigations of ICs and Systems (THERMINIC 2017)
Publisher: IEEE
A performance assessment of a 2-axis scanning mirror galvanometer for powder bed fusion

Additive Manufacturing by powder bed fusion allows production of high strength parts with complex features, not possible through conventional manufacturing. To experiment and test current theory within laser processing of metal powder, an open and customizable laser scanner platform is developed and constructed. The platform seeks to fully support and enable the laser driven process of selective consolidation metal powder, as most industrially available powder bed fusion machine tools are closed and proprietary systems. This allows the machine tool manufacturer to strictly control how the system is used and therefore maintain stability through limiting the operator to use proprietary software hardware and process materials but unfortunately limits to an equally wide extent how such machine tools can be applied for research purposes as it renders the scientist to become a mere operator of the machine tool. A galvanometer based laser scanning system is here presented. The system was designed to meet a theoretical resolution of 0.009 mm. From inspiration of the use of optomechanical hole plates as reference artefacts for coordinate metrology a test was conducted to verify the accuracy of the laser scanning system. The system was found to perform excellent for relative positioning. Absolute positioning of the laser beam did not conform with design specifications, as the test deviated by 0.12 mm with respect to the nominal test value, yet this is expected in the future to be met from the implementation of a better galvanometer control system.

Application of silicone based elastomers for manufacturing of Green Fiber Bottle

Due to ever-increasing demand of sustainable products, eco-friendly packaging solutions are finding their importance in the paper packaging industry [1]. Green Fiber Bottle (GFB) is an alternative to plastic, glass and metal based packaging for beverages. The manufacturing of paper bottle is a two-stage process, where the wood fibers are first thermoformed in the desired shape followed by drying of the formed geometry [2]. To ensure the robustness of the bottle and to avoid shrinkage of cellulose fibers, the wet-formed bottle is pressurized using a silicone core. The core is inserted inside the drying tool and inflated. This keeps the wet bottle under pressure thereby enhancing formation of good hydrogen bonds, and hence providing good strength. The feasibility of the tool design concept is supported with Finite Element Model. The hyperelastic behaviour of silicone is defined by the deformation energy function (W). To simulate the inflation action of the core, Yeoh’s model is used for modelling of W. The strength of the GFB is correlated with the pressure the bottle can hold and the cut-off burst pressure from experiments is also reported in this work.
Application of silicone based elastomers for manufacturing of Green Fiber Bottle

Due to ever-increasing demand of sustainable products, eco-friendly packaging solutions are finding their importance in the paper packaging industry. Green Fiber Bottle (GFB) is an alternative to plastic, glass and metal based packaging for beverages. The tool concept for manufacturing of paper bottle uses a silicone based elastomer as the core. The expansion of core in the tool resists shrinkage of paper during drying as well as helps in obtaining good fiber compaction. The feasibility of the tool concept in the production of GFB is discussed in this work.

Applications of Fiber-Reinforced Polymers in Additive Manufacturing

Additive manufacturing technologies are these years entering the market of functional final parts. Initial research has been performed targeting the integration of fibers into additive manufactured plastic composites. Major advantages, among others, are for example increased tensile strength and Young's modulus. Key challenges in the field, as of now, are proper fiber placement, fiber seizing, an increased knowledge in the used materials and how they are applied into engineering solutions through proper control of the additive manufacturing process. The aim of this research is the improved understanding of fiber-reinforcement in additive manufacturing in terms of production and application. Vat polymerization and material extrusion techniques for composite additive manufacturing were investigated with respect of increasing adhesion between the matrix material and the fibers. Process optimization was performed in order to avoid matrix cracks and delamination.
A preliminary study on replication and quality correlation of on-part and on-runner polymer injection moulded micro features

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Giannekas, N. (Intern), Tosello, G. (Intern), Zhang, Y. (Intern)
Publication date: 2017
Event: Poster session presented at Polymer Replication on Nanoscale 2017, Aachen, Germany.
Main Research Area: Technical/natural sciences

A sheet metal necking formability diagram for nonlinear strain paths
A new procedure for drawing forming limit curves is suggested. The theoretical basis for computing the forming limit curve due to diffuse necking, for nonlinear strain paths, is derived. The theoretically determined forming limit curve is compared with experimentally determined forming limits for both linear and bilinear strain paths. Reasonable agreement is observed. The procedure can also be utilized for nonlinear strain paths in general.

General information
State: Accepted/In press
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Materials and Surface Engineering
Authors: Christiansen, P. (Intern), Jensen, M. R. B. (Intern), Winther, G. (Intern)
Number of pages: 8
Publication date: 2017
Main Research Area: Technical/natural sciences

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Scopus rating (2017): SNIP 0.412 SJR 0.279 CiteScore 0.76
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.89 SJR 0.386 SNIP 0.632
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.225 SNIP 0.514 CiteScore 0.51
Web of Science (2015): Indexed yes
A Soft Tooling process chain employing Additive Manufacturing for injection molding of a 3D component with micro pillars

The purpose of the research presented in this paper is to investigate the capability of a soft tooling process chain employing Additive Manufacturing (AM) for preproduction of an insert with micro features by injection molding. The Soft Tooling insert was manufactured in a high temperature photopolymer by Digital Light Processing (vat photopolymerization). The mold cavity was formed by two insert halves, by design; both inserts have four angled tines, with micro holes (Ø200 μm, 200 μm deep) on the surface. Injection molding with polyethylene was used with the soft tool inserts to manufacture the final production components. The diameter and height of the pillars that were replicated on the molded components were characterized by means of a 3D profilometer. The influence of the injection molding parameters on the replication was evaluated using a 2-levels DOE of three factors. The uniformity of the pillars are also evaluated regarding the diameter and height.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
Authors: Zhang, Y. (Intern), Pedersen, D. B. (Intern), Segebrecht Gaţe, A. (Ekstern), Mischkot, M. (Intern)
Pages: 138–144
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Main Research Area: Technical/natural sciences

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Volume: 27
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Assessment of the Contour Method for 2-D Cross Sectional Residual Stress Measurements of Friction Stir Welded Parts of AA2024-T3—Numerical and Experimental Comparison

The contour method is one of the newest techniques for obtaining residual stress fields from friction stir welded (FSW) parts, experimentally. This method has many advantages; however, edge effects coming from the process itself might introduce artifacts in the obtained results, and this was slightly touched upon in the very first paper on the method. This concern is further assessed in the present work, where the contour method is compared with the results that were obtained numerically via a thermomechanical model and experimentally via the cut-compliance method. For the two-dimensional (2-D) cross sectional map obtained by the method, peak stresses in tension are observed in the mid-section of the FSW butt-welded plates at the distance of the tool radius from the centerline. The corresponding numerical simulation indicates the same behavior because of the particular clamping conditions, and consequently this should not be interpreted as a misleading result of the contour method. Edge effects from the cutting process involved in the contour method should, however, be taken into consideration, most likely resulting in the residual stresses observed near the surfaces of the cross section being less extreme in reality than observed.
A study of DLC coatings for ironing of stainless steel

Stamping of sheet metal components without lubrication or using minimum amount of hazard free lubricant is a possible solution to diminish health hazards to personnel and environmental impact and to reduce production costs. This paper studies the application of diamond-like coating (DLC) under severe lubrication conditions by adopting strip reduction testing to replicate industrial ironing production of deep drawn, stainless steel cans. Three DLC coatings are investigated; multi-layer, double layer and single layer. Experiments revealed that the double layer coating worked successful, i.e. with no sign of galling using no lubrication even at elevated tool temperature, while the other two coatings peeled off and resulted in severe galling unless lubrication was applied.
A study on replication and quality correlation of on-part and on-runner polymer injection molded micro features

Injection molding is increasingly gaining place in manufacturing of polymer components as it can ensure a cost efficient production with short cycle times. To ensure the quality of the produced parts and the stability of the process it is essential to perform frequent metrological inspections. In contrast to injection molding's short cycle time, a metrological quality control can require a significant amount of time. The late detection of the problem can result to high losses and scrap rate.

This paper presents an alternative approach to process monitoring and part quality control with fast off/in-line metrology of physical part quality indicators (“Product Fingerprint”). The proposed approach is based on the concept of metrology applied to dedicated micro features, positioned on the runners, similar or equal to those in the part in order to access the quality of the produced plastic parts. A designed experiment was employed to map the experimental space and quantify the pillars replication depending on position and processing parameter combinations. The pillars were assessed and the main effects of the processing parameters, were calculated to reveal that the effects of process parameter change were similar in all measurement positions. Results showed that the product fingerprints have a correlation to the quality of on-part micro features. The concept can support the creation of a fast part quality monitoring system that has the potential to decrease the use of off-line time-consuming detailed metrology for part approval.

A third order accurate Lagrangian finite element scheme for the computation of generalized molecular stress function fluids

A third order accurate, in time and space, finite element scheme for the numerical simulation of three-dimensional time-dependent flow of the molecular stress function type of fluids in a generalized formulation is presented. The scheme is an extension of the K-BKZ Lagrangian finite element method presented by Marín and Rasmussen (2009).
Augmented Reality Interfaces for Additive Manufacturing

This paper explores potential use cases for using augmented reality (AR) as a tool to operate industrial machines. As a baseline we use an additive manufacturing system, more commonly known as a 3D printer. We implement novel augmented interfaces and controls using readily available open source frameworks and low cost hardware. Our results show that the technology enables richer and more intuitive printer control and performance monitoring than currently available on the market. Therefore, there is a great deal of potential for these types of technologies in future digital factories.

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Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark, MIT Media Lab

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Lagrangian, Finite element, Molecular stress function, Polymer melt, Melt
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Publication: Research - peer-review › Journal article – Annual report year: 2017
Biological features produced by additive manufacturing processes using vat photopolymerization method

Bio inspired surfaces have attracted great interest due to their potential applications in different industries by using a variety of structures. The fabrication of microstructures having complex shapes have been developed within the recent decades. This work realizes the direct fabrication of micro biological features by Additive Manufacturing (AM) processes. The study characterizes the additive manufacturing processes for polymeric micro part productions using the vat photopolymerization method. A specifically designed vat photopolymerization AM machine suitable for precision printing at the micro dimensional scale has been developed, built and validated. In order to evaluate the AM machine capability a Tokay gecko test part that contains microscale pillars with widened tips was used as benchmark sample. Two main printing parameters were selected for the study: exposure time and layer thickness. In order to select the optimal range of printing parameters, a sensitivity analysis was carried out prior to the final experiment. The print quality was assessed in terms of features heights, tip heights and tip diameters.

Cavity prediction in sand mould production applying the DISAMATIC process

The sand shot in the DISAMATIC process is simulated by the discrete element method (DEM) taking into account the influence and coupling of the airflow with computational fluid dynamics (CFD). The DEM model is calibrated by a ring shear test, a sand pile experiment and a slump test. Subsequently, the DEM model is used to model the propagation of the green sand inside the mold chamber and the results are compared to experimental video footage. The chamber contains two cavities designed to quantify the deposited mass of green sand. The deposition of green sand in these two cavities is investigated with three cases of different air vent settings which control the ventilation of the chamber. These settings resulted in different air- and particle-velocities as well as different accumulated masses in the cavities, which were successfully simulated by the model.
CFD simulation and statistical analysis of moisture transfer into an electronic enclosure

Condensation and moisture related problems are the cause of failures in many cases and consequently serious concerns for reliability in electronics industry. Thus, it is important to control the moisture content and the relative humidity inside electronic enclosures. In this work, a computational fluid dynamics (CFD) model is developed to simulate moisture transfer into a typical electronic enclosure. In the first attempt, an isothermal case is developed and compared against the well-known RC circuit analogy considering the behavior of an idealized electronic enclosure. It is shown that the RC method predicts a faster trend for the moisture transfer into the enclosure compared to the CFD. The effect of several important parameters, namely, position of the opening, initial relative humidity inside the enclosure, length and radius of the opening and temperature is studied using the developed CFD model for the isothermal case. The model is then combined with a two level factorial design to identify the significant factors as well as the potential interactions using the numerical simulation results. In the second part of this study, a non-isothermal case is studied, in which the enclosure is exposed to two different conditions, i.e., internal temperature oscillation only and combined cyclic changes of ambient relative humidity and temperature. The results are compared with experimental data from literature, and show that the local climate inside the enclosure responds faster to the temperature changes compared to the RH changes. The trends predicted by the CFD simulations can be used to decide for the right time and position of a commercial adsorbent and/or thermal mass inside the enclosure to control the local climate.
Moisture, Diffusion, Electronic enclosure, CFD, Factorial design, Cyclic changes

**Challenges and opportunities of fibre-reinforced polymers in additive manufacturing with focus on industrial applications**

Functional parts made by additive manufacturing of polymers have entered the area of industrial applications in recent years providing a wide range of materials with various mechanical, thermal, and electrical properties. These additive manufacturing processes can be combined with known fibre-reinforcements applying modified material parameters with the use of fibre-reinforced polymers.

An increase of tensile strength and Young’s modulus result from the application of short fibres in a polymer matrix opening up perspectives for a variety of industrial applications such as injection moulding, biomedical engineering, aerospace, racing, and train technology. A literature survey was conducted in order to identify challenges and opportunities in these fields.

**General information**

**State:** Published  
**Organisations:** Department of Mechanical Engineering, Manufacturing Engineering  
**Authors:** Hofstätter, T. (Intern), Pedersen, D. B. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)  
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**Publication date:** 2017

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**Main Research Area:** Technical/natural sciences  
**Conference:** euspen and ASPE Special Interest Group Meeting: Additive Manufacturing, Leuven, Belgium, 10/10/2017 - 10/10/2017  
**Additive Manufacturing Technology, Review, Fibre-reinforced Polymers, Industrial Applications**  
**Electronic versions:**  
201710_EuspenSIG_Challenges_Paper_v3_peer.pdf. Embargo ended: 12/04/2018  
**Publication:** Research - peer-review › Article in proceedings – Annual report year: 2017
Characterisation and full-scale production testing of multifunctional surfaces for deep drawing applications

Full-scale deep drawing tests using tools featuring multifunctional surfaces are carried out in a production environment. Multifunctional tools display regularly spaced, transversal grooves for lubricant retention obtained by hard-turning, separated by smooth bearing plateaus realized by robot assisted polishing. Advanced methods are employed to characterise the tools' surface topographies, detecting the surface features and analysing them separately according to their specific function. Four different multifunctional dies as well as two un-textured references are selected for testing. The tests are run using a non-hazardous, environmentally friendly lubricant, and the forming forces are constantly recorded. Multifunctional dies exhibit very good performances, with no galling occurrence and punch forces generally lower than the two references.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Strecon A/S
Authors: Godi, A. (Intern), Grønbæk, J. (Ekstern), De Chiffre, L. (Intern)
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Web of Science (2017): Indexed yes
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Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 1.197 SNIP 1.847 CiteScore 2.55
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 1.349 SNIP 1.863 CiteScore 2.46
Scopus rating (2013): SJR 0.992 SNIP 1.771 CiteScore 2.01
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.776 SNIP 1.799 CiteScore 1.69
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.941 SNIP 1.988 CiteScore 1.72
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 1.124 SNIP 2.324
Scopus rating (2009): SJR 0.917 SNIP 1.183
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Functional surfaces, Metal forming, Production tests, Surface characterisation, Metal drawing, Deep drawing tests, Environmentally friendly lubricants
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Source: FindIt
Source-ID: 2319823705
Publication: Research - peer-review › Journal article – Annual report year: 2016

Characterization of additive manufacturing processes for polymer micro parts productions using direct light processing (DLP) method

The process capability of additive manufacturing (AM) for direct production of miniaturized polymer components with micro features is analyzed in this work. The consideration of the minimum printable feature size and obtainable tolerances of AM process is a critical step to establish a process chains for the production of parts with micro scale features. A specifically designed direct light processing (DLP) AM machine suitable for precision printing has been used. A test part is designed having features with different sizes and aspect ratios in order to evaluate the DLP AM machine capability to fabricate polymer micro scale features geometries. Four different factors are evaluated for the AM process analysis: printing layer thickness, exposure time, film thickness and geometry. The process optimization of the workpiece quality features is carried out to highlight potential and challenges of the micro AM process.
Characterizing Green Fiber Bottle Prototypes Using Computed Tomography

Due to ever increasing demand of sustainability and biodegradability, there arises a need to develop environmentally friendly packaging products. Green fiber bottle is a packaging product for carbonated beverages, made out of cellulose fibers. The production process accounts for moulding paper pulp in the desired shape and structure. However, there are certain limitations associated to the product characterization using tactile measuring methods. In this work, a new approach has been applied for defect analysis and quality control of non-homogenous prototype paper products using computed tomography.

Chemically extracted nanocellulose from sisal fibres by a simple and industrially relevant process

A novel type of acetylated cellulose nanofibre (CNF) was extracted successfully from sisal fibres using chemical methods. Initially, a strong alkali treatment was used to swell the fibres, followed by a bleaching step to remove the residual lignin and finally an acetylation step to reduce the impact of the intermolecular hydrogen bonds in the nanocellulose. The result of this sequence of up-scalable chemical treatments was a pulp consisting mainly of micro-sized fibres, which allowed simpler handling through filtration and purification steps and permitted the isolation of an intermediate product with a high solids content. An aqueous dispersion of CNF could be obtained directly from this intermediate pulp by simple magnetic stirring. As a proof of concept, the dispersion was used directly for preparing a highly translucent CNF film, illustrating that there are no large aggregates in the prepared CNF dispersion. Finally, CNF films with alkali extracts were also prepared, resulting in flatter films with an increased mass yield and improved mechanical strength.
Computer Vision for Additive Manufacturing.

Ever since the commercialization of additive manufacturing in the late 80’s, it has been clear what enormous potential the technology could have, potentially disrupting several industries. However, we have yet to see the technology fully adopted by the manufacturing industry. One of the issues that has prevented widespread adoption of 3D printing for use within manufacturing is the apparent lack of quality control during and after the printing process. This thesis demonstrates how...
computer vision may be applied in beneficial ways within additive manufacturing. The main contributions aim at solving part of the challenges required for the technology to reach its full envisioned potential, and to reach widespread industry adoption as a de-facto manufacturing modality. Quality control has been a major milestone to overcome in this regard. As a result, a core part of the contributions revolves around this central topic. The work is separated into three main categories: The first two concerning process and quality control of appearance and geometry. The third category concerns machine interaction paradigms within additive manufacturing. Here, challenges are addressed within the 3D ecosystem, aiming towards facilitating a fluid integration of additive manufacturing within the factory of tomorrow.

**General information**

State: Submitted
Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Eiríksson, E. R. (Intern), Aanæs, H. (Intern), Pedersen, D. B. (Intern)
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Volume: 447
ISSN: 0909-3192
Main Research Area: Technical/natural sciences

**Relations**

Projects:
Computer Vision for Additive Manufacturing.
Publication: Research › Ph.D. thesis – Annual report year: 2017

**Considerations on the Construction of a Powder Bed Fusion Platform for Additive Manufacturing**

As the demand for moulds and other tools becomes increasingly specific and complex, an additive manufacturing approach to production is making its way to the industry through laser based consolidation of metal powder particles by a method known as powder bed fusion. This paper concerns a variety of design choices facilitating the development of an experimental powder bed fusion machine tool, capable of manufacturing metal parts with strength matching that of conventional manufactured parts and a complexity surpassing that of subtractive processes. To understand the different mechanisms acting within such an experimental machine tool, a fully open and customizable rig is constructed. Emphasizing modularity in the rig, allows alternation of lasers, scanner systems, optical elements, powder deposition, layer height, temperature, atmosphere, and powder type. Through a custom-made software platform, control of the process is achieved, which extends into a graphical user interface, easing adjustment of process parameters and the job file generation.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Micro- and Nanotechnology
Authors: Andersen, S. A. (Intern), Nielsen, K. (Intern), Pedersen, D. B. (Intern), Nielsen, J. S. (Intern)
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Publication date: 2017
Conference: Nordic Laser Materials Processing Conference (NOLAMP16), Aalborg, Denmark, 22/08/2017 - 22/08/2017
Main Research Area: Technical/natural sciences

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Scopus rating (2016): CiteScore 0.65 SJR 0.347 SNIP 0.574
Scopus rating (2015): SJR 0.262 SNIP 0.572 CiteScore 0.61
Scopus rating (2014): SJR 0.401 SNIP 0.696 CiteScore 0.78
Scopus rating (2013): SJR 0.29 SNIP 0.605 CiteScore 0.72
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.28 SNIP 0.623 CiteScore 0.5
Constant interchain pressure effect in extensional flows of oligomer diluted polystyrene and poly(methyl methacrylate) melts

The constant ‘interchain pressure’ idea has been addressed, to evaluate if it is an adequate quantitative assumption to describe the fluid mechanics of oligomer diluted entangled NMMD polymer systems. The molecular stress function constitutive framework has been used with the constant interchain pressure assumption. Furthermore, the maximal extensibility based on the number of Kuhn steps in an entanglement has been used based on the relative Padé inverse Langevin function. The model predictions agree with the extensional measurements on all previously published poly(methyl methacrylate)s and almost all published oligomer diluted NMMD polystyrenes. The only deviation is on the most diluted and largest molecular weight case of an 18% 1880 kg/mol polystyrene in oligomer diluent. In this case, the maximal extensibility is not needed.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Chemical and Biochemical Engineering, The Danish Polymer Centre
Authors: Rasmussen, H. K. (Intern), Huang, Q. (Intern)
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Publication date: 2017
Main Research Area: Technical/natural sciences

Publication information
Journal: Rheologica Acta
Volume: 56
Issue number: 1
ISSN (Print): 0035-4511
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.063 SJR 0.704 CiteScore 1.9
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.9 SJR 0.634 SNIP 1.026
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.876 SNIP 1.272 CiteScore 2.09
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.725 SNIP 1.181 CiteScore 1.72
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.877 SNIP 1.38 CiteScore 2.09
ISI indexed (2013): ISI indexed yes
Continuous Strip Reduction Test Simulating Tribological Conditions in Ironing

Laboratory testing of tribo-systems for sheet metal forming applications must ensure similar conditions with the tribo-parameters that are commonly utilized in real production in order to generate data that is meaningful for industry. The main parameters to consider are the tool and workpiece materials, surface roughnesses, normal pressure, sliding length, sliding speed, interface temperature and lubrication. This paper proposes a new Strip Reduction Test (SRT) for industrial ironing processes that is capable of replicating the highly severe tribological conditions that are experienced during both the forward stroke and the backward retraction of the punch. The new SRT tool design is implemented in a new Universal Sheet Tribo-Tester (UST), which can run multiple tests continuously from a coil. The test is capable of simulating various process parameters such as reduction, drawing speed, tool temperature, sliding length and quantifying the onset of breakdown of the lubricant film and subsequent galling after several strokes not only when emulating the forward strokes but also the backward strokes. Preliminary tests disclose promising results as regards the identification of lubricant film breakdown by detecting changes in measured force, surface roughness and/or torque values.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Lisbon
Authors: Üstünyagiz, E. (Intern), Nielsen, C. V. (Intern), Christiansen, P. (Intern), Martins, P. A. (Ekstern), Bay, N. O. (Intern)
Pages: 2286–2291
Publication date: 2017
Conference: International Conference on the Technology of Plasticity (ICTP 2017), Cambridge, United Kingdom, 17/09/2017 - 17/09/2017
Cost estimation of a specifically designed direct light processing (DLP) additive manufacturing machine for precision printing

Additive Manufacturing (AM) refers to a portfolio of novel manufacturing technologies based on a layer-by-layer fabrication method. The market and industrial application of additive manufacturing technologies as an established manufacturing process have increased exponentially in the last years creating new opportunities for manufacturers in a variety of industrial sectors. AM is an essential prototyping technique for product design and development that is used in many different fields. However, the suitability of AM applications in actual production in an industrial context needs to be determined. This study presents a cost estimation model for precision printing with a specifically designed Digital Light Processing (DLP) AM machine built and validated at the Technical University of Denmark. The model presented in this study can be easily adapted and applied to estimate within a high level of confidence the cost of any part manufactured with the mentioned 3D printing technology.

Creating a Multi-material Probing Error Test for the Acceptance Testing of Dimensional Computed Tomography Systems

The requirement of quality assurance of inner and outer structures in complex multi-material assemblies is one important factor that has encouraged the use of industrial X-ray computed tomography (CT). The application of CT as a coordinate...
measurement system (CMS) has opened up new challenges, typically associated with performance verification, specification definition and thus standardization. Especially when performing multi-material measurements, further, new, challenging effects are included in dimensional CT measurements, e.g. the influence of material A on material B in multi-material scenarios and the appropriate parameters for surface determination in a multi-surface setting. Thus, this paper presents – as part of a multi-material acceptance test and to create trust in multi-material CT measurement – a new concept for multi-material probing error testing (P-test) and discusses the test design and the first experimental results. This paper also attempts to perform a critical analysis of this new concept featuring a compound sphere made of two half spheres of different materials and tries to perform analyses of geometrical features of the new standard.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Physikalisch-Technische Bundesanstalt
Authors: Borges de Oliveira, F. (Ekstern), Stolfi, A. (Intern), Bartscher, M. (Ekstern), Neugebauer, M. (Ekstern)
Number of pages: 8
Publication date: 2017

Host publication information
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Main Research Area: Technical/natural sciences
Conference: 7th Conference on Industrial Computed Tomography (iCT 2017), Leuven, Belgium, 07/02/2017 - 07/02/2017
Acceptance testing, Multi-material measurements, Computed tomography (CT), Standardization, Probing error test (P-test)
Electronic versions:
Multi_Material_Probing_paperiCT2017_Final.pdf. Embargo ended: 09/02/2017
Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

Current trends in micro electrical discharge machining (µEDM) for practical applications
Micro electrical discharge machining is a novel non-traditional technique for machining of micro scale components and features on micro-components. There are a few remarkable developments in this area in the last two years, and the attempts are aiming at reducing the size of components. As the manufacturing necessities for practical applications upsurge, the demand for complex micro-features also increases. In addition, numerous research issues associated with the applications come up which remain unexplained. Considering these characteristics, this paper is divided into the following sections: i) fabrication of complex features and structures using µEDM, ii) analysis of tool electrode wear in µEDM, iii) condition monitoring in µEDM, iv) energy assessment in µEDM, and, v) analysis of machined surfaces in µEDM. The recent trends in µEDM are summarized and future research directions are evolved.

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State: Submitted
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Puthumana, G. (Intern)
Number of pages: 29
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Journal: International Journal of Automotive and Mechanical Engineering
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Scopus rating (2015): SJR 0.4 SNIP 1.413 CiteScore 2.58
Scopus rating (2014): SJR 0.267 SNIP 0.784 CiteScore 1.21
Scopus rating (2013): SJR 0.449 SNIP 2.015 CiteScore 1.54
Scopus rating (2012): SJR 0.138 SNIP 0.16 CiteScore 0.2
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Original language: English
Spark machining, µEDM, Micro-features, Energy assessment, µEDMed surfaces and tool wear
Source: PublicationPreSubmission
Source-ID: 127264179
Publication: Research - peer-review › Journal article – Annual report year: 2017
Designing a Tool System for Lowering Friction during the Ejection of In-Die Sintered Micro Gears

The continuous improvements in micro-forging technologies generally involve process, material, and tool design. The field assisted sintering technique (FAST) is a process that makes possible the manufacture of near-net-shape components in a closed-die setup. However, the final part quality is affected by the influence of friction during the ejection phase, caused by radial expansion of the compacted and sintered powder. This paper presents the development of a pre-stressed tool system for the manufacture of micro gears made of aluminum. By using the hot isostatic pressing (HIP) sintering process and different combinations of process parameters, the designed tool system was compared to a similar tool system designed without a pre-stressing strategy. The comparison between the two tool systems was based on the ejection force and part fidelity. The ejection force was measured during the tests, while the part fidelity was documented using an optical microscope and computed tomography in order to obtain a multi-scale characterization. The results showed that the use of pre-stress reduced the porosity in the gear by 40% and improved the dimensional fidelity by more than 75% compared to gears produced without pre-stress.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Electrical Engineering, Automation and Control
Authors: Cannella, E. (Intern), Nielsen, E. K. (Intern), Stolfi, A. (Intern)
Number of pages: 15
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Main Research Area: Technical/natural sciences

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Journal: Micromachines
Volume: 8
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Scopus rating (2017): CiteScore 2.31 SJR 0.493 SNIP 0.987
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 1.83 SJR 0.395 SNIP 0.791
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 0.463 SNIP 0.925 CiteScore 1.78
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 0.625 SNIP 1.341 CiteScore 2.1
Scopus rating (2013): SJR 0.479 SNIP 1.107 CiteScore 1.73
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.472 SNIP 1.285 CiteScore 1.28
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.222 SNIP 0.882
ISI indexed (2011): ISI indexed no
Original language: English
Micro sintering, Field assisted sintering technique, Hot isostatic pressing, Micro gears, Computed tomography, Dimensional accuracy, Porosity analysis
Electronic versions:
micromachines_08_00214.pdf
DOIs:
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Publication: Research - peer-review › Journal article – Annual report year: 2017

Detection of the onset of galling in strip reduction testing using acoustic emission
Galling is an important issue in metal forming of tribologically severe materials such as high strength steel, stainless steel, Al- or Ti-alloys, since it leads to poor surface quality of the formed components, production stops and possibly deterioration of tools. The onset of galling is difficult to detect, since it is either based on the operator's personal judgement or indirect measuring techniques. The application of acoustic emission measuring technique for characterization of onset of galling in sheet metal forming is discussed in the presented paper. The strip reduction test, which emulates the ironing process, has been examined in order to evaluate onset of galling and how this is related to the generated acoustic emission parameters. Preliminary investigations have shown that differences can be found in the acoustic emission signal parameters depending on the frictional conditions between the tool and the workpiece surfaces. A correlation to the severity of galling is found. This is inspected through observations of tested workpiece surfaces in SEM and measurements of the surface roughness. The acoustic emission measuring technique is found to possess promising
Development and Testing of Tailored Tool Surfaces for Sheet Metal Forming

This thesis describes measures taken to minimize or substitute environmentally hazardous lubricants applied in sheet metal forming processes by less harmful lubricants or not applying lubricant at all. The breakdown of lubricant film often leads to galling, and therefore application of the hazardous lubricants has spurred industrial interest. In order to face a serious challenge in trying to stimulate less consumptions of such hazardous lubricants, the PhD project was intended to lead to improvements in resistivity towards galling in sheet metal forming by studying three different subjects; compressibility of lubricants, application of structured tool surfaces and application of anti-seizure tool coatings.

In order to analyze the mechanisms of lubricant entrapment and escape, knowledge of the lubricant bulk modulus characterizing the compressibility of lubricant is required. Two methods were studied to achieve this purpose. A simple laboratory test consisting of upsetting a specially designed metal cylinder with a lubricant reservoir together with elasto-plastic, numerical modelling of the metal cylinder is carried out in order to determine the bulk modulus at low pressure regimes of approximately 100 MPa. The above mentioned simple experimental procedure for determining lubricant bulk modulus gives a first rough estimate, and it is supplemented by a more advanced laboratory test based on a newly designed equipment. The lubricant compressibility experiment with a direct pressure measurement inside the high-pressure container allows for the direct determination of the bulk modulus at various pressure levels with no influence from friction in the sealing between punch and container. Using water as a reference, a good agreement between the experimental bulk modulus and values suggested in literature was found. Testing of liquid lubricants has revealed a nonlinear relationship between the bulk modulus and the pressure.

While texturing of workpiece surfaces to promote lubrication in sheet metal forming has been applied for several decades, tool surface texturing is rather new. A detailed background investigation and fundamental analysis of different textured tool surface arrangements have been carried out by Strip Reduction Test (SRT). Low as well as high viscosity oils were tested at varying sliding speeds. Micro-textured surfaces on the tool were made using an in-house micro-milling machine for the manufacturing. The SRT tools were manufactured with longitudinal, shallow pocket geometries oriented perpendicular to the sliding direction. The pockets have small angles to the workpiece surface and varying distance. The experiments show an optimum distance between the pockets to exist that creates a table mountain topography with flat plateaus and narrow pockets in between. If the flat plateaus are too narrow, an increase in drawing load and pick-up on the tool plateaus is observed. The same occurs for too wide plateaus. The tool textures were advantageous at larger sliding speeds when
using higher viscosity oils, which facilitates the escape of trapped lubricant by micro-plasto-hydrodynamic lubrication. Large lubricant viscosity results in higher sheet plateau roughness and prevents pick-up and galling. A theoretical friction model for a soft workpiece deforming against a textured tool surface was proposed. The friction model takes into account the plastic wave motion appearing, when the workpiece material flows into and out of local pockets between the flat plateaus of a table mountain tool surface topography. The friction model supports the experimental findings of an optimum distance between the pockets, where the contribution to friction by mechanical interlocking of the strip in the pockets is limited and lubrication of the plateaus is enhanced by micro-plasto-hydrodynamic lubrication. It was found that an optimum amount of tool texture exists which reduces friction and thus drawing load for the table-mountain tool surface topography.

Stamping of sheet metal components without lubrication or using minimum amount of hazard free lubricant is a possible solution to diminish health hazards to personnel and environmental impact and to reduce production costs. Adopting SRT, which emulates industrial ironing production of deep drawn, stainless steel cans, Diamond-Like Carbon (DLC) coating were deposited on SRT tools. The DLC coated tools with multi-, double- and single-layer coating structures were tested under severe tribological conditions, i.e., high normal pressure and temperature. A screening test campaign on a manually operated sheet tribo-tester is carried out to identify promising candidates. The screening tests revealed that the double layer coating worked successfully, i.e., with no sign of galling using no lubrication even at elevated tool temperature, while the other coatings peeled off and resulted in severe galling unless lubrication was applied. The next test campaign on an automatic sheet tribo-tester examines the durability of the promising candidate as regards persistence towards pick-up. It is shown that the double-layer coating, DLC/Hyperlox®, can function effectively if a minimum quantity of hazard free lubricant is applied and hence, avoid peeling off of the coating leading to galling. Numerical simulation using a thermo-mechanical analysis supports the experimental findings, where lubrication lowers the temperature at the tool/workpiece interface by reducing the friction.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Sulaiman, M. H. B. (Intern), Nielsen, C. V. (Intern), Bay, N. O. (Intern), Christiansen, P. (Intern)
Number of pages: 165
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Relations
Projects:
Development and Testing of Tailored Tool Surfaces for Sheet Metal Forming
Publication: Research › Ph.D. thesis – Annual report year: 2017
Direct electroplating of plastic for advanced electrical applications

Electrodeposition or electroplating is predominantly applied to metallic components. Electroplating of plastics is possible in some cases where an initial electroless plating layer of nickel or copper is made to provide a conductive surface on the plastic part. This paper proposes a method for direct electroplating of plastic eliminating the need for slow and expensive processes like electroless metal deposition, PVD coating, painting with conductive inks etc. The results obtained from the test demonstrate the potential of direct electroplating of plastic to enhance the electrical conductivity and the use of electroplated plastics for advanced applications like Moulded Interconnect Devices (MIDs).

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, Institute for Product Development
Authors: Islam, A. (Intern), Hansen, H. N. (Intern), Tang, P. T. (Intern)
Pages: 209–212
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Main Research Area: Technical/natural sciences

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Volume: 66
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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 2.055 SNIP 3.158
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 3.294 CiteScore 3.83
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.123 SNIP 3.992 CiteScore 4.39
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.598 SNIP 3.818 CiteScore 3.87
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.088 SNIP 4.156 CiteScore 3.04
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.117 SNIP 3.46 CiteScore 2.81
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.12 SNIP 3.449
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.652 SNIP 2.219
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Drying of a tape-cast layer: Numerical investigation of influencing parameters

In this study, the evaporation of water from a ceramic-water mixture is investigated numerically with the purpose of understanding the drying process of the thin sheets produced by the tape casting process. In the scope of this work, a Representative Elementary Volume (REV) scale model concept for coupling non-isothermal multi-phase compositional porous-media flow and single-phase compositional laminar free-flow developed by Jabbari et al. (2016), is used for a thorough analysis of the influential parameters. Specifically, we investigate the influence of ventilation speed magnitude, \( v_{\text{max}} \), the equivalent diameter of particles of the porous medium, \( d_p \), the porosity of the porous medium, \( \phi \) the initial temperature in the free-flow region, \( T_{\text{ff}} \), and the initial temperature in the porous-medium region, \( T_{\text{pm}} \), on the characteristic drying curves of a thin ceramic layer. We, moreover, conduct a statistical analysis based on numerical experiments in combination with a fractional factorial design of the aforementioned parameters. The analysis accounts for the effects of parameters on the characteristic drying curves of a thin ceramic layer. The effects of varying each of the parameters as well as their mutual interaction are shown with particular attention to the maximal drying rate as well as the final time for the drying process.

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Universität Stuttgart
Authors: Jabbaribehnam, M. (Intern), Shojaee Nasirabadi, P. (Intern), Jambhekar, V. A. (Ekstern), Hattel, J. H. (Intern), Helmig, R. (Ekstern)
Pages: 2229-2238
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Main Research Area: Technical/natural sciences

Publication information

Volume: 108
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Ratings:
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Web of Science (2018): Indexed yes
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Scopus rating (2017): CiteScore 4.23 SJR 1.498 SNIP 2.048
The purpose of this research is to analyze how additive manufacturing can create value when it is utilized as a supportive technology to injection molding by quantifying the cost advantages that can be obtained. Tooling for the product development phase is investigated as pilot integration area of additive manufacturing with injection molding. Cost considerations are discussed through the development of a cost estimation model. The study shows that integration of additive manufacturing in the product development phase for fabrication of soft tooling is economically convenient with a cost reduction of 79.8% and 89.9%. The cost models on additive manufacturing have been built so far on the idea of substituting injection molding with additive manufacturing. In response to this literature gap, this research addresses the advantages of additive manufacturing utilized in a synergistic rather than disruptive way to create value in the injection molding process chain.
Economic trade-offs of additive manufacturing integration in injection moulding process chain

Additive Manufacturing has emerged as an innovative set of novel technologies capable of replacing established manufacturing processes due to fabrication of highly complex parts and its continuous improvements of efficiency and cost effectiveness. This study is based on the idea that through the creation of synergies between additive and conventional manufacturing technologies it is possible to achieve greater cost advantages and operational benefits than by substituting injection moulding with additive manufacturing. The analysis presented explores the cost advantages that can be secured when additive manufacturing is used to support the fabrication of mould inserts for the product development phase of the injection moulding process chain. This study shows that fabrication of soft tooling by mean of AM is economically convenient with a cost reduction between 80% and 90%. Break-even points analysis based on the lot size of the product development phase is also investigated and it shows that the use of AM is cost effective up to 3400 units for the smaller geometry and up to 500 units for the larger insert geometry.
Effect of shot peening on the residual stress and mechanical behaviour of low-temperature and high-temperature annealed martensitic gear steel 18CrNiMo7-6

A martensitic gear steel (18CrNiMo7-6) was annealed at 180 degrees C for 2h and at similar to 750 degrees C for 1h to design two different starting microstructures for shot peening. One maintains the original as-transformed martensite while the other contains irregular-shaped sorbite together with ferrite. These two materials were shot peened using two different peening conditions. The softer sorbite + ferrite microstructure was shot peened using 0.6 mm conditioned cut steel shots at an average speed of 25 m/s in a conventional shot peening machine, while the harder tempered martensite steel was shot peened using 1.5 mm steel shots at a speed of 50 m/s in an in-house developed shot peening machine. The shot speeds in the conventional shot peening machine were measured using an in-house lidar set-up. The microstructure of each sample was characterized by optical and scanning electron microscopy, and the mechanical properties examined by microhardness and tensile testing. The residual stresses were measured using an Xstress 3000 G2R diffractometer equipped with a Cr K alpha x-ray source. The correspondence between the residual stress profile and the gradient structure produced by shot peening, and the relationship between the microstructure and strength, are analyzed and discussed.

General information
State: Published
Organisations: Department of Mechanical Engineering, Department of Wind Energy, Manufacturing Engineering, Materials science and characterization, Meteorology & Remote Sensing, Composites and Materials Mechanics, Materials and Surface Engineering, Chongqing University, Chalmers University of Technology, Nanjing University of Science and Technology
Authors: Yang, R. (Ekstern), Zhang, X. (Intern), Mallipeddi, D. (Ekstern), Angelou, N. (Intern), Toftegaard, H. L. (Intern), Li, Y. (Ekstern), Ahlstrom, J. (Ekstern), Lorentzen, L. (Intern), Wu, G. (Ekstern), Huang, X. (Intern)
Number of pages: 7
Publication date: 2017
Main Research Area: Technical/natural sciences

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Scopus rating (2017): CiteScore 0.49 SJR 0.201 SNIP 0.573
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.39 SJR 0.197 SNIP 0.535
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.197 SNIP 0.361 CiteScore 0.22
Scopus rating (2014): SJR 0.206 SNIP 0.362 CiteScore 0.18
Scopus rating (2013): SJR 0.205 SNIP 0.287 CiteScore 0.16
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.183 SNIP 0.257 CiteScore 0.14
ISI indexed (2012): ISI indexed no
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ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.179 SNIP 0.155
Original language: English
MATERIALS, GRAIN-SIZE
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DOIs:
10.1088/1757-899X/219/1/012046
Source: FindIt
Source-ID: 2392030897
Publication: Research - peer-review › Journal article – Annual report year: 2017
Effect of TWD estimation error on the depth of machined cavities in micro-EDM milling

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Puthumana, G. (Intern), Bissacco, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 2
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Event: Abstract from XXVIII CIRP Sponsored Conference on Supervising and Diagnostics of Machining Systems, Karpacz, Poland.
Main Research Area: Technical/natural sciences
EDM, Precision machining, Tool electrode wear
Source: PublicationPreSubmission
Source-ID: 130450582
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2017

Effects of carbon fibres on the life cycle assessment of additively manufactured injection moulding inserts for rapid prototyping

A life cycle assessment was conducted to evaluate the global warming potential and human toxicity of injection moulding processes applying newly developed tool inserts produced with vat polymerisation. The inserts were subject to increasing content of carbon fibres to improve their mechanical properties and lifetime. The additively manufactured inserts are compared to the standard materials steel, aluminium and brass. The investigated part of the production and prototyping phase considers the insert itself, the moulded part, and resulting waste material of the injection moulding process.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Management Engineering, Quantitative Sustainability Assessment
Authors: Hofstätter, T. (Intern), Bey, N. (Intern), Mischkot, M. (Intern), Stotz, P. M. (Intern), Pedersen, D. B. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 5
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Additive Manufacturing Technology, Life Cycle Assessment, Fibre-reinforced Polymers, Injection Moulding
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Effects of fast mold temperature evolution on micro features replication quality during injection molding

The growing demand to manufacture, with high accuracy, functional structures in the micro and sub-micrometer range polymer based microsystem products calls for reliable mass production processes. Being injection molding (IM) the preferential technology employed for polymer mass fabrication and mold temperature one of the most relevant process parameter to enhance polymer replication at the micro meter scale, the present study investigates effects of fast mold temperature evolution on final replication quality of produced injection molded parts. Micro features master geometries were produced by UV lithography and subsequent nickel electroplating. The mold temperature was controlled by a thin heating device (composed by polyimide as insulating layer and polyimide carbon black loaded as electrical conductive layer) able to increase the temperature on mold surface in a few seconds (40Â°C/s) by Joule effect and let the surface to cool down soon after. This heating device allowed to maintain mold temperature at a constant value for a time that could be equal to the filling time or longer. A fully characterized isotactic polypropylene was used as the polymer material during the injection molding experiments. The experiments revealed that the replication was mostly sensitive to cavity pressure and mold temperature. In particular, an increase of holding pressure and mold temperature enhanced the replication. Also, the heating time increased the replication quality.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Salerno
Authors: Liparoti, S. (Ekstern), Calaon, M. (Intern), Speranza, V. (Ekstern), Tosello, G. (Intern), Pantani, R. (Ekstern), Hansen, N. H. (Intern), Titomanlio, G. (Ekstern)
Electro sinter forging of titanium disks

Electro sinter forging (ESF) is a new sintering process based on the principle of electrical Joule heating. In the present work, middle frequency direct current (MFDC) was flowing through the powder compact, which was under mechanical pressure. The main parameters are the high electrical current, up to 10 kA, and the low voltage, 1-2 V, resulting in heat generation in the powder. Figure 1 shows the experimental setup. The punches were made of a conductive material;
namely a copper alloy. The die, which has to be electrically insulating, was made of alumina. The ESF process takes 3-4s including the following phases: (i) feeding of powder (ii) pre-compaction (iii) heating by electrical current during 100-200ms (iv) cooling (v) ejection. Figure 2 shows an example of measured pressure and current during sintering of the sample shown in Figure 3. As compared to conventional sintering [1] and spark plasma sintering [2], the main advantages are the decreased sintering time and high relative density [3]. The short time at high temperature avoids grain growth and creep. The compacted particles are bonded together because of high temperature at the boundaries. A theoretical model for the bonding mechanisms is described by Al-Hassani [4]. Optimization of process parameters, i.e. pressure, time and current, is needed to obtain high densification without reaching the melting temperature. The main sample properties are density, geometry and strength. In-process monitoring of the density can be done by measuring the electrical resistance during the sintering process [5], since low electrical resistance corresponds to high density. It is, however, necessary to be aware that increased temperature, on the other hand, increases the resistance. SEM micrographs and Computed Tomography (CT) are carried out for off-line pore and porosity analysis, respectively.

**Evaluation of optical functional surfaces on the injection moulding insert by micro milling process**

This study presents the optimization of micro milling process for manufacturing injection moulding inserts with an optical functional surface. The objective is the optimal surface functionality. Micro ridges were used as the microstructures to realize the function to generate contrast between orthogonally textured areas by reflecting light in different directions. In order to maximize the contrast, a sample was machined with the same structures and dimensions, according to a Design of Experiments (DOEs) to optimize the milling parameters by considering the contrast as a response. The contrast was evaluated based on the image processing method. The proper cutting condition was selected in order to obtain machined surface with the highest contrast and the results presented by DOE analysis. The correlations between the cutting parameters, the burrs height, and the function were determined. The contrast was found to be proportional to the spindle speed and feed rate and “oil+air” was considered as the preferred cooling method.

**Evaluation of polymer micro parts produced by additive manufacturing processes using vat photopolymerization method**

Micro manufacturing scale feature production by Additive Manufacturing (AM) processes for the direct production of miniaturized polymer components is analysed in this work. The study characterizes the AM processes for polymer micro parts productions using the vat photopolymerization method. A specifically designed vat photopolymerization AM machine suitable for precision printing has been developed, built and validated. In order to evaluate the AM machine capability a test part is designed having features with different sizes and aspect ratios. The printing parameters selected for the evaluation are considered as exposure time, light intensity and layer thickness. In order to have an initial optimal range of parameters values, a sensitivity analysis carried out prior to the final experimental plan. The print quality was assessed in terms of separation between the rows and columns of printed cubes, the number of printed features with square cross section and the surface roughness. The results declare the importance of different factors in micro AM processes.
General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Davoudinejad, A. (Intern), Pedersen, D. B. (Intern), Tosello, G. (Intern)
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Evaluation of surface roughness and geometrical characteristic of additive manufacturing inserts for precision injection moulding

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Davoudinejad, A. (Intern), Charalambis, A. (Intern), Pedersen, D. B. (Intern), Tosello, G. (Intern)
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Experimental approach for the uncertainty assessment of 3D complex geometry dimensional measurements using computed tomography at the mm and sub-mm scales

The dimensional verification of miniaturized components with 3D complex geometries is particularly challenging. Computed Tomography (CT) can represent a suitable alternative solution to micro metrology tools based on optical and tactile techniques. However, the establishment of CT systems’ traceability when measuring 3D complex geometries is still an open issue. In this work, an alternative method for the measurement uncertainty assessment of 3D complex geometries by using CT is presented. The method is based on the micro-CT system Maximum Permissible Error (MPE) estimation, determined experimentally by using several calibrated reference artefacts. The main advantage of the presented method is that a previous calibration of the component by a more accurate Coordinate Measuring System (CMS) is not needed. In fact, such CMS would still hold all the typical limitations of optical and tactile techniques, particularly when measuring miniaturized components with complex 3D geometries and their inability to measure inner parts. To validate the presented method, the most accepted standard currently available for CT sensors, the Verein Deutscher Ingenieure/Verband Deutscher Elektrotechniker (VDI/VDE) guideline 2630-2.1 is applied. Considering the high number of influence factors in CT and their impact on the measuring result, two different techniques for surface extraction are also considered to obtain a realistic determination of the influence of data processing on uncertainty. The uncertainty assessment of a workpiece used for micro mechanical material testing is firstly used for micro mechanical material testing is firstly used to confirm the method, due to its feasible calibration by an optical CMS. Secondly, the measurement of a miniaturized dental file with 3D complex geometry is carried out. The estimated uncertainties are eventually compared with the component’s calibration and the micro manufacturing tolerances to demonstrate the suitability of the presented CT calibration procedure. The 2U/T ratios resulting from the validation workpiece are, respectively, 0.27 (VDI) and 0.35 (MPE), by assuring tolerances in the range of ± 20–30 µm. For the dental file, the EN <1 value analysis is favorable in the majority of the cases (70.4%) and 2U/T is equal to 0.31 for sub-mm measurands (L <1 mm and tolerance intervals of ± 40–80 µm).

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Centro Universitario de la Defensa, Universidad de Zaragoza, Autonomous University of Baja California Sur
Authors: Jiménez, R. (Ekstern), Torralba, M. (Ekstern), Yagüe-Fabra, J. A. (Ekstern), Ontiveros, S. (Ekstern), Tosello, G. (Intern)
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Publication date: 2017

This study investigates the micro end-milling process by using a 3D finite element modeling (3D FEM) approach. The FE model is developed for contouring up-milling operation to predict chip flow, burr formation and cutting forces. Different cutting conditions were simulated in order to investigate the influence of process variables that might be difficult or even impossible to follow in the physical experiments, particularly at this scale. 3D simulations of chip flow and temperature distribution are compared in various cutting conditions. The results of the burr formation and cutting forces predictions are compared against the experiments. The correlations were observed in terms of burr dimension trends and force profile shapes and magnitude.

FlowCyl: one-parameter characterisation of matrix rheology

The FlowCyl is a simple flow viscometer – a modification of the Marsh Cone test apparatus developed to characterize cement pastes and grouts. The FlowCyl gives a one parameter characterisation of rheology called the flow resistance ratio or $\lambda Q$ for use in the Particle-Matrix concrete proportioning Model (PMM) as a description of the viscous phase of the concrete, while another parameter related to packing density is used to describe the particle phase. There have been numerous studies which have shown how the matrix $\lambda Q$ values affect the rheological parameters of concretes with a given particle system. Recent studies have shown that the FlowCyl test, which has previously proven acceptable for the one-parameter characterisation of matrix phase rheology, is probably not suitable for matrices with high powder content and a superplasticiser dosage below the surface adsorption saturation. This paper reviews current studies that compare the measurements of the FlowCyl test conducted to analyse the effect of yield shear stress (according to the Bingham model) on the measured flow resistance ratio $\lambda Q$.
Flow visualization and simulation of the filling process during injection molding

To directly compare experimental moldings from an injection molding machine with simulations, a special mold has been produced with a glass window. The injection plane is perpendicular to the opening and closing planes, in order for the 55 mm thick glass window to be easily visible from the side. A high speed camera recording 500 frames per second was employed, and the mold had three thermocouples and two pressure sensors installed. The molded part is a 2 mm thick plate with a 0.5 mm thin section, which creates a characteristic V-shaped flow pattern. Two different materials were employed, namely ABS and a high viscosity PC. Simulations were performed using the actual machine data as input, including the injection screw acceleration. Furthermore, the nozzle and barrel geometries were included as a hot runner to capture the effect of compressibility of the material in front of the screw. These two had significant effects on the filling times and injection pressure calculated by the simulations. Other effects investigated included transient thermal management of the mold, pressure dependent viscosity and wall slip, but their effect were not remarkably large in this work. The obtained simulation results showed deviations within 10-30 ms (relative deviation in the order of 5-10%) for the ABS and slightly more for the high viscosity PC in the range of 100-500 ms (relative deviation in the order of 20-30%) on timings between different sections during filling.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Guerrier, P. (Intern), Tosello, G. (Intern), Hattel, J. H. (Intern)
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Scopus rating (2017): SNIP 2.049 SJR 1.377 CiteScore 2.78
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 2.76 SJR 1.107 SNIP 2.093
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 1.197 SNIP 1.847 CiteScore 2.55
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 1.349 SNIP 1.863 CiteScore 2.46
Scopus rating (2013): SJR 0.992 SNIP 1.771 CiteScore 2.01
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.776 SNIP 1.799 CiteScore 1.69
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.941 SNIP 1.988 CiteScore 1.72
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 1.124 SNIP 2.324
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Geometrically Optimized 3D Printed Mini-Devices for Oral Drug Delivery

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Nanoprobes, Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
Authors: Vaut, L. (Intern), Juszczyk, J. J. (Ekstern), Jensen, K. E. (Intern), Andersen, A. J. (Intern), Tosello, G. (Intern), Boisen, A. (Intern)

Geometrically Optimized 3D Printed Mini-Devices for Oral Drug Delivery
Ductile iron is nowadays widely used in key industrial sectors like offshore, transport and energy production, accounting for as much as 25% of the total casting production in the world. It is well known that ductile iron parts, depending on their size, may contain residual stresses developing over distances of a few millimeters or more, which arise due to the presence of constraints that hinder the free thermal contraction of the material during cooling. Fortunately, dedicated studies performed in the last few decades have provided a detailed understanding of the phenomenon, and today reliable tools exist that allow predicting and coping with the problem in almost all practical cases.

On the other hand, the intrinsic composite nature of ductile iron suggests the possible formation of another type of residual stresses, at much shorter length scales, associated with the thermal contraction mismatch between the two main metallurgical phases forming the material microstructure: the graphite nodules and the metallic matrix. Surprisingly, the subject has not received much consideration in the past, probably due to the common belief that the graphite particles are very soft and unable to withstand any kind of loading. As a matter of fact, however, experimental evidence exists for their mechanical importance, especially at relatively high temperature and under compressive loadings, indicating that ductile iron might not be considered as a merely “voided material” in all situations.

Taking this as point of departure, the present work initially focuses on finding a satisfactory description of the nodules’ thermo-elastic behavior, which is shown to be missing in the published literature, by means of micro-mechanical homogenization analyses based on a representative unit cell. These, combined with the application of elastic bound theory for polycrystalline materials, lead to the conclusion that the nodules cannot be considered as homogeneous and isotropic at the microstructural scale. Consequently, a novel strategy to simulate their elastic response is proposed, which consists in modeling their characteristic internal structure, composed of graphite platelets arranged into conical sectors, in an explicit manner. The resulting anisotropic model turns out to provide homogenized values for the ductile iron thermo-elastic properties at the macro-scale in excellent agreement with the experiments. In addition, it also indicates that the average thermal contraction of the nodules is likely 3 to 4 times smaller compared to that of the surrounding matrix, hence confirming the existence of a driving force for the formation of stresses at the local scale. In order to investigate this last aspect, the final stages of the manufacturing process are simulated numerically, accounting for the different thermal expansion of the nodules and of the matrix during both the eutectoid transformation and the subsequent cooling to room temperature. The results show the formation of significant residual stresses in the matrix region close to the nodules, which are mainly deviatoric and strongly affected by the number of conical sectors forming the graphite particles.

To support the numerical findings, whose relevance calls for an adequate experimental validation, two techniques are employed. The Oliver-Pharr nano-indentation method is considered first, with the aim of obtaining some direct information concerning the constitutive behavior of the individual graphite particles. Unfortunately, the technique turns out to feature a number of assumptions that pose strong limitations to its applicability to brittle, inhomogeneous and anisotropic structures like the nodules. Interestingly, one of them is related to a concealed way of accounting for the particular contact condition arising between the indenter and the sample during the test, which is revealed in detail in this work for the first time in literature.

The second technique considered is a novel 3D X-ray diffraction method based on synchrotron radiation. This time, the experiments are successful and lead to the determination of the residual stress state around a single nodule lying beneath the material surface. The results are the first ever produced, and confirm the theoretical predictions that local stresses up to approximately half the macroscopic yield strength may remain in the ductile iron microstructure after manufacturing. Needless to say, this new type of residual stresses is expected to play an important role in determining the properties of ductile iron. Knowledge of the factors controlling it will pave the way for further optimization of the material performance.
under in-service loading.

**Green fiber bottle: Towards a sustainable package**
The Green Fiber Bottle is a fully biodegradable bottle made from molded paper pulp. Its development depends on the establishment of the manufacturing technology. Impulse drying, an innovative way of drying, has the potential to improve significantly the manufacturing process of the Green Fiber Bottle, towards a sustainable packaging.

**Green Fiber Bottle: Towards a Sustainable Package and a Manufacturing Process**
The Green Fiber Bottle is a fully biodegradable bottle made from molded paper pulp, which is a renewable resource. Its development depends on the development of the manufacturing technology. Impulse drying, an innovative way of drying, and FORMCELL, a method to speed the mold reconfiguration, have the potential to improve significantly the manufacturing process of Green Fiber Bottle, towards a sustainable packaging.
Hierarchical Structure and Strengthening Mechanisms in Pearlitic Steel Wire

Microstructure evolution and strengthening mechanisms have been analyzed in a cold-drawn pearlitic steel wire (the strongest engineering materials in the world) with a nanostructure down to 10 nm and a flow stress up to 5.4 GPa. The interlamellar spacing and the cementite lamellae thickness are reduced during drawing in accordance with the change in wire diameter up to a strain of 2.5. At a higher strain enhanced thinning of cementite lamellae points to decomposition and carbon enrichment of the ferrite lamellae. Dislocations are stored as individual dislocations and in low angle boundaries. No saturation in the dislocation density is observed and it increases to $5 \times 10^{16}$ m$^{-2}$ at a strain of 5.4. A high dislocation density at the ferrite/cementite/ferrite interface is also observed. Boundary strengthening, dislocation strengthening and solid solution hardening are suggested and good agreement is found between the calculated flow stresses and experimental values.

General information
State: Published
Organisations: Department of Mechanical Engineering, Department of Wind Energy, Manufacturing Engineering, Materials science and characterization, Materials and Surface Engineering
Authors: Zhang, X. (Intern), Hansen, N. (Intern), Huang, X. (Intern), Godfrey, A. W. (Intern)
Publication date: 2017
Event: Abstract from TMS 2017, San Diego, United States.
Main Research Area: Technical/natural sciences
Electronic versions:
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Source: PublicationPreSubmission
Source-ID: 138509426
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2017

Hot-blade cutting of EPS foam for double-curved surfaces—numerical simulation and experiments

In the present paper, experimental and numerical studies of a newly developed process of Hot-Blade Cutting used for free forming of double-curved surfaces and cost effective rapid prototyping of expanded polystyrene foam is carried out. The experimental part of the study falls in two parts. The first presents a number of large-scale cutting samples combining linear cuts with and without inclination measured from the horizontal direction of cutting, while in the second, the thermal phenomena in the process are studied based on infrared measurements of the hot-blade tool made by observation during the cutting process. A novel measurement method for determination of kerfwidth (i.e., the gap space after material removal) applying a commercially available large-scale optical 3D scanning technique was developed and used. A one-dimensional thermo-electro-mechanical numerical model for Hot-Blade Cutting similar to the one previously proposed by Petkov and Hattel (Int J Machine Tools Manuf 107:50–59 2016) for Hot-Wire Cutting of Polystyrene foam is used to simulate the process and describe the effects taking place within the hot-blade during different cutting procedures. The obtained results are graphically presented and discussed in relation to the aim for higher geometrical accuracy of the Hot-Blade Cutting process.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Petkov, K. P. (Intern), Hattel, J. H. (Intern)
Pages: 4253-4264
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Main Research Area: Technical/natural sciences
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.3 SJR 1.046 SNIP 1.608
Humidity Buildup in Electronic Enclosures Exposed to Constant Conditions

Electronic components and devices are exposed to a wide variety of climatic conditions, therefore the protection of electronic devices from humidity is becoming a critical factor in the system design. The ingress of moisture into typical electronic enclosures has been studied with defined parameters such as openings in the enclosure (drain holes, intentional openings or leak) and sealing and casing material. Related corrosion reliability issues due to humidity buildup have been evaluated using an interdigitated surface insulation resistance pattern placed inside the enclosure during exposure. The moisture buildup inside the enclosure has been simulated using an equivalent RC circuit consisting of variables like controlled resistors and capacitors to describe the diffusivity, permeability, and storage in polymers.
The objective of this research is to investigate the influence of injection molding parameters on the dimensional replication of microstructure surfaces in injection molding with additively manufactured soft tooling inserts in a photopolymer material. The replication degree of micropillars on injection-molded tine rings was assessed and a Design of Experiments (DOE) approach was used to investigate which factors influence the replication. A full factorial analysis with three factors at two levels lead to the conclusion that a high mold temperature increases the replication degree of the pillar diameter and decreases the replication degree of the pillar height. A high melt temperature increases the pillar diameter independently from the pillar height. A higher injection speed affects both pillar diameter and height negatively. In addition, the study showed a significant difference in the replication degree between inserts on the injection side and the ejector side of the mold respectively. Also, a position closer to the injection gate supports a higher replication degree. Insert wear was found insignificant within the experimental range of up to 100 injection cycles.
Influence of Processing Conditions on the Mechanical Behavior of MWCNT Reinforced Thermoplastic Nanocomposites

The influence of the processing conditions and MWCNT content on the mechanical properties of PA6,6-based nanocomposites are investigated. In addition to the composition of the composites, the impact of manufacturing conditions such as dilution mechanism, twin-screw extruder mixing specifications, and injection molding parameters on the behavior of the nanocomposites are evaluated. Results show that while the increase in the content of MWCNTs can lead to 40.0% enhancement in the mechanical properties, changing the processing parameters varies the values by 30.0% in the same content. The mechanisms involved in the modulation of the nanocomposites properties are also discussed.

Influence of the worn tool affected by built-up edge (BUE) on micro end-milling process performance: A 3D finite element modeling investigation

Micro milling process has been utilized for several decades due to the flexibility of the process in producing complex components. The small size of the process makes the comprehension of cutting phenomenon details more difficult. This study presents a 3D finite element modeling (3D FEM) approach for the micro end-milling process of Aluminum material (Al6082-T6). 3D FEM simulations are carried out in full slot micro end-milling and contour up milling. The model first implements the actual tool geometry and then the effect of typical built-up edge (BUE) on the milling tool. The influence of BUE on the process performance is investigated by comparing the predicted 3D chip flow shape, burr formation and
Cutting forces with experiments conducted on an ultra-high precision micro milling center. Simulations indicate that BUE has significant impact on the chip shape and chip load for different teeth engagements. Results prove that also burr height is negatively affected by the presence of BUE. The predicted micro milling cutting forces resulted affected by BUE with different teeth engagements. Analysis of experimental measured forces indicates comparable results in respect to simulated profiles confirming the usefulness of the develop 3D FE modelling approach.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Politecnico di Milano
Authors: Davoudinejad, A. (Intern), Tosello, G. (Intern), Annoni, M. (Ekstern)
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Main Research Area: Technical/natural sciences

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Volume: 18
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.998 SJR 0.663 CiteScore 1.66
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.54 SJR 0.595 SNIP 0.915
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.643 SNIP 1.062 CiteScore 1.42
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.702 SNIP 1.456 CiteScore 1.58
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.664 SNIP 1.694 CiteScore 1.76
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.652 SNIP 2.173 CiteScore 1.77
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.468 SNIP 1.487 CiteScore 1.22
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.37 SNIP 0.86
Scopus rating (2009): SJR 0.413 SNIP 0.833
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Micro milling, Finite element modeling, Built-up edge, Chip flow, Burr formations
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Influence of tool texture on friction and lubrication in strip reduction
Tool texturing is studied as a method to enhance lubrication and prevent the occurrence of galling. Strip reduction test tools manufactured with longitudinal, shallow pocket geometries oriented perpendicular to the sliding direction are tested. The pockets have small angles to the workpiece surface and varying distance. The experiments show an optimum distance between the pockets to exist that creates table mountain topography with flat plateaus and narrow pockets in between. If the flat plateaus are too narrow, an increase in drawing load and pick-up on the tool plateaus is observed. The same occurs for too wide plateaus. A theoretical friction model supports the experimental findings of an optimum distance between the pockets, where the contribution to friction by mechanical interlocking of the strip in the pockets is limited and lubrication of the plateaus is enhanced by micro-plasto-hydrodynamic lubrication.
Influence of tool texture on friction and lubrication in strip reduction

The manufacturing precision and accuracy in the production of polymer lab-on-a-chip components with 100-130 nm deep nanochannels are evaluated using a metrological approach. Replication fidelity on corresponding process fingerprint test nanostructures over different substrates (nickel tool and polymer part) is quantified through traceable atomic force microscope measurements. Dimensions of injection moulded (IM) and injection-compression moulded (ICM) thermoplastic cyclic olefin copolymer nanofeatures are characterized depending on process parameters and four different features positions on a 30 × 80 mm² area. Replication capability of IM and ICM technologies are quantified and the products tolerance at the nanometre dimensional scale verified.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Danish Fundamental Metrology
Authors: Calaon, M. (Intern), Tosello, G. (Intern), Garnaes, J. (Ekstern), Hansen, H. N. (Intern)
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Web of Science (2018): Indexed yes
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Scopus rating (2017): CiteScore 2.02 SJR 0.554 SNIP 0.968
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.74 SJR 0.63 SNIP 1.067
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.687 SNIP 1.265 CiteScore 1.96
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.802 SNIP 1.316 CiteScore 1.84
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.737 SNIP 1.233 CiteScore 1.74
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.936 SNIP 1.491 CiteScore 1.92
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.036 SNIP 1.443 CiteScore 2.43
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.013 SNIP 1.637
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.144 SNIP 1.5
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.243 SNIP 1.616
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.422 SNIP 1.815
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.264 SNIP 2.098
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.165 SNIP 2.073
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.057 SNIP 1.881
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.416 SNIP 1.579
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.103 SNIP 1.507
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.763 SNIP 1.651
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.741 SNIP 1.011
Scopus rating (1999): SJR 0.742 SNIP 1.052

Original language: English
Cyclic olefin copolymer, Metrology, Microfluidic polymer systems, Nanostructures, Precision molding
Injection Moulding Pilot Production: Performance Assessment of Tooling Process Chains Based on Tool Inserts Made from Brass and A 3d Printed Photopolymer

Additive Manufacturing is becoming a viable option for the production of injection molding inserts in pilot production settings. This work compares an insert made from brass using conventional machining with an insert made from a proprietary photopolymer using Digital Light Processing (DLP) through the application of precision injection molding. The performance of the inserts is analyzed focusing on design, metrological aspects, tool lifetime, and thermal performance.

In the experiment, a disk-shape geometry (diameter 41.5 mm, thickness 3.5 mm) was injection molded in Low-Density Polyethylene in a two-cavity mold. The inserts as well as selected injection molded parts were analyzed with an optical 3D micro-coordinate measuring machine. It was found that additive manufacturing technology can lead to a significantly more cost effective pilot production, both in terms of development time and investment. DLP technology enables fast production of micro-features, however insert production with DLP is less reliable than milling e.g. when considering process repeatability. Photopolymer and brass inserts lead to differences in optical surface appearance on the injection molded parts. The lifetime of the photopolymer inserts is challenging to predict reliably. Depending on how many parts need to be produced, the use of several photopolymer inserts instead of one brass insert is a means to overcome the shorter lifetime and can represent a cost-effective alternative to machined inserts. In order to exploit the advantages of using additive manufactured injection mold inserts, specific tool design rules have to be applied.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
Number of pages: 5
Publication date: 2017

Injection Moulding Simulation and Experimental Validation of Hearing Aid Shells

This paper presents the validation results of the Moldex3D simulations and experiments carried on a complex 3D part, it critically analyzes the capability of Moldex3D and provides the guideline for more accurate simulation with the commercial software. Moldex3D with Boundary Layer Meshing (BLM) mode was adopted in this work to simulate the injection molding process of a hearing aid shell made of Polybutylene Terephthalate (PBT) filled with 30% glass fiber. The typical hearing aid shells are complex thin-walled structures made by injection molding. Highly sophisticated molds and lots of process optimizations by trial and errors are needed to make successful shells for hearing aids. In this context, a dedicated simulation tool can be very useful to reduce the time and cost for developing the new hearing aids. In this work, the injection molding experimental validation of the Moldex3D simulation was conducted for the upper shell of a hearing aid. With the pressure sensors integrated in the molding tool, real cavity pressure data was collected and the real filling time was estimated to replicate the processing conditions in the simulation. Injection time, injection pressure; pressure loss and warpage were taken as the main comparison criteria. Different parameter settings in Moldex3D were investigated to find their influence on the accuracy of the simulation. Results showed that the injection molding process prediction from the simulation was relatively precise when the nozzle geometry, the pressure effect on the viscosity and the determination of a proper heat transfer coefficient (HTC), etc. were considered. The agreement observed between the warpage of the experimental molded parts and simulated parts was not good. Warpage were dominated by the fiber orientation which was extremely dependent on the filling HTC and the RPR (Retarding Principal Rate Model) used in Moldex3D for the fiber orientation model.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, Technical University of Denmark
Authors: Islam, A. (Intern), Li , X. (Ekstern)
Number of pages: 1
Publication date: 2017
Event: Abstract from 33rd Annual Meeting of the Polymer Processing Society (PPS33), Cancun, Mexico.
In-line 3D print failure detection using computer vision

Here we present our findings on a novel real-time vision system that allows for automatic detection of failure conditions that are considered outside of nominal operation. These failure modes include warping, build plate delamination and extrusion failure. Our system consists of a calibrated camera whose position and orientation is known in the machine coordinate system. We simulate what the object under print should look like for any given moment in time. This is compared to a segmentation of the current print, and statistical detection of significant deviation. We demonstrate that this methodology precisely and unambiguously detects the time point of print failure.

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Failure detection, Computer vision, Fused deposition modeling (FDM)
Source: PublicationPreSubmission
Source-ID: 139557938
Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

Inner centering in parting line area of injection mould using side locks

Injection moulding is characterized by high precision requirements. In particular, the demands regarding the mould plates alignment are in order of few micro meters. This research introduces a methodology to measure the misalignment in injection moulding. Eddy current sensors are used in the system to perform measurements for a whole cycle. In a long run of the mould, a comparison of mould deviation between the first and the last cycles is obtained.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Mahshid, R. (Intern), Hansen, H. N. (Intern)
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In situ observations of graphite formation during solidification of cast iron

Grey cast irons are a group of alloys with a unique combination of properties in terms of mechanical performance and castability. These properties are strongly related to their composite structure where graphite precipitates are embedded in a metallic matrix. The graphite precipitates form during solidification and growth continues throughout solid state cooling and the eutectoid transformation. Years of research have greatly improved the understanding of the basic mechanisms that control graphite growth as well as the ability to control graphite morphology during industrial production of cast
components. This is important since the shapes of the graphite precipitates play a determining role for the properties of grey cast irons. However, to reach the full potential of cast irons and enable high-performance light-weight designs, more in-depth knowledge of the mechanisms controlling graphite growth and morphological developments is required. It is the aim of the present thesis to contribute with new insights within these fields.

In ductile cast irons graphite precipitate as spheroids which result in a material in which the mechanical properties are similar to those of steel. To predict the mechanical properties of ductile cast iron it is important to estimate the density of nodules as well as the distribution of nodule shapes and sizes at room temperature. This emphasises the importance of models which can correctly describe the nucleation and growth of spheroidal graphite during solidification.

In this thesis, the solidification of cast iron is studied with focus on formation and growth of spheroidal graphite. To this end, an experiment is conducted at the Diamond Light Source synchrotron facility in Harwell, UK: Employing an environmental cell developed at the Manchester X-ray Imaging Facility at the University of Manchester, a small cylindrical sample of ductile cast iron is melted. During re-solidification, the sample is continuously imaged. As a result, the first time resolved imaging of graphite formation in three dimensions is presented in the present thesis. A comparison of a one dimensional model for spheroidal graphite growth to experimental observations showed that the model can describe the observations relatively well despite its simplicity. The investigation also showed that a gradually decreasing growth rate towards the end of solidification is not reflected in the model in spite of an extension to solid state growth presented in the present thesis. From the analysis it is clear that the presented data is of an unprecedented quality and that it represents a solid basis for validation of future models.

Solidification simulations of a ductile cast iron component highlights the importance of the nucleation model for the correct prediction of the final nodule density as well as the cooling curve. The tomographic data showed that nucleation within the studied sample is initiated at very high undercoolings and that it accelerates rapidly as eutectic solidification takes off. Experimental data can be reasonably described by two different models both emphasising the importance of taking into account the fraction solid in nucleation models.

Since very limited graphite particle movement is observed during the course of solidification, the particles must be anchored in austenite and most likely also encapsulated while they grow. Simultaneously, spherical graphite particles undergo significant morphological changes and in many cases develop irregular features. Furthermore, the particles which are the most irregular after solidification grow significantly faster than their regular counterparts and it seems that fast growth is associated to the development of irregular features. These observations are slightly surprising and highly interesting as it is usually assumed that irregular graphite shapes develop when the graphite is in contact with the liquid melt. These results have important implications for how degeneracy of spheroidal graphite should be understood and theoretically described in the future.
Integrated Quality Control of Precision Assemblies using Computed Tomography

Computed Tomography (CT) is bringing about a profound change in the way that tolerance verification is performed in industry. CT allows the inner and the outer geometry of a workpiece to be measured without the need for external access or destructive testing. These are significant advantages over coordinate measuring machines (CMMs) when working with complex and fragile parts. This Ph.D. project at DTU Mechanical Engineering concerns the applicability of CT for quality control of precision assemblies. Investigations to quantify the accuracy of CT measurements, reference artefacts to correct systematic errors in CT, and an international comparison on CT of Assemblies have been carried out during the project.

A series of investigations regarding the influence of the CT post-processing factors on the accuracy of CT measurements was carried out. Post-processing factors such as surface determination, data filtering and feature fitting were considered within the present investigations. The investigations were conducted on two CT systems, showing different metrological performances, and involved a variety of multi-material assemblies, having different shapes and materials. The investigation results have showed that CT measurements on assemblies can be successfully conducted and that the surface determination method appears to be able to segment multi-material workpieces without any loss of accuracy. A novel type of artefact for calibration of the scale error in CT has been developed within the project. One kind of artefact comprises a carbon fibre tubular structure on which a number of reference ruby spheres are glued. Another kind comprises an invar disc on which several reference ruby spheres are positioned at different heights using carbon fibre rods. The artefact is positioned and scanned together with the workpiece inside the CT scanner producing a 3D reference system for the measurement. The two artefacts were calibrated on a tactile CMM and their applicability demonstrated using different calibrated workpieces. The use of the developed artefacts ensures a considerable reduction of time by compressing the full process of calibration, scanning, measurement, and re-calibration, into a single imaging. The use of the artefacts also allows a considerable reduction of the amount of data generated from CT scanning.

Interlaboratory comparison on Computed Tomography of assemblies was carried out as a part of the Ph.D. study. The comparison involved 22 research laboratories from 7 countries, and was based on the circulation of two assemblies. With respect to previous comparisons that only focused on physical items, the present comparison introduced a voxel item, which was an assembly scanned by the coordinator and distributed electronically to participants. The comparison results demonstrated that (i) length measurements are made without problems by most of the participants who corrected systematic errors effectively; (ii) CT post-processing has a sizable impact as the measurand complexity increases; (iii) the majority of the participants stated measurement uncertainties although many of them provided poor statements.

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Integrated Quality Control of Precision Assemblies using Computed Tomography
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Integration of Fiber-Reinforced Polymers in a Life Cycle Assessment of Injection Molding Process Chains with Additive Manufacturing

Additive manufacturing technologies applied to injection molding process chain have acquired an increasingly important role in the context of tool inserts production, especially by vat polymerization. Despite the decreased lifetime during their use in the injection molding process, the inserts come with improvements in terms of production time, costs, exibility, as well as potentially improved environmental performance as compared to conventional materials in a life cycle perspective. This contribution supports the development of additively manufactured injection molding inserts with the use of fiber-reinforced vat polymerization technology. The life cycle assessment of the prototyping process chain for rapid prototyping with high exibility provides a base for industrial applications in injection molding.

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Internal Casting Stresses and Dimensional Stability

It is common knowledge that cast iron components may be affected by the presence of residual stresses. This often represents a serious threat, because residual stresses almost invariably cause a significant degradation of the most important material properties, such as reduced fracture toughness, accelerated stress corrosion, decreased fatigue resistance, and so on. In addition, they can also be responsible for undesirable shape distortions, which may compromise the fulfillment of geometrical tolerance requirements. As a consequence, a good understanding of what residual stresses are, how they form during the process, and how they can be prevented or at least minimized is indispensable to achieve the highest casting quality.

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Internal shear cracking in bulk metal forming

This paper presents an uncoupled ductile damage criterion for modelling the opening and propagation of internal shear cracks in bulk metal forming. The criterion is built upon the original work on the motion of a hole subjected to shear with superimposed tensile stress triaxiality and its overall performance is evaluated by means of side-pressing formability tests in Aluminium AA2007-T6 subjected to different levels of pre-strain. Results show that the new proposed criterion is able to combine simplicity with efficiency for predicting the onset of fracture and the crack propagation path for the entire set of
test cases regardless the amount of pre-strain derived from previous upsetting under near frictionless conditions. The new proposed criterion can be easily implemented in existing finite element programs and its scope of application allows extending previous work on the opening modes in surface cracking to internal cracks formed under three-dimensional states of stress that are typical of bulk metal forming.

**General information**

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Investigation of process parameters influence on flash formation in injection moulding of polymer micro features through design of experiments

Micro injection moulding is one of the key technologies for micro manufacture due to its mass-production capability and relatively low component cost. Flash defects are among the most critical issues in the replication of micro features and constitute a manufacturing constrain in applying injection moulding in a range of micro engineering applications. In the present research the effects of four processing parameters on the amount of flash on a micro finger test structure were investigated using two different polymer materials and applying DOE approach. In particular, the following process parameters were considered: injection speed, holding pressure, melt temperature and mould temperature. The study revealed that for the materials with lower viscosity the injection speed, followed by barrel temperature, are the most influential parameters for increasing the amount of flash. On the other hand, barrel temperature, injection velocity, and mould temperature resulted as the most influential parameters for increasing the flash amount when moulding with high viscosity materials. Conversely, the holding pressure did not have a clear effect on the flash amount.

Investigation of the mechanical properties of GNP/MWCNT reinforced PA66 hybrid nanocomposites

The multifunctional characteristics of nanocomposites have introduced novel possibilities for different industrial sectors. However, the stable and optimized production of polymeric nanocomposite components is challenging. This research investigates the mechanical behavior of thermoplastic based nanocomposites reinforced with two prominent nanofillers namely Multi Walled Carbon Nanotubes (MWCNT) and Graphene NanoPlatelets (GNP) manufactured through industrially viable methods. Three main groups of Polyamide (PA 66) based nano- and hybrid composite specimens namely PA 66/MWCNT, PA 66/GNP, and PA 66/MWCNT/GNP are prepared. Different contents and mixture ratios of the nanofillers are incorporated in the polymeric matrix through the dilution process using a twin-screw extruder. The influence of the manufacturing parameters and content of the nanofillers on the mechanicalproperties of the nanocomposite specimens are investigated. Results show that the inclusion of either of the nanomaterials improves the elastic modulus and tensile strength of the nanocomposites significantly. Moreover, the combination of the two nanofillers in the nanocomposites is resulting into completely novel material properties which do not follow the linear combinations of the observed behaviors. In fact, the interaction between the two different nanofillers influences both dispersion state and mechanical properties. The mechanisms of modulation in the properties and dispersion states are also discussed using scanning electron microscopy and rheological investigations. The research provides an insight to manufacture tailored hybrid nanocomposites with the optimized mechanical properties.
Investigation of Tooling for Anisotropic Optical Functional Surfaces

This paper studied steel inserts with anisotropic surfaces for injection moulding. The inserts surfaces were machined by a five-axis micro-milling machine and the surface structures will be replicated by injection moulding. The aim of the surface structuring is to maximize visible contrast between horizontally orthogonal textured surfaces from a certain viewing angle, of both the insert and the polymer replicas. The contrast is defined by the difference of the reflectance between two areas with horizontally orthogonal textures under a certainly fixed light source. The brightness of the surface is assessed by processing the images obtained from a digital microscope Hirox RH-2000 [1]. Figure 1 illustrates the studied surface structure and the microscope. The optical axis of microscope can be tilted within 90 degrees from the horizontal level, which simulates the viewing angle; the analysed surface texture can be rotated horizontally by the adjusting the stage so only one surface was used to achieve orthogonal textures and images at different rotation angle can be captured. Via image processing tool, the reflectance (brightness of the obtained images) will be analysed and therefore the contrast can be calculated.

Investigation on the micro injection molding process of an overmolded multi-material micro component

Micro injection molding (μIM) is one of the few technologies capable of meeting the increasing demand of complex shaped micro plastic parts. This process, combined with the overmolding technique, allows a fast and cost-efficient production of multi-material micro components, saving numerous and difficult assembly steps, being the plastic molded directly on a metal substrate. In this scenario, an investigation on the fully automated micro overmolding manufacturing technology of a three-material micro component for acoustic applications has been carried out. Preliminary experiments allowed to identify an initial process window by considering the main defects affecting the part quality (flashes and gate marks). Within this range, the effect of three injection molding parameters, namely mold temperature, melt temperature and injection speed, has been evaluated with respect to the critical geometrical characteristics of the component. An optical CMM with sub-micrometric resolution has been employed for the measurements. Results show that the process parameters have a significant influence on some component features, while others mainly depend on the insert alignment inside the micro mold cavity.

Joining end-to-end tubing of dissimilar materials by forming
Kinetics modeling of delta-ferrite formation and retainment during casting of supermartensitic stainless steel

The kinetics model for multi-component diffusion DICTRA was applied to analyze the formation and retainment of δ-ferrite during solidification and cooling of GX4-CrNiMo-16-5-1 cast supermartensitic stainless steel. The obtained results were compared with results from the Schaeffler diagram, equilibrium calculations and the Scheil model in Thermo-Calc, and validated by using microscopy and energy dispersive X-ray spectroscopy for chemical analysis on a cast ingot. The kinetics model showed that micro-segregation from solidification homogenizes within 2–3 s (70 °C) of cooling, and that retained δ-ferrite originates from the incomplete transformation to austenite. The kinetics model predicted the measured amount of δ-ferrite and the partitioning of Cr and Ni reasonably well. Further, it showed that slower cooling for the investigated alloy leads to less retained δ-ferrite, which is in excellent agreement with experimental results.

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Selective laser melting is fast evolving into an industrially applicable manufacturing process. While components produced from high-value materials, such as Ti6Al4V and Inconel 718 alloys, are already being produced, the processing of multi-material components still remains to be achieved by using laser additive manufacturing. The physical handling of multi-material in a SLM setup continues to be a primary challenge along with the selection of process parameters/plan to achieve the desired results – both challenges requiring considerable experimental undertakings. Consequently, numerical process modelling has been adopted towards tackling the latter challenge in an effective manner.

In this paper, a numerical simulation based optimization study is undertaken to enable selective laser melting of multi-material tool inserts. A standard copper specimen covered by a thin layer of nickel is chosen, over which a layer of steel has been deposited using cold-spraying technique, such as to protect the microstructure of Ni during selective laser melting. The process modelled thus entails additively manufacturing a steel tool insert around the multi-material specimen with a goal of achieving a dense product while preventing recrystallization in the Nickel layer. The process is simulated using a high-fidelity thermo-microstructural model with constant processing parameters to capture the effect on Nickel layer. Based on results, key structural and process parameters are identified, and subsequently an optimization study is conducted using evolutionary algorithms to determine the appropriate process parameter values as well as processing sequence. The optimized process plan is then used to manufacture real multi-material tool insert samples by selective laser melting.

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Laser confocal microscope noise evaluation on injection compression moulded (ICM) transparent polymer Fresnel lenses

The evaluation of an adequate and robust measuring strategy, for roughness assessment of polymer Fresnel lenses, is put under assessment. An 'on-sample' measurement noise, is evaluated using a laser confocal microscope (OLYMPUS © Lext). Secondly, the lowest-noise roughness measuring procedure, on an injection compression moulded (ICM) Fresnel lens, is defined. A set of two different objectives is considered, i.e. a standard series (SO), against a long working distance one (LWD); two different magnifications objectives, 50x and 100x and the use or not of a dark environment. The noise evaluation is performed by comparing 'on-sample' noise with the one calculated on an optical flat. Noise is investigated by means of established methods, i.e. subtraction and averaging methods. Afterwards, the lowest-noise analysis is structured following a 23 full factorial experimental planning, whose factors are measuring working distance, objective magnification and room lighting. The result confirms a strong difference of noise, using the considered objectives. The most interesting result is that the performance of SO 50x objective is better than LWD 100x.

Life Cycle Assessment of Fiber-Reinforced Additive Manufacturing for Injection Molding Insert Production

Additively manufactured (AM) injection molding (IM) inserts have proved to be capable to substitute conventionally manufactured metal inserts with polymer-based insert enforced with short, virgin, unseized carbon fibers (CFs). It has been shown that the implementation of AM technology resulted in significant improvements when investigating costs and cycle time for smaller part series. However, being a novel technology, AM inserts yield undesired characteristics, e.g. in terms of potential environmental impact because of the lower lifetime compared to metal inserts. Based on physical performance tests, this contribution provides a comparison of environmental performance of conventionally vs. additively manufactured inserts in a full life cycle perspective indicated in Figure 1, including materials, production, use and end-of-life (EoL) stages.

Local microstructure and flow stress in deformed metals

The microstructure and flow stress of metals are related through many well-known strength-structure relationships based on structural parameters, where grain size and dislocation density are examples. In heterogeneous structures, the local stress and strain are important as they will affect the bulk properties. A microstructural method is presented which allows the local stress in a deformed metal to be estimated based on microstructural parameters determined by an EBSD.
analysis. These parameters are the average spacing of deformation introduced boundaries and the fraction of high angle boundaries. The method is demonstrated for two heterogeneous structures: (i) a gradient (sub)surface structure in steel deformed by shot peening; (ii) a heterogeneous structure introduced by friction between a tool and a workpiece of aluminum. Flow stress data are calculated based on the microstructural analysis, and validated by hardness measurement and 2D numerical simulations. A good agreement is found over a plastic strain range from ~1 to 5.

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Low Loss Polycarbonate Polymer Optical Fiber for High Temperature FBG Humidity Sensing
We report the fabrication and characterization of a polycarbonate (PC) microstructured polymer optical fiber (mPOF) Bragg grating (FBG) humidity sensor that can operate beyond 100°C. The PC preform, from which the fiber was drawn, was produced using an improved casting approach to reduce the attenuation of the fiber. The fiber loss was found reduced by a factor of two compared to the latest reported PC mPOF [20], holding the low loss record in PC based fibers. PC mPOF-BG was characterized to humidity and temperature, and a relative humidity (RH) sensitivity of 7.31± 0.13 pm/% RH in the range 10–90% RH at 100°C and a temperature sensitivity of 25.86±0.63 pm/°C in the range 20–100 °C at 90% RH were measured.

General information
Material testing of copper by extrusion-cutting

An investigation was carried out on the use of extrusion-cutting as a material test method operating at severe conditions of strain, strain-rate and temperature, such as in machining. In extrusion-cutting, a shoe constrains the chip back surface producing a geometrically defined orthogonal cutting process which can be modelled using methods from the theory of plasticity such as, e.g., slip-line and upper-bound. The process was previously proposed for use as a material testing technique to determine the shear flow stress of materials under strains, strain rates and temperatures relevant for analytical modelling of metal cutting. This work represents a new step where the final objective is the generation of stress-strain curves that can be used in analytical models as well as using Finite Element Method (FEM) simulations. A new experimental setup for extrusion-cutting using discs as workpieces was developed and implemented on a CNC lathe. An investigation was carried out extrusion-cutting copper discs using high-speed-steel cutting tools at 100 m/min cutting speed. Flow stress values for copper under machining-relevant conditions were obtained from measurement of the extrusion-cutting force on the tool and application of a simple upper-bound model for the extrusion-cutting process. An attempt to extend the validity of test data to cover a range of cutting conditions was made, and suggestions for improvement of the simple theoretical model given. (C) 2017 Published by Elsevier B.V.
Mathematical modelling of moisture transport into an electronic enclosure under non-isothermal conditions

In contrast to high fidelity CFD codes which require higher computational effort/time, the well-known Resistor-Capacitor (RC) approach requires much lower calculation time, but has a lower resolution of the geometrical arrangement. Therefore, for enclosures without too complex geometry in their interior, it is more efficient to use the RC method for thermal management and design of electronic compartments. Thus, the objective of this paper is to build an in-house code based on the RC approach for simulating coupled heat and mass transport into a (closed) electronic enclosure. The developed code has the capability of combining lumped components and a 1D description. Heat and mass transport is based on a FVM discretization of the heat conduction equation and Fick's second law. Simulation results are compared with corresponding experimental findings and good agreement is found. Since, the paper concerns climatic cyclic conditions, a study is accomplished on investigating different material properties (thermal conductivity, diffusivity, solubility) for moisture control inside an enclosure. Further simulations were performed to study the response of temperature and moisture inside an enclosure exposed to the B2 STANAG climatic cyclic conditions. Moreover, the time for moisture build-up inside an enclosure under cyclic conditions is presented for different material properties.

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Scopus rating (2012): SJR 0.574 SNIP 1.323 CiteScore 1.6
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BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.607 SNIP 1.327 CiteScore 1.63
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.576 SNIP 1.064
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Measurement noise of a point autofocus surface topography instrument

Optical instruments for areal topography measurement can be especially sensitive to noise when scanning is required. Such noise has different sources, including those internally generated and external sources from the environment.

Micro injection moulding process optimization of an ultra-small POM three-dimensional component

Replication-based manufacturing processes are a cost-effective method for producing complex and net-shaped components [1]. Micro injection moulding has a prominent place among them for its capability of accurately and precisely produce micro plastic parts in large production scale [2], [3]. In this study, the optimization of the micro injection moulding process of an ultra-small (volume: 0.07 mm³; mass: 0.1 mg) three-dimensional Polyoxymethylene (POM) micro component for medical applications (see Figure 1) is presented. Preliminary experiments highlighted the need for venting channels in order to facilitate the evacuation of air from the micro cavity, allowing the consistent achievement of complete filling. If, on one hand, the implemented venting channel (depth: 4 μm) solved the issue, on the other, it caused the formation of a micro-scaled flash on the part. In order to optimize the part geometry with respect to design specifications, the flash areal size was utilized as quality indicator. A design of the experiments approach was carried out in order to study the effects of melt temperature, mould temperature, holding pressure and injection speed. For this task, a two-level full factorial design was selected. The flash size (i.e. flash area) of each moulded part was characterized and measured using a state-of-the-art 3D focus variation microscope featuring sub-micrometric lateral resolution (see Figure 2). The results of the analysis show that the flash can be successfully used to highlight the most significant process parameters with respect to the part quality (see Figure 3). Being the flash area also measurable using an appropriate 2D camera, this opens the door to future in-line and cost-effective dimensional quality assurance.
Micro/Nano manufacturing
Micro- and nano-scale manufacturing has been the subject of an increasing amount of interest and research effort worldwide in both academia and industry over the past 10 years. Traditional (MEMS) manufacturing, but also precision manufacturing technologies have been developed to cover micro-scale dimensions and accuracies. Furthermore, these fundamentally different technology ecosystems are currently combined in order to exploit strengths of both platforms. One example is the use of lithography-based technologies to establish nanostructures that are subsequently transferred to 3D geometries via injection molding.

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Modeling and evaluation of the influence of micro-EDM sparking state settings on the tool electrode wear behavior
Micromachining technologies are now being employed in various industries for generation of precise features on engineering components. Among these processes, micro electrical discharge machining is a 'non-contact' machining
technology suitable for material removal from electrically conductive materials characterized by considerable wear of the tool used for material removal. This paper presents an investigation involving modeling and estimation of the effect of settings for generation of discharges in stable conditions of micro-EDM on the phenomenon of tool electrode wear. A stable sparking condition during the process is achieved with varying voltage (V), capacitance (C), threshold (T), and discharge frequency (f). The tool electrode wear model has revealed that the energy of the sparks interacting with the tool surfaces control the phenomenon through the settings of capacitance followed by the voltage. The variables controlling the current settings for generation of stable discharges are not found to interact with each other to generate a variation on the tool wear. An increase in feed rate from 2 to 6 μm/s causes a decrease in TWR by 17%. The analysis and modeling approach helps achieve a condition for the minimum tool wear for this micro-EDM process configuration.

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Modeling of the effect of tool wear per discharge estimation error on the depth of machined cavities in micro-EDM milling
In micro-EDM milling, real time electrode wear compensation based on tool wear per discharge (TWD) estimation permits the direct control of the position of the tool electrode frontal surface. However, TWD estimation errors will cause errors on the tool electrode axial depth. A simulation tool is developed to determine the effects of errors in the initial estimation of TWD and its propagation effect with respect to the error on the depth of the cavity generated. Simulations were applied to micro-EDM milling of a slot of 5000 μm length and 50 μm depth and validated through slot milling experiments performed on a micro-EDM machine. Simulations and experimental results were found to be in good agreement, showing the effect of error amplification through the cavity depth.

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Modeling the Anisotropic Reflectance of a Surface with Microstructure Engineered to Obtain Visible Contrast after Rotation

Engineering of surface structure to obtain specific anisotropic reflectance properties has interesting applications in large scale production of plastic items. In recent work, surface structure has been engineered to obtain visible reflectance contrast when observing a surface before and after rotating it 90 degrees around its normal axis. We build an analytic anisotropic reflectance model based on the microstructure engineered to obtain such contrast. Using our model to render synthetic images, we predict the above mentioned contrasts and compare our predictions with the measurements reported in previous work. The benefit of an analytical model like the one we provide is its potential to be used in computer vision for estimating the quality of a surface sample. The quality of a sample is indicated by the resemblance of camera-based contrast measurements with contrasts predicted for an idealized surface structure. Our predictive model is also useful in optimization of the microstructure configuration, where the objective for example could be to maximize reflectance contrast.
Modelling the effect of coating on the stresses and microstructure evolution in chill casting of wind turbine main shafts

The purpose of the present work is to quantify the effect of the inside coating on chills for casting of large wind turbine main shafts with respect to the evolution of internal stresses. These are known to affect the lifetime of the chills, and this is a major cost for the foundries today. Simulations of the casting process are performed with four different heat transfer coefficients (HTCs) between the casting and the chill, and the resulting transient stress fields are reported in the chill. The microstructural evolution in the casting in terms of the nodule count is also modelled in the simulations. The outcome is validated by comparisons with samples taken out from a critical region of main shafts cast in sand and in chills. The results reveal minor reductions in the maximum principal stresses on the inner and outer surfaces of the chill of 3.1% and 18.5%, respectively, from changing the HTC from 2000 to 500 W m$^{-2}$ K$^{-1}$. These results indicate that the lifetime of the chill will not be significantly improved by adding a thicker layer of coating. The microstructure evolution is not very much affected by the HTC value with a maximum reduction in nodule count of 6.5%. Therefore, it is concluded that the material quality obtained from casting the main shafts in chills (and hence the performance of the part) is still much better than for sand casting, even though a very thick layer of coating is applied. Copyright © 2017 John Wiley & Sons, Ltd.

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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.201 SNIP 2.165 CiteScore 3.06
Web of Science (2015): Indexed yes
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Molding 4.0 - The Economics of an Injection Molding As-a-Service Business Model

During the last few years, the term Industry 4.0 or The Fourth Industrial Revolution, made its appearance and spread across industries. While it is accepted that the term broadly refers to a set of recent innovations with potential to disrupt value and process chains, the heterogeneity of actors involved contributes to a hazy definition of the phenomenon. In this work, Industry 4.0 is analyzed by analyzing into its influence on the plastics industry, with a focus on the injection molding technology. A new business model for the plastic industry is proposed, which fosters closer cooperation with suppliers and Internet-of-Things integration of equipment on the manufacturing company shop-floor. Automated quality control, predictive maintenance, and energy efficiency are identified as main levers of improvement, and associated cost savings are quantified for a total of 4.13Me. This study shows how the paradigm of Industry 4.0 is able to disrupt the industry by decreasing machine downtime and offering remarkable improvements in machine up-time. The present research aims to highlighting some of the opportunities for the plastic industry enabled by the implementation of an Internet of Things architecture.

General information
Monitoring of the thermal deformations on polymer parts using a vision system

Dimensional measurements in production environment are affected by non-controlled temperature conditions. In the case of polymer parts the high thermal expansion coefficient leads to significant dimensional changes. In order to achieve high accuracy in dimensional measurements, thermal deformations must be monitored and the measurements compensated. In this investigation thermal deformations on polymer parts are monitored using a vision system consisting of a camera equipped with telecentric lenses focused on the surface of the part. The magnification of the optics and an axial illumination allow appreciating the surface texture and surface details on the parts. A set of images is acquired at varying temperature. Digital image correlation with subpixel resolution is performed on images to estimate the displacement of the surface features. The effectiveness of the calculation is related to the quality of the surface features caught by the camera. Experimental tests are performed on a commercial ABS (Acrylonitrile Butadiene Styrene) part. Two series of pictures are acquired in different locations of the part during a cooling period of 10 minutes. Traceability of the method is established through a calibrated artefact for optical microscopes. Displacement measurement uncertainties lower than 0.5 μm have been documented.

Moulded Pulp Manufacturing: Overview and Prospects for the Process Technology

Eco-friendly packaging such as moulded pulp products have gained commercial importance in the recent years. However, it remains a greatly under-researched area, and there is an arising need to consolidate the best practices from research and industry in order to increase its implementation. The goal of this paper is to give an overview of the main aspects involved in the manufacture of moulded pulp products. This includes a classification of moulded pulp products, historical and current applications, production processes, materials, mechanical properties and environmental sustainability. Moreover, based on the latest research in the field, an innovative drying technique that utilizes concepts derived from impulse drying is presented, and the implementation of this process technology is discussed.
Multi-objective optimization of cellular scanning strategy in selective laser melting

The scanning strategy for selective laser melting - an additive manufacturing process - determines the temperature fields during the manufacturing process, which in turn affects residual stresses and distortions, two of the main sources of process-induced defects. The goal of this study is to develop a multi-objective approach to optimize the cellular scanning strategy.
strategy such that the two aforementioned defects are minimized. The decision variable in the chosen problem is a combination of the sequence in which cells are processed and one of six scanning strategies applied to each cell. Thus, the problem is a combination of combinatorial and choice optimization, which makes the problem difficult to solve. On a process simulation domain consisting of 32 cells, our multi-objective evolutionary method is able to find a set of trade-off solutions for the defined conflicting objectives, which cannot be obtained by performing merely a local search. Possible similarities in Pareto-optimal solutions are explored.

**Multi Scale Micro and Nano Metrology for Advanced Precision Moulding Technologies**

The technological revolution that has deeply influenced the manufacturing industry over the past two decades opened up new possibilities for the realisation of advanced micro and nano systems but, at the same time, traditional techniques for quality assurance became not adequate any longer, as the technology progressed. The gap between the needs of the manufacturing industry and the well-organized structure of the dimensional and geometrical metrology appeared, above all, related to the methodologies and, also, to the instrumentation used to deal with the incessant scaling down of the critical dimensions of the novel micro and nano production. Nowadays, design methodologies and concurrent tolerance guidelines are not yet available for advanced micro manufacture. Moreover, there are no shared methodologies that deals with the uncertainty evaluation of feature of size in the sub-millimetre scale.

On the other hand, a large choice of measurement equipment is now available but limitations in their use and of the instruments themselves are, in many cases, not completely understood, yet. In this context, the ambition of the PhD project was to develop and implement a complete metrological framework for advanced precision micro moulded products with micro/nano structured surfaces and micro/nano geometries, across several length scales.

Uncertainty evaluation and traceability, specification intervals formulation, assessment of the moulded parts replication and a deep investigation on the optical instruments currently available for micro/nano dimensional and geometrical measurements were all subjects of the research conducted during the three years of the PhD course of study and that were collected in this final work.

Traceability and uncertainty evaluation were dealt with the development of a comprehensive statistical methodology based on the well-known frequentist approach. It was successfully applied to dimensional and geometrical measurements in the micro/nano length scale.

A novel method was developed on purpose for the formulation of specification intervals. Based on the evaluation of the shrinkage uncertainty, it allows to discriminate between the shrinkage of 1D and 2D features and cope with the influence of length scale. The method was applied and validated in the specific case of a micro-powder injection moulding production. Nevertheless, it is of general validity for any moulding process in which the material undergoes a change in dimensions from the mould cavity, due to a phase transformation. In parallel to the formulation of specification intervals, an investigation of two instruments with two different working principle proved a mutual dependence between the quality of the measurement process and the quality of the production. The measurement process influenced the quality assurance, but the lack of quality of the parts influenced the measurement process.

The surface texture replication was investigated about the amplitude (Sa, Sq) and the slope (Sdq) and assessed by the replication fidelity, i.e., comparing the produced parts with the tool used to replicate the geometry and evaluating the measurement uncertainty. The evaluation included the repeatability and reproducibility of the production process, the amplitude and slope replication of the features on the surface, the evaluation of the uncertainty of the replication fidelity. The investigation of optical instruments started with the processing of the data of an international comparison of surface texture measurements, in the sub-micrometre scale, by optical instruments, organised under the umbrella of the Scientific Technical Committee on ‘Surfaces’ (STC-S) of The International Academy for Production Engineering (CIRP). The comparison unveiled the state-of-the-art performance, in the sub-micrometre scale, of the three main microscopes working principle currently used in areal topography measurement (confocal microscopy, coherent scanning interferometry and
focus variation microscopy). Results showed that agreement between optical instruments and reference measurements (by atomic force microscopy) could be reached to some extent, largely depending on the technology of the instruments used.

The limitations of the performance of the optical instruments were, also, inspected in specific cases that can arise during practical operation and that are becoming more and more common in modern micro and nano manufacturing. Several environmental sources were identified (thermal drifts, air conditioning system, stray light), which can introduce substantial environmental noise into the measurements, but, also, internal noise related to a prolonged use of an instrument.

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Multi-Scale Modeling of the Structural and Vibrational Behavior of Carbon Nanotube Reinforced Polymeric Nanocomposite Plates
Polymeric nanocomposites reinforced with carbon nanotubes are being considered as alternatives in many industrial applications. However, the mechanical behavior of the industrially produced nanocomposites is yet to be fully understood. In this study, Polyamide 6,6-based nanocomposites reinforced with different contents of multi-walled carbon nanotubes (MWCNTs) were manufactured using an injection moulding process. A multi-scale approach was followed to numerically model the mechanical behavior of the nanostructured materials. In order to find the stiffness matrix of the carbon nanotubes, different loading scenarios were conducted on the tubes using molecular dynamics simulations (LAMMPS). The derived properties of the carbon nanotubes from the atomistic simulations were included in a Benveniste Mori-Tanaka based micromechanical model allowing us to acquire the elastic mechanical properties in the produced nanocomposites with different arrangements and contents of the nanotubes. The numerical results were also compared with the experimental properties of the nanocomposites produced via different processing settings leading to distinct microstructures. Eventually the derived properties and stiffness matrices were incorporated in an in-house finite element code for plate vibrations. The results show how the arrangement and the content of the carbon nanotubes in the injection-moulded nanocomposite plates define their structural and vibrational behavior.

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Numerical modelling of the bonding process for wind turbine blades: model validation

Adhesive is typically used in the joint between the two shells composing a wind turbine blade. The bonding process of a blade can be characterized as a squeeze flow problem where the top shell is forced towards the bottom shell, resulting in a deformation in the adhesive. In this study, a 3-D numerical models developed in order to analyse adhesive propagation in squeeze flow problems with 3-D flow effects. The model is validated by comparison with an experiment where a rectangular prism shaped adhesive sample is squeezed between two parallel plates. In the numerical model the rheological behaviour of the adhesive is approximated with the Bingham material model. The numerical model is in good agreement with the experimental results. In the future, the model will be used to optimize the bonding process of wind turbine blades, save weight and reduce the levelized cost of energy.

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Numerical simulation of flow and compression of green sand

The focus of the industrial PhD project was concentrated on the production of the sand mold (green sand) which gives the cast component its final geometrical shape. In order to ensure a high quality of the cast component, it is important to control the manufacturing process of the mold itself so that it is homogeneous and stable. Therefore gaining a basic understanding of how the flow and deposition of green sand should be characterized and modelled is important, so that it could be used for simulation of the manufacturing process of the sand mold. The flowability of the green sand is important when the sand flows down through the hopper filling the chamber with sand during the sand shot. The flowability of green sand is mostly governed by the amount of water and bentonite which both decrease it. The flowability and the internal forces thus control how well you can fill a complex mold geomet-try in which shadowing from ribs and other geometric obstacles may be present. If the flow stops prematurely it might hinder the mould from being completely filled or result in too high variation in the material density which could influence the final surface of the cast part. The wet bridges created by the bentonite makes the sand grains stick together where the bentonite and water make the green sand very cohesive and by squeezing the mixture it obtains mechanical properties that stabilizes the mold to acquire a strong mold for the casting process. Therefore the green sand flowability is important during the sand shot for a proper filling of the chamber, and subsequently the solid mechanical proper-ties during the squeezing process are important for the final strength of the mold. This is problematic since these mechanical behaviours have an inverse relationship, e.g. if the green sand is too dry then the green sand flowability will be very high and the strength of the mold will be low and vice versa at least for the wet green sand up to a certain water content level. Therefore, obtaining the correct green sand condition and improving the filling of the mold during the sand shot are of great importance. The Discrete Element Method (DEM) was chosen as the numerical model since the dis-crete nature of the method simulates the granular structure of the green sand with good agreement. The DEM model uses a rolling resistance model to emulate the non-spherical quartz sand particles’ resistance to rolling as well as a cohesive model to emulate the binding of the quartz sand particles from the bentonite. The green sand was characterized with a ring shear tester where the yield locus was found and a new way to define the flowability was suggested. The ring shear tester was used to obtain the static friction coefficients for the DEM model. A sand pile experiment was used to investigate the simple mechanical behaviour of green sand from the measured height. From this height the DEM model was also calibrated with respect to obtaining the values of the rolling resistance and obtaining the parameter in cohesive model. The project dealt with the flow of the sand particles and the deposition of sand during the production of sand molds using the sand shot in the DISAMATIC process. The deposition of the green sand in the chamber was investigated with a special cavity design where air vents were placed inside the cavities. The air vents are used to transport the green sand with an airflow during the sand shot. By changing the air vents settings in the chamber and in the cavities it was possible to improve the filling in the narrow passages in the cavity design, thereby improving the final sand mold as well. The sand shot with the cavity design was simulated by the discrete element method (DEM) modelling the flow of the green sand combined with classical computational fluid dynamics (CFD) for modelling the airflow in the chamber and the airflow through the air vents. These experiments and simulations gave beneficial insights to the DISAMATIC process and how to improve it. Additionally fluidization properties of green sand were investigated with a fluidized bed and the newly developed Anton Paar Powder Cell was used to obtain the fluidized viscosity. Commercial aspects
Knowledge was acquired about the filling of the mold chamber with green sand in a special designed cavity geometry. The settings of the air vents together with the air pressure initially applied in the air tank gave valuable ideas for improving the
filling in the cavities thereby improving the final mold. Furthermore, it was possible to apply the commercial software of STAR-CCM+ using the combined CFD-DEM model to simulate the process with a 3-D slice representation of the geometry successfully. This makes it more feasible to develop a stand-alone code in the future for simulating the DISAMATIC process. The sand shot in the DISAMATIC process might also be modelled with a continuum model where the ring shear tester could give indications of the solid mechanical behaviour of the green sand and the Anton Paar Powder Cell could be used for obtaining the fluidized viscosities of the green sand.

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Numerical Simulations of Planar Extrusion and Fused Filament Fabrication of Non-Newtonian Fluids
In this study, the planar extrudateswelling of power-law and Oldroyd-B fluidsare investigated. Our numerical predictions are in good agreement with the other results available in the literature. In addition, a simplified two-dimensional model of fused filament fabrication that provides details of the flow in the gap between the printing head and the substrate is presented. Thenumerical simulations use the streamfunction/log-conformation and thevolume-of-fluid methods.

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BFI (2010): BFI-level 1
BFI (2009): BFI-level 1
BFI (2008): BFI-level 1
On the Application of Replica Molding Technology for the Indirect Measurement of Surface and Geometry of Micromilled Components

The evaluation of micromilled parts quality requires detailed assessments of both geometry and surface topography. However, in many cases, the reduced accessibility caused by the complex geometry of the part makes it impossible to perform direct measurements. This problem can be solved by adopting the replica molding technology. The method consists of obtaining a replica of the feature that is inaccessible for standard measurement devices and performing its indirect measurement. This paper examines the performance of a commercial replication media applied to the indirect measurement of micromilled components. Two specifically designed micromilled benchmark samples were used to assess the accuracy in replicating both surface texture and geometry. A 3D confocal microscope and a focus variation instrument were employed and the associated uncertainties were evaluated. The replication method proved to be suitable for characterizing micromilled surface texture even though an average overestimation in the nano-metric level of the Sa parameter was observed. On the other hand, the replicated geometry generally underestimated that of the master, often leading to a different measurement output considering the micrometric uncertainty.

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On the performance of micro injection moulding process simulations of TPE micro rings

Micro injection moulding (µIM) process simulations can be used as a powerful tool for the optimization of the design of mould, parts and process. However, numerous scale effects introduce relevant challenges in terms of both validation and accuracy of the simulations [1-2]. In this study, a case study based on the micro injection moulding process of thermoplastic elastomer (TPE) micro rings (volume: 1.5 mm³, mass: 2.2 mg) for sensor applications was treated. Injection moulding process simulations using Autodesk Moldflow Insight 2016® were applied with the aim of accomplishing two main tasks: the prediction of the main parts defects (weld lines and air traps) and of effects of the main injection moulding process parameters, namely mould temperature, melt temperature, injection speed and holding pressure, on the part geometrical accuracy. A three-dimensional multi-scale mesh was implemented to discretize the geometry of the parts and the feeding system. Mesh sizes of 500 μm, 250 μm and 50 μm were used for discretizing sprue, runners and parts respectively (see Figure 1). The outcomes of the simulations were directly compared to real moulded parts based on SEM inspections and focus variation measurements. The results show that the implemented model is capable of accurately capturing the position and the magnitude of the micro ring weld lines and air traps. It was therefore demonstrated that micro scaled defects can be successfully predicted using a suitable model. Finally, process simulations correctly predicted the effects of the four investigated process parameters on the part dimensions. In particular, the deviation between real parts measurements and simulations results was on average 2 μm, demonstrating that single digit micrometric simulation accuracy was successfully achieved (see Figure 2).

General information
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Authors: Baruffi, F. (Intern), Calaon, M. (Intern), Tosello, G. (Intern)
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Overview of friction modelling in metal forming processes

In metal forming processes, friction between tool and workpiece is an important parameter influencing the material flow, surface quality and tool life. Theoretical models of friction in metal forming are based on analysis of the real contact area in tool-workpiece interfaces. Several research groups have studied and modelled the asperity flattening of workpiece material against tool surface in dry contact or in contact interfaces with only thin layers of lubrication with the aim to improve understanding of friction in metal forming. This paper aims at giving a review of the most important contributions during the last 80 years covering experimental techniques, upper bound solutions, slip-line analyses and numerical simulations. Each of the contributions shed light on the importance of the real contact area and the influencing parameters including the material properties, surface conditions, normal pressure, sliding length and speed, temperature changes,
friction on the flattened plateaus and deformation of the underlying material. The review illustrates the development in the understanding of asperity flattening and the methods of analysis. Finally, the present paper discusses the necessary future work in order to advance further in modelling of real contact area in relation to implementation of frictional conditions existing finite element codes for simulation of metal forming processes.

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Authors: Nielsen, C. V. (Intern), Bay, N. O. (Intern)
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**Parallel direct solver for finite element modeling of manufacturing processes**
The central processing unit (CPU) time is of paramount importance in finite element modeling of manufacturing processes. Because the most significant part of the CPU time is consumed in solving the main system of equations resulting from finite element assemblies, different approaches have been developed to optimize solutions and reduce the overall computational costs of large finite element models.

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Authors: Nielsen, C. V. (Intern), Martins, P. (Ekstern)
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Series: Woodhead Publishing Reviews: Mechanical Engineering
Performance Simulation and Verification of Vat Photopolymerization Based, Additively Manufactured Injection Molding Inserts with Micro-Features

Injection molding soft tooling inserts manufactured additively with vat photopolymerization represent a valid technology for prototyping and pilot production of polymer parts. However, a significant drawback is the low heat conductivity of photopolymers influencing cycletime and part quality. In this research, the thermal performance of a 20x20x2.7 mm³ injection molding insert was simulated. A thermal camera was used to assess the quality and accuracy of the simulation. Both, simulation and measurements showed that the temperature cycle during injection molding becomes stationary within 3 to 5 cycles. After 2800 injection molding cycles, the experiment was stopped and the insert was still intact.

Photogrammetry for Repositioning in Additive Manufacturing

In this preliminary work, we present our current status on how to use single camera photogrammetry to determine the orientation of an additively manufactured partly finished object that has been repositioned in the printing chamber, from a single image taken with a calibrated camera, and comparing this to the CAD model of the object. We describe how this knowledge can be used to update the machine code of the printer such that printing of the object can be resumed. This opens possibilities for embedding and assembling foreign parts into the additive manufacturing pipeline, adding another layer of flexibility to the process. However, due to various error sources in estimating the orientation of the object, more work is needed before this update can be applied.

Photogrammetry for Repositioning in Additive Manufacturing

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**PicPrint: Embedding pictures in additive manufacturing**

Here we present PicPrint, a method and tool for producing an additively manufactured lithophane, enabling transferring and embedding 2D information into additively manufactured 3D objects. The method takes an input image and converts it to a corresponding height-map, indicating the material density required to achieve a brightness specified at any given location. Non-linear scattering properties are compensated for using predefined falloff profiles. Using the produced height-map, a watertight mesh is distorted to match the specified material densities, after which the mesh is ready for either direct print on an additive manufacturing system, or transfer to other geometries via Boolean mesh operations.

**General information**
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Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Department of Mechanical Engineering, Manufacturing Engineering  
Number of pages: 3  
Publication date: 2017

**Predicting the onset of cracks in bulk metal forming by ductile damage criteria**

Three different ductile damage criteria, Ayada, normalized Cockcroft and Latham and a new shear stress based criterion taking into account hydrostatic tension, are utilized for predicting the onset of cracks in various deformation processes. It is found that the Ayada criterion predicts well the onset of cracks when they originate from hydrostatic tension. The shear based criterion predicts cracks triggered by shear and the normalized Cockcroft and Latham criterion indicates the overall area of onset of cracks caused by either hydrostatic or shear stresses. However the prediction is not as accurate as the Ayada criterion for cracks caused by hydrostatic tension.

**General information**
State: Published  
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Universidade de Lisboa  
Authors: Christiansen, P. (Intern), Nielsen, C. V. (Intern), Martins, P. A. (Ekstern), Bay, N. O. (Intern)  
Pages: 2048-2053  
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Conference: International Conference on the Technology of Plasticity (ICTP 2017), Cambridge, United Kingdom, 17/09/2017 - 17/09/2017  
Main Research Area: Technical/natural sciences
Preface to special issue of selected papers from Theoretical, Experimental, and Computational Mechanics (TECM)

We are pleased to introduce this special issue of the Applied Mathematical Modelling journal with highlights from the Theoretical, Experimental, and Computational Mechanics Symposium (TECM-2015). This special issue consists of four rigorously selected papers originally presented at TECM-2015 as a part of the 13th International Conference of Numerical Analysis and Applied Mathematics 2015 (ICNAAM 2015), which was held on 23-29 September 2015 in Rhodes, Greece. The symposium attracted a broad range of international and local leaders in theoretical, experimental, and computational mechanics across various fields and application.

The symposium did an excellent job of outlining the current landscape of computational mechanics and its capabilities in solving complex industrial problems in the process industries, and we agree with the editor-in-chief of the journal that it is certainly worthwhile recording this in the form of a special issue. The selected papers from the TECM-2015 for potential inclusion in this special issue were identified by the TECM-2015 Organizing Committee based on quality, relevance and scope.

All selected papers were significantly expanded in content by their authors, and were subjected to the rigorous APM review process. We wish to thank the authors for their hard work in turning the original conference papers into top quality full journal articles. We also wish to thank our international reviewers who kindly agreed to review the articles to ensure that the quality of the papers matches those of Applied Mathematical Modelling standards.

General information

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Warwick
Authors: Jabbari, M. (Ekstern), Sarlak Chivaee, H. (Intern), Hattel, J. H. (Intern)
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Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.074 SNIP 1.974 CiteScore 2.73
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Pressure-assisted forming of non-concentric tubular cross sections with solid medium

Pressure-assisted forming of tubes allows producing a wide variety of tubular components that are difficult or impossible to fabricate by means of conventional tube forming. In contrast to previous investigations in the field that were almost exclusively focused on the utilization of fluids (tube hydroforming) or elastomers (tube rubber forming) as pressuring medium, the subject matter of this article is centred in the utilization of low melting point, recyclable, metallic alloys as solid pressurizing medium. The aims and scope of the article are centred on the feasibility of forming straight carbon steel tubes into complex gooseneck geometries with non-concentric cross sections using lead as a solid pressuring medium and employing a double-action cam-driven tool system. The presentation is focused on the tool system, on its adequacy to produce customized tubular components, on the required forming forces and on the typical modes of deformation that result from the different movements provided by the vertical and horizontal actuators of the double-action tool system. Results and observations confirm that the utilization of a double-action tool system with a solid pressurizing medium to assist plastic deformation and prevent collapse can be successfully and effectively employed to fabricate non-concentric tubular cross sections for prototypes and small batches of lightweight components.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Universidade de Lisboa
Authors: Alves, L. M. (Ekstern), Silva, C. M. (Ekstern), Nielsen, C. V. (Intern), Martins, P. A. (Ekstern)
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Pre-treatment of Biomass By Rolling - A Combined Experimental and Numerical Analysis

Pre-treatment of bulk straw material by rolling is studied as a possible method to prepare for subsequent biogas production. A combined experimental and theoretical study is presented. A pilot rolling mill with a double screw feeder is designed and constructed for crushing of bulk straw. Experiments show that the roll speed and the roll reduction should be chosen within a specific range depending on the injection screw speed to avoid blocking or insufficient compaction. A mechanical testing procedure of the bulk straw material including closed die compaction testing as well as simple upsetting of pre-compacted billets of straw is carried out based on which a mathematical model for the yield surface is determined fitting to a geological cap model for porous material similar to the Drucker-Prager spherical cap model. An experimental test campaign is carried out to determine the feasible process window for pre-treatment of wheat straw by roll pressing varying the feed, the roll gap, the roll speed and the moisture content of the bulk straw.
Process chain for fabrication of anisotropic optical functional surfaces on polymer components

This paper aims to introduce a process chain for fabrication of anisotropic optical functional surfaces on polymer products. The surface features under investigation are composed of micro serrated ridges. The scope was to maximize the visible contrast between horizontally orthogonal textured surfaces from a certain viewing angle. The process chain comprised three steps: tooling, replication, and quality assurance. Tooling was achieved by precision micro milling. Replication processes such as injection moulding, hot embossing, blow moulding, etc. were employed according to the specific type of product. In order to implement the traceability of the manufacturing process, the geometry and dimension of the micro structure on the tool and the replica were assessed via metrological methods. The functionality of the anisotropic surfaces on the polymer replicas were evaluated by a gonioreflectometer and image processing. Eventually, according to the function evaluation of polymer products, the process chain steps will be optimized by tuning the tooling and moulding processes.
Quantification of deformation microstructure at ultra-low tensile strain in pure Al prepared by spark plasma sintering

A sample of Al with grain size of 5.1 µm, prepared by spark plasma sintering, was deformed to a nominal strain of 0.35% under exposure to X-ray synchrotron radiation, allowing spatially resolved orientation measurements to be made during loading by use of a micro-diffraction technique. A significant heterogeneity in the deformation pattern between grains was observed. A statistical analysis shows that grain deformation depends more on crystallographic orientation than on grain size, with grains with tensile axis lying towards the <001>-<101> border of the unit triangle tending to undergo larger deformation. Other possible reasons for the different deformation behaviour between individual grains are briefly discussed.
Replication assessment of surface texture at sub-micrometre scale

Precision molding and micro injection molding (μIM) have been the main replication technologies allowing for a rapid reduction of the dimensions of the products and, consequently, for the realization of new advanced micro and nano systems. Such miniaturization in the manufacture of polymer micro-parts and parts with micro and nano surfaces is still in progress and requires new specially developed solutions in all the steps of injection molding processes [1]. The achievement of a full surface replication of the tool insert component, when molding the polymer melt, is essential in advanced μIM technology [2]. A replication process requires reproducing a master geometry by conveying it to a substrate material. It is typically induced by means of different energy sources (usually heat and force) and a direct physical contact between the master and the substrate. Furthermore, concepts of advanced products may be founded on combined processes and process chains, including large variety of materials (mainly polymers, glass or metals) and different dimensional scales. Hence, it is particularly critical when dealing with increasingly small dimensions in micro and nanostructured surfaces. In addition, because of the replication nature of molding processes, the required specifications for the manufacture of micro molded components must be ensured by means of a metrological approach to surface replication and dimensional control of both master geometry and replicated substrate [3]-[4]. Therefore, a detailed knowledge is necessary of not only absolute dimensions and geometrical quantities, but also of the measurement uncertainty, which is a decisive parameter to deal with the quality assurance of micro and nano manufactured components [5]. In this context, the quality of the achieved surface texture replication was assessed by the replication fidelity, i.e., comparing the produced parts with the tool used to replicate the geometry. Furthermore, the uncertainty of the replication fidelity was achieved by propagating the uncertainties evaluated for both masters and replicas. Finally, despite the specimens investigated were made of thermoplastic polymers, the techniques employed are general and can be used to describe any kind of material of the replicated substrate.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Quagliotti, D. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
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Replication of micro and nano-features on iPP by injection molding with fast cavity surface temperature evolution

The production of polymeric components with functional structures in the micrometer and sub-micrometer range is a complex challenge for the injection molding process, since it suffers the use of low cavity surface temperatures that induce the fast formation of a frozen layer, thus preventing accurate replication of micro and nano-features.

In this work, a thin heating device allowed reaching and maintaining the desired temperature on the cavity surface, by joule effect. A nickel insert with micro and nano-features in relief was located on the cavity surface, and the replication by isotactic polypropylene of the features was analyzed, by Atomic Force Microscopy, under several process parameters. The increase of holding pressure enhanced the replication, but accurate replication was achieved only increasing the cavity surface temperature. A heating time comparable with cavity filling time was sufficient to obtain accurate replication, with adequate surface temperatures.

In the case of nano-features, the replication accuracy was affected by the morphology developed on the molding surface, that is aligned along the flow direction with dimensions comparable with the dimension of the nano-features. Therefore, their formation on the surface reduced the accuracy of replication in the direction orthogonal to the flow front.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Salerno
Authors: Speranzaa, V. (Ekstern), Liparotia, S. (Ekstern), Calaon, M. (Intern), Tosello, G. (Intern), Pantania, R. (Ekstern), Titomanlio, G. (Ekstern)
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Main Research Area: Technical/natural sciences

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Replication quality assessment and uncertainty evaluation of a polymer precision injection moulded component

Among all the recently born manufacturing technologies, precision injection moulding holds a central role, being the only replication process currently capable of accurately producing complex shaped polymer parts integrating micrometric features on a mass scale. In this scenario, a study on the replication quality of a polymer injection moulded precision component for telecommunication applications is presented. The effects of the process parameters on the component dimensional variation have been investigated using a statistical approach. Replication fidelity of produced parts has been assessed using a focus variation microscope with sub-micrometric resolution. Measurement uncertainty has then been evaluated, according to the GUM considering contributions from different process settings combinations and mould
geometries. The analysis showed that the injection moulding manufacturing process and the utilized measurement chain are indeed capable of providing the high precision needed for the production. The calculated uncertainties are compatible with the imposed part requirements.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Alicona Imaging GmbH, Flann Microwave Limited
Authors: Baruffi, F. (Intern), Calaon, M. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern), Prantl, M. (Ekstern), Miller, N. (Ekstern)
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Precision injection moulding, Uncertainty budget, Optical micro metrology, Polymer replication
Source: Publication PreSubmission
Source-ID: 132847452
Publication: Research - peer-review › Article in proceedings – Annual report year: 2017

**Replication quality assessment and uncertainty evaluation of a polymer precision injection moulded component**

Precision injection moulding holds a central role in manufacturing as only replication process currently capable of accurately producing complex shaped polymer parts integrating micrometric features on a mass scale production. In this scenario, a study on the replication quality of a polymer injection moulded precision component for telecommunication applications is presented. The effects of the process parameters on the component dimensional variation have been investigated using a statistical approach. Replication fidelity of produced parts has been assessed using a focus variation microscope with sub-micrometric resolution. Measurement uncertainty has then been evaluated, according to the GUM considering contributions from different process settings combinations and mould geometries. The analysis showed that the injection moulding manufacturing process and the utilized measurement chain are indeed capable of providing the high precision needed for the production. The calculated uncertainties are compatible with the imposed part requirements.

**General information**

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**Response surface modelling of tool electrode wear rate and material removal rate in micro electrical discharge machining of Inconel 718**

Inconel 718 is a corrosion-resistant and high strength nickel-based alloy with wide range of applications including components for cryogenic tankage, liquid fueled rockets and casings for aircraft engines. The material is characterized by high hardness, high temperature strength, low thermal conductivity and high strength causing it extremely difficult to machine. Micro-Electrical Discharge Machining (Micro-EDM) is a non-conventional method that has a potential to overcome these restrictions for machining of Inconel 718. Response Surface Method (RSM) was used for modelling the tool Electrode Wear Rate (EWR) and Material Removal Rate (MRR) with the input factors such as voltage (V), peak current (I_p) and pulse on-time (T_on). The RSM analysis of variance results show that the main input factors’ pulse off-time and peak voltage are significant in controlling the tool electrode wear rate at 95% confidence level. An increase in voltage from 30 to 45 V and pulse on-time from 1 to 3 μs causes a linear decrease in EWR by 35%. Using response surface modeling, a 3 minimum EWR of 12.3184 μm /min and a maximum MRR of 37.2151 μm /min is obtained at a current of 1.07 A, pulse ontime of 4.44 μs, pulse off-time of 4.06 μs and voltage of 60 V.

**General information**
Revisiting liquid lubrication methods by means of a fully coupled approach combining plastic deformation and liquid lubrication

This paper presents a new approach based on a fully coupled procedure in which the lubricant flow and the plastic deformation of the metallic material in metal forming are solved simultaneously. The proposed method is an alternative to conventional modelling techniques which allow studying the effect of a broad range of parameters directly on the friction conditions. The approach is applied to strip reduction of a sheet with mesoscopic surface pockets in order to investigate the escape of lubricant from the pocket by means of Micro Plasto HydroDynamic Lubrication and Micro Plasto HydroStatic Lubrication. For the investigation on Micro Plasto HydroStatic Lubrication, the friction along the tool–workpiece contact interface and the back tension are taken as parameters, and the backward escape Micro Plasto HydroDynamic Lubrication is investigated by variations in lubricant viscosity by means of a combined numerical and analytical model, and by variations in drawing speed. Good agreement is found with the experimental observations.

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Scopus rating (2015): SJR 0.611 SNIP 0.939 CiteScore 0.98
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.598 SNIP 1.05 CiteScore 0.89
BFI (2013): BFI-level 1
Rheology of high melt strength polypropylene for additive manufacturing

Rheological measurements of high melt strength polypropylene (HMS-PP) were used in order to generate master curves describing the shear-dependent viscosity in comparison to acrylonitrile butadiene styrene copolymer (ABS). The latter material showed specific disadvantages in terms of thermal stability, whereas HMS-PP showed a more stable behavior at the investigated temperatures. Hereafter, the material was used in a fused deposition modeling additive manufacturing process, focusing on the investigation of possible improvements of HMS-PP over ABS. Based on the extrusion parameters for ABS, adapted parameters for HMS-PP were determined using a fused deposition modeling test bench. The rheological survey clearly showed changes in the melt viscosity of both ABS and HMS-PP due to thermal degradation. However, the comparison of rheological data of the virgin materials with those of printed material showed negligible changes. This leads to the conclusion that the thermal degradation of HMS-PP and ABS during the fused deposition modeling process is negligible, due to the short exposure time to elevated temperatures. Copyright © 2017 VBRI Press.
Selecting the optimum engineering model for the frequency response of fcc nanowire resonators

The full potential of the nanoelectromechanical systems, NEMS, as one of the leading ex-amples among the new-generation sensing technologies, is yet to be realized. One of the main challenges on the road is the mechanical modeling of their core elements, the tiny mechanical building blocks such as the nanowire resonators. The success of the engineer-ing design of such miniaturized systems will depend heavily on the availability of accurate mechanistic models with the least possible computational cost. Although a variety of models are available for this purpose, the boundaries between their admissible domains remain rather vague. For example, analytical approaches including Euler–Bernoulli and Timoshenko beam theories provide closed-form solutions and work reasonably well for moderate nanowire geometries, and hence, they are frequently utilized in the literature. However, their validity in the case of extreme surface-to-volume ratios remains questionable. Classical finite element method can partially be used to address these deficiencies. On the other hand, molecular dynamics provide accurate results, while nanowire geometries studied with this computationally demanding technique usually remain confined to dimensions below those of practical interest. To address these issues, a benchmarking study among analytical and numerical techniques is carried out, where Surface Cauchy–Born theory serves as the reference. Using gold nanowires with different dimensions and boundary conditions, it is observed that analytical models are applicable within a length- to-thickness ratio range of 7–11 in the fixed–fixed configuration, whereas they can be used safely within a length-to-thickness ratio range of less than 25 in the fixed–free configuration. Deviations as high as 50% are encountered for length-to-thickness ratios exceeding 11 for both the analytical approach and the classical finite element method in the fixed–fixed structure. The deviations are quantitatively linked to the dominance of the surface effect through the use of the Surface Cauchy–Born model. For length-to-thickness ratios less than 7, the lack of cross-sectional deformations in analytical treatment is also observed to lead to high deviations for the fixed–fixed configuration through the comparison with higher-order beam theories. Results are verified with silver nanowires as well. The work provides a guideline for selecting the optimum mechanical model given the nanowire resonator dimensions and boundary conditions.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Koc University
Authors: Nasr Esfahani, M. (Ekstern), Yilmaz, M. (Ekstern), Sonne, M. R. (Intern), Hattel, J. H. (Intern), Alaca, B. E. (Ekstern)
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Scopus rating (2017): SNIP 1.394 SJR 0.876 CiteScore 2.68
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Shot peening speed measurements using lidar technology

The shot peening technique is used for the surface modification of metallic components that are part of wind turbines, such as gears, bolts and blade coatings to prevent erosion. An important parameter of this technique is the dynamic energy of emitted shots. In this context the objective of this project is to present a proof of concept measurement method for the evaluation of the speed of the shots. A remote sensing laser anemometer was selected as a probing instrument of the peening shots' speed since it avoids any disturbances to the flow from the presence of an in-situ instrument. Furthermore, the risk of damaging the peening machine by installing an instrument inside the chamber during operation is eliminated by this approach. Laser anemometers are being researched and developed in the department of Wind Energy, mainly in the framework of the WindScanner.dk infrastructure project [1], but also validated and used in monitoring the wind conditions around wind turbines (wake and inflow), over complex terrain as well as offshore.
Simultaneous measurement of temperature and humidity with microstructured polymer optical fiber Bragg gratings

A microstructured polymer optical fiber (mPOF) Bragg grating sensor system for the simultaneous measurement of temperature and relative humidity (RH) has been developed and characterized. The sensing head is based on two in-line fiber Bragg gratings recorded in a mPOF. The sensor system has a root mean square deviation of 1.04 % RH and 0.8 °C in the range 10 to 90% RH and 20 to 80 °C. The proposed sensor system is easy to fabricate, cheap and compact.

Solution-Mediated Annealing of Polymer Optical Fiber Bragg Gratings at Room Temperature

In this letter, we investigate the response of poly(methylmethacrylate) (PMMA) microstructured polymer optical fiber Bragg gratings (POFBGs) after immersion in methanol/water solutions at room temperature. As the glass transition temperature of solution-equilibrated PMMA differs from the one of solvent-free PMMA, different concentrations of methanol and water lead to various degrees of frozen-in stress relaxation in the fiber. After solvent evaporation, we observe a permanent blue-shift in the grating resonance wavelength. The main contribution in the resonance wavelength shift arises from a permanent change in the size of the fiber. The results are compared with conventional annealing. The proposed methodology is cost-effective as it does not require a climate chamber. Furthermore, it enables an easy-to-control tuning of the resonance wavelength of POFBGs.
State-of-the-art of fiber-reinforced polymers in additive manufacturing technologies

Additive manufacturing technologies have received a lot of attention in recent years for their use in multiple materials such as metals, ceramics, and polymers. The aim of this review article is to analyze the technology of fiber-reinforced polymers and its implementation with additive manufacturing. This article reviews recent developments, ideas, and state-of-the-art technologies in this field. Moreover, it gives an overview of the materials currently available for fiber-reinforced material technology.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Hofstätter, T. (Intern), Pedersen, D. B. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
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Scopus rating (2016): CiteScore 1.24 SJR 0.423 SNIP 0.687
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.492 SNIP 0.861 CiteScore 1.32
BFI (2014): BFI-level 1
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Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
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ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.525 SNIP 0.874 CiteScore 1
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Stress and Strain Gradients in a Low Carbon Steel Deformed under Heavy Sliding

A recent study [1] has shown that a microstructure can be refined to a record low of 5 nm and that dislocation glide is still a controlling mechanism at this length scale. In this study, by heavy rotatory sliding of a low carbon steel a gradient structure has been produced extending to about 2.5 mm below the surface reducing the structural scale to the nanometer dimension and increasing the strength to extreme values by dislocation and boundary strengthening. The microstructure and texture gradient are analyzed and stress and strain gradients produced by plastic deformation are evaluated based on the deformation microstructure using the classic stress-structure relationship. Computational and materials modelling has been advanced from bulk to gradient structures leading to dissemination of constitutive stress-strain equations in gradient structures.
Synchrotron measurements of local microstructure and residual strains in ductile cast iron

The local microstructure and distribution of thermally induced residual strains in ferrite matrix grains around an individual spherical graphite nodule in ductile cast iron (DCI) were measured using a synchrotron X-ray micro-diffraction technique. It is found that the matrix grains are deformed, containing dislocations and dislocation boundaries. Each of the residual strain components in the matrix grains exhibits a complex pattern along the circumferential direction of the nodule. Along the radial direction of the nodule, strain gradients from the interface to the grain interior are seen for some strain components, but only in some matrix grains. The observed residual strain patterns have been analysed by finite element modelling, and a comparison between the simulation and experiments is given. The present study of local residual stress by both experimental characterization and simulation provide much needed information for understanding the mechanical properties of DCI, and represent an important contribution for the microstructural design of new DCI materials.
The effect of saturation on resin flow in injection pultrusion: a preliminary numerical study

In this study, a 2-D Darcy's law based numerical model is developed in order to investigate the effect of saturation on the propagation of the resin in the die chamber of a pultrusion line. The numerical model is established using the finite volume method and alternating direction implicit scheme. The implemented saturation and relative permeability curves are adopted from relationships presented in the literature. The results of the numerical model highlights the importance of accurately determining the saturation curve when included in a numerical solver that is used to predict the resin flow in injection pultrusion. Further research is planned within this field in order to identify realistic saturation curves for fiber reinforcements used in resin injection pultrusion.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark, Fiberline Composites A/S
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Source: PublicationPreSubmission
Source-ID: 140796424
Publication: Research - peer-review › Paper – Annual report year: 2017

The impact of tool wear on the functionality of replicated polymer surface with micro structures

Wear happened frequently in the tooling process of mold for polymer production. The scope of this paper is to understand how the wear of the milling tool affected the function of the replicated polymer surface. This study is part of the process chain of fabrication of optical functional surfaces on polymer composites. The aiming function of the surfaces is to maximize the reflectance from a certain viewing angle and direction, and minimize from its horizontally orthogonal position, i.e. to maximize the contrast between two horizontally orthogonal view positions at the same inclination. A five-axis micro milling machine was employed to pattern the surface of a steel insert for subsequent polymer replication.

In order to conduct the study, 1200 pixels (0.8 x 0.8 mm²) was machined on the surface of a steel insert using the same mill tool (Φ0.5 mm, ARNO®); each of the pixels contains 16 ridges which is illustrated in figure 1 (a). The obtained surface structures were replicated using liquid silicon rubber (LSR).

The mill tool was inspected by scanning electron microscope (SEM) before and after the machining. Noticeable wear was observed. The weight of the studied tool was measured before and after machining for comparison. The obtained surface features on the insert and the LSR replica were measured using a confocal 3D laser scanner. The reflectance of the surfaces on the LSR replica was evaluated using a gonioreflectometer[1]. The gonioreflectometer captured the images of every 100th pixel from all the viewing angles by rotating the sample holder and tilting the objective lens. The reflectance for each configuration were obtained via image processing tools.

Results in this study include: 1. Tool wear was visualized by SEM images, which is shown in figure 1 (b). 2. However, the weight decrease could not be detected due to lack of precision in the measurement. 3. The number of defects on the obtained surface structures increased significantly along with the process. 4. The reflectance of these pixels on the LSR replica decreased from the first machined one to the last one.

As a conclusion, the tool (Φ 0.5mm, ARNO®) used in this study worn after machining for approximately 100 pixels, considering the function loss of replica surface. Future work will be dedicated to the methods that can prolong the tool life.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics
Authors: Li, D. (Intern), Zhang, Y. (Intern), Regi, F. (Intern), Tosello, G. (Intern), Nielsen, J. B. (Intern)
Number of pages: 1
The Influence of Tool Texture on Friction and Lubrication in Strip Reduction Testing

While texturing of workpiece surfaces to promote lubrication in metal forming has been applied for several decades, tool surface texturing is rather new. In the present paper, tool texturing is studied as a method to prevent galling. A strip reduction test was conducted with tools provided with shallow, longitudinal pockets oriented perpendicular to the sliding direction. The pockets had small angles to the workpiece surface and the distance between them were varied. The experiments reveal that the distance between pockets should be larger than the pocket width, thereby creating a topography similar to flat table mountains to avoid mechanical interlocking in the valleys; otherwise, an increase in drawing load and pick-up on the tools are observed. The textured tool surface lowers friction and improves lubrication performance, provided that the distance between pockets is 2–4 times larger than the pocket width. Larger drawing speed facilitates escape of the entrapped lubricant in the pockets. Testing with low-to-medium viscosity oils leads to a low sheet roughness on the plateaus, but also local workpiece material pick-up on the tool plateaus. Large lubricant viscosity results in higher sheet plateau roughness, but also prevents pick-up and galling.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Sulaiman, M. H. B. (Intern), Christiansen, P. (Intern), Bay, N. O. (Intern)
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Tool surface texture, Lubricant entrapment, Strip drawing test
Electronic versions:
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Bibliographical note
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Relations
Activities:
Influence of tool texture on friction and lubrication in strip reduction
Publication: Research - peer-review › Journal article – Annual report year: 2017

The Particle-Matrix model: limitations and further improvements needed
According to the Particle-Matrix Model (PMM) philosophy, the workability of concrete dependson the properties of two phases and the volumetric ratio between them: the fluid matrix phase (<0.125 mm) and the solid particle phase (> 0.125 mm). The model has been successfully applied to predict concrete workability for different types of concrete, but has also indicated that some potential cases exist when its application is limited. The paper presents recent studies on improving the method by analysing how the PMM one-point flow parameter λQ can be expressed by rheological models (Bingham and
Thermal modelling of extrusion based additive manufacturing of composite materials

One of the hottest topics regarding manufacturing these years is additive manufacturing (AM). AM is a young branch of manufacturing techniques, which by nature is disruptive due to its completely different manufacturing approach, wherein material is added instead of removed. By adding material layer by layer, mould and customised tooling requirements from the conventional manufacturing are reduced or removed, which leads to increased customisation options and enables new part complexities without increasing the manufacturing cost. AM hence enables customised small volume productions of composite parts not feasible by conventional manufacturing techniques. This sets up new requirements to the part verification and validation, while conventional destructive tests become too expensive. This initial study aims to investigate alternative options to this destructive testing by increasing process knowledge, and validating the generated toolpaths before the real manufacturing process takes place: Hence removing time consuming and expensive trial-and-error processes for new products. This study applies a 2D restricted finite volume model aimed to describe thermoplastic Acrylonitrile-butadiene-styrene (ABS) and thermosetting polyurethane (PU) material extrusion processes. During the experimental evaluation of the produced models it is found that some critical material properties needs to be further investigated to increase the precision of the model. It is however also found that even with only sparse material property information, the simulations show quite accurate temperature simulations when compared to the experimental results. Additionally it is during the thermoplastic experiments seen that the temperature characteristic of the simulations is in good agreement with the ones obtained from the experiments. Moreover it is found that the thermosetting experiments show increased reaction rate at higher catalyst concentrations which is in good agreement with the conducted simulation.

Thermo-Electrical Mathematical Model for Prediction of Ni-Cr Hot-Wire Temperature in Free Air and Inside Small Circular Cavities

A one-dimensional thermo-electrical mathematical model describing the heating and cooling of thin Ni-Cr20% wires is presented. The model is applied for wires in a free air environment and to wires placed in small circular cavities formed by expanded polystyrene material. The basis of the model is a semicoupled solution of the heat conduction equation and the electrical diffusion equation in a one-dimensional (1-D) control volume finite-difference framework. A study on the available natural convection correlations for thin metal wires for Rayleigh numbers in the range of $10^3 - 10^5$ is carried out in order to select an appropriate heat transfer coefficient for the time-dependent heating and cooling of a wire. The model is tested against experimental data and is found to be in a good agreement with previous investigations. Based on the findings, expressions for the heat transfer coefficient of a hot wire inside a small circular cavity are suggested.
The transition between undiluted and oligomer-diluted states of nearly monodisperse polystyrenes in extensional flow
We have measured the startup and steady extensional viscosity of two narrow molar mass distributed (NMMD) polystyrenes, a 910 kg/mole and a 545 kg/mole, diluted in a NMMD 4.29 kg/mole styrene oligomer, with a wide concentration range from 90 down to 17%. The constant interchain pressure model, proposed by Rasmussen and Huang (Rheol Acta 53(3):199–208 (2014a)), predicts the extensional viscosity well for the dilutions with lower concentrations. However, for the 70 and 90% 545 kg/mole samples which represent the transition between the diluted and undiluted states, the model predictions are less satisfactory. Another concept based on interchain pressure, proposed by Wagner (Rheol Acta 53(10):765–777 (2014)), also shows agreement with the measured data.
Three-Dimensional X-Ray Diffraction Technique for Metals Science
The three-dimensional X-ray diffraction (3DXRD) is a new, advanced technique for materials characterization. This technique utilizes high-energy synchrotron X-rays to characterize the 3D crystallographic structure and strain/stress state of bulk materials. As the measurement is non-destructive, the microstructural evolution as a function of time can be followed, i.e. it allows 4D (x, y, z characterizations, t). The high brilliance of synchrotron X-rays ensures that diffraction signals from volumes of micrometer scale can be quickly detected and distinguished from the background noise, i.e. its spatial resolution can be micrometer scale and the measurement can be conducted within a reasonable time frame (a few hours). The 3DXRD microscope has originally been developed in cooperation between former RisÃ¸ National Laboratory and the European Synchrotron Radiation Facility. Currently, this technique has been implemented in several large synchrotron facilities, e.g. the Advanced Photon Source (APS) in USA and the Spring-8 in Japan. Another family of 3DXRD technique that utilizes white beam synchrotron X-rays has also been developed in parallel in cooperation between Oak Ridge National Laboratory and APS. This article reviews the 3DXRD technique. The content includes the idea behind the technique, the principle and specification (spatial, angular, temporal resolutions and sample environment etc.) of the technique. Several applications of the techniques in metallurgy are given, including: grain-scaled stress analysis during tensile deformation, recrystallization growth kinetics, recrystallization nucleation, growth of individual recrystallized grain, grain growth after recrystallization, and local residual strain/stress analysis. The recent development of the 3DXRD technique and its potential use for materials science in the future will be briefly discussed at the end.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Materials science and characterization, Harbin Institute of Technology
Authors: Zhang, Y. (Intern), Fan, G. (Intern)
Pages: 181-187
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Main Research Area: Technical/natural sciences

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Scopus rating (2014): CiteScore 0.11
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Tolerances in micro manufacturing

This paper describes a method for analysis of tolerances in micro manufacturing. It proposes a mapping of tolerances to dimensions and compares this with current available international standards. The analysis documents that tolerances are not scaled down as the absolute dimension. In practice a tolerance level of 10 - 100 μm seems to be the preferred level no matter the absolute dimension.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology
Authors: Hansen, H. N. (Intern), Zhang, Y. (Intern), Islam, A. (Intern)
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Main Research Area: Technical/natural sciences
Micro Injection Molding, Micro overmolding, Optical micro metrology
Electronic versions:
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Traceability investigation in Computed Tomography using industry-inspired workpieces

This paper concerns an investigation of the accuracy of Computed Tomography (CT) measurements using four industry-inspired workpieces. A total of 16 measurands were selected and calibrated using CMMs. CT measurements on industry-inspired workpieces were carried out using two CTs having different metrological performance. Different scanning strategies and parameters were selected between two CTs in order to better understand the impact of the operator. The quantification of the measurement uncertainty for CT measurements was also achieved using two different approaches. Metrological compatibility between CTs and between CTs and CMMs was finally assessed using the En value concept.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Karlsruhe Institute of Technology KIT
Authors: Kraemer, A. (Ekstern), Stolfi, A. (Intern), Schneider, T. (Ekstern), De Chiffre, L. (Intern), Lanza, G. (Ekstern)
Number of pages: 9
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Computed tomography, Metrology, Measurement Uncertainty
Electronic versions:
iCT_2016_.pdf. Embargo ended: 09/02/2017

Two-Photon Polymerization lithography for three-dimensional micro polymer parts manufacturing evaluation

Two-photon polymerization (2PP) technique is one of the common techniques to realize the fabrication of high-quality 3D microstructures. The combination between the laser power, the printing strategy, and the printed feature size are not completely assessed. This study characterizes the additive manufacturing processes by Direct Laser Writing (DLW) for fabrication of 3D microstructures. The printing samples were selected from a certified calibrated set with different sizes consisting of five boxes ranging from 8 μm to 200 μm. The laser power was selected as a variable parameter in order to find out the effect of various powers in printing size and strategy. Six different powers were selected from 0.6 mW to 1.6 mW for each set of the structure. The results show the importance of choosing the right power value, otherwise the structures would be burned for too high power or not completely polymerised for too low one. In addition, they show the importance of a good scaffolding, especially for bigger structures where the geometry can be distorted.

General information
Zeonex microstructured polymer optical fiber: fabrication friendly fibers for high temperature and humidity insensitive Bragg grating sensing

In the quest of finding the ideal polymer optical fiber (POF) for Bragg grating sensing, we have fabricated and characterized an endlessly single mode microstructured POF (mPOF). This fiber is made from cyclo-olefin homopolymer Zeonex grade 480R which has a very high glass transition temperature of 138 °C and is humidity insensitive. It represents a significant improvement with respect to the also humidity insensitive Topas core fibers, in that Zeonex fibers are easier to manufacture, has better transmittance, higher sensitivity to temperature and better mechanical stability at high temperature. Furthermore, Zeonex has very good compatibility with PMMA in terms of dilatation coefficients for co-drawing applications. The Zeonex mPOF has a core and cladding diameter of 8.8 µm and 150 µm, respectively, with a hole to pitch ratio of 0.4 and a minimum propagation loss of 2.34 ± 0.39 dB/m at 690.78 nm. We have also inscribed and characterized fiber Bragg gratings (FBGs) in Zeonex mPOFs in the low loss 850 nm spectral band.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Woyessa, G. (Intern), Fasano, A. (Intern), Markos, C. (Intern), Stefani, A. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
Number of pages: 10
Publication date: 2017
Main Research Area: Technical/natural sciences

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Scopus rating (2017): SJR 0.952 SNIP 1.167 CiteScore 2.78
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 2.74 SJR 1.042 SNIP 1.23
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 1.34 SNIP 1.351 CiteScore 3.07
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 1.521 SNIP 1.623 CiteScore 3.17
Scopus rating (2013): SJR 1.757 SNIP 2.357 CiteScore 3.42
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 1.609 SNIP 1.774 CiteScore 2.58
Web of Science (2012): Indexed yes
Web of Science (2011): Indexed yes
Original language: English
Electronic versions:
Zeonex-PMMA microstructured polymer optical FBGs for simultaneous humidity and temperature sensing

In this Letter, we report for the first time, to the best of our knowledge, the fabrication and characterization of a Zeonex/PMMA microstructured polymer optical fiber (mPOF) Bragg grating sensor for simultaneous monitoring of relative humidity (RH) and temperature. The sensing element (probe) is based on two separate in-line fiber Bragg gratings (FBGs) inscribed in the fabricated mPOF. A root mean square deviation of 0.8% RH and 0.6°C in the range of 10%-90% RH and 20°C-80°C was found. The developed mPOFBG sensor constitutes an efficient route toward low-cost, easy-to-fabricate and compact multi-parameter sensing solutions.

General information

State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Woyessa, G. (Intern), Pedersen, J. K. M. (Intern), Fasano, A. (Intern), Nielsen, K. (Intern), Markos, C. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
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Main Research Area: Technical/natural sciences

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Scopus rating (2017): CiteScore 3.89 SJR 1.79 SNIP 1.597
Web of Science (2017): Indexed yes
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Scopus rating (2016): CiteScore 3.54 SJR 1.769 SNIP 1.549
Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 2.013 SNIP 1.53 CiteScore 3.53
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.429 SNIP 1.997 CiteScore 3.86
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.441 SNIP 2.058 CiteScore 3.95
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.577 SNIP 1.92 CiteScore 3.52
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.519 SNIP 2.453 CiteScore 3.69
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
A novel artefact for calibration of the scale in 3D X-ray Computed Tomography (CT) is presented. The artefact comprises a carbon fibre tubular structure on which a number of reference ruby spheres are glued. The artefact is positioned and scanned together with the workpiece inside the CT scanner providing a reference system for measurement. The artefact allows a considerable reduction of time by compressing the full process of calibration, scanning, measurement, and recalibration, into a single process. The method allows a considerable reduction of the amount of data generated from CT scanning. A prototype was calibrated and its applicability demonstrated.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Stolfi, A. (Intern), De Chiffre, L. (Intern)
Pages: 499-502
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Web of Science (2018): Indexed yes
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Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
3D-printed PMMA Preform for Hollow-core POF Drawing

In this paper we report the first, to our knowledge, 3D-printed hollow-core poly(methyl methacrylate) (PMMA) preform for polymer optical fibre drawing. It was printed of commercial PMMA by means of fused deposition modelling technique. The preform was drawn to cane, proving good enough quality of drawing process and the PMMA molecular weight to be appropriate for drawing. This ascertains that the manufacturing process provides preforms suitable for hollow-core fibre drawing. The paper focuses on maximisation of transparency of PMMA 3D printouts by optimising printing process parameters: nozzle temperature, printing speed and infill.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Aston University
Authors: Zubel, M. G. (Ekstern), Fasano, A. (Intern), Woyessa, G. (Intern), Sugden, K. (Ekstern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
Pages: 6
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Electronic versions: PP32.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Accuracy assessment of an industrial actuator

A commercial linear actuator equipped with a 0.1 μm resolution encoder was used as a contact displacement sensor with adjustable force. The accuracy of the position reading of the actuator was evaluated from experimental data taking into account the uncertainty contributions. The tests consisted of length measurements of grade 0 steel gauge blocks. Measurements with different values of contact force were performed to assess its influence. A statistical analysis of the experimental data was performed to support the accuracy assessment. Systematic effects were identified and corrected. An expanded uncertainty (k=2) lower than 1 μm was estimated.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Politecnico di Torino
Authors: Dalla Costa, G. (Intern), Genta, G. (Ekstern), Barbato, G. (Ekstern), De Chiffre, L. (Intern), Hansen, H. N. (Intern)
Number of pages: 6
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Scopus rating (2016): CiteScore 1.6 SNIP 1.374 SJR 0.719
Scopus rating (2015): SJR 0.605 SNIP 1.075
Scopus rating (2014): SJR 0.755 SNIP 1.4
Scopus rating (2013): SJR 0.53 SNIP 1.373
ISI indexed (2013): ISI indexed no
Original language: English
Actuator, Accuracy, Uncertainty
Electronic versions:
Accuracy Enhancement of CT Measurements using Data Filtering

This paper describes the impact of data filtering on CT capability to inspect assemblies. The investigation was carried out using an industrial multi-material assembly provided by Novo Nordisk A/S. The assembly comprises two parts made of polyoxymethylene (POM) and of an alloy comprising polycarbonate (PC) and acrylonitrile butadiene styrene (ABS), respectively. 3D median filters with different window sizes were taken in account as influence factors, while a variety of dimensional and geometrical tolerances were used as evaluation parameters. All measurands were calibrated using a tactile CMM with uncertainty below 7 μm.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Novo Nordisk A/S
Authors: Stolfi, A. (Intern), Kallasse, M. (Ekstern), Carli, L. (Ekstern), De Chiffre, L. (Intern)
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Computed tomography, Dimensional metrology, Multi-material measurements, INTERAQCT Marie Curie, Data filtering, Polymers
Electronic versions:
Enhancing_the_Accuracy_of_Computed_Tomography_Measurements_using_Data_Filtering.pdf
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http://www.ndt.net/search/docs.php3?showForm=off&id=18750
Source: PublicationPreSubmission
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A computational model for heterogeneous heating during pulsed laser irradiation of polymers doped with light-absorbing microparticles

Doping of polymers with light-absorbing microparticles to increase their optical properties is a commonly used pre-treatment technique in laser processing of polymers. The presence of these particles plays an important role during laser heating of the polymer that influences its surface characteristics. This work presents a study based on a computational model of laser heating of polymer doped with light-absorbing microparticles accounting for the heterogeneous nature of heating. The work aims at gaining a fundamental insight into the nature of the heating process and to understand the role of microparticles. The results suggest that apart from the laser intensity and pulse duration, the properties of the microparticles including their size and distribution also play an important role during the laser heating of polymers.

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BFI (2018): BFI-level 1
A conceptual framework for designing micro electrical connectors for hearing aid instruments

Electrical connectors play vital roles in modern electronic instruments. Hearing aid devices as advanced combinations of micro mechanics and electronics comprise various electrical connectors for different purposes. However, the current trend in the miniaturization along with the sharp technological advancements have urged them to incorporate increased number of electrical contacts. The current paper presents a conceptual framework for designing and manufacturing novel plug and socket systems for hearing aid instruments by using the state of art manufacturing technologies for micro components. These concepts have the capability of using as different connectors like RIC (Receiver In the Canal), programming and FM connection either individually or together. Various conceptual designs are provided for flexible connectors and their advantages and disadvantages are discussed in detail through different computer simulations and experiments on the 3-D printed prototypes. In fact, the presented designs not only are able to provide a range of functions for other similar micro products, but also depict an outline for the challenges in this area and the possible approach and solutions in the design of micro electrical connectors.

General information
State: Published
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Pages: 4
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Hearing aid, Conceptual design, Electrical connector, Micro components
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A constitutive analysis of the extensional flows of nearly monodisperse polyisoprene melts


General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Rasmussen, H. K. (Intern)
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Main Research Area: Technical/natural sciences
Publication information
Acoustic emission-based in-process monitoring of surface generation in robot-assisted polishing

The applicability of acoustic emission (AE) measurements for in-process monitoring of surface generation in the robot-assisted polishing (RAP) was investigated. Surface roughness measurements require interruption of the process, proper surface cleaning and measurements that sometimes necessitate removal of the part from the machine tool. In this study, stabilisation of surface roughness during polishing rotational symmetric surfaces by the RAP process was monitored by AE measurements. An AE sensor was placed on a polishing arm in direct contact with a bonded abrasive polishing tool, and a cylindrical workpiece in Vanadis 4E steel was polished in 40 polishing passes from an initial turned surface roughness Ra = 3.1 µm down to Ra = 0.07 µm. The polishing task was performed in five intervals and after 4, 8, 20, 30 and 40 passes, the resulting surface roughness was measured. The results show a decreasing trend in measured AE signal power and RMS, which is well qualitatively correlated with the development of surface roughness during polishing. The trend allows the identification of an asymptote representing the process completion (stabilisation of surface roughness), reliable for correct in-process determination of the process endpoint. This makes it possible to reliably determine the right time for changing the polishing media to finer abrasive when applying a given set of parameters is no longer effective to create a smoother surface, thus improving the efficiency of the process. The findings enabling automatic detection of optimal process endpoint allow intelligent process control, creating fundamental elements in development of robust fully automated RAP process for its widespread industrial application.
Activity-based Sustainability Assessment of Highly Automated Manufacturing

Sustainability of technology is a multifaceted endeavor and a main requirement from industry is to make it a profitable business case with clearly defined targets. To achieve that, a new assessment framework and applicable method [1] is presented which has been developed closely with industry. It uses a top-down decision-making process known from financial target setting for each cost center and the well-known life-cycle perspective according to ISO 14040 [2] in Sustainability Assessment. Thereby it is possible to allocate absolute environmental thresholds of functionalities (e.g. “transportation”) down to smallest production units by using activity-based target setting in a consistent way to lowers risks in the planning phase of products and production.

General information
State: Published
Organisations: Department of Management Engineering, Quantitative Sustainability Assessment, Department of Mechanical Engineering, Manufacturing Engineering
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Adaptive Layer Height During DLP Materials Processing
This research aims to show how manufacturing speeds during vat polymerisation can be vastly increased through an adaptive layer height strategy that takes the geometry into account through analysis of the relationship between layer height, cross-section variability and surface structure. This allows for considerable process speedup during the Additive Manufacture of components that contain areas of low cross-section variability, at no loss of surface quality. The adaptive slicing strategy was tested with a purpose-built vat polymerisation system and numerical engine designed and constructed to serve as a Next-Gen technology platform. By means of assessing hemispherical manufactured test specimen and through 3D surface mapping with variable-focus microscopy and confocal microscopy, a balance between minimal loss of surface quality with a maximal increase of manufacturing rate has been identified as a simple angle-dependent rule. The achievable increase in manufacturing rate was above 38% compared to conventional part slicing.

A fully-coupled approach combining plastic deformation and liquid lubrication
This paper presents a new approach based on a fully coupled procedure in which the lubricant flow and the plastic deformation of the metallic material are solved simultaneously. The approach is applied to strip reduction of a sheet with surface pockets in order to investigate the escape of the lubricant from the pocket by means of MicroPlasto HydroDynamic Lubrication (MPHDL) and Micro Plasto HydroStatic Lubrication (MPHSL) mechanisms.

A Fully-Coupled Approach for Modelling Plastic Deformation and Liquid Lubrication in Metal Forming
This paper presents a new approach for combined modelling of plastic deformation and liquid lubrication in the contact interfaces between material and tooling in metal forming including situations where the lubricant is functioning as a pressure carrier. The approach is an alternative to conventional modelling techniques based on the utilization of friction shear stresses built upon existing friction laws as e.g. the Coulomb law and the law of constant friction stress. As such it represents a shift from phenomenological modelling adopting an artificial friction layer technique consisting of interface elements with fictitious small stiffness to physical modelling based on a fully coupled procedure in which the lubricant flow and the plastic deformation of the metallic material are solved simultaneously. The approach takes advantage of the intrinsic velocity-pressure characteristics of the finite element flow formulation which stands on the border line between fluid and solid mechanics and allows treating the lubricants as viscous incompressible (or nearly incompressible) fluid and the metallic materials as non-Newtonian, high viscous, incompressible fluids. The presentation is focused on the theoretical
and numerical fundamentals of the proposed approach and includes selected examples in order to illustrate its advantages and limitations.

**General information**
*State:* Published
*Organisations:* Department of Mechanical Engineering, Manufacturing Engineering, Universidade de Lisboa
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*Main Research Area:* Technical/natural sciences
*Conference:* 7th International Conference on Tribology in Manufacturing Processes (ICTMP 2016), Phuket, Thailand, 28/02/2016 - 28/02/2016
*Plastic deformation, Lubrication, Viscous flow, Finite element method*
*Electronic versions:*
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*Publication: Research - peer-review › Article in proceedings – Annual report year: 2016*

**A micro-mechanical analysis of thermo-elastic properties and local residual stresses in ductile iron based on a new anisotropic model for the graphite nodules: Paper**

In this paper, the thermo-elastic behavior of the graphite nodules contained in ductile iron is derived on the basis of recent transmission electron microscopy investigations of their real internal structure. The proposed model is initially validated by performing a finite element homogenization analysis to verify its consistency with the room-temperature elastic properties of ductile iron measured at the macro scale. Subsequently, it is used to investigate the formation of local residual stresses around the graphite particles by simulating the manufacturing process of a typical ferritic ductile iron grade, and the results are compared with preliminary measurements using synchrotron X-rays. Finally, the obtained accurate description of the stress & strain field at the micro scale is used to shed light on common failure modes reported for the nodules and on some peculiar properties observed in ductile iron at both micro and macro scale.

**General information**
*State:* Published
*Organisations:* Department of Mechanical Engineering, Manufacturing Engineering
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*Main Research Area:* Technical/natural sciences

**Publication information**
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*Volume:* 24
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*Article number:* 055012
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*BFI (2018):* BFI-level 2
*Web of Science (2018):* Indexed yes
*BFI (2017):* BFI-level 2
*Scopus rating (2017):* SNIP 0.93 SJR 0.821 CiteScore 1.8
*Web of Science (2017):* Indexed yes
*BFI (2016):* BFI-level 2
*Scopus rating (2016):* CiteScore 1.82 SJR 1.076 SNIP 1.05
*Web of Science (2016):* Indexed yes
*BFI (2015):* BFI-level 2
*Scopus rating (2015):* SJR 1.225 SNIP 1.057 CiteScore 1.73
*BFI (2014):* BFI-level 2
*Scopus rating (2014):* SJR 1.305 SNIP 1.157 CiteScore 1.81
*Web of Science (2014):* Indexed yes
*BFI (2013):* BFI-level 2
*Scopus rating (2013):* SJR 1.083 SNIP 1.197 CiteScore 1.25
Parallel kinematics have been adopted by more than 25 manufacturers of high-end desktop 3D printers [Wohlers Report (2015), p.118] as well as by research projects such as the WASP project [WASP (2015)], a 12 meter tall linear delta robot for Additive Manufacture of large-scale components for construction engineering applications. The parallel kinematics of a linear delta robot has the potential to out-complete Cartesian point-based deposition systems with respect of acceleration and thus repositioning speeds since the primary movable mass in these types of systems can be kept to a minimum. This research identifies that the rapid lift and repositioning capabilities of delta robots can reduce defects on extruded 3D printed parts when compared to traditional Cartesian motion systems. This is largely due to the fact that repositioning is so rapid that the extruded strand is instantly broken, and that repositioning can be completed before material oozing from the extruder can occur. The aim will be to address one of the primary disadvantages to parallel kinematics systems. Calibration and geometrical validation. Calibration of a delta robot can be a source of frustration. This research aim to provide the operator with a strong tool for easing this task. The kinematics and calibration of delta robots, in particular, are less researched than that of traditional Cartesian robots, for which tried-and-true methods for calibrating are well known. A forwards and reverse virtual model of a delta robot has been developed in order to decompose the different types of geometrical errors into 6 elementary cases. Deliberate introduction of errors to the virtual machine has subsequently allowed for the generation of deviation plots that can be used as a strong tool for the identification and correction of...
geometrical errors on a physical machine tool.

Analysis of moisture transport between connected enclosures under a forced thermal gradient

Nowadays, many electronic products are exposed to harsh climatic conditions, and hence the protection of these devices is a crucial factor in the design of systems. Therefore, the modelling tools have become very useful in electronics design which supports the search of optimal electronics design and humidity control solutions. While high fidelity CFD codes are too time-consuming due to computational effort/time, the well-known Resistor-Capacitor (RC) approach has much lower calculation time and is more efficient to use in enclosures without too complex geometry in their interior. Thus, the objective of this paper is to build an in-house code based on the RC approach for simulating coupled heat and mass transport. The developed code is used for simulating moisture transport between two boxes/enclosures having different temperatures, connected with a tube of known geometry. It has also the capability of combining a 1D description and lumped components. Here, a FVM discretization of the heat conduction equation and Fick's second law for 1D description is applied to model heat and mass transport. The intention is to predict the amount of moisture transported only via diffusion (convection is neglected in this study) through the tube from the warm to the cold region.

Analysis of the effect of ultrasonic vibrations on the performance of micro-electrical discharge machining of A2 tool steel

The application of ultrasonic vibrations to a workpiece or tool is a novel hybrid approach in micro-electrical discharge machining. The advantages of this method include effective flushing out of debris, higher machining efficiency and lesser short-circuits during machining. This paper presents a systematic analysis of the influence of kinetic effects of the ultrasonic vibrations on the material removal rate (MRR) and tool electrode wear rate (TWR). The tool wear ratio was estimated for the process at all processing conditions. The maximum variation in tool wear ratio is observed to be 82%. Therefore, MRR and TWR were independently analyzed by using three scientific tools: i) AOM plots, ii) interaction plots and iii) three-dimensional scatter plots. The increase in MRR is 47% corresponding to an increase in the maximum power of vibrations by 30%. The ultrasonic vibrations are found to be very effective at higher machining depths for achieving stable machining conditions. Regression equations were developed for MRR and TWR with capacitance, ultrasonic vibration factor, feed rate and machining time.
Analytical solution to the 1D Lemaitre’s isotropic damage model and plane stress projected implicit integration procedure

In the present paper, for the first time in literature an exact analytical solution to Lemaitre's isotropic damage model is developed for the special case of uniaxial tensile testing. This is achieved by taking advantage of a convenient formulation of the isotropic hardening function, which allows obtaining an integral relationship between total strain and effective stress. By means of the generalized binomial theorem, an expression in terms of infinite series is subsequently derived. The solution is found to simplify considerably existing techniques for material parameters identification based on optimization, as all issues associated with classical numerical solution procedures of the constitutive equations are eliminated. In addition, an implicit implementation of the plane stress projected version of Lemaitre's model is discussed, showing that the resulting algebraic system can be reduced to a single non-linear equation. The accuracy of the proposed integration scheme is then verified by means of the presented 1D analytical solution. Finally, a closed-form expression for the consistent tangent modulus taking damage evolution into account is given, and its impact on the convergence rate is analyzed.
An analytical solution describing the shape of a yield stress material subjected to an overpressure

Many fluids and granular materials are able to withstand a limited shear stress without flowing. These materials are known as yield stress materials. Previously, an analytical solution was presented to quantify the yield stress for such materials. The yield stress is obtained based on the density as well as the spread length and height of the material when deformed in a box due to gravity. In the present work, the analytical solution is extended with the addition of an overpressure that acts over the entire body of the material. This extension enables finding the shape of a yield stress material with known density and yield stress when for instance deformed under water or subjected to a forced air pressure.

General information
State: Published
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Number of pages: 5
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Main Research Area: Technical/natural sciences

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Ratings:
To analyze the heating and cooling phase of an induction heated injection molding tool accurately, the temperature dependent magnetic properties, namely the non-linear B-H curves, need to be accounted for in an induction heating simulation. Hence, a finite element model has been developed, including the non-linear temperature dependent magnetic data described by a three-parameter modified Frohlich equation fitted to the magnetic saturation curve, and solved with an iterative procedure. The numerical calculations are compared with experiments conducted with two types of induction coils, built in to the injection molding tool. The model shows very good agreement with the experimental temperature measurements. It is also shown that the non-linearity can be used without the temperature dependency in some cases, and a proposed method is presented of how to estimate an effective linear permeability to use with simulation codes not able to utilize a non-linear solver. (C) 2015 Elsevier B.V. All rights reserved.
An international comparison of surface texture parameters quantification on polymer artefacts using optical instruments

An international comparison of optical instruments measuring polymer surfaces with arithmetic mean height values in the sub-micrometre range has been carried out. The comparison involved sixteen optical surface texture instruments (focus variation instruments, confocal microscopes and coherent scanning interferometers) from thirteen research laboratories worldwide. Results demonstrated that: (i) Agreement among different instruments could be achieved to a limited extent; (ii) standardised guidelines for uncertainty evaluation of areal surface parameters are needed for users; (iii) it is essential that the performance characteristics (and especially the spatial frequency response) of an instrument is understood prior to a measurement.

General information
State: Published
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 2.055 SNIP 3.158
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 3.294 CiteScore 3.83
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.123 SNIP 3.992 CiteScore 4.39
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.598 SNIP 3.818 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.088 SNIP 4.156 CiteScore 3.04
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.117 SNIP 3.46 CiteScore 2.81
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.12 SNIP 3.449
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.652 SNIP 2.219
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
An optimized outlier detection algorithm for jury-based grading of engineering design projects

This work characterizes and optimizes an outlier detection algorithm to identify potentially invalid scores produced by jury members while grading engineering design projects. The paper describes the original algorithm and the associated adjudication process in detail. The impact of the various conditions in the algorithm on the false positive and false negative rates is explored. A response surface design is performed to optimize the algorithm using a data set from Fall 2010. Finally, the results are tested against a data set from Fall 2011. It is shown that all elements of the original algorithm (the base rule and the three additional conditions) play a role in the algorithm's performance and should be included in the algorithm. Because there is significant interaction between the base rule and the additional conditions, many acceptable combinations that balance the FPR and FNR can be found, but no true optimum seems to exist. The performance of the best optimizations and the original algorithm are similar. Therefore, it should be possible to choose new coefficient values for jury populations in other cultures and contexts logically and empirically without a full optimization as long as the algorithm assumptions are valid and the limitations for its use are well understood.

General information
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Pages: 172-184
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Main Research Area: Technical/natural sciences

Publication information
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Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
A Review of Literature on analysis of JIG Grinding Process

Jig grinding is a process practically used by tool and die makers in the creation of jigs or mating holes and pegs on dies. The abrasives normally used in jig grinding are divided into Natural Abrasives and Artificial Abrasives. Artificial Abrasives are preferred in manufacturing of grinding wheels in jig grinding, because of their uniformity and purity. In this paper, a brief review of the analysis of jig grinding process considering various research trends is presented. The areas highlighted are: optimization, selection of abrasives, selection of processing conditions and practical considerations. The optimization of parameters in jig grinding process is important to maximize productivity and to improve quality. The abrasives of hard jig grinding wheels get blunt quickly so these are recommended to grind workpiece of low hardness and soft grinding wheels are recommended for hard material workpieces. The jig grinding is also classified into rough grinding and precision grinding, based on the processing conditions. The jig grinding process is also adapted for a variety of practical applications and for different materials.
A Review on the Mechanical Modeling of Composite Manufacturing Processes

The increased usage of fiber reinforced polymer composites in load bearing applications requires a detailed understanding of the process induced residual stresses and their effect on the shape distortions. This is utmost necessary in order to have more reliable composite manufacturing since the residual stresses alter the internal stress level of the composite part during the service life and the residual shape distortions may lead to not meeting the desired geometrical tolerances. The occurrence of residual stresses during the manufacturing process inherently contains diverse interactions between the involved physical phenomena mainly related to material flow, heat transfer and polymerization or crystallization.

Development of numerical process models is required for virtual design and optimization of the composite manufacturing process which avoids the expensive trial-and-error based approaches. The process models as well as applications focusing on the prediction of residual stresses and shape distortions taking place in composite manufacturing are discussed in this study. The applications on both thermoset and thermoplastic based composites are reviewed in detail.
A self-calibrating robot based upon a virtual machine model of parallel kinematics

A delta-type parallel kinematics system for Additive Manufacturing has been created, which through a probing system can recognise its geometrical deviations from nominal and compensate for these in the driving inverse kinematic model of the machine. Novelty is that this model is derived from a virtual machine of the kinematics system, built on principles from geometrical metrology. Relevant mathematically non-trivial deviations to the ideal machine are identified and decomposed into elemental deviations. From these deviations, a routine is added to a physical machine tool, which allows it to recognise its own geometry by probing the vertical offset from tool point to the machine table, at positions in the horizontal plane. After automatic calibration the positioning error of the machine tool was reduced from an initial error after its assembly of ±170 µm to a calibrated error of ±3 µm. Excelling by speed, the calibration was executed in less than 3 min.
A Self-Peeling Vat for Improved Release Capabilities During DLP Materials Processing

This paper describes research to increase the competitiveness of vat polymerisation by increasing the manufacturing rate while lowering the normal forces that induce part stress during the lift procedure of vat based systems. This is achieved through introducing a polymerisation vat that allows for an eased release of the manufactured part from the vat by means of a flexible membrane system. A membrane of fluorinated ethylene polymer will through elastic deformation automatically peel off the part as the part is lifted during layer changes. Peeling has been qualified by means of a truncated inverted cone as test geometry. As the cross-sectional diameter of the cone increase throughout the build-job, the geometry will release from the glass based build platform at the point where the peeling force exceed the adhesion force between platform and part. At failure point the lateral surface area of the top and bottom of the truncated cone is used as a measure of the performance of the vat with respect to release-capability. This has been tested at increasing manufacturing rates. The new self-peeling vat outperformed industrial state-of-the-art vats by 814% percent.

General information
State: Published
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Authors: Pedersen, D. B. (Intern), Zhang, Y. (Intern), Nielsen, J. S. (Intern), Hansen, H. N. (Intern)
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A simulation of the effect of TWD (tool wear per discharge) estimation error on the depth of machined surfaces in micro-EDM milling

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Puthumana, G. (Intern), Bissacco, G. (Intern), Hansen, H. N. (Intern)
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A systematic approach applied in design of a micro heat exchanger

The number of products benefiting from micro components in the market is increasing, and consequently, the demand for well-matched tools, equipment and systems with micro features is eventually increasing as well. During the design process of micro products, a number of issues appear which are inherent due to the down scaling or physical phenomena dominating in the micro range but negligible in the macro scale. In fact, some aspects in design for micro manufacturing are considerably different compared to the de- sign procedure taken at the macro level. Identifying the differences between design considerations at micro compared to macro scale, and defining potential guidelines based on them, provides an opportunity to modify the conventional design methodologies towards becoming micro specific. In this paper, the need for a micro-oriented approach for designing micro products which has not been investigated hitherto studied.

For this purpose, an additional step named 'Rules To Consider' (RTC) is added to the conventional design methodologies. This step is constituted based on the feedbacks gained during analyzing the different iterations of the design. The knowledge obtained during the design process of a micro product can be added to the RTC unit, and this unit becomes enriched progressively in design process of similar micro products and supplemented to the conventional design methodologies to be served as a micro-oriented design methodology. In order to present the application of RTC unit, the design process of a micro heat exchanger is investigated. Manufacturability and functional performance are considered as evaluation criteria, and the lessons learned from each design iteration and evaluation are employed in the subsequent design proposals until an acceptable design is achieved. Thermal performance of the heat exchangers is evaluated using finite element (FE) simulation of the conjugate heat transfer. The design proposals are optimized in terms of geometrical dimensions, and a sensitivity analysis is conducted on the mass flow rate and heat generation power in the heat source. Finally, the designs with higher thermal performance and manufacturability are introduced. The result of the thermal analysis reveals the fact that the presence of the fins and modification of their dimensions as well as the constituent material for fabricating the micro heat exchanger do not significantly improve the thermal performance of the micro heat exchangers. This is an interesting outcome which can result in considerable reduction of the manufacturing costs by simplifying the geometrical design of the heat exchanger. The micro-specific design considerations which are extracted from the design process of the micro heat exchanger are added to the RTC unit and can be applied as guidelines in design process of any other micro heat exchanger. In other words, the current study can provide a useful guideline in design for manufacturing of micro products.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Management Engineering, Department of Energy Conversion and Storage
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Scopus rating (2017): CiteScore 2.8 SJR 0.994 SNIP 1.697
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.3 SJR 1.046 SNIP 1.608
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.889 SNIP 1.325 CiteScore 1.8
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.082 SNIP 1.841 CiteScore 2.03
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
A thermo-electro-mechanical simulation model for hot wire cutting of EPS foam

A one-dimensional thermo-electro-mechanical mathematical model describing the effects taking place within a Ni-Cr20% wire used in a hot-wire cutting process for free forming and rapid prototyping of expanded polystyrene (EPS) is investigated and simulated. The model implements and solves three semi coupled non-linear differential equations (the heat diffusion equation, the electrical diffusion equation and the static equilibrium equation) with temperature dependent parameters in order to predict the temperature, kerfwidth, longitudinal stress and displacement, and other process parameters during cutting of EPS in contact with a cutting tool made of an electrically heated metal wire attached to a robot device. The finite difference method is used to solve the coupled equations in the two environments (domains) in which the hot-wire operates, namely air and EPS. The model is calibrated against experimentally obtained data. Novel findings are a transient temperature-dependent kerfwidth prediction and a relation between kerfwidth and the cutting angle as measured from the horizontal direction. These are important relations in the aim for higher geometrical accuracy of the hot-wire cutting process. (C) 2016 Elsevier Ltd. All rights reserved.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Petkov, K. (Intern), Hattel, J. H. (Intern)
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Bonding mechanisms in spot welded three layer combinations

The strength of a spot weld generally stems from fusion bonding of the metal layers, but other solid state bonding mechanisms also contribute to the overall strength. Metallurgical analyses are presented to identify the phases formed near and across the weld interfaces and to identify the occurring bonding mechanisms. When welding a combination of three galvanized steel layers where one outer layer is a thin low-carbon steel it is a common challenge to obtain nugget penetration into the thin low-carbon steel. It therefore happens in real production that no nugget is formed across this interface. It has been shown previously that such a joint can reach relatively high strength resulting in plug failure in tensile shear testing. Additional strength due to these bonding mechanisms is also obtained in common spot welds in the so-called corona band around the weld nugget.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Materials and Surface Engineering
Authors: Moghadam, M. (Intern), Tiedje, N. S. (Intern), Seyyedian Choobi, M. (Intern), Nielsen, C. V. (Intern), Pantleon, K. (Intern), Bay, N. O. (Intern)
Number of pages: 12
Publication date: 2016

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Source: PublicationPreSubmission
Source-ID: 123573017
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Calibration of a Numerical Model for Heat Transfer and Fluid Flow in an Extruder

This paper discusses experiments performed in order to validate simulations on a fused deposition modelling (FDM) extruder. The nozzle has been simulated in terms of heat transfer and fluid flow. In order to calibrate and validate these simulations, experiments were performed giving a significant look into the physical behaviour of the nozzle, heating and cooling systems. Experiments on the model were performed at different sub-mm diameters of the extruder. Physical parameters of the model – especially temperature dependent parameters – were set into analytical relationships in order to receive dynamical parameters. This research sets the foundation for further research within melted extrusion based additive manufacturing. The heating process of the extruder will be described and a note on the material feeding will be given.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Micro- and Nanotechnology
Authors: Hofstätter, T. (Intern), Pedersen, D. B. (Intern), Nielsen, J. S. (Intern), Pimentel, R. (Intern), Mischkot, M. (Intern), Hansen, H. N. (Intern)
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Main Research Area: Technical/natural sciences

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Calibration of surface roughness standards

The key comparison EURAMET.L-K8.2013 on roughness was carried out in the framework of a EURAMET project starting in 2013 and ending in 2015. It involved the participation of 17 National Metrology Institutes from Europe, Asia, South America and Africa representing four regional metrology organisations. Five surface texture standards of different type were circulated and on each of the standards several roughness parameters according to the standard ISO 4287 had to be determined. 32 out of 395 individual results were not consistent with the reference value. After some corrective actions
the number of inconsistent results could be reduced to 20, which correspond to about 5% of the total and can statistically be expected. In addition to the material standards, two softgages were circulated, which allow to test the software of the instruments used in the comparison. The comparison results help to support the calibration and measurement capabilities (CMCs) of the laboratories involved in the CIPM MRA. The final report has been peer-reviewed and approved for publication by the CCL, according to the provisions of the CIPM Mutual Recognition Arrangement (CIPM MRA).

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Industrial Technology Research Institute, Swiss Federal Institute for Metrology, Bundesamt für Eich- und Vermessungswesen, Centro Español de Metrología, Centre for Metrology and Accreditation, TÜBITAK National Metrology Institute, Instituto Portugues Da Qualidade, SP Sveriges Tekniska Forskningsinstitut AB, Directorate of Measures and Precious Metals, National Institute of Metrology, National Metrology Centre, National Metrology Institute of South Africa, National institute of Metrology, Quality and Technology, Laboratoire National d’Essais, Central Office of Measures, Istituto Nazionale di Ricerca Metrologica
Authors: Thalmann, R. (Ekstern), Nicolet, A. (Ekstern), Meli, F. (Ekstern), Picotto, G. B. (Ekstern), Matus, M. (Ekstern), Carcedo, L. (Ekstern), Hemming, B. (Ekstern), Ganioglu, O. (Ekstern), De Chiffre, L. (Intern), Saraiva, F. (Ekstern), Bergstrand, S. (Ekstern), Zelenika, S. (Ekstern), Tonmueanwai, A. (Ekstern), Tsai, C. (Ekstern), Shihua, W. (Ekstern), Kruger, O. (Ekstern), de Souza, M. M. (Ekstern), Salgado, J. A. (Ekstern), Ramotowski, Z. (Ekstern)
Number of pages: 57
Publication date: 2016
Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.47 SJR 0.88 SNIP 1.789
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.813 SNIP 1.611 CiteScore 1.96
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.997 SNIP 2.119 CiteScore 2.49
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.001 SNIP 1.955 CiteScore 1.88
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.153 SNIP 1.745 CiteScore 1.78
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.074 SNIP 1.726 CiteScore 1.64
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.779 SNIP 1.62
Ceramic tape casting: A review of current methods and trends with emphasis on rheological behaviour and flow analysis

Tape casting has been used to produce thin layers of ceramics that can be used as single layers or can be stacked and laminated into multilayered structures. Today, tape casting is the basic fabrication process that provides multilayered capacitors and multilayered ceramic packages. In tape casting the rheological behaviour of the slurry as well as the material flow during casting are of utmost importance since these phenomena to a large extent determine the final properties and hence the quality of the cast product. During the last decades this has led to an increasing number of works in literature within fluid flow analysis of tape casting. In the present paper a review of the development of the tape casting process with particular focus on the rheological classifications as well as modelling the material flow is hence presented and in this context the current status is examined and future potential discussed.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Energy Conversion and Storage, Electrofunctional materials, Nanyang Technological University, National Technical University of Athens
Authors: Jabbaribehnam, M. (Intern), Bulatova, R. (Intern), Tok, A. I. Y. (Ekstern), Bahl, C. (Intern), Mitsoulis, E. (Ekstern), Hattel, J. H. (Intern)
Pages: 39-61
Publication date: 2016
Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.917 SJR 0.779 CiteScore 2.81
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.4 SJR 0.715 SNIP 1.044
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Comparison of conventional Injection Mould Inserts to Additively Manufactured Inserts using Life Cycle Assessment

Polymer Additive Manufacturing can be used to produce soft tooling inserts for injection moulding. Compared to conventional tooling, the energy and time consumption during production are significantly lower. As the life time of such inserts is significantly shorter than the life time of traditional brass, aluminium, or steel inserts, multiple inserts might be needed to produce a large number of parts.

In an ongoing study, a simplified Life Cycle Assessment has been carried out in order to provide information on how the four alternative insert materials perform in comparison in terms of their potential environmental impact and yield throughout the development and pilot phase. Insert geometry is particularly advantageous for pilot production and small production sizes.

In this research, Life Cycle Assessment is used to compare the environmental impact of soft tooling by Additive Manufacturing (using Digital Light Processing) and three traditional methods for the manufacture of inserts (milling of brass, steel, and aluminium) for injection moulds during the pre-production phase.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Management Engineering, Quantitative Sustainability Assessment, Technical University of Denmark
Authors: Hofstätter, T. (Intern), Bey, N. (Intern), Mischkot, M. (Intern), Lunzer, A. (Ekstern), Pedersen, D. B. (Intern), Hansen, H. N. (Intern)
Number of pages: 2
**Comparison of measurements from optical CMM and focus-variation microscope of a μPIM mechanical part**

**General information**

*State:* Published  
*Organisations:* Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark  
*Authors:* Quagliotti, D. (Intern), Salaga, J. (Ekstern), Tosello, G. (Intern), Hansen, H. N. (Intern)  
*Number of pages:* 1  
*Publication date:* 2016  
*Event:* Poster session presented at euspen’s 16th International Conference & Exhibition, Nottingham, United Kingdom.  
*Main Research Area:* Technical/natural sciences  
*Electronic versions:* AliconaDeMeet_P1.61_euspen2016.pdf  
*Publication:* Research - peer-review › Poster – Annual report year: 2016

Two sets of 5 green and 5 sintered mechanical parts, manufactured by micro powder injection moulding (μPIM), were measured using an optical coordinate measuring machine (OCMM) and a focus-variation microscope (FVM). The examined features of size, including diameter, radii and distances, span in the range of (10−1−101) mm. Comparing the corresponding measurements from the two instruments, a relative maximum deviation of 8 % was found for the linear dimensions of the green parts and a relative maximum deviation of 6 % for the ones of the sintered parts. The maximum relative deviation of the radii was 17 % for the green parts and 30 % for the sintered parts (relative deviations have been evaluated considering focus-variation measurements as reference). OCMM showed some problems in the detection of the smallest dimensional features (above all radii) where the presence of defects on the edges, quite typical for parts produced by μPIM, was particular critical for the measurements. The extraction of results obtained from FVM was less critical because performed with a dedicated post-processing software which allowed to better define the measured dimensions. Furthermore, the chance to measure other geometrical features, such as surface texture and flatness, may depict FVM measurements as more attractive. However, measurements should be suitable for in-line quality control, in a production environment, where fast cycle time is required and measuring times are more compatible to those of the OCMM.

**Computation Tomography characterization of the Green Fiber Bottle**

The work carried out in this research aims at identifying suitable ways for thorough characterization of the quality of paper bottles. Industrial X-ray Computed Tomography (XCT) is particularly advantageous in determining the quality of paper bottles and thus correlating it with the production process. The Green Fiber Bottle (GFB) is a freeform geometry consisting of cellulose fibers. Accurate dimensional measurements such as wall thickness of the GFB is not possible using Coordinate Measuring Machines (CMMs). XCT on one hand provides an effective means of measuring wall thickness and on the other hand it also helps in identifying voids in the order of 110 μm at any location in the bottle geometry.
Contact area measurements on structured surfaces
In connection with the use of brass specimens featuring structured surfaces in a tribology test, an algorithm was developed for automatic measurement of the contact area by optical means.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics
Authors: Kürkçüyildiz, Ö. C. (Intern), Jensen, S. H. N. (Intern), De Chiffre, L. (Intern)
Number of pages: 1
Publication date: 2016
Event: Poster session presented at Euspen's S.I.G. Meeting, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
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Source: PublicationPreSubmission
Source-ID: 128476167
Publication: Research - peer-review › Poster – Annual report year: 2017

Correction of systematic behaviour in topographical surface analysis
Four specimens in the sub-micrometre range and with different polishing were topographically investigated in five areas over their respective surfaces. Uncertainties were evaluated with and without correction for systematic behaviour and successively analysed by a design of experiment (DOE). Results showed that the correction for systematic behaviour allowed for a lower value of the estimated uncertainty when the correction was adequate to completely recognise the systematic effects. If not, the correction can produce an overestimation of the uncertainty.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Lego Group, Politecnico di Milano
Authors: Quagliotti, D. (Intern), Baruffi, F. (Intern), Tosello, G. (Intern), Gasparin, S. (Ekster), Annoni, M. (Ekster), Parenti, P. (Ekster), Sobiecki, R. (Intern), Hansen, H. N. (Intern)
Pages: 277-280
Publication date: 2016

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Publisher: Research Publishing Services
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Main Research Area: Technical/natural sciences
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Source: PublicationPreSubmission
Source-ID: 125883743
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Creation of a microstructured polymer optical fiber with UV Bragg grating inscription for the detection of extensions at temperatures up to 125°C

We describe the fabrication of a polycarbonate (PC) micro-structured polymer optical fiber (mPOF) and the writing of fiber Bragg gratings (FBGs) in it to enable strain and temperature measurements. We demonstrate the photosensitivity of a dopant-free PC fiber by grating inscription using a UV laser. We further show that PC Bragg gratings can be extended up to at least 3% without affecting the initial functionality of the micro-structured fiber. The response of PC FBGs to temperature up to 125°C is also investigated. Polycarbonate has good mechanical properties and its high temperature resistance might extend the range of application of polymeric FBGs.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Federal Institute for Materials Research and Testing
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Number of pages: 6
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Volume: 9886
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CT crown for on-machine scale calibration in Computed Tomography

A novel artefact for on-machine calibration of the scale in 3D X-ray Computed Tomography (CT) is presented. The artefact comprises an invar disc on which several reference ruby spheres are positioned at different heights using carbon fibre rods. The artefact is positioned and scanned together with the workpiece inside the CT scanner producing a 3D reference system for the measurement. The artefact allows a considerable reduction of time by compressing the workflow of calibration, scanning, measurement, and re-calibration. Furthermore, the method allows a considerable reduction of the amount of data generated from CT scanning. A prototype was calibrated on a tactile CMM and its applicability in CT scanning demonstrated using a calibrated workpiece.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Stolfi, A. (Intern), De Chiffre, L. (Intern)
Number of pages: 2
Publication date: 2016

Host publication information
Title of host publication: Proceedings of euspen’s 16th International Conference & Exhibition
Main Research Area: Technical/natural sciences
Conference: euspen’s 16th International Conference & Exhibition, Nottingham, United Kingdom, 30/05/2016 - 30/05/2016
Designing for Color in Additive Manufacturing

In this paper we present a color design pipeline for 3D printed or additively manufactured parts. We demonstrate how to characterize and calibrate a commercial printer and how to obtain its forward and backward color transformation models. We present results from our assistive color design tool, allowing for colorimetric accurate prints and visualization of the printed outcome, prior to print. Lastly, we demonstrate our pipeline by accurately reproducing a real physical object.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Department of Mechanical Engineering, Manufacturing Engineering
Pages: 98-102
Publication date: 2016

Determination of Lubricant Bulk Modulus in Metal Forming by Means of a Simple Laboratory Test and Inverse FEM Analysis

The influence of workpiece surface topography on friction, lubrication and final surface equality in metal forming operations is well known and has been pointed out by many researchers. This is especially the case when liquid lubricants are applied in situations, where increased surface roughness facilitates the lubricant entrainment, pressurization and possible escape by micro-plasto-hydrodynamic lubrication. In order to model these mechanisms an important lubricant property designated as the bulk modulus is needed for characterizing the compressibility of the lubricant. The present paper describes a simple, practical test to determine the bulk modulus. Combination of the experimental upsetting of an axisymmetric metal workpiece containing a truncated conical surface pocket with an inverse finite element analysis of the test allows determining the lubricant bulk modulus. The finite element analysis couples lubricant flow with plastic deformation of the metal directly. Results show that the proposed procedure allows determining an approximate bulk modulus for the lubricant.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Instituto Superior Técnico
Authors: Hafis, S. M. (Intern), Christiansen, P. (Intern), Martins, P. A. F. (Ekstern), Bay, N. (Intern)
Pages: 316-323
Publication date: 2016

Determination of stamp deformation during imprinting on semi-spherical surfaces

We developed a process for double curved injection molding inserts presenting nanostructured surfaces. Line gratings with a line width and spacing of 500 nm as well as arrays of pillars, both up to an aspect ratio of unity, have been successfully transferred onto steel mold surfaces. A thin film of sol-gel was applied onto spherical injection mold inserts and subsequently imprinted using a flexible stamp. A hard curing step transformed the sol-gel into a quartz-like and durable material.

As an example, we present theory and results regarding the imprint of pillar nanostructures on semi-spherical mold surfaces. Imprints were realized on three different radii of circumference of the spherical mold: R = 0.5 mm, R = 1.0 mm,
and R = 2 mm. After hard-curing of the imprinted sol-gel, the inserts were used for cold-mold as well as vario-therm injection molding. The polymer replicas and the inserts were characterized by analyzing the center-to-center distance of the pillars at several points across the spheres. From the measurements and the observed deviation of the distance of pillars, the stamp deformation was calculated. Finally, the experimentally determined deformation of the flexible stamp was compared with predictions provided by a geometrical model [1]. Simulated and experimental observations were in good accordance.

Future work will include the application of current results to design nanostructured patterns for which the stamp deformation will be compensated to achieve more reliable surface characteristics.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Micro- and Nanotechnology, Polymer Micro & Nano Engineering, InMold Biosystems A/S, Nanyang Technological University
Authors: Kafka, J. (Ekstern), Matschuk, M. (Ekstern), Pranov, H. (Ekstern), Kofod, G. (Ekstern), Taboryski, R. J. (Intern), Sonne, M. R. (Intern), Lam, Y. C. (Ekstern)
Number of pages: 1
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**Distribution and Orientation of Carbon Fibers in Polylactic Acid Parts Produced by Fused Deposition Modeling**

The aim of this paper is the understanding of the fiber orientation by investigations in respect to the inner configuration of a polylactic acid matrix reinforced with short carbon fibers after a fused deposition modeling extrusion process. The final parts were analyzed by X-ray, tomography, and magnetic resonance imaging allowing a resolved orientation of the fibers and distribution within the part. The research contributes to the understanding of the fiber orientation and fiber reinforcement of fused deposition modeling parts in additive manufacturing.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Vienna, Vienna University of Technology, University Hospital St. Pölten
Authors: Hofstätter, T. (Intern), W. Gutmann, I. (Ekstern), Koch, T. (Ekstern), Pedersen, D. B. (Intern), Tosello, G. (Intern), Heinz, G. (Ekstern), Hansen, H. N. (Intern)
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Main Research Area: Technical/natural sciences
Additive Manufacturing Technology, Fused Deposition Modeling, Biomaterials, Fiber- Reinforced Polymers, Carbon Fibers
Electronic versions:
4683.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

**Drying of a tape-cast layer: Numerical modelling of the evaporation process in a graded/layered material**

Evaporation of water from a ceramic layer is a key phenomenon in the drying process for the manufacturing of water-based tape cast ceramics. In this paper we present a coupled free-flow-porous-media model on the Representative Elementary Volume (REV) scale for coupling non-isothermal multi-phase compositional porous-media flow — for the ceramic layer — and single-phase compositional laminar free flow — for the air above it. The preliminary results show the typical expected evaporation behaviour from a porous medium initially saturated with water, and water–vapour transport to the free-flow region in accordance with the available results from the literature. We elaborate on and discuss the characteristic drying-rate curve for a single layer ceramic, and compare it with that of a graded/layered ceramic. We, moreover, show the influence of the mean diameter of particles of the porous medium (dp) — which directly affects the intrinsic permeability (K) based on the well-known Ergun’s equation — of each single ceramic layer on the drying behaviour of a graded/layered ceramic.
Dynamic Length Metrology (DLM) for measurements with sub-micrometre uncertainty in a production environment

Conventional length metrology for traceable accurate measurements requires costly temperature controlled facilities, long waiting time for part acclimatisation, and separate part material characterisation. This work describes a method called Dynamic Length Metrology (DLM) developed to achieve sub-micrometre accuracy on metal parts, or micrometre accuracy on polymer parts, directly in a production environment. The method consists in the simultaneous measurement of all quantities affecting dimensions of a part over time (dynamically), involving a number of sensors and reference artefacts, followed by mathematical or numerical modelling of the thermo-mechanical effects. It is hereby possible concurrently to predict condition-specific material properties as well as part dimensions at any point, time, temperature, humidity, etc. Knowing all systematic errors and influencing factors, and their combined effect, on a given length, it is possible to calculate the corrected length at 20°C, zero measuring force, etc. An estimation of the measurement uncertainty U can be obtained following the guidelines of the GUM, dimensional values and their uncertainties being the final result of the analysis. Preliminary investigations have indicated that the approach is viable, either using analytical modelling or FEM. An expanded uncertainty (k=2) lower than 0.4 μm was achieved using a steel gauge block as workpiece.

Economic benefits of metrology in manufacturing

In streamlined manufacturing systems, the added value of inspection activities is often questioned, and metrology in particular is sometimes considered only as an avoidable expense. Documented quantification of economic benefits of metrology is generally not available. This work presents concrete examples from industrial production, in which the added value of metrology in manufacturing is discussed and quantified. Case studies include: general manufacturing, forging, machining, and related metrology. The focus of the paper is on the improved effectiveness of metrology when used at product and process design stages, as well as on the improved accuracy and efficiency of manufacturing through better measuring equipment and process chains with integrated metrology for process control.
Effect of Geometry in Frequency Response Modeling of Nanomechanical Resonators

The trend towards nanomechanical resonator sensors with increasing sensitivity raises the need to address challenges encountered in the modeling of their mechanical behavior. Selecting the best approach in mechanical response modeling amongst the various potential computational solid mechanics methods is subject to controversy. A guideline for the selection of the appropriate approach for a specific set of geometry and mechanical properties is needed. In this study, geometric limitations in frequency response modeling of flexural nanomechanical resonators are investigated. Deviation of Euler and Timoshenko beam theories from numerical techniques including finite element modeling and Surface Cauchy-Born technique are studied. The results provide a limit beyond which surface energy contribution dominates the mechanical behavior. Using the Surface Cauchy-Born technique as the reference, a maximum error on the order of 50% is reported for high-aspect ratio resonators.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Koc University
Authors: Esfahania, M. N. (Ekstern), Yilmaz, M. (Ekstern), Sonne, M. R. (Intern), Hattel, J. H. (Intern), Alaca, B. E. (Ekstern)
Number of pages: 4
Publication date: 2016
Main Research Area: Technical/natural sciences

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  Scopus rating (2017): CiteScore 0.26 SJR 0.165 SNIP 0.3
  BFI (2016): BFI-level 1
  Scopus rating (2016): CiteScore 0.21 SJR 0.165 SNIP 0.246
  BFI (2015): BFI-level 1
  Scopus rating (2015): SJR 0.18 SNIP 0.218 CiteScore 0.18
  BFI (2014): BFI-level 1
  Scopus rating (2014): SJR 0.171 SNIP 0.202 CiteScore 0.17
  BFI (2013): BFI-level 1
  Scopus rating (2013): SJR 0.164 SNIP 0.187 CiteScore 0.16
  ISI indexed (2013): ISI indexed no
  BFI (2012): BFI-level 1
  Scopus rating (2012): SJR 0.176 SNIP 0.193 CiteScore 0.14
  ISI indexed (2012): ISI indexed no
  BFI (2011): BFI-level 1
  Scopus rating (2011): SJR 0.161 SNIP 0.16 CiteScore 0.12
  ISI indexed (2011): ISI indexed no
  Web of Science (2011): Indexed yes
  BFI (2010): BFI-level 1
  Scopus rating (2010): SJR 0.166 SNIP 0.158
  BFI (2009): BFI-level 1
  Scopus rating (2009): SJR 0.163 SNIP 0.156
  BFI (2008): BFI-level 1
  Scopus rating (2008): SJR 0.17 SNIP 0.132
  Web of Science (2008): Indexed yes
  Scopus rating (2007): SJR 0.171 SNIP 0.176
Effect of Micro Electrical Discharge Machining Process Conditions on Tool Wear Characteristics: Results of an Analytic Study

Micro electrical discharge machining is one of the established techniques to manufacture high aspect ratio features on electrically conductive materials. This paper presents the results and inferences of an analytical study for estimating the effect of process conditions on tool electrode wear characteristics in micro-EDM process. A new approach with two novel factors anticipated to directly control the material removal mechanism from the tool electrode are proposed; using discharge energy factor (DEf) and dielectric flushing factor (DFf). The results showed that the correlation between the tool wear rate (TWR) and the factors is poor. Thus, individual effects of each factor on TWR are analyzed. The factors selected for the study of individual effects are pulse on-time, discharge peak current, gap voltage and gap flushing pressure. The tool wear rate decreases linearly with an increase in the pulse on-time. A maximum increase of 28.57% has been observed between peak current of 1 and 1.5 A. TWR decreases with an increase in pressure by 19.6%.

Effect of process parameters on the dryness of molded pulp products

Molded pulp products are made from cellulose fibers dispersed in water then formed, drained and dried. As in the conventional papermaking process, the most energy intensive operation (including time) is drying. To gain a better understanding of the process parameters involved and to investigate their influence on the final product's dryness, two experimental plans were designed and analyzed by means of design of experiments (DOE). A numerical simulation of the heat model was developed with the aim of finding the process time window.
Effect of Process Parameters on the Total Heat Damaged Zone (HDZ) during Micro-EDM of Plastic Mold Steel 1.2738

In micro electrical discharge machining, three subsurface layers are formed on the workpiece, they are; recast zone, heat affected zone and converted zone, primarily due to heating-quenching cycles. The HDZ in micro-EDM is characterized by cracks and weakness in the grain boundary and thermal residual stresses. This paper presents the effect of process parameters on the HDZ in micro-EDM of plastic mold steel 1.2738. As the energy of the sparks increases, the thickness of the HDZ increases and the average coefficient of correlation between energy and HDZ considering three different sections of the zone is 0.8099. Therefore, the effect of process parameters governing the discharge energy are analyzed; they are: average current (Ia), peak current (Ip) and pulse ‘on-time’ (Ton). An overall increase in heat-damaged zone thickness by 105% is observed with an increase in pulse on time.

Environmentally clean micromilling of electron beam melted Ti6Al4V

The paper is aimed at evaluating the performances of Minimum Quantity Lubrication (MQL), dry cutting and cryogenic cooling when applied to the micro-milling of Ti6Al4V titanium alloy samples obtained by Additive Manufacturing (AM) using the Electron Beam Melting (EBM) technology. The micro-milling tests were carried out on a high precision 5-axis micro-milling center, at varying cutting speed and feed per tooth. The performances of the different lubrication/cooling strategies were analyzed in terms of surface integrity, namely surface topography, nano-hardness and sub-surface microstructural alterations, in order to prove the impact of clean cutting conditions when applied to micro-machining of a AM titanium alloy of biomedical interest. It is shown that dry cutting assures the same performances of MQL, representing then the most suitable option to decrease the environmental impact of the machining process. (C) 2016 Elsevier Ltd. All rights reserved.
Estimation of Water Diffusion Coefficient into Polycarbonate at Different Temperatures Using Numerical Simulation

Nowadays, many electronic systems are exposed to harsh conditions of relative humidity and temperature. Mass transport properties of electronic packaging materials are needed in order to investigate the influence of moisture and temperature on reliability of electronic devices. Polycarbonate (PC) is widely used in the electronics industry. Thus, in this work the water diffusion coefficient into PC is investigated. Furthermore, numerical methods used for estimation of the diffusion coefficient and their assumptions are discussed. 1D and 3D numerical solutions are compared and based on this, it is shown how the estimated value can be different depending on the choice of dimensionality in the model.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
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Scopus rating (2005): SJR 0.217 SNIP 0.416
Evolution of Surface Texture and Cracks During Injection Molding of Fiber-Reinforced, Additively-Manufactured, Injection Molding Inserts

This paper investigates the lifetime and surfacedeterioration of additively-manufactured, injection-moulding inserts. The inserts were produced using digital light processing and were reinforced with oriented short carbon fibers. The inserts were used during injection molding of low-density polyethylene until their failure. The molded products were used to analyse the development of the surface roughness and wear. By enhancing the lifetime of injection-molding inserts, this work contributes to the establishment of additively manufactured inserts in pilot production.

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State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
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Experimental Investigation of Comparative Process Capabilities of Metal and Ceramic Injection Molding for Precision Applications

The purpose of this paper is to make a comparative study on the process capabilities of the two branches of the powder injection molding (PIM) process—metal injection molding (MIM) and ceramic injection molding (CIM), for high-end precision applications. The state-of-the-art literature does not make a clear comparative picture of the process capabilities of MIM and CIM. The current paper systematically characterizes the MIM and CIM processes and presents the process capabilities in terms of part shrinkage, surface replication, tolerance capability, and morphological fidelity. The results and discussion presented in the paper will be useful for thorough understanding of the MIM and CIM processes and to select the right material and process for the right application or even to combine metal and ceramic materials by molding to produce metal–ceramic hybrid components.

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Authors: Islam, A. (Intern), Giannekas, N. (Intern), Marhofüer, D. M. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
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Experimental investigation of surface determination process on multi-material components for dimensional computed tomography

The possibility of measuring multi-material components, while assessing inner and outer features simultaneously makes X-ray computed tomography (CT) the latest evolution in the field of coordinate measurement systems (CMSs). However, the difficulty in selecting suitable scanning parameters and suitable surface determination settings, limits a better acceptance of CT as a CMS. Moreover, standard CT users are subject to the algorithms and boundary conditions implied by the use of commercial analysis software. In this context, this paper is concerned with the experimental evaluation of the influence of surface determination process on multi-material measurements, using functions available in the commercial CT data analysis software Volume Graphics VGStudio Max 2.2.6. Calibrated step gauges made of different materials, i.e. PEEK, PPS, and Al were used as reference standards. The step gauges were assembled in such a way as to have different multi-material X-ray absorption ratios. Comparative measurements of mono-material assemblies were performed as well. Different segmentation processes were considered (e.g. ISO-50%, local threshold, region growing, etc.), patch-based bidirectional length analyses were carried out to perform in-material measurements on the assemblies. This work discusses the different approaches based on real CT scans, and aims to provide advice on the segmentation process for multi-material measurements.
Here we present the fabrication of a solid-core microstructured polymer optical fiber (mPOF) made of polycarbonate (PC), and report the first experimental demonstration of a fiber Bragg grating (FBG) written in a PC optical fiber. The PC used in this work has a glass transition temperature of 145°C. We also characterize the mPOF optically and mechanically, and further test the sensitivity of the PC FBG to strain and temperature. We demonstrate that the PC FBG can bear temperatures as high as 125°C without malfunctioning. In contrast, polymethyl methacrylate-based FBG technology is generally limited to temperatures below 90°C.
Fast Mold Temperature Evolution on Micro Features Replication Quality during Injection Molding
The growing demand to manufacture, with high accuracy, functional structures in the micro and sub-micro meter range polymer based microsystem products calls for reliable mass production processes. Being injection molding (IM) the preferential technology employed for polymer mass fabrication and mold temperature one of the most relevant process parameter to enhance polymer replication at the micro meter scale, the present study investigates effects of fast mold temperature evolution on final replication quality of produced injection molded parts. Micro features master geometries were produced by UV lithography and subsequent nickel electroplating. The mold temperature was controlled by a thin heating device (composed by polyimide as insulating layer and polyimide carbon black loaded aselectrical conductive layer) able to increase the temperature on mold surface in a few seconds (40°C/s) by Joule effect and let the surface to cool down soon after. This heating device allowed to maintain mold temperature at a constant value for a time that could be equal to the filling time or longer. A fully characterized isotactic polypropylene was used as the polymer material during the injection molding experiments. The experiments revealed that the replication was mostly sensitive to cavity pressure and mold temperature. In particular, an increase of holding pressure and mold temperature enhanced the replication. Also the heating time increased the replication quality.

Feasibility study of injection mouldable conductive plastic for the hearing aid applications
Electrically conductive polymers can combine the advantage of plastic processing with the unique electrical properties which are usually found in metals. This article presents a feasibility study of an electrically conductive plastic for hearing aid antennas. Focus will be placed to critically analyse the electrical properties of the potential conductive plastic in a two component injection moulding process chain. The purpose of this experimental study is to mimic the real scenario in a hearing aid device and conclude the antenna’s efficiency based on the results obtained with OTA (over the air) 3D measuring system in comparison with an ideal copper antenna at 2.4 GHz. An analysis of the association between the conductive plastic processing parameters in regards to its electrical performance is discussed and evaluated.

Free-form nanostructured tools for plastic injection moulding
We present results on a recently developed process to provide nanostructured surfaces on curved free-form injection moulding tools. The nanostructures are prepared using a sol-gel type coating, which can be applied by various means.
Nanostructures are transferred from master structures originated typically by lithography. The nanostructures are imprinted by means of flexible stamps. After imprinting, nanostructures in the sol-gel are cured by baking, by which the material is converted to a quartz-like substance. Line patterns with depths up to about 500 nm and aspect ratio of up to 1 have been realized and successfully transferred to plastic parts during injection moulding. As an example, we present theory and results regarding the imprint of pillar nanostructures on a semi-spherical mold surface, followed by injection molding of the same. The deformation of the flexible stamp is characterized by measurement of inter-pillar distance on various points on the sphere, and compared to predictions provided by a geometrical model. Moulded plastic parts show good replication of the pillar structure. There are various practical advantages to the new process: the application of the coating is possible on both flat, single-curved and double-curved surfaces; the coating and the baking step is compatible with typical steel types in common usage for injection moulding; the coating is conformal with a rela-tively high surface roughness up to Ra = 100 nm, accommodating several surface finishing methods such as fine milling and diamond polishing; the coating has slightly insulating properties, which improve the nanostructure transfer properties compared to metal nanostructures; several durability studies have shown that the nanostructures on the injection moulding tool surface are unaffected for at least 100,000 injection moulding cycles; the imprinting of nanostructures has been successfully attempted with several types of thermoplastic polymer, including PS, ABS, PE, PP, COC (Topaz), and PA (Nylon), showing that most polymers are compatible, while some may require an increase in mold temperature for full transfer of nanostructure depth. In conclusion, the process for nanostructured surfaces on double-curved or free-form injection moulding tools relies on flexible stamps, giving rise to predictable deformation of the pattern. The sol-gel process provides for a durable tool with accommodation of imperfect injection tool surface.
Gate Design in Injection Molding of Microfluidic Components Using Process Simulations

Just as in conventional injection molding of plastics, process simulations are an effective and interesting tool in the area of microinjection molding. They can be applied in order to optimize and assist the design of the microplastic part, the mold, and the actual process. Available simulation software is however actually made for macroscopic injection molding. By means of the correct implementation and careful modeling strategy though, it can also be applied to microplastic parts, as it is shown in the present work. Process simulations were applied to two microfluidic devices (amicrofluidic distributor and a mixer). The paper describes how the two devices were meshed in the simulations software to obtain a proper simulation.
model and where the challenges arose. One of the main goals of the simulations was the investigation of the filling of the parts. Great emphasis was also on the optimization of selected gate designs for both plastic parts. Subsequently, the simulation results were used to answer the question which gate design was the most appropriate with regard to the process window, polymer flow, and part quality. This finally led to an optimization of the design and the realization of this design in practice as actual steel mold. Additionally, the simulation results were critically discussed and possible improvements and limitations of the gained results and the deployed software were described. Ultimately, the simulation results were validated by cross-checking the flow front behavior of the polymer flow predicted by the simulation with the actual flow front at different time steps. These were realized by molding short shots with the realized molds and were compared to the simulations at the global, i.e., part level and at the local, i.e. feature level.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology
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**General Friction Model Extended by the Effect of Strain Hardening**
An extension to the general friction model proposed by Wanheim and Bay [1] to include the effect of strain hardening is proposed. The friction model relates the friction stress to the fraction of real contact area by a friction factor under steady state sliding. The original model for the real contact area as function of the normalized contact pressure is based on slip-line analysis and hence on the assumption of rigid-ideally plastic material behavior. In the present work, a general finite element model is established to, firstly, reproduce the original model under the assumption of rigid-ideally plastic material, and secondly, to extend the solution by the influence of material strain hardening. This corresponds to adding a new variable and, therefore, a new axis to the general friction model. The resulting model is presented in a combined function suitable for e.g. finite element modeling of friction in metal forming, where the material generally strain hardens. The extension of the model to cover strain hardening materials is validated by comparison to previously published experimental data.

**General information**
State: Published
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Green Fiber Bottle: the fully biodegradable packaging
The ambition of the Green Fiber Bottle (GFB) project is to manufacture a fully biodegradable bottle. Carlsberg is the intended end user, and they aim to package their beer in the new bottle. The new product is intended to replace the existing plastic and glass bottles, and thus reducing their impact on the environment, especially the oceans. For example, the life span of a plastic bottle in the ocean is 500 years, and during its degradation, the plastic is reduced to micro pieces, which causes the starvation of several marine animals.

The new bottle is completely made from molded paper pulp, which is a renewable resource. Nevertheless, due to food and drugs limitations, only virgin paper fibers must be employed in the production. The bottle could then be left to biodegrade in nature or enter a recycle system, along with other paper-based product. In order to contain the liquid, the bottle has to have an inner coating barrier. The most reliable solution proposed is to coat the inner walls with silicon dioxide, which is not biodegradable but rather environmentally inert.

To enhance the environmental footprint and sustainability of the bottle, and to be competitive with the existing technologies, the manufacturing technology for the production of the bottle has to offer the possibility of significant energy savings. Molded pulp products are made from wood fibers dispersed in water, and then they are formed, drained and dried. A relatively large quantity of resources (i.e. energy and time) is consumed during the drying process. It is in this process stage that an innovative way of drying the products can be exploited by using the concept of impulse drying. Impulse drying is an advance drying technique in which water is removed from a wet paper pulp by the combination of mechanical pressure and intense heat. In this process, the wet pulp is exposed to pressures ranging from 30 bar to 50 bar and temperatures typically between 200 °C and 400 °C. At these intense conditions, the wet pulp is dried in the order of seconds.

Many challenges must be dealt with to enable the use of such improvement in the production of the GFB. One of the research topics currently under investigation is the understanding and modelling of the impulse drying effect. Experimental evidence proves that a part of the liquid content in the paper pulp transforms into steam, and the correlated expansion eases the movement of the water out of the product. This secondary effect should be at the base of the reason why the drying takes place in a considerable short time. Nevertheless, a complete understanding of the phenomena has not been achieved, and thus a complete control of the drying mechanism is yet to be realized. The need of a physical model is thus clear in order to enable the use of impulse drying in a production environment.

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Authors: Didone, M. (Intern), Tosello, G. (Intern)
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High accuracy and precision micro injection moulding of thermoplastic elastomers micro ring production
The mass-replication nature of the process calls for fast monitoring of process parameters and product geometrical characteristics. In this direction, the present study addresses the possibility to develop a micro manufacturing platform for micro assembly injection moulding with real-time process/product monitoring and metrology. The study represent a new concept yet to be developed with great potential for high precision mass-manufacturing of highly functional 3D multi-material (i.e. including metal/soft polymer) micro components. The activities related to HINMICO project objectives proves the importance of using tool geometries as reference calibrated artefacts to establish effective process technology development and control. The results allow identifying the correct process windows for optimal part quality reducing product dimensional variation in the micrometer dimensional range. The proposed metrological approach enabled to quantify product dimensional variations based on process and tooling capabilities.

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High Throughput Integrated Technologies for Multimaterial Functional Micro Components (EU FP7 HINMICO 2013-2016)
The objective of the HINMICO project is the development and optimization of manufacturing processes for the production of high-added value high quality multi-material micro-components, with the possibility of additional, functionalities, through more integrated, efficient and cost-effective process chains.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Ik4-Tekniker, University of Birmingham, EuroOrthodencia, Mondragon Assembly, Ortofon AS, Tekniker Technological Center, Eibar (Spain), Flann Microwave Limited, French Technical Centre for Plastic and Composites
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Improved Friction Joint With Self-Locking Grips
Flexible risers are used in the oil industry to transport liquids and gas from the seafloor to extraction and production equipment at the sea surface. Ongoing research aims at using composite materials instead of steel, in order to reduce weight and increase stiffness. Ensuring an optimal load transfer between the composite and metal components is very important. This paper presents an improved method for anchoring a flat fiber reinforced tendon using a double grip system with self-locking grips. The novelty is the combination of new experimental results and finite element (FE) analysis to develop a superior dry friction grip. Experimental results are carried using a dedicated test setup, through which the test parameters can be accurately controlled. The efficiency of the grip system during pullout is superior to results obtained with flat grips. Numerical results offer an in-depth understanding of the influence between friction, geometrical parameters, and performance, making it possible to optimize the design. Results show that this grip system offers immediate technical applications, in a variety of conditions.

General information
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Improvement in Surface Characteristics of Polymers for Subsequent Electroless Plating Using Liquid Assisted Laser Processing

Metallization of polymers is a widely used process in the electronic industry that involves their surface modification as a pre-treatment step. Laser-based surface modification is one of the commonly used techniques for polymers due to its speed and precision. The process involves laser heating of the polymer surface to generate a rough or porous surface. Laser processing in liquid generates superior surface characteristics that result in better metal deposition. In this study, a comparison of the surface characteristics obtained by laser processing in water vis-à-vis air along with the deposition characteristics are presented. In addition, a numerical model based on the finite volume method is developed to predict the temperature profile during the process. Based on the model results, it is hypothesized that physical phenomena such as vapor bubble generation and plasma formation may occur in the presence of water, and it is because of these effects that causes an increase in surface porosity.

Improving accuracy of overhanging structures for selective laser melting through reliability characterization of single track formation on thick powder beds

Repeatability and reproducibility of parts produced by selective laser melting is a standing issue, and coupled with a lack of standardized quality control presents a major hindrance towards maturing of selective laser melting as an industrial
scale process. Consequently, numerical process modelling has been adopted towards improving the predictability of the outputs from the selective laser melting process. Establishing the reliability of the process, however, is still a challenge, especially in components having overhanging structures. In this paper, a systematic approach towards establishing reliability of overhanging structure production by selective laser melting has been adopted. A calibrated, fast, multiscale thermal model is used to simulate the single track formation on a thick powder bed. Single tracks are manufactured on a thick powder bed using same processing parameters, but at different locations in a powder bed and in different laser scanning directions. The difference in melt track widths and depths captures the effect of changes in incident beam power distribution due to location and processing direction. The experimental results are used in combination with numerical model, and subjected to uncertainty and reliability analysis. Cumulative probability distribution functions obtained for melt track widths and depths are found to be coherent with observed experimental values. The technique is subsequently extended for reliability characterization of single layers produced on a thick powder bed without support structures, by determining cumulative probability distribution functions for average layer thickness, sample density and thermal homogeneity.

**General information**

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**Organisations:** Department of Mechanical Engineering, Manufacturing Engineering

**Authors:** Mohanty, S. (Intern), Hattel, J. H. (Intern)

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**Influence of Process Temperatures on Blister Creation in Micro Film Insert Molding of a Dual Layer Membrane**

In this work the suitability of a dual layer membrane, consisting of a non-woven Polypropylene (PP) support and a membrane layer made out of Polyethylene Terephthalate (PET) for Micro Film Insert Molding (μFIM) was investigated. The emergence of blisters at the surface of the PET-membrane layer was observed for some combinations of the process parameters used in this investigation. Since these blisters are not only an optical issue but can also deteriorate the functionality of the membrane, a blister free over moulding of the membrane is required. In particular the mold and the barrel temperature were found to influence this blister creation. The influence of these two parameters on the amount of blisters and the blister height, characterized by the a real surface topography parameters peak material portion (Smr1) and reduced peak height (Spk), is presented in this paper.

**General information**

**State:** Published

**Organisations:** Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, University of Bradford

**Authors:** Wöhner, T. (Intern), R. Whiteside, B. (Ekstern), Tosello, G. (Intern), Hansen, H. N. (Intern), Islam, A. (Intern)

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**Publisher:** Research Publishing Services
Injection molding of micro pillars on vertical side walls using polyether-ether-ketone (PEEK)

This paper investigates the replication of microstructures on a vertical wall by PEEK injection molding. A 4-cavity insert was used in the injection molding. Pre-fabricated nickel plates with ø 4 μm micro holes on the surface were glued on vertical walls in the cavities. 3 cavities were coated by CrN, TiN and TiB2 respectively, the remaining one was not coated as a reference. The effect of coating was compared via the morphology of the micropillars on the polymer parts. 4000 injection molding cycles were repeated. The roughness of the coated surface was measured. The reasons for the demolding result were discussed.

Injection moulding and selective metallisation technologies for polymer Microsystems

The present paper describes how developing and optimizing high-throughput integrated technologies for the production of miniaturised multi-material and multi-functional components at industrial scale. Based on 2 industrial demonstrators (a band diplexer and a micro aeraulic device), the paper shows that many technologies have to be combined to succeed: injection moulding process, copper plating, laser ablation, laser welding, glue welding,...
In-Situ Monitoring in Additive Manufacturing Using Contact Image Sensors

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InteraqCT Comparison on Assemblies - Final Report
An interlaboratory comparison on industrial X-ray Computed Tomography (CT) was organized by the Centre for Geometrical Metrology (CGM), Department of Mechanical Engineering, Technical University of Denmark (DTU) and carried as part of the Marie Curie ESR Project INTERAQCT. In the comparison, 22 laboratories from 7 countries were involved, and two assemblies, Assembly 1 and Assembly 2, having different materials and sizes were circulated. Assembly 1 is a physical item while Assembly 2 is a CT scan of industrial assembly. Various measurands are considered, encompassing lengths, diameters, roundness and concentricity. A multi-material length is also included in the comparison. Two different scanning approaches were considered within the comparison exercise for Assembly 1. The first approach, coded as "Own Choice", does not apply any scanning restrictions on any of the scanning parameters. The second one, coded as "FastScan", introduced a series of limitations, including the scanning time and the number of images per projection. 22 samples of Assembly 1 were circulated in parallel to the participants. A single sample of Assembly 2 was electronically circulated to the participants. The results of each participant are kept confidential. Participants can identify their individual results using an anonymous identification number provided by the coordinator at the beginning of the circulation. All samples were measured by the coordinator using a coordinate measuring machine before and after circulation. The samples of Assembly 1 have shown a good stability over the total comparison time of 8 months. No stability investigation was conducted on Assembly 2 due to the absence of circulation. Depending on the item and measurand, the reference expanded uncertainties (k=2) ranged from 1.1 μm to 2.6 μm. Participants stated measurement uncertainties in the range between 2 μm and 100 μm for all measurands of Assembly 1. The majority of participants stated measurement uncertainties based on MPE, whereas just a few participants used more complex uncertainty models. The metrological consistency of participants’ results was investigated using the En value, where |En| < 1 indicates agreement between measurement results while |En| ≥ 1 shows disagreement. 71% of the measurements conducted using the Fast Scan approach are in accordance with the reference values. 59% of the measurements conducted using the Own Choice approach in agreement with the reference values. 59% of the measurements conducted using the Fast Scan approach are in accordance with the reference values. L2, L3, and T, which are bidirectional measurands, show lower agreement than L1 and L4, which are unidirectional lengths. The majority of participants obtained similar results in both scanning approaches. A few participants achieved significantly different measurement results, most probably due to the impossibility of selecting suitable scanning parameters. Systematic errors were detected for some participants, especially in CT systems not built for metrology. Results for Assembly 2 showed that increasing the complexity of the measurand increases the range of variation among participants. A good agreement was obtained among InteraqCT_FinalReport Page 4 of 74 participants for diameters, whereas a worse agreement was registered for roundness and concentricity. It was also observed that participants obtained different results although they used similar inspection software and measuring strategies. Measuring procedures provided by the coordinator for both assemblies were followed by participants without problems. Most participants carried out measurements and sent their results to the coordinator according to the schedule.

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Authors: Stolfi, A. (Intern), De Chiffre, L. (Intern)
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Publication date: 2016
Investigation of digital light processing using fibre-reinforced polymers

Literature research shows multiple applications of fibre-reinforced polymers (FRP) respectively in fused deposition modelling and gypsum printing influencing the quality of the products in terms of stress and strain resistance as well as flexibility. So far, applications of fibre-reinforced polymers in digital light processing (DLP) are limited. Fibre-reinforced polymer composites were manufactured into test objects using digital light processing. Short fibres were used in an unordered manner. An anisotropic property due to fibre orientation within the material was observed. The importance of fibre length and shape compared to layer thickness has been investigated including concepts to circumvent clustering of the fibres. This research contributes to the implementation of fibre-reinforced polymers in additive manufacturing.
technologies. Digital light processing allows generation of miniaturized objects with relatively high surface quality compared to other additive manufacturing technologies. This paper aims to move fibre reinforced resin parts one step closer towards mechanically strong production-quality components.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Hofstätter, T. (Intern), Pedersen, D. B. (Intern), Nielsen, J. S. (Intern), Mischkat, M. (Intern), Hansen, H. N. (Intern)
Number of pages: 2
Publication date: 2016

Investigation of the in-solution relaxation of polymer optical fibre Bragg gratings
We investigate the response of PMMA microstructured polymer optical fibre Bragg gratings when immersed in methanol/water solutions. Overall we observe a permanent blue-shift in Bragg grating wavelength after solvent evaporation. The main contribution in the resonance wavelength shift probably arises from a permanent change in the size of the fibre, as already reported for high-temperature annealing of polymer optical fibres. As a consequence of the solution concentration dependence of the glass transition temperature of polymers, different methanol/water solutions lead to various degrees of frozen-in stress relaxation with an overall blue-shift of the Bragg grating wavelength.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation
Authors: Fasano, A. (Intern), Woyessa, G. (Intern), Janting, J. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
Pages: 4
Publication date: 2016

Investigation on the micromilled surface characterization through replica technology
Micromilling is one of the most suitable technologies for the direct manufacturing of freeform micro components as well as for the generation of complex geometries typical of micro mould manufacturing. In this context, a detailed knowledge of the surface topography is fundamental to deal with quality control and tolerances to meet the parts functionality. However, in many cases, the reduced accessibility caused by the part complex features (e.g. microcavities, micro-holes, deep-cores) prevents from performing a direct measurement of the surface, using both contact and non-contact techniques. This represents an open issue that, in some cases, can be tackled by adopting the replication technology. The method consists in obtaining the replicated surface and performing its measurement using suitable measuring systems. This paper evaluates the actual performance of a commercial replication product for the indirect measurement of micromilled surfaces, characterized by submicrometer roughness levels. The study assesses the performance of the replication method by measuring the surface roughness (in terms of Sa) of specifically designed micromilled flat surfaces. A 3D confocal optical microscope is employed for the measurements. Two different workpiece materials (AISI 440, annealed and hardened), two different milling conditions (roughing and finishing types) and three replications of each surface are analyzed. The replication resulted suitable for characterizing micromilled surfaces even if it gives an average
overestimation in the nanometric level of the Sparameter.

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**Length determination on industrial polymer parts from measurement performed under transient temperature conditions**

A way to reduce the cost of metrology in manufacturing is to perform dimensional verification directly in the production environment, avoiding a long and expensive acclimatization phase. In this work the effect of a transient temperature state, typical of the production environment, was investigated on commercial polymer parts. Two points length measurements were performed before the stabilization of the temperature and length at standard conditions was estimated. The experiments consisted of synchronized measurements of length and temperature of the part over several minutes during the cooling phase, from 27 °C to 20 °C approximately. The length variation was measured by means of an inductive probe and the temperature with an RTD surface sensor. The frame of the system was composed by elements in Zerodur and Invar to minimize the thermal deformations of the structure. Uniform temperature in the part was assumed. The reference length at 20 °C (L20) was calculated with an a posteriori regression of the data from the complete cooling curve. A prediction of L20 was then performed exploiting partial segments of the curve. Several segments with different time spans and starting points were evaluated. The procedure was repeated 5 times on 5 nominally identical parts. An expanded uncertainty (k=2) below 2μm was evaluated for the predicted length at 20 °C.

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**Low temperature surface hardening of stainless steel; the role of plastic deformation**

Thermochemical surface engineering by nitriding of austenitic stainless steel transforms the surface zone into expanded austenite, which improves the wear resistance of the stainless steel while preserving the stainless behavior. As a consequence of the thermochemical surface engineering, huge residual stresses are introduced in the developing case, arising from the volume expansion that accompanies the dissolution of high interstitial contents in expanded austenite. This work addresses two aspects of the role of plastic deformation on the case developing during low temperature nitriding: - plastic deformation of metastable austenitic stainless steels leads to the development of strain-induced martensite, which compromises the uniformity and the homogeneity of the expanded austenite zone. - during low temperature surface engineering composition and stress profiles develop. On numerical modelling the evolution of composition and stress profiles from the processing parameters temperature, time and gas composition it is necessary to include elastic-plastic accommodation of the composition-induced strains associated with lattice expansion.
Material Removal Mechanisms Analysis in the dry Electrical Discharge Machining and Possibilities for Micro-machining Applications

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Puthumana, G. (Intern)
Number of pages: 1
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Main Research Area: Technical/natural sciences
Electronic versions: Govindan_DTU_Sustain_2016.pdf
Source: PublicationPreSubmission
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Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Mathematical modelling of coupled heat and mass transport into an electronic enclosure
In contrast to high fidelity CFD codes which require higher computational effort/time, the well-known Resistor-Capacitor (RC) approach requires much lower calculation time, but also with a lower resolution of the geometrical arrangement. Therefore, for enclosures without too complex geometry in their interior, it is more efficient to use the RC method for thermal management and design of electronic compartments. Thus, the objective of this paper is to build an in-house code based on the RC approach for simulating coupled heat and mass transport into a (closed) electronic enclosure. The developed code has the capability of combining lumped components and a 1D description. Heat and mass transport is based on a FVM discretization of the heat conduction equation and Fick's second law. Simulation results are compared with corresponding experimental findings and good agreement is found. Second simulation was performed to study the response of temperature and moisture inside an enclosure exposed to the B2 STANAG climatic cyclic conditions.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Staliulionis, Z. (Intern), Jabbaribehnam, M. (Intern), Hattel, J. H. (Intern)
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Main Research Area: Technical/natural sciences
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Source: FindIt
Source-ID: 2349187977
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016
Metrology of sub-micron structured polymer surfaces

Precision moulding is an essential technology for the miniaturisation of moulded parts and it is continuously needing for specially developed solutions to face new challenges in injection moulding (IM) processes. One of the key challenges in advanced IM technology is the achievement of a full surface replication of the tool insert component when moulding the polymer melt [1]. This aspect is particularly critical when dealing with increasingly small dimensional scales in micro- and nano-structured surfaces [2, 3]. In this context, a metrological investigation of polymer replicated surfaces using metal masters with different types of finish has been carried out. Four types of surface finish were considered: a) Diamond buff polishing. b) Grit paper polishing. c) Stone polishing. d) Dry blast polishing (see Fig. 1). Both master and replicated surfaces were measured using a laser scanning confocal microscope. Hence, the replication fidelity was evaluated comparing the measurements of the polymer surfaces against the ones of the masters. The amplitude and the slope replications were considered calculating respectively $S_q$ and $S_{dq}$ areal surface texture parameters. The expanded uncertainty was also evaluated according to ISO 15530-3:2011, adapted to optical measurements, and propagated to the replication fidelity. A good amplitude replication was achieved for stone polished surfaces with a replication fidelity larger than 90%. The dry blast ones were evaluated with an amplitude replication fidelity of about 70%. The worst amplitude replication was achieved for both diamond buff and grit paper polished surfaces with a replication fidelity around 50%. The tendency is almost the same for slope replication but the replication fidelity values are lower: 70% for stone polished surfaces, 50% for dry blast and grit paper polished surfaces, 30% for diamond buff polished surfaces.
Modeling coupled heat and mass transfer during drying in tape casting with a simple ceramics-water system

In many industrial processes such as in tape casting for electronics or in the food industry, drying is one of the determining physical phenomena. In this study, the evaporation of water from a ceramic-water mixture is investigated with the purpose of understanding the drying rate in the drying process of thin sheets produced by the tape casting process. The rate of mass loss in the drying process is a key factor that often is of interest, as it affects the final properties of the tapes. The 1D heat conduction equation is solved numerically to obtain the temperature field in a ceramic sheet. The change in the concentration of the water content is then used as the driving force for diffusive mass transport of the water. Mass-averaged thermal properties are assumed for the ceramic-water mixture in the initial stage. As the water evaporates, the thermal properties of the solid ceramic become more dominant since the fraction of water approaches zero. The developed model is used to simulate a simple test for the drying process. The drying rate is simply calculated by examining the water content in each time step. It is found that the mass loss due to the evaporation is increasing close to linearly with the drying time corresponding to an almost constant drying rate. However, the rate starts to decrease after some time in the simulation. It is also shown that too extensive surface drying results in a slow diffusion rate from the bottom, which in turn reduces the drying rate in general and hence is not favorable from a process viewpoint.
Modeling the effect of probe force on length measurements on polymer parts

Measurement uncertainty at micrometer level is in the future going to be very common in dimensional measurements on polymer parts. Accurate dimensional measurement of polymer parts is becoming a key and common practice in the industry, especially when micrometer tolerances are required. When conducting measurements with a contact probe there is always a force applied to the part. This force (0.3N – 3.3N) leads to deformations that influence the final result. The unknown deformation of the part under the measurement conditions can produce significant errors in the measurement. In the present work, Hertzian contact theory was applied to find the deformation analytically, where the measuring force was imposed to the part. Material properties of the polymer and radius of the probe tip were known parameters. The finite element software ABAQUS was then used to model the contact problem numerically. Both analytical and numerical approaches were compared with the experimental results. The results showed that the numerical model was able to predict the deformation of the polymer part due to different probe forces. Furthermore it was shown, that the probe force should be taken into account when measurement with a few micrometer accuracy should be performed on thin walled polymer parts.

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Modeling the effects of electrical and non-electrical parameters on the material removal and surface integrity in case of μEDM of a non-conductive ceramic material using a combined fuzzy-AOM approach

Micro-EDM is a non-contact process based on the thermoelectric energy between a tool electrode and a workpiece. In μEDM process, the mechanism of material removal is melting and evaporation. The thermal energy in the discharge plasma helps remove material from the workpiece, at the same time deteriorates the quality and integrity of the workpiece surface. The material removal phenomenon in μEDM of partially conductive and non-conductive materials is very complex.

This paper presents a novel approach to model the effects of electrical and non-electrical parameters on the material removal phenomenon and surface integrity for a non-conductive ceramic material. The fuzzy logic modeling system is employed for predicting the μEDM process responses. The trends in the material removal rate and hardness values with the chosen electrical and non-electrical parameter for the model and obtained using AOM approach are compared.
average deviation between the model predictions and the results obtained using AOM plots is less than 10%. The material removal rate (MRR) decreases linearly with voltage, indicating a difference in material removal mechanism in the μEDM of non-conductive materials.

**General information**
- State: Published
- Organisations: Department of Mechanical Engineering, Manufacturing Engineering
- Authors: Puthumana, G. (Intern)
- Pages: 15-22
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- Electronic versions: Modeling_the_effects_of_electrical.pdf
- DOIs: 10.14257/ijast.2016.95.02
- Source: PublicationPreSubmission
- Source-ID: 125108877
- Publication: Research - peer-review › Journal article – Annual report year: 2017

Modeling the elastic behavior of ductile cast iron including anisotropy in the graphite nodules

This paper presents a micro-mechanical approach to model the intrinsic elastic anisotropy of the graphite particles in ductile iron. Contrary to most of the published works in the field, the constitutive behavior is directly derived on the basis of the nodule characteristic internal structure, composed of graphite platelets arranged into conical sectors. In this way, the large uncertainty traditionally associated with local mechanical measurements of micro-hardness is eliminated. The proposed anisotropic description is validated by simulating the macroscopic ductile iron elastic response by means of a 3D periodic unit cell model. In this respect, an explicit procedure to enforce both periodic displacement and periodic traction boundary conditions in ABAQUS is presented, and the importance of fulfilling the traction continuity conditions at the unit cell boundaries is discussed. It is shown that localized inelastic deformation is likely to develop for loading conditions which can still be considered as elastic at the macroscopic scale. The presence of a weak interface between the graphite and the matrix is also investigated, and it is found to affect the results to a limited extent only.

**General information**
- State: Published
- Organisations: Department of Mechanical Engineering, Manufacturing Engineering
- Authors: Andriollo, T. (Intern), Thorborg, J. (Intern), Hattel, J. H. (Intern)
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- Journal: International Journal of Solids and Structures
- Volume: 100-101
- ISSN (Print): 0020-7683
- Ratings:
  - BFI (2018): BFI-level 2
  - Web of Science (2018): Indexed yes
  - BFI (2017): BFI-level 2
  - Scopus rating (2017): CiteScore 2.66 SJR 1.295 SNIP 1.516
  - Web of Science (2017): Indexed yes
  - BFI (2016): BFI-level 2
  - Scopus rating (2016): CiteScore 2.8 SJR 1.548 SNIP 1.771
  - Web of Science (2016): Indexed yes
  - BFI (2015): BFI-level 2
  - Scopus rating (2015): SJR 1.456 SNIP 1.893 CiteScore 2.66
  - Web of Science (2015): Indexed yes
Modelling of fluid flow in tape casting of thin ceramics: Analytical approaches and numerical investigations

Tape casting has been used to produce thin layers of ceramics that can be used as single layers or can be stacked and laminated into multilayered structures. Many startup products such as multilayered inductors, multilayered varistors, piezoelectrics, ceramic fuel cells and lithium ion battery components are dependent upon tape casting technology. One of the growing sciences in the processing of ceramics by tape casting is the use of fluid flow analysis to control and enhance the final tapes. The fluid dynamics analysis of the ceramic slurries during tape casting is an efficient mean to elucidate the physical parameters crucial to the process. A review of the development of the tape casting process with particular focus on modelling the material flow is presented and in this context the current status is examined and future potential
Modelling of real area of contact between tool and workpiece in metal forming processes including the influence of subsurface deformation

New equipment for testing asperity deformation at various normal loads and subsurface elongations is presented. Resulting real contact area ratios increase heavily with increasing subsurface expansion due to lowered yield pressure on the asperities when imposing subsurface normal stress parallel to the surface. Finite element modelling supports the presentation and contributes by extrapolation of results to complete the mapping of contact area as function of normal pressure and one-directional subsurface strain parallel to the surface. Improved modelling of the real contact area is the basis for estimating friction in the numerical modelling of metal forming processes.
In the present work, a manufacturing process for transferring nanostructures from a glass wafer, to a double-curved insert for injection moulding is demonstrated. A nanostructure consisting of sinusoidal cross-gratings with a period of 426 nm is successfully transferred to hemispheres on an aluminium substrate with three different radii; 500 μm, 1000 μm and 2000 μm, respectively. The nanoimprint is performed using a 50 μm thick nickel foil, manufactured using electroforming. During
the imprinting process, the nickel foil is stretched due to the curved surface of the aluminium substrate. Experimentally, it is possible to address this stretch by counting the periods of the cross-gratings via SEM characterization. A model for the deformation of the nickel foil during nanoimprint is developed, utilizing non-linear material and geometrical behaviour. Good agreement between measured and numerically calculated stretch ratios on the surface of the deformed nickel foil is found, and it is shown, that from the model it is also possible to predict the geometrical extend of the nanostructured area on the curved surfaces.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Polymer Micro & Nano Engineering, Department of Micro- and Nanotechnology, InMold BioSystems A/S, Danish Fundamental Metrology, Nanyang Technological University
Authors: Sonne, M. R. (Intern), Cech, J. (Intern), Pranov, H. (Ekstern), Kofod, G. (Ekstern), Garnæs, J. (Ekstern), Lam, Y. C. (Ekstern), Hattel, J. H. (Intern), Taboryski, R. J. (Intern)
Number of pages: 6
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BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.26 SJR 0.165 SNIP 0.3
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.21 SJR 0.165 SNIP 0.246
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.18 SNIP 0.218 CiteScore 0.18
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.171 SNIP 0.202 CiteScore 0.17
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.164 SNIP 0.187 CiteScore 0.16
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.176 SNIP 0.193 CiteScore 0.14
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.161 SNIP 0.16 CiteScore 0.12
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.166 SNIP 0.158
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.163 SNIP 0.156
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.17 SNIP 0.132
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.171 SNIP 0.176
Scopus rating (2006): SJR 0.184 SNIP 0.187
Scopus rating (2005): SJR 0.217 SNIP 0.416
Scopus rating (2004): SJR 0.198 SNIP 0.249
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.153 SNIP 0.063
Modelling the deformations during the manufacturing of nanostructures on non-planar surfaces for injection moulding tool inserts: Paper

This paper presents a new manufacturing process for transferring nanostructures from a glass wafer to a curved aluminium insert for polymer injection moulding. A nanostructure consisting of sinusoidal cross-gratings with a period of 426 nm is successfully transferred to hemispheres with different radii via an embossing process. The embossing is done into a glass-like resist called HSQ, using a 50 μm thick nickel foil, manufactured with electroforming. During the imprinting process the nickel foil is stretched due to the curved surface of the aluminium substrate and it is experimentally possible to characterize this stretch by counting the periods of the cross-gratings via SEM characterization. A numerical model for simulating the deformation of the nickel foil during nanoimprint is also developed, utilizing non-linear material and geometrical behaviour. Good agreement between measured and numerically calculated stretch ratios on the surface of the deformed nickel foil is shown, and from the model it is also possible to predict the limiting boundary of the nanostructures on the curved surfaces, with decreasing radii.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Polymer Micro & Nano Engineering, Department of Micro- and Nanotechnology, InMold Biosystems A/S, Danmarks Nationale Metrologiinstitut, Nanyang Technological University
Authors: Sonne, M. R. (Intern), Cech, J. (Intern), Pranov, H. (Ekstern), Kofod, G. (Ekstern), Garnæs, J. (Ekstern), Lam, Y. C. (Ekstern), Hattel, J. H. (Intern), Taboryski, R. (Intern)
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Ratings:
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.02 SJR 0.554 SNIP 0.968
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.74 SJR 0.63 SNIP 1.067
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.687 SNIP 1.265 CiteScore 1.96
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.802 SNIP 1.316 CiteScore 1.84
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.737 SNIP 1.233 CiteScore 1.74
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Modelling the evolution of composition-and stress-depth profiles in austenitic stainless steels during low-temperature nitriding: Paper

Nitriding of stainless steel causes a surface zone of expanded austenite, which improves the wear resistance of the stainless steel while preserving the stainless behaviour. During nitriding huge residual stresses are introduced in the treated zone, arising from the volume expansion that accompanies the dissolution of high nitrogen contents in expanded austenite. An intriguing phenomenon during low-temperature nitriding is that the residual stresses evoked by dissolution of nitrogen in the solid state, affect the thermodynamics and the diffusion kinetics of nitrogen dissolution. In the present paper solid mechanics was combined with thermodynamics and diffusion kinetics to simulate the evolution of composition-depth and stress-depth profiles resulting from nitriding. The model takes into account a composition-dependent diffusion coefficient of nitrogen in expanded austenite, short range ordering (trapping) of nitrogen atoms by chromium atoms, and the effect of composition-induced stress on surface concentration and diffusive flux. The effect of plasticity and concentration-dependence of the yield stress was also included.

General information
State: Published
Organisations: Department of Mechanical Engineering, Materials and Surface Engineering, Manufacturing Engineering
Moisture diffusion coefficients determination of furan bonded sands and water based foundry coatings

Moisture content in furan bonded sand and water based coatings can be one of the main causes for gas related defects in large cast iron parts. Moisture diffusion coefficients for these materials are needed to precisely predict the possible moisture levels in foundry moulds. In this study, we first compare two different experimental methods that can be used to determine moisture diffusion coefficients. Then, we determine diffusion coefficients for water based coatings and for different types of furan binders and we investigate the effects of compaction, dust levels and temperature. Finally, we provide an example on how it is possible to apply this knowledge to estimate moisture variation in a sand mould during production.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Global Castings A/S
Authors: Di Muoio, G. L. (Ekstern), Tiedje, N. S. (Intern)
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.671 SJR 0.387 CiteScore 0.79
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.74 SJR 0.382 SNIP 0.857
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Moisture ingress into electronics enclosures under isothermal conditions

The number of electronics used in outdoor environment is constantly growing. The humidity causes about 19% of all electronics failures and, especially, moisture increases these problems due to the ongoing process of miniaturization and lower power consumption of electronic components. Moisture loads are still not understood well by design engineers, therefore this field has become one of the bottlenecks in the electronics system design. The objective of this paper is to model moisture ingress into an electronics enclosure under isothermal conditions. The moisture diffusion model is based on a 1D quasi-steady state (QSS) approximation for Fick's second law. This QSS approach is also described with an electrical analogy which gives a fast tool in modelling of the moisture response. The same QSS method is applied to ambient water vapour variations. The obtained results are compared to an analytical solution and very good agreement is
Molecular Gastronomy Meets 3D Printing: Layered Construction via Reverse Spherification

The potential use of additive manufacturing (AM) techniques for processing of food can span from satisfaction of basic necessities to high-end cuisine and fine dining. The purpose of this study was to explore how AM, specifically extrusion-based layer-wise deposition, can be combined with the reverse spherification technique that is widely used in molecular gastronomy. First, by manual extrusion, we identify suitable recipes and ingredient concentrations to form freestanding features in a liquid bath. Subsequently, a desktop extrusion is adapted for the deposition of a calcium solution into an alginate bath first as a two-dimensional (2D) pathway and then as three-dimensional (3D) geometry by layer-wise deposition. The 2D geometries are measured and compared to a nominal geometry, to elucidate how tool speed and extrusion rate influence form and dimensional accuracy. We demonstrate that motorized extrusion-based AM can be combined with reverse spherification to form stable objects by gelation of fruit-based solutions. In addition, a wider set of manual experiments shows the possibility of combining different flavors and the creation of complex multilayer and multiflavor objects. Additional studies on the deposition precision are required to optimize the process of creating a full 3D geometry. This study shows that 3D printing via reverse spherification can bridge the gap between culinary art and AM technology, and enable new capabilities for creation of dining experiences. This is a step toward the digital design and manufacturing of unique edible objects with complex flavors, textures, and geometries.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Massachusetts Institute of Technology
Authors: D’Angelo, G. (Intern), Hansen, H. N. (Intern), Hart, A. J. (Ekstern)
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Main Research Area: Technical/natural sciences

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Volume: 3
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ISSN (Print): 2329-7662
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Scopus rating (2017): SNIP 1.301 SJR 0.808 CiteScore 2.31
Web of Science (2017): Indexed Yes
Scopus rating (2016): SJR 0.547 SNIP 1.306 CiteScore 0.8
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 0.388 SNIP 2.1
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Source: FindIt
Source-ID: 2343400874
Publication: Research - peer-review › Journal article – Annual report year: 2016

Moulding process characterization of paper bottles using computed tomography

The paper presents an approach of evaluating the moulding process for production of paper bottles using Computed Tomography (CT). Moulded Pulp Products (MPP) are made of a formed, dewatered and dried mixture of pulp fibers and water. Modern industrial pulp moulding is dated back to the year 1903 when a patent for MPP production was acquired by Martin L. Keyes. With an increasing demand for environmental friendly products, researchers are now focusing on investigating advance manufacturing process for production of MPP.

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State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Saxena, P. (Intern), Bissacco, G. (Intern)
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Multiple Crack Growth Prediction in AA2024-T3 Friction Stir Welded Joints, Including Manufacturing Effects

A great deal of attention is currently paid by several industries toward the friction stir welding process to realize lightweight structures. Within this aim, the realistic prediction of fatigue behavior of welded assemblies is a key factor. In this work an integrated finite element method - dual boundary element method (FEM-DBEM) procedure, coupling the welding process simulation to the subsequent crack growth assessment, is proposed and applied to simulate multiple crack propagation, with allowance for manufacturing effects. The friction stir butt welding process of the precipitation hardened AA2024-T3 alloy was simulated using a thermo-mechanical FEM model to predict the process induced residual stress field and material softening. The computed stress field was transferred to a DBEM environment and superimposed to the stress field produced by a remote fatigue traction load applied on a notched specimen. The whole procedure was finally tested comparing simulation outcomes with experimental data. The good agreement obtained highlights the predictive capability of the method. The influence of the residual stress distribution on crack growth and the mutual interaction between propagating cracks were analyzed as well.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Salerno
Authors: Carlone, P. (Ekstern), Citarella, R. (Ekstern), Sonne, M. R. (Intern), Hattel, J. H. (Intern)
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Web of Science (2018): Indexed yes
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Scopus rating (2017): SNIP 1.997 SJR 1.402 CiteScore 3.17
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.13 SJR 1.648 SNIP 2.564
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.646 SNIP 2.49 CiteScore 2.79
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.096 SNIP 2.847 CiteScore 2.74
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.658 SNIP 2.579 CiteScore 2.58
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.945 SNIP 2.91 CiteScore 2.41
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 2.081 SNIP 2.828 CiteScore 2.33
ISI indexed (2011): ISI indexed yes
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Numerical investigation of friction joint between Basalt Fiber Reinforced Composites and aluminum
Flexible risers are used in the offshore oil industry for exporting hydrocarbons from subsea equipment to floating production and storage vessels. The latest research in unbonded flexible pipes aims to reduce weight by replacing metal components with composite materials. This would result in lighter and stiffer flexible risers, which would be well suited for ultra deep water applications. This paper develops a new finite element model used for evaluating the efficiency of anchoring flat unidirectional fiber reinforced tendons in a mechanical grip. It consists two flat grips with the fiber reinforced tendon in between. The grips are pressed against the composite and the pullout force is ensured through friction. The novelty of the paper is represented by the detailed investigation of the influence between the coefficient of friction and the pullout force. By comparing numerical and experimentally obtained results, it is possible to show the importance of friction decay in the grip. Improper contact between the grips and composite is also taken into account and leads to good agreement between numerical and experimental results. This study shows how to avoid overestimating the efficiency of such grip by using dry friction in finite element models.

General information
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Numerical Modelling of Drawbeads for Forming of Aluminium Alloys

The drawbeads in stamping tools are usually designed based on experience from the forming of steel. However, aluminium alloys display different forming behaviour to steels, which is not reflected in the drawbead design for tools used for stamping aluminium. This paper presents experimental results from different semi-circular drawbead geometries commonly encountered in automotive dies and compares them to those obtained from Stoughton’s analytical drawbead model and the 2D plane strain drawbead model set up using LS-DYNA. The study was conducted on lubricated NG5754 strips. The results presented are in terms of drawbead restraining force versus strip displacement, as a function of drawbead depth. The FE drawbead model agrees well with the experiments whereas the analytical model overpredicted the drawbead forces.
Numerical modelling of evaporation in a ceramic layer in the tape casting process

Evaporation of water from a ceramic layer is a key phenomenon in the drying process for the manufacturing of tape cast ceramics. This process contains mass, momentum and energy exchange between the porous medium and the free-flow region. In order to analyze such interaction processes, a Representative Elementary Volume (REV)-scale model concept is presented for coupling non-isothermal multi-phase compositional porous-media flow and single-phase compositional laminar free-flow. The preliminary results show the typical expected evaporation behaviour from a porous medium initially saturated with water, and its transport to the free-flow region according to the existent results from the literature.

General information
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BFI (2013): BFI-level 1
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ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.176 SNIP 0.193 CiteScore 0.14
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BFI (2011): BFI-level 1
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ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.166 SNIP 0.158
BFI (2009): BFI-level 1
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BFI (2008): BFI-level 1
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Scopus rating (2006): SJR 0.184 SNIP 0.187
Scopus rating (2005): SJR 0.217 SNIP 0.416
Numerical modelling of the flow in the resin infusion process on the REV scale: A feasibility study

The resin infusion process (RIP) has developed as a low cost method for manufacturing large fibre reinforced plastic parts. However, the process still presents some challenges to industry with regards to reliability and repeatability, resulting in expensive and inefficient trial and error development. In this paper, we show the implementation of 2D numerical models for the RIP using the open source simulator DuMuX. The idea of this study is to present a model which accounts for the interfacial forces coming from the capillary pressure on the so-called representative elementary volume (REV) scale. The model is described in detail and three different test cases - a constant and a tensorial permeability as well as a preform/Balsa domain - are investigated. The results show that the developed model is very applicable for the RIP for manufacturing of composite parts. The idea behind this study is to test the developed model for later use in a real application, in which the preform medium has numerous layers with different material properties.

General information
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ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.176 SNIP 0.193 CiteScore 0.14
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Numerical simulation of transient moisture and temperature distribution in polycarbonate and aluminum electronic enclosures

The challenge of developing a reliable electronic product requires huge amounts of resources and knowledge. Temperature and thermal features directly affect the life of electronic products. Furthermore, moisture can be damaging for electronic components. Nowadays, computational fluid dynamics (CFD) analysis has been proven as a useful tool to exploit the detailed and visualized information about the fluid flows; and hence it can be helpful for predicting local climate inside the electronic enclosures. In this study, the temperature and moisture distributions inside an idealized electronic enclosure with some heat producing components are investigated. It is shown how the enclosure material can influence local climate inside the enclosure using transient numerical simulations. The effect of heat transfer coefficient and wall thickness of the enclosure is also investigated. The enclosure material and the heat transfer coefficient of the enclosure with the environment are found to be influential on the mean temperature and relative humidity; however, the significance of their effects are not the same at different levels. Natural convection plays a key role in RH and temperature distribution.

General information

State: Published
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Numerical Simulation of Transient Moisture Transfer into an Electronic Enclosure

Electronic systems are sometimes exposed to harsh environmental conditions of temperature and humidity. Moisture transfer into electronic enclosures and condensation can cause several problems such as corrosion and alteration in thermal stresses. It is therefore essential to study the local climate inside the enclosures to be able to protect the electronic systems. In this work, moisture transfer into a typical electronic enclosure is numerically studied using CFD. In order to reduce the CPU-time and make a way for subsequent factorial design analysis, a simplifying modification is applied in which the real 3D geometry is approximated by a 2D axial symmetry one. The results for 2D and 3D models were compared in order to calibrate the 2D representation. Furthermore, simulation results were compared with experimental data and good agreement was found.
First, we define in this paper two benchmark flows readily usable by anyone calibrating a numerical tool for concrete flow prediction. Such benchmark flows shall allow anyone to check the validity of their computational tools no matter the numerical methods and parameters they choose. Second, we compare numerical predictions of the concrete sample final shape for these two benchmark flows obtained by various research teams around the world using various numerical techniques. Our results show that all numerical techniques compared here give very similar results suggesting that numerical simulations of concrete filling ability when neglecting any potential components segregation have reached a technology readiness level bringing them closer to industrial practice.
Objectives comparison in a confocal microscope using pseudo-random roughness artefacts

The increasing importance of optical microscopy in the geometrical and dimensional assessment of structured and freeform surfaces has easily overcome many difficulties related to the use of contact instruments. Nonetheless, some concerns related to optical instruments when measuring such surfaces are still open. The working distance (WD) of some standard (ST) lenses, e.g., can prevent from freely moving alongside features at different heights and positions of structured and freeform shapes due to the risk of collisions. In such cases, the so-called long working distance (LWD) objectives allow to operate at a longer distance from the surface under measurement, saving the same field of view (FoV) but accepting lower numerical apertures.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Quagliotti, D. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
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On Coulomb and Viscosity damped single-degree-of-freedom vibrating systems

Attention on friction damping mechanisms could be of interest for vibration reduction, and appears therefore to be desirable. Presentations of textbook analyses on mechanical vibration of a viscosity damped single degree system [mass, spring and eventually damping] are numerous. Often they begin with an assumption of a sin/cos behaviour of mass-amplitude ($x$) versus time ($t$) solution to the governing equation $[M \cdot \text{acceleration} = \text{Sum of forces}]$. The solutions have all an equal sin/cos form. This may indicate that mass and spring are prime elements of the model and that damping mainly has an amplitude reducing influence.

The amount of analyses of friction damped system is comparatively more limited. The periodic square wave is a frequently occurring type of friction in this type of analyses. This periodic square wave is often named Coulomb friction. It can be resolved in an infinite series of harmonic components with frequencies 1, 3, 5, … times the basic frequency of the square wave and with respective amplitudes: $(4/\pi) \cdot (1, 1/3, 1/5, \ldots) \cdot F_\mu(\omega t)$. $F_\mu(\omega t)$: the square wave amplitude. The governing equation for the sequence of a free vibration with Coulomb friction damping is nonlinear, but is linear within each $1/2$ period. A complete solution can therefore be made up compounding solutions from $1/2$ periods by inserting end conditions from one $1/2$ period as initial conditions for the following $1/2$ period. – Only spring and Coulomb forces act together.

As a Coulomb force is conceivable as an infinite series of harmonic components the appearance of harmonics could be expected in the behaviour of the amplitude ($x$) of the mass versus the time ($t$) in the solution. Some authors may have considered this possibility previously. But the solutions for friction damping can be written as $[(x + K_1) / K_2] \cdot \cos(\omega_n t)$; $K_1$ and $K_2$ are constants, adjustable within each $1/2$ period. $\omega_n$ is the undamped natural frequency. Apparently has friction damping alone an amplitude reducing effect. Based on these textbook presentations it appears noteworthy that displacement $x(t)$ is described alone with the $\cos(\omega_n t)$ function, that is, a completely pure cosine sequence, without triggering higher harmonics.

One conclusion could be that a free vibration with Coulomb friction damping integrates all harmonics into the constant Coulomb force: $F_\mu(\omega_n t)$. This hypothesis of an integrating mechanism may, however, not be valid when the system works, driven by the force $F_0(\cos(\omega t))$.

On the isotropic elastic constants of graphite nodules in ductile cast iron: Analytical and numerical micromechanical investigations

A comprehensive description of the mechanical behavior of nodules in ductile iron is still missing in the published literature. Nevertheless, experimental evidence exists for the importance of such graphite particles during macroscopic material deformation, especially under compressive loading. In the present paper, the nodules' elastic properties are thoroughly investigated by means of both analytical and numerical techniques. The analysis takes into account the influence of several non-linear phenomena, as local residual stresses arising during solid-state cooling, interface debonding and limited particle strength. It is shown that if the nodule internal structure is considered, the traditional isotropy assumption leads to the definition of a domain of admissible values for the effective elastic constants. However, micromechanical calculations indicate that values within the domain do not provide mesoscopic moduli in agreement with Young's modulus and Poisson's ratio recorded for common ferritic ductile iron grades. This suggests that graphite nodules may not be considered isotropic at the microscopic scale, at least from a mechanical viewpoint.
Optimization of electronic enclosure design for thermal and moisture management using calibrated models of progressive complexity

The thermal and moisture management of electronic enclosures are fields of high interest in recent years. It is now generally accepted that the protection of electronic devices is dependent on avoiding critical levels of relative humidity (typically 60–90%) during operations. Leveraging the development of rigorous calibrated CFD models as well as simple predictive numerical tools, the current paper tackles the optimization of critical features of a typical two-chamber electronic enclosure. The progressive optimization strategy begins the design parameter selection by initially using simpler equivalent RC-circuit models for concentration of water vapor and temperature in the electronic enclosure. After reducing the potential parameter-value space for the critical features using the RC-approach, the optimization strategy uses simpler 2D CFD models of temperature and moisture transport to further focus the parameter-value space, before shifting to 3D CFD models for final evaluations and verification. The approach results in a system capable of predicting optimum design features for the thermal and moisture management of electronic enclosures in a time-efficient and practically implementable manner.

Particle migration using local variation of the viscosity (LVOV) model in flow of a non-Newtonian fluid for ceramic tape casting

In this paper, the migration of secondary particles in a non-Newtonian ceramic slurry in the tape casting process is investigated with the purpose of understanding the particle distribution patterns along the casting direction. The Ostwald-de Waele power law model for the non-Newtonian flow behaviour is assumed in the simulation of the ceramic slurry flow. A local variation of the viscosity (LVOV) model as a function of the particle volume fraction is introduced and taken into account in the advection and the settling of the particles in the flow field. The results show that using the LVOV model changes the particle distribution pattern from being a constant distribution to a semi-layered one. The presence of such layered structure is highly affecting the subsequent sintering process, which in turn causes anisotropic shrinkage of the dried tapes. Moreover, it is found that increasing the substrate velocity (casting speed) leads to a more uniform distribution of the particles inside the ceramic slurry, in which case the shear induced particle migration is dominating over the gravity induced one.
Particle migration, Viscosity, Non-Newtonian, Tape casting, Fluidflow

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Performance verification of focus variation and confocal microscopes measuring tilted ultra-fine surfaces

The behaviour of two optical instruments, specifically a laser scanning confocal microscope and a focus-variation microscope, was investigated considering measurements of tilted surfaces. The measured samples were twelve steel artefacts for mould surface finish reference, covering Sa roughness parameter in the range (101—103) nm. The 3D surface texture parameters considered were Sa, Sq and Sdq. The small working distance of the confocal microscope objectives influenced the measurement setup, preventing from selecting a high tilting angle. The investigation was carried out comparing measurements of flat surfaces (0° tilt) with measurements of 12.5° tilted surfaces. The confocal microscope results showed a high sensitivity to tilting due to the laser beam reflection on the metal surfaces. The focus variation microscope results were more robust with respect to the considered angular variation, although they were out of the instrument operating range except for one of the twelve artefacts.
Potentiality Studies of Stainless Steel 304 Material for Production of Medical Equipment using Micro Electrical Discharge Machining (micro-EDM) Analysis and Modeling

Stainless steel 304 (SS304) is a material widely used for production of medical equipment mainly because of its anti-corrosive properties. It has excellent mechanical properties, strength and reliability because of which it is one of the best materials for fabrication of medical devices. This paper presents a systematic, scientific analysis, modeling study and optimization of quality characteristics of SS304 material by using micro-electrical discharge drilling process. The analysis of variance, main effects analysis, interactions analysis and study of contour plots were performed for three response variables; they are: material removal rate (MRR), volumetric tool wear rate (TWR) and geometric oversize. An overall increase in MRR is observed with an increase in capacitance, and the maximum increase was 61%. In the analysis of TWR, the volumetric tool electrode wear rate varies linearly with voltage. The interaction plots between voltage and capacitance showed that the lowest tool electrode wear rate is achieved at a capacitance of 0.10 μF at all levels of gap voltage. Capacitance is the only parameter influencing geometrical oversize in micro-EDM of SS304. The model equations for all the response variables and process parameters were developed. Grey relational analysis was used to optimize the micro-EDM quality characteristics, and the highest grey relational grade (GRG) of 0.8021 was obtained at a voltage of 100 V and a capacitance of 0.4 μF.

Potential of impulse drying technology for molded pulp products manufacture

The vision of the Green Fiber Bottle (GFB) project is to develop a paper bottle for beer, which will be both recyclable and biodegradable. The early prototypes of the bottle are very promising but there are huge technical and scientific challenges ahead to mature the production technology. The possibility of applying the concept of impulse drying during the drying stage is suggested. This would give benefits in terms of productivity and it would also reduce energy consumption. With the aim of understanding and controlling the impulse drying phenomena, a simplified approach is proposed. Finally, a potential design for a testing equipment is described.
**Precision and Accuracy Parameters in Structured Light 3-D Scanning**

Structured light systems are popular in part because they can be constructed from off-the-shelf low cost components. In this paper we quantitatively show how common design parameters affect precision and accuracy in such systems, supplying a much needed guide for practitioners. Our quantitative measure is the established VDI/VDE 2634 (Part 2) guideline using precision made calibration artifacts. Experiments are performed on our own structured light setup, consisting of two cameras and a projector. We place our focus on the influence of calibration design parameters, the calibration procedure and encoding strategy and present our findings. Finally, we compare our setup to a state of the art metrology grade commercial scanner. Our results show that comparable, and in some cases better, results can be obtained using the parameter settings determined in this study.

**Probabilistic analysis of a thermosetting pultrusion process**

In the present study, the effects of uncertainties in the material properties of the processing composite material and the resin kinetic parameters, as well as process parameters such as pulling speed and inlet temperature, on product quality (exit degree of cure) are investigated for a pultrusion process. A new application for the probabilistic analysis of the pultrusion process is introduced using the response surface method (RSM). The results obtained from the RSM are validated by employing the Monte Carlo simulation (MCS) with Latin hypercube sampling technique. According to the results obtained from both methods, the variations in the activation energy as well as the density of the resin are found to have a relatively stronger influence on the centerline degree of cure at the exit. Moreover, different execution strategies are examined for the MCS to investigate their effects on the accuracy of the random output parameter.
Process chain modeling and selection in an additive manufacturing context

This paper introduces a new two-dimensional approach to modeling manufacturing process chains. This approach is used to consider the role of additive manufacturing technologies in process chains for a part with micro scale features and no internal geometry. It is shown that additive manufacturing can compete with traditional process chains for small production runs. Combining both types of technology added cost but no benefit in this case. The new process chain model can be used to explain the results and support process selection, but process chain prototyping is still important for rapidly evolving fields like additive manufacturing.

General information
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Process Optimization for Injection Moulding of Passive Microwave Components

The demand for micro components has increased during the last decade following the overall trend towards miniaturization. Injection moulding is the favoured technique for the mass manufacturing of micro components or larger parts with micro-structured areas due to its ability to cost effectively replicate very complex shapes, precise tolerances and in high numbers. In order to secure Europe’s leading role in the sector of micro-fabrication the capabilities of injection moulding need to be further developed.

In this research a product for telecommunication, a diplexer unit, has been manufactured utilizing the injection moulding process. A design of experiment study has been carried out, varying process parameters such as injection speed, holding pressure, mould- and barrel temperature. The replicated parts are characterized by measuring geometric features and the part weight. Using an evaluation algorithm for modelling, the influence of different moulding parameters on the final part quality was assessed. Firstly a process model and secondly a quality model has been calculated. The results shows that part quality can be controlled by monitoring characteristic numbers.

Quantifying the Contribution of Post-Processing in Computed Tomography Measurement Uncertainty

This paper evaluates and quantifies the repeatability of post-processing settings, such as surface determination, data fitting, and the definition of the datum system, on the uncertainties of Computed Tomography (CT) measurements. The influence of post-processing contributions was determined by calculating the standard deviation of 10 repeated measurement evaluations on the same data set. The evaluations were performed on an industrial assembly. Each evaluation includes several dimensional and geometrical measurands that were expected to have different responses to the various post-processing settings. It was found that the definition of the datum system had the largest impact on the uncertainty with a standard deviation of a few microns. The surface determination and data fitting had smaller contributions with sub-micron repeatability.
Reducing residual stresses and deformations in selective laser melting through multi-level multi-scale optimization of cellular scanning strategy

Residual stresses and deformations continue to remain one of the primary challenges towards expanding the scope of selective laser melting as an industrial scale manufacturing process. While process monitoring and feedback-based process control of the process has shown significant potential, there is still dearth of techniques to tackle the issue. Numerical modelling of selective laser melting process has thus been an active area of research in the last few years. However, large computational resource requirements have slowed the usage of these models for optimizing the process. In this paper, a calibrated, fast, multiscale thermal model coupled with a 3D finite element mechanical model is used to simulate residual stress formation and deformations during selective laser melting. The resulting reduction in thermal model computation time allows evolutionary algorithm-based optimization of the process. A multilevel optimization strategy is adopted using a customized genetic algorithm developed for optimizing cellular scanning strategy for selective laser melting, with an objective of reducing residual stresses and deformations. The resulting thermo-mechanically optimized cellular scanning strategies are compared with standard scanning strategies and have been used to manufacture standard samples. © (2016) COPYRIGHT Society of Photo-Optical Instrumentation Engineers (SPIE). Downloading of the abstract is permitted for personal use only.
Revisiting Veerman's interpolation method

This article describes an investigation of Veerman's interpolation method and its applicability for determining sheet metal formability. The theoretical foundation is established and its mathematical assumptions are clarified. An exact Lagrangian interpolation scheme is also established for comparison. Bulge testing and tensile testing of aluminium sheets containing electro-chemically etched circle grids are performed to experimentally determine the forming limit of the sheet material. The forming limit is determined using (a) Veerman's interpolation method, (b) exact Lagrangian interpolation and (c) FE simulations. A comparison of the determined forming limits yields insignificant differences in the limit strain obtained with Veerman's method or exact Lagrangian interpolation for the two sheet metal forming processes investigated. The agreement with the FE-simulations is reasonable.
Rheological Characterization of Green Sand Flow
The main aim of this paper is to characterize experimentally the flow behaviour of the green sand that is used for casting of sand moulds. After the sand casting process is performed, the sand moulds are used for metal castings. The rheological properties of the green sand is important to quantify as they can be used to evaluate whether the casting process will be successful. In addition, the properties can potentially be implemented in a computational fluid dynamics model which can be used as a tool to optimize the process. The rheological experiments are carried out on a MCR 502 rheometer with a new module for characterizing granular materials. The new module enables viscosity measurements of the green sand as function of the shear rate at different flow rates, i.e. 0, 2, 4, 6, 8, 10, 12 and 15 L/min. The results show generally that the viscosity decreases with both the shear- and flow rate. In addition, the measurements show that the green sand flow follows a shear-thinning behaviour even after the full fluidization point.

Rheology of High-Melt-Strength Polypropylene for Additive Manufacturing
Acrylonitrile butadiene styrene (ABS) is a widely used material for additive manufacturing (AM) fused deposition modeling (FDM). The rheological properties of high-melt-strength polypropylene (HMS-PP) were compared to commercially available ABS 250 filament to study the possibility of using this material for FDM. The aim of this research contribution was to generate a full description of the viscosity in a plate-to-plate rheometer. Moreover, the materials were used in an FDM process focusing on the investigation of possible improvements of HMS-PP over ABS. The latter material showed specific disadvantages in terms of thermal stability. In particular, the storage modulus G', loss modulus G", and complex viscosity were measured at temperatures between 170 °C and 250 °C and brought to superimpose using the time-temperature
superposition method to create master curves of the two materials. The comparison of the time sweep allowed the conclusion that HMS-PP is more stable by showing less variation during the studied period of two hours. The master curves of ABS concluded that data measured at 250 °C deviates significantly from the curves derived from measurements at lower temperatures. In particular, the storage modulus and complex viscosity data of ABS 250 could not be used to enlarge the master curve values. HMS-PP showed a more stable behavior at the studied temperatures, and all data points were suitable to create the master curves. Practical studies to determine adapted extrusion parameters for HMS-PP were carried out using an FDM machine. ABS was extruded through a J-Head extruder with 0.4 mm nozzle-diameter and 243 °C extrusion temperature. The extrusion was performed in a vertical direction with gravitational forces pointing in the extrusion direction. The fused filament depended on the extrusion speed and diameter, resulting in an optimal printing speed of 60 to 80 mm/min. The HMS-PP granule was extruded into a filament of 1.75 mm diameter and then extruded through a J-Head and E3D with 0.4 mm nozzle-diameter and 200 to 240 °C. A comparison of the primary material with the printed material showed negligible changes in the measurement curves which might lead to the conclusion that the degradation of HMS-PP during the FDM process is as low as the degradation of ABS.

General information
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Robotic Hot-Blade Cutting: An Industrial Approach to Cost-Effective Production of Double Curved Concrete Structures

This paper presents a novel method for cost-effective, robotic production of double curved formwork in Expanded Polystyrene (EPS) for in situ and prefabricated concrete construction. A rationalization and segmentation procedure is developed, which allows for the transilibration of double curved NURBS surfaces to Euler elastica surface segments, while respecting various constraints of production. An 18 axis, tri-robot system approximates double curved NURBS surfaces by means of an elastically deformed and heated blade, mounted on the flanges of two manipulators. Re-orienting or translating either end of the blade dynamically deforms the blade’s curvature. The blade follows the contours of the rationalized surface by continuous change in position and orientation of the end-effectors. The concept’s potential is studied by a pilot production of a full-scale demonstrator panel assembly.

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Selection of items for "InteraqCT Comparison on Assemblies"
A new interlaboratory comparison concerning dimensional measurements from CT scans on assemblies is coordinated by DTU as an activity under the InteraqCT Marie Curie project. The paper discusses the selection of comparison items. The first assembly is a reference object produced at DTU, comprising an aluminium step gauge embedded inside a glass tube. The item is distributed to participants who are offered to carry out dimensional measurements at two different levels: 1) as instructed by coordinator; 2) at participant’s own choice. The second assembly is based on an industrial assembly, provided by Novo Nordisk A/S, encompassing two different polymer materials. This item consists of a data set for electronical distribution to participants who are offered to carry out dimensional measurements at two different levels: 1) high noise data set and 2) low noise data set.

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Semi-empirical prediction of moisture build-up in an electronic enclosure using analysis of variance (ANOVA)
Electronic systems are exposed to harsh environmental conditions such as high humidity in many applications. Moisture transfer into electronic enclosures and condensation can cause several problems as material degradation and corrosion. Therefore, it is important to control the moisture content and the relative humidity inside electronic enclosures. In this work, moisture transfer into a typical polycarbonate electronic enclosure with a cylindrical shape opening is studied. The effects of four influential parameters namely, initial relative humidity inside the enclosure, radius and length of the opening and temperature are studied. A set of experiments are done based on a fractional factorial design in order to estimate the time constant for moisture transfer into the enclosure by fitting the experimental data to an analytical quasi-steady-state model. According to the statistical analysis, temperature and the opening length are found as the most significant factors. Based on analysis of variance of the derived time constants, a semi-empirical regression model is proposed to predict the moisture transfer time constant with an adjusted R2 of 0.98; which demonstrated that the model can be used for estimation with a reasonable accuracy. The results show that the temperature has the highest effect on the moisture transfer time constant. Furthermore, the length of the opening is found to be more influential on the moisture transfer time constant at lower temperatures compare to high temperatures, according to the predictions made through the semi-empirical model.

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Shape Effect of Crushed Sand Filler on Rheology: A Preliminary Experimental and Numerical Study

Two types of filler from crushed sand were mixed with cement paste with constant superplasticizer dosage per mass of cement to investigate how their shape affects the rheology. The fillers were mylonitic quartz diorite and limestone produced using Vertical Shaft Impact (VSI) crusher and air classification, and had length/thickness (L/T) aspect ratios of 2.00 and 1.82, respectively. The particles were characterized with X-ray micro-computed tomography, coupled with spherical harmonic analysis to mathematically describe the full 3-D shape of the particles, while the rheological performance was quantified with the slump flow test (i.e. mini cone). The shape effect was isolated in the experiments by the use of non overlapping bimodal particle distributions of cement particles with a number average diameter of approximate to 0.01 mm and filler particles with a number average diameter of approximate to 0.1 mm. The two filler types were tested with a range of chi-values (volume of cement divided by total volume of solids). The flowability of the matrix increased with decreasing aspect ratios of the filler. However, the chi-value at which the maximum volume fraction threshold was obtained varied for the two filler types. Subsequently, a discrete element model was utilized to simulate the experimental data, thereby providing an initial step toward a numerical tool that can assist when proportioning self-compacting concrete with high volumes of crushed sand fines.

Shearing Nanometer-Thick Confined Hydrocarbon Films: Friction and Adhesion

We present molecular dynamics (MD) friction and adhesion calculations for nanometer-thick confined hydrocarbon films with molecular lengths 20, 100 and 1400 carbon atoms. We study the dependency of the frictional shear stress on the confining pressure and sliding speed. We present results for the pull-off force as a function of the pull-off speed and the sliding speed. Some of the results are analyzed using the simple cobblestone model and good semiquantitative agreement between the model predictions, and the MD results are found.
Shrinkage calibration method for µPIM manufactured parts

Five green and five sintered parts of a micro mechanical component, produced by micro powder injection moulding, were measured using an optical coordinate measuring machine. The aim was to establish a method for quality assurance of the final produced parts. Initially, the so called “green” parts were compared with the sintered parts (final products) calculating the percentage of shrinkage after sintering. Successively, the expanded uncertainty of the measured dimensions were evaluated for each single part as well as for the overall parts. Finally, the estimated uncertainty for the shrinkage was evaluated propagating the expanded uncertainty previously stated and considering green and sintered parts correlated. Results showed that the proposed method can be effective instating tolerances if it is assumed that the variability on the dimensions induced by the shrinkage equals the propagated expanded uncertainty.

Simulating the DISAMATIC process using the discrete element method — a dynamical study of granular flow

The discrete element method (DEM) is applied to simulate the dynamics of the flow of green sand while filling a mould using the DISAMATIC process. The focus is to identify relevant physical experiments that can be used to characterize the material properties of green sand in the numerical model. The DEM parameters describing the static friction coefficients are obtained using a ring shear tester and the rolling resistance and cohesion value is subsequently calibrated with a sand pile experiment. The calibrated DEM model is used to model the sand shot in the DISAMATIC process for three different sand particle flow rates as captured on the corresponding video footage of the interior of the chamber. A mould chamber with three ribs mounted on the fixed pattern plate forming four cavities is chosen as a reference geometry to investigate the conditions found in the real moulding process. The geometry of the cast part and the casting system can make the moulding process complicated due to obstacles such as ribs that deflect the sand flow causing “shadows effects” around the cavities of the mould. These dynamic effects are investigated by the qualitative flow dynamics and quantitative mould filling times captured in the video footage and simulated by the calibrated DEM model. Both two- and three-dimensional DEM models are considered and found to produce results in good agreements with the video footage of the DISAMATIC process.
Simulering af horisontella informningsmatare
Informningsmatare erbjuder gjuterierna nya möjligheter för matning vid gjutning. Den speciella utformningen av informningsmatare gör att de kan placeras på ställen där normalt matare inte kan placeras. Användning av dessa nya matare ställer samtidigt nya krav på simuleringar, som skall visa omfattningen och placeringen av porositeter i de gjutna ämnena.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Vedel-Smith, N. K. (Intern)
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Simulering af ram-up sleeve efterfödare

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Vedel-Smith, N. K. (Intern)
Pages: 5-10
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Main Research Area: Technical/natural sciences

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Single mode step-index polymer optical fiber for humidity insensitive high temperature fiber Bragg grating sensors
We have fabricated the first single-mode step-index and humidity insensitive polymer optical fiber operating in the 850 nm wavelength ranges. The step-index preform is fabricated using injection molding, which is an efficient method for cost effective, flexible and fast preparation of the fiber preform. The fabricated single-mode step-index (SI) polymer optical fiber (POF) has a 4.8µm core made from TOPAS grade 5013S-04 with a glass transition temperature of 134°C and a 150 µm cladding made from ZEONEX grade 480R with a glass transition temperature of 138°C. The key advantages of the proposed SIPOF are low water absorption, high operating temperature and chemical inertness to acids and bases and many polar solvents as compared to the conventional poly-methyl-methacrylate (PMMA) and polystyrene based POFs. In addition, the fiber Bragg grating writing time is short compared to microstructured POFs.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Woyessa, G. (Intern), Fasano, A. (Intern), Stefani, A. (Intern), Markos, C. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
Pages: 1253-1260
Publication date: 2016
Main Research Area: Technical/natural sciences
Spot feeding spheroidal graphite iron with exothermic and insulating ram-up sleeves in vertically parted moulds

Improvement of feeder technologies for energy savings in cast iron foundries is not only the title of the project behind this dissertation, it is a good idea that can improve casting yield and reduce production cost, and in turn strengthening the foundries competitive advantage. The approach to solving feeding problems today is for a large part based on methodologies and know-how developed more than 50 years ago. This dissertation addresses the state-of-the-art as it is used presently in the foundries, reviewing the fundamentals of spot feeding cast iron.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Vedel-Smith, N. K. (Intern)
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Step-height measurements on sand surfaces: A comparison between optical scanner and coordinate measuring machine

As with other manufacturing processes, modern casting is aiming at higher precision. To this, traceable measurements on sand moulds have become necessary. Optical 3D scanning offers a high degree of flexibility but suffers from lack of traceability, in particular when the object is sand. In this work step-heights ranging from 0.1 mm to 5.0 mm were made on 6 customised sand samples with an average grain size of 230 µm, produced using a hard binder that can be scanned both by tactile and optical probes. The step-heights were measured using a CMM with ø8 mm tactile probe. An optical 3D scanner based on triangulation principle using fringe projection was also used to measure the step heights resulting in a point cloud for each scanning. A similar measurement procedure with scanner was made using the scanners software to simulate a ball probe with the same size of CMM probe and following the same routine to touch the different positions on the polygonised mesh. Each measurement was repeated 5 times. The results of step height measurements on sand surfaces showed a maximum error of ± 12 µm for CMM, while scanner shows only ± 4 µm. Generally speaking, optical step height values were measured up to 27 µm larger than CMM measurements. A conclusion from this investigation is that CMM cannot be used to ensure traceability of optical measurements on this type of surface.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
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Main Research Area: Technical/natural sciences
Strength analysis and modeling of cellular lattice structures manufactured using selective laser melting for tooling applications

Additive manufacturing is rapidly developing and gaining popularity for direct metal fabrication systems like selective laser melting (SLM). The technology has shown significant improvement for high-quality fabrication of lightweight design-efficient structures such as conformal cooling channels in injection molding tools and lattice structures. This research examines the effect of cellular lattice structures on the strength of workpieces additively manufactured from ultra-high-strength steel powder. Two commercial SLM machines are used to fabricate cellular samples based on four architectures—solid, hollow, lattice structure and rotated lattice structure. Compression test is applied to the specimens while they are deformed. The analytical approach includes finite element (FE), geometrical and mathematical models for prediction of collapse strength. The results from the the models are verified with experimental data and it is shown that they agree well. The results from this research show that using lattice structures significantly reduces the strength of material with respect to solid samples while indicating no serious increase of strength compared to hollow structures. In combination with an analysis of microstructures, a description of strength analysis is obtained with respect to process parameters.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Danish Technological Institute
Authors: Mahshid, R. (Intern), Hansen, H. N. (Intern), Loft Højbjerg, K. (Ekstern)
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Web of Science (2017): Indexed yes
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.844 SNIP 2.623 CiteScore 4.51
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.364 SNIP 3.403 CiteScore 4.36
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.024 SNIP 3.215 CiteScore 3.8
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.963 SNIP 3.171 CiteScore 3.31
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Stress relaxation following uniaxial extension of polystyrene melt and oligomer dilutions

The filament stretching rheometer has been used to measure the stress relaxation following the startup of uniaxial extensional flow, on an narrow molar mass distribution (NMMD) polystyrene melt and styrene oligomer dilutions thereof. All samples used here were characterized in molecular weight, mechanical spectroscopy, and constant strain rate uniaxial extension in the work of Huang et al. [Macromolecules 46, 5026–5035 (2013); ACS Macro Lett. 2, 741–744 (2013)]. The stress relaxation following the steady extensional stress was measured on a 285 kg/mole NMMD polystyrene and two 1.92 kg/mole styrene oligomer dilutions thereof (PS-285k, PS-285k/2k-72, and PS-285k/2k-44 in the work of Huang et al. [Macromolecules 46, 5026–5035 (2013)]). The two dilutions contained 28 and 56 wt. % oligomer, respectively. Further, the stress relaxation on a 545 kg/mole NMMD polystyrene diluted with 48 wt. % 0.972 kg/mole styrene oligomer (PS-545k/1k-52 in the work of Huang et al. [ACS Macro Lett. 2, 741–744 (2013)]) was measured as well. All the terminal relaxations could be predicted by a Doi and Edwards, e.g., pure configurational, type of model. At smaller time scales, agreement with a molecular stress function type of constitutive representation was observed for all measured relaxations. VC 2016 The Society of Rheology.

General information
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Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Huang, Q. (Intern), Rasmussen, H. K. (Intern)
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BFI (2018): BFI-level 2
Study of doping non-PMMA polymer fibre canes with UV photosensitive compounds

We propose a solution doping method for polycarbonate (PC) and TOPAS polymer optical fibre (POF) canes using different UV photosensitive dopants aiming to reduce the fibre Bragg grating inscription time at the typical Bragg grating inscription wavelength (325nm). Three-ring solid-core PC mPOF canes and hollow-core TOPAS canes were doped with a solution of dopants in acetone/methanol and hexane/methanol respectively. Doping time, solvent mixture concentration and doping temperature were optimised. A long and stepwise drying process was applied to the doped canes to ensure complete solvent removal. This is required to avoid the formation of any bubbles during the fibre drawing process.

General information
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Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Maria Curie-Skłodowska-University
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The effect of surface nano-corrugation on the squeeze-out of molecular thin hydrocarbon films between curved surfaces with long range elasticity

The properties of linear alkane lubricants confined between two approaching solids are investigated by a model that accounts for the roughness, curvature and elastic properties of the solid surfaces. We consider linear alkanes of different chain lengths from [Formula: see text] to [Formula: see text], confined between corrugated solid walls. The pressure necessary to squeeze out the lubricant increases rapidly with the alkane chain length, but is always much lower than in the case of smooth surfaces. The longest alkanes form domains of ordered chains and the squeeze-out appears to nucleate in the more disordered regions between these domains. The short alkanes stay fluid-like during the entire squeeze out process which result in a very small squeeze-out pressure which is almost constant during the squeeze-out of the last monolayer of the fluid. In all cases we observe lubricant trapped in the valley of the surface roughness, which cannot be removed independent of the magnitude of the squeezing pressures.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Forschungszentrum Jülich GmbH
Authors: Sivebæk, I. M. (Intern), Persson, B. N. J. (Ekstern)
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.87 SJR 1.339 SNIP 0.945
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.257 SNIP 1.035 CiteScore 3.07
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.497 SNIP 1.269 CiteScore 3.09
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.602 SNIP 1.231 CiteScore 2.74
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.861 SNIP 1.307 CiteScore 3.34
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.899 SNIP 1.451 CiteScore 3.86
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.844 SNIP 1.252
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.809 SNIP 1.27
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.857 SNIP 1.32
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.899 SNIP 1.348
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.938 SNIP 1.364
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.958 SNIP 1.435
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.892 SNIP 1.47
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.475 SNIP 1.364
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.93 SNIP 0.929
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.89 SNIP 0.818
Scopus rating (1999): SJR 0.956 SNIP 0.9

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Nanotribology, Molecular dynamics, Thin films, Squeeze-out of monolayers, Wear
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The effect of TWD estimation error on the geometry of machined surfaces in micro-EDM milling
In micro EDM (electrical discharge machining) milling, tool electrode wear must be effectively compensated in order to achieve high accuracy of machined features [1]. Tool wear compensation in micro-EDM milling can be based on off-line techniques with limited accuracy such as estimation of the volumetric wear ratio and continuous compensation proportional to the in-plane displacements (anticipated wear compensation) or real time wear sensing [2]. Tool wear per discharge (TWD) is a parameter based on which a novel approach has been developed for tool wear compensation based on discharge counting and statistical characterization of the discharge population [3]. The TWD based approach permits the direct control of the position of the tool electrode front surface. However, TWD estimation errors will generate a self-amplifying error on the tool electrode axial depth during micro-EDM milling. Therefore, accuracy of the tool wear compensation method as well as the geometry of the machined feature depends on the variability of TWD during machining operation. This paper analyses the effect of errors on the estimation of TWD on geometry of the machined features, in the case of a typical slot machining process. The error propagation effect is demonstrated through a software simulation tool developed by the authors for determination of the correct TWD for subsequent use in compensation of electrode wear in EDM milling. The implemented model uses an initial arbitrary estimation of TWD and a single experiment with determination of number of discharges and removed electrode volume. The simulation tool developed is used to calculate the effects of errors in the initial estimation of TWD on the propagation effect of error on the depth of the cavity generated. Simulations were applied to EDM milling of a slot of 5000 μm length and 50 μm depth, with a segment length of 100 μm and layer thickness of 1 μm. Simulations have been performed for TWD estimation errors ranging from -15% to +15%, see Figure 1: a. In order to validate the results obtained using simulations, slot milling experiments were performed on a SARIX SX-200 micro-EDM machine. Tungsten carbide rod of Ø300 μm and Stavax steel blocks were used as the tool material and workpiece material respectively. The programming for machining along the segments and along each layer was done using G codes. The population of discharge current signals were characterized for selection of the trigger level to count all the discharges contributing to the tool wear. Experiments were replicated five times to ensure the repeatability of the results. From the simulations, it is observed that the depth error due to TWD estimation error is magnified and transmitted in different progresses along the tool path. The simulation results show that a variation in TWD estimation error from +1% to +5%, the maximum error in the geometry of micro-EDM milled profile varied from +6.14% to +40.52%. It is observed that results of depth predicted using the simulation and the average depth obtained using experiments match thoroughly within an error of 5%, see Figure 1: b.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Puthumana, G. (Intern), Bissacco, G. (Intern), Hansen, H. N. (Intern)
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The influence of cellular structures on flow stress of high strength components manufactured using SLM
Additive manufacturing has shown significant improvement in material and machines for high-quality solid freeform fabrication processes such as selective laser melting (SLM). In particular, manufacturing lattice structures using the SLM procedure is of interest. This research examines the effect of cellular materials on compression strength. The specimens are manufactured additively using industrial 3D printing systems from high-strength alloy. The material has the right mechanical properties for manufacturing tool components. This includes samples with solid and lattice structures. The Compression tests are applied to the both samples while they are deformed. The flow stress curves from this research show that using cellular material significantly reduces the yield stress of the samples. This reduction compromises the efficiency of the new structure with respect to the material save.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Danish Technological Institute
Authors: Mahshid, R. (Intern), Hansen, H. N. (Intern), Loft Højbjerg, K. (Ekstern)
Number of pages: 2
The influence of humidity on accuracy length measurement on polymer parts

The work deals with an experimental study of the influence of humidity on accurate length measurements on ABS parts. Polymer parts absorb water from the ambient until they reach hygroscopic equilibrium. Water content causes an expansion of the polymer part. The relationship between the water content and this expansion has been barely studied, especially from a metrology point of view including its contribution to the measurement uncertainty. The experimental set-up includes a humidity chamber, an invar fixture with 8 inductive probes and a scale. The humidity chamber was used to create the experiment ambient conditions. The invar fixture with the inductive probes, with a resolution of 0.1 μm, allows length measurement on 8 ABS parts at the same time. The scale was used to collect the water content variation during the experiment with a resolution of 0.1 mg. The length and weight of the ABS parts were measured at 5 levels of relative humidity from 50 %RH to 90 %RH, and constant temperature, 20 ±0.2˚C. Water content equilibrium with the ambient was achieved at each level by acclimatization of the parts for 24 hours. An average length variation over the humidity range of 15 μm was found. A condition specific coefficient of moisture expansion of 69±4 μm/(Δ of weight in mg) was estimated.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark, Lego Systems A/S
Authors: Madruga, D. G. (Intern), Alexiou, A. (Ekstern), Dalla Costa, G. (Intern), De Chiffre, L. (Intern), Neves, L. C. (Ekstern)
Number of pages: 2
Publication date: 2016

The Lubricity of Glycerol and its Solutions

Glycerol has been recognised as an excellent diesel fuel and lubricant. It is a liquid that can originate from the transesterification of plant oil that also results in plant oil methyl (or ethyl) ester (biodiesel). Machine elements lubricated by glycerol show very low friction, in fact lower than the one predicted by hydrodynamic lubrication calculations. Addition of water to glycerol lowers the friction but increases the wear. In the present paper the lubricity (boundary lubrication performance) of glycerol and its solutions with water, ethanol and methanol is investigated. Dilution of glycerol up to 15% shows no wear in a standard wear test. Decrease in the glycerol content below 85% reveals significant wear and solutions with less than 15% glycerol show nearly the same wear as the solvent itself. The conclusion is that glycerol may be an excellent lubricant in hydrodynamics but when it is operated in boundary lubrication it is not very effective in reducing the wear levels induced by the pure solvents.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
Authors: Sivebæk, I. M. (Intern), Jakobsen, J. (Ekstern)
Number of pages: 6
Publication date: 2016
Thermo-coupled Surface Cauchy-Born Theory: An Engineering Finite Element Approach to Modeling of Nanowire Thermomechanical Response

There are remarkable studies geared towards developing thermomechanical analyses of nanowires based on quasiharmonic and Molecular Dynamics simulations. These methods exhibit limited applicability due to the associated computational cost. In this study an engineering finite-temperature model based on Surface Cauchy-Born theory is developed, where surface energy is accounted for in the prediction of the thermomechanical response. This is achieved by using a temperature-dependent interatomic potential in the standard Cauchy-Born theory with a surface energy contribution. Simultaneous calculation of thermal and mechanical stresses is achieved by eliminating the diagonalization matrix of entropy in the quasiharmonic system. This leads to a reduction in the degrees of freedom by more than 99% in comparison with equivalent Molecular Dynamics models. For the purpose of validation, results obtained on copper and nickel nanowires through the proposed method are compared with those of the more involved Molecular Dynamics simulations. This comparison verifies the significant reduction in the computational process with an acceptable accuracy. Hence, the proposed method provides a promising engineering tool without compromising the underlying physics of the problem and has potential implications in the effective modeling of the nanoscale thermomechanical behavior.
Three-dimensional local residual stress and orientation gradients near graphite nodules in ductile cast iron

A synchrotron technique, differential aperture X-ray microscopy (DAXM), has been applied to characterize the microstructure and analyze the local mesoscale residual elastic strain fields around graphite nodules embedded in ferrite matrix grains in ductile cast iron. Compressive residual elastic strains are measured with a maximum strain of \( \sim 6.5 - 8 \times 10^{-4} \) near the graphite nodules extending into the matrix about 20 \( \mu \)m, where the elastic strain is near zero. The experimental data are compared with a strain gradient calculated by a finite element model, and good accord has been found but with a significant overprediction of the maximum strain. This is discussed in terms of stress relaxation during cooling or during storage by plastic deformation of the nodule, the matrix or both. Relaxation by plastic deformation of the ferrite is demonstrated by the formation of low energy dislocation cell structure also quantified by the DAXM technique.

General information
State: Published
Organisations: Department of Wind Energy, Materials science and characterization, Department of Mechanical Engineering, Manufacturing Engineering, Argonne National Laboratory, Oak Ridge National Laboratory
Authors: Zhang, Y. (Intern), Andriollo, T. (Intern), Fæster, S. (Intern), Liu, W. (Ekstern), Hattel, J. H. (Intern), Barabash, R. (Ekstern)
Pages: 173-180
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Main Research Area: Technical/natural sciences
Three-dimensional numerical modeling of an induction heated injection molding tool with flow visualization

Using elevated mold temperature is known to have a positive influence of final injection molded parts. Induction heating is a method that allow obtaining a rapid thermal cycle, so the overall molding cycle time is not increased. In the present research work, an integrated multi-turn induction heating coil has been developed and assembled into an injection molding tool provided with a glass window, so the effect of induction heating can directly be captured by a high speed camera. In addition, thermocouples and pressure sensors are also installed, and together with the high speed videos, comparison of the induction heating and filling of the cavity is compared and validated with simulations. Two polymer materials ABS and HVPC were utilized during the injection molding experiments carried out in this work. A nonlinear electromagnetic model was employed to establish an effective linear magnetic permeability. The three-dimensional transient thermal field of the
mold cavity was then calculated and compared with the experiments. This thermal field was transferred to an injection molding flow solver to compare simulations and experimental results from the high speed video, both with and without the effect of induction heating. A rapid thermal cycle was proved to be feasible in a mold with an integrated induction coil. Furthermore, it was shown that the process can be modeled with good accuracy, both in terms of the thermal field and of the flow pattern.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Energy Conversion and Storage, Electrofunctional materials
Authors: Guerrier, P. (Intern), Tosello, G. (Intern), Nielsen, K. K. (Intern), Hattel, J. H. (Intern)
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BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.8 SJR 0.994 SNIP 1.697
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Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 0.889 SNIP 1.325 CiteScore 1.8
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.082 SNIP 1.841 CiteScore 2.03
Web of Science (2014): Indexed yes
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BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.971 SNIP 2.099 CiteScore 1.75
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BFI (2011): BFI-level 1
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Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.785 SNIP 1.445
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.797 SNIP 1.384
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.52 SNIP 1.029
Web of Science (2008): Indexed yes
Tolerance Verification of an Industrial Assembly using Computed Tomography

This paper reports on results of tolerance verification of a multi-material assembly by using Computed Tomography (CT). The workpiece comprises three parts which are made out of different materials. Five different measurands were inspected. The calculation of measurement uncertainties was attempted by way of a ball plate. Comparison between CT and results from a traditional coordinate measuring machine was also involved in this study.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
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Number of pages: 4
Publication date: 2016

Towards in process control of polymer micro manufactured components

In the last decade the number of applications of micro components has increased steadily. In order for Europe to maintain its leading role in the polymer micro-fabrication industry there is a need of expansion for processes capabilities for mass manufacture. The present study focuses on the design of a fast-integrated inspection method aimed at part quality monitoring and tolerance conformance verification. The proposed approach investigates as product case study the optimization of polymer (VECTRA® E820i) passive micro microwave components. A focus variation 3D optical high-speed metrology system was employed to perform the measurements on the produced polymer parts. Automated measuring routine allowed fast dimensional quality mapping of the functional sub-mm features integrated in the plastic frame of the final microwave component. Design of experiment (DOE) was adopted to quantify significant factors affecting the final replication quality of the produced critical features. Measurement results have shown product conformance varying with the distance from the gate and features orientation with respect to the polymer flow direction.

General information
State: Published
Traceability of Height Measurements on Green Sand Molds using Optical 3D Scanning

Establishing a reliable measurement procedure for dimensional measurements on green sand molds is a prerequisite for analysis of geometric deviations in mass production of quality castings. Surface of the green sand mold is not suitable for measurements using a tactile coordinate measuring machine (CMM) which is traceable to the meter unit. Optical scanners are increasingly used for dimensional metrology without the risk of damaging the surface, but lack of international standards makes it difficult to establish traceability of their measurements and compare them to tactile instruments. This paper presents a metrological approach for height measurement on green sand molds using an optical 3D scanner with fringe projection. A new sand sample was developed with a hard binder to withstand the contact force of a touch probe, while keeping optical cooperativeness similar to green sand. The sample was calibrated on a dial gage set-up and implemented in optical measurements. The procedure of using calibrated workpieces (ISO 15530-3) was used to determine the uncertainty of optical measurements.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
Authors: Mohaghegh, K. (Intern), Yazdanbakhsh, S. A. (Ekstern), Tiedje, N. S. (Ekstern), De Chiffre, L. (Intern)
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Source-ID: 119118112
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Traceability of optical length measurements on sand surfaces

This work concerns traceable measurements on moulds used in automatic casting lines made of green sand, which has a very low strength against the force of a contact probe. A metrological set-up was made based on the use of calibrated workpieces following ISO 15530-3 to determine the uncertainty of optical measurements on a sand surface. A new customised sand sample was developed using a hard binder to withstand the contact force of a touch probe, while keeping optical cooperativeness similar to that of green sand. The length of the sample was calibrated using a dial gauge set-up. An optical 3D scanner with fringe pattern projection was used to measure the length of a green sand sample (soft sample) with traceability transfer through the hard sample. Results confirm that the uncertainty of the optical scanner on the substituted hard sample is similar to that of the soft sample, so the hard sample can successfully represent the soft sample in the ISO 15530-3 procedure. The expanded uncertainty (k=2) of length measurements on sand was estimated to 10 µm.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
Authors: Mohaghegh, K. (Intern), Yazdanbakhsh, S. A. (Ekstern), Tiedje, N. S. (Intern), De Chiffre, L. (Intern)
Number of pages: 2
Publication date: 2016
Two process chains for creating functional surfaces on a mold for 3D geometry

Polymer products with functional surfaces are applied in many fields such as medical and bio technology [1][2]. It is believed that certain types of micro- or nano-structured surfaces can enhance tissue anchoring [3]. However, most technologies for the fabrication of micro-structured functional surfaces are still limited to flat geometries or geometries with constant curvature [4]. Typically products that need micro structuring on the surface have a three dimensional and complex geometry. There are huge demands for investigation in establishing the micro structures on the surface of a 3D mold. This paper describes and compares 2 approaches for fabricating micro-structured surfaces suitable for patterning of 3D shape cavities for injection moulding. The application investigated for the research is a part of a fixture for electrodes to be implanted inside human body. It is a ring with four wings as illustrated by Figure 1.

Vortex behavior of the Oldroyd-B fluid in the 4-1 planar contraction simulated with the streamfunction-log-conformation formulation

In this paper, we present numerical solutions of the Oldroyd-B fluid flowing through a 4:1 planar contraction, for Weissenberg numbers (Wi) up to 20. The incompressible viscoelastic flows are simulated with the streamfunction-log-conformation methodology. The log-conformation representation guarantees by construction the positive-definiteness of the conformation tensor, which circumvents the appearance of the high Weissenberg number problem. In addition, the streamfunction flow formulation removes the pressure variable from the governing equations and automatically satisfies the mass conservation. Thus, the streamfunction-log-conformation reformulation is beneficial for the accuracy and stability of the numerical algorithm. The resulting governing equations are solved with a high-resolution finite-volume method. Our numerical results for the reattachment length and the intensity of the recirculation vortices produced at the contraction plane are in excellent agreement with the benchmark solutions, available in the literature for Weissenberg numbers up to 3. For highly elastic flows, our results agree qualitatively well with the data of Afonso et al. (2011) [53]. Our simulations predict the reduction of the vortex size with increasing Wi, up to Wi = 5. Moreover, we observe a periodic third vortex growth and annihilation regime for Wi ≥ 15. The periodic vortex growth and annihilation is correlated with the accumulation of elastic strain in the cavity upstream of the contraction. This elastic instability is viewed as a mechanism that releases the elastic energy accumulated in the Oldroyd-B fluid at the fringe of the recirculation vortices. The dimensionless period of the third vortex annihilation appears to be independent on the Weissenberg number.
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.509 SJR 1.14 CiteScore 2.44
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Scopus rating (2016): CiteScore 2.43 SJR 1.145 SNIP 1.604
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.155 SNIP 1.505 CiteScore 2.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.988 SNIP 1.324 CiteScore 1.96
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.09 SNIP 1.408 CiteScore 1.93
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.232 SNIP 1.743
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.534 SNIP 1.504
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.519 SNIP 1.917
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.342 SNIP 1.477
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.439 SNIP 1.456
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Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.288 SNIP 1.82
Scopus rating (2003): SJR 1.326 SNIP 1.312
Scopus rating (2002): SJR 1.755 SNIP 1.679
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.293 SNIP 1.155
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Zeonex Microstructured Polymer Optical Fibre Bragg Grating Sensor

We fabricated an endlessly single mode and humidity insensitive Zeonex microstructured polymer optical fibre (mPOF) for fibre Bragg grating (FBG) temperature and strain sensors. We inscribed and characterise FBGs in Zeonex mPOF for the first time.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Woyessa, G. (Intern), Fasano, A. (Intern), Markos, C. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
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3D numerical simulation of projection welding of square nuts to sheets

The challenge of developing a three-dimensional finite element computer program for electro-thermo-mechanical industrial modeling of resistance welding is presented, and the program is applied to the simulation of projection welding of square nuts to sheets. Results are compared with experimental observations and measurements produced by the authors with the aim and objective of assessing the accuracy, reliability and validity of the theoretical and numerical developments. The numerical developments include implementation of friction between deformable objects in the finite element flow formulation inorder to model the frictional sliding between the square nut projections and the sheets during the welding process. It is proved that the implementation of friction increases the accuracy of the simulations, and the dynamic influence of friction on the process is explained. © 2014 Elsevier B.V. All rights reserved.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, SWANTEC Software and Engineering ApS, University of Lisbon
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.62 SJR 1.717 SNIP 2.646
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.385 SNIP 2.463 CiteScore 2.9
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
3D Viscoelastic Finite Element Modelling of Polymer Flow in the Fiber Drawing Process for Microstructured Polymer Optical Fiber Fabrication

The process of drawing an optical fiber from a polymer preform is still not completely understood, although it represents one of the most critical steps in the process chain for the fabrication of microstructured polymer optical fibers (mPOFs). Here we present a new approach for the numerical modelling of the fiber drawing process using a fully three-dimensional and time-dependent finite element method, giving significant insight into this widely spread mPOF production technique. Our computational predictions are physically based on the viscoelastic fluid dynamics of polymers. Until now the numerical modelling of mPOF drawing has mainly been based on principles, such as generalized Newtonian fluid dynamics, which are not able to cope with the elastic component in polymer flow. In the present work, we employ the K-BKZ constitutive equation, a non-linear single-integral model that combines both elastic and viscous ideas and can appropriately describe the physics of polymers under processing.
**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Teknologisk Institut
Authors: Fasano, A. (Intern), Rasmussen, H. K. (Intern), Marín, J. M. R. (Ekstern)
Number of pages: 4
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**Accurate characterisation of post moulding shrinkage of polymer parts**
The work deals with experimental determination of the shrinkage of polymer parts after injection moulding. A fixture for length measurements on 8 parts at the same time was designed and manufactured in Invar, mounted with 8 electronic gauges, and provided with 3 temperature sensors. The fixture was used to record the length at a well-defined position on each part continuously, starting from approximately 10 minutes after moulding and covering a time period of 7 days. Two series of shrinkage curves were analysed and length values after stabilisation extracted and compared for all 16 parts. Values were compensated with respect to the effect from temperature variations during the measurements. Prediction of the length after stabilisation was carried out by fitting data at different stages of shrinkage. Uncertainty estimations were carried out and a procedure for the accurate characterisation of post moulding shrinkage of polymer parts was developed. Expanded uncertainties (k=2) of 3 μm were obtained.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Lego Systems A/S, Technical University of Denmark
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

**Achieving Control of Coating Process in your Foundry**
Achieving control of coating thickness in foundry moulds is needed in order to guarantee uniform properties of the mould but also to achieve control of drying time. Since drying time of water based coatings is heavily dependent on the amount of water present in the coating layer, a stable coating process is prerequisite for a stable drying process. In this study, we analyse the effect of different variables on the coating layer properties. We start by considering four critical variables identified in a previous study such as sand compaction, coating density, dipping time and gravity and then we add centre points to the original experimental plans to identify possible non-linear effects and variation in process stability. Finally, we investigate the relation between coating penetration (a variable that is relatively simple to measure in production) and other coating layer thickness properties (relevant for the drying process design). Correlations are found and equations are provided. In particular it is found that water thickness can be directly correlated to penetration with a simple linear equation and without the need to account for other variables.

**General information**
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Global Castings A/S
Authors: Di Muoio, G. L. (Ekstern), Tiedje, N. S. (Intern)
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Main Research Area: Technical/natural sciences
A comparative study of metal and ceramic injection moulding for precision applications

Powder injection moulding (PIM) process is an attractive process as it combines the possibilities of net-shape and large-scale production with wide range of material varieties. This article presents a comparative study of two branches of PIM processes with the focus on precision application. The two branches of PIM - metal injection moulding (MIM) and ceramic injection moulding (CIM) have been developed in parallel. Both processes are in a stage now where they can offer exciting possibilities for mass production of extremely precise and complex net shape products. For some applications, PIM process presents a dilemma for choosing between MIM and CIM as both the material classes can offer specific advantages and the process steps are identical. So a comparative study about the process capabilities between CIM and MIM will be useful for thorough understanding of the processes and to select the right material and process for the right application. With this motivation, the current paper systematically characterizes the PIM and CIM process and presents the process capabilities in terms of part shrinkage, surface replication, tolerance capability and morphological fidelity.

Additive manufacturing for the production of inserts for micro injection moulding

The production of inserts for micro injection moulding using additive manufacturing technology has the potential to greatly improve the efficiency of pilot production and reduce overall time to market. In this work, Digital Light Processing (DLP) was used to produce micro injection moulding inserts with different types of geometric features. The dimensional accuracy of the mould inserts and workpieces as well as insert durability and mould wearing were investigated and statistically analysed. The mould developed clearly visible cracks but remained in one piece until the experiment ended after 50 shots.
Adjustable broaching tool for tolerance compensation in precision manufacturing

Current manufacturing of precision tools for machining typically requires processes such as grinding, EDM or laser processing in order to comply with high requirements on tolerances. However even tools manufactured by these processes come short, when a new batch of workpieces are supplied, and their tolerances are not compliant. This approach presents a precision broaching tool for adjusting the inner diameter of an external broach. The tool compensates for the manufacturing tolerance chain of tool and workpieces by up to 37 m. The approach is based on conventional shrink fitting of cold forging tools. A numerical and analytical model of the compression is compared with experimental results.

Advanced Process Chains for Prototyping and Pilot Production based on Additive Manufacturing

For many years, Additive Manufacturing (AM) has been a well-established production technology used mainly for rapid prototyping. But the need for increased flexibility and economic low volume production led to the discovery of Additive Manufacturing as a suitable fabrication technique (Mellor 2013). With technological progress and the development of new processes, AM technology now starts to become a serious option for mass production. It enables new options for material choice, shape and internal structure. Productivity in production of e.g. metal parts can be increased due to mass and cost reduction and better parts functionality (Ponche 2014). Also, the use of AM machines for spare parts can potentially reduce costs and downtime, and lead to a higher robustness to supply chain disruptions (Khajavi 2013). Control and optimization of the involved process chains are crucial for a fast and robust implementation of AM technology in the industrial world.
A Method for Dimensional and Surface Optical Measurements Uncertainty Assessment on Micro Structured Surfaces Manufactured by Jet-ECM

Surface texture and step height measurements of electrochemically machined cavities have been compared among optical and tactile instruments. A procedure is introduced for correcting possible divergences among the instruments and, ultimately, for evaluating the measurement uncertainty according to the ISO GUM.

Analysis of Ingot Forging Damage Evolution Using Different Simulation Methods

Unbonded flexible pipes find extensive use in the offshore oil industry. Although more expensive than rigid pipe, the total cost of flexible pipe installations are often less. This is because flexible pipes are easier to store and deploy, coupled with
superior fatigue performance. Among other things, they serve for the transportation of hydrocarbons from the subsea facilities to the production and drilling equipment at the sea surface. Flexible risers are the prime choice for connecting floating production, storage and offloading facilities, because they are specially designed for dynamic capabilities. The structure of flexible pipes consists of several concentric layers, each with a specific purpose. The most common used flexible pipe is the type III, which contains a central component, made from an interlocking stainless steel structure that provides collapse strength. The central component is called the carcass. A permeation polymer barrier is extruded over the carcass, followed by the pressure armor. On top, two counter-wound helical layers form the tensile armor. These carry forces in axial direction, and constitute the main focus of this thesis. In conventional flexible pipes, the tensile armor layer is made from steel. However, as oil exploitation goes to deeper and deeper waters, the strength/weight ratio of steel armor becomes unfavorable. In order to achieve higher tensile strength and to reduce the overall weight of the pipe, in the future, the tensile armor must be made of composite materials. One of the problems related to the substitution of tensile steel members is that anchoring in the metallic end fittings of the pipe is very challenging. The purpose of this thesis is to ensure the transfer of tensile loads between a unidirectional fiber reinforced polymer and a metallic counterpart. A new double grip design with flat faces is proposed, in which the loads are transferred through friction. The behavior of such grip is studied by means of experimental testing and finite element modeling. Several iterations of the grip system were evaluated over the course of the project. Initial effort did concentrate on creating an experimental setup which allows to control and record force and displacement values with great accuracy. Pullout tests using several sets of materials and grips, with different geometries and surface roughness were executed. Besides the experimental work, a finite element model was constructed for each of the experimental configurations. Initial effort is used to understand the behavior of the grip and obtain good accuracy with the finite element model. Experimental data is used as input. The model makes it possible to visualize the piece-wise onset of movement in the grip, and to measure the contact stresses distribution and evolution during pullout. The results of the experimental and numerical analysis show that it is possible to reliably anchor composite materials using a metallic grip. The models developed during the project show how to improve the efficiency of the grip system. Analysis of the boundary conditions show that several technical solutions can be chosen, without sacrificing performance. It is possible to create grips to fit a wide variety of constructive solutions.

A new numerical framework to simulate viscoelastic free-surface flows with the finite-volume method

A new method for the simulation of 2D viscoelastic flow is presented. Numerical stability is obtained by the logarithmic-conformation change of variable, and a fully-implicit pure-streamfunction flow formulation, without use of any artificial diffusion. As opposed to other simulation results, our calculations predict a hydrodynamic instability in the 4:1 contraction geometry at a Weissenberg number of order 4. This new result is in qualitative agreement with the prediction of a non-linear subcritical elastic instability in Poiseuille flow. Our viscoelastic flow solver is coupled with a volume-of-fluid solver in order to predict free-surfaces in extrusion.

General information
State: Published
Organisations: Department of Mechanical Engineering, Solid Mechanics, Manufacturing Engineering, National Oilwell Varco Denmark I/S
Authors: Costache, A. (Intern), Berggreen, C. (Intern), Glejbøl, K. (Ekstern), Sivebæk, I. M. (Intern)
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A new numerical framework to simulate viscoelastic free-surface flows with the finite-volume method

A new method for the simulation of 2D viscoelastic flow is presented. Numerical stability is obtained by the logarithmic-conformation change of variable, and a fully-implicit pure-streamfunction flow formulation, without use of any artificial diffusion. As opposed to other simulation results, our calculations predict a hydrodynamic instability in the 4:1 contraction geometry at a Weissenberg number of order 4. This new result is in qualitative agreement with the prediction of a non-linear subcritical elastic instability in Poiseuille flow. Our viscoelastic flow solver is coupled with a volume-of-fluid solver in order to predict free-surfaces in extrusion.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Comminal, R. (Intern), Spangenberg, J. (Intern), Hattel, J. H. (Intern)
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Main Research Area: Technical/natural sciences
An investigation on the role of thermal fins in the design of micro heat exchangers

The different dominant physical phenomena in design for micro and macro scale products result in different design considerations for both categories. In the current study, a few design concepts are proposed as micro heat exchangers. In addition, the influential parameters on design of a micro heat exchanger in comparison with the effective factors in
designing its macro counterpart are investigated. Numerical simulations in the finite element software COMSOL are used to evaluate the thermal performance of both micro and macro heat exchangers. The result of the analysis reveals the fact that the presence of some features such as "fins" in micro heat exchanger is not as significant as it is in macro scale. The results of this study can be employed as guidelines in design of similar micro heat exchangers.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Energy Conversion and Storage, Electrofunctional materials
Authors: Omidvarnia, F. (Intern), Hansen, H. N. (Intern), Sarhadi, A. (Intern)
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Main Research Area: Technical/natural sciences
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Source: PublicationPreSubmission
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Anisotropy and fracture modes I and III in a flange test specimen
Formability in bulk metal forming was revisited in a recent paper by considering plasticity, ductile damage and fracture modes for a number of test specimens. One of the test specimens is a flange component showing failure by both fracture mode I and mode III upon compression between two flat parallel planes. The analysis of the flange component was assisted by numerical simulation which will be presented in further details in this presentation. The combination of the relevant ductile damage criterion with an element removal technique allows crack opening in the flange component in agreement with experimental observations. The circumferential location of the crack initiation in the flange is determined by asymmetric deformation and material imperfections. The asymmetric deformation is triggered in the numerical simulation by anisotropy, which is implemented in the employed finite element computer program.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Universidade de Lisboa
Authors: Nielsen, C. V. (Intern), Silva, C. M. (Ekstern), Alves, L. M. (Ekstern), Martins, P. A. (Ekstern), Bay, N. O. (Intern)
Pages: 139-141
Publication date: 2015

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Main Research Area: Technical/natural sciences
Source: PublicationPreSubmission
Source-ID: 106818627
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Application of Functional Nano-Patterning to Polymer Medical Micro Implants
Improvement of cells adhesion to medical implants can be achieved through specific surface nano-patterns. The application of nano-patterns to planar surfaces can be obtained in a number of ways. However, the application of functional nano-patterns to complex 3D surfaces is a challenging task. In this paper the application of a nano-pattern deriving from aluminium anodizing to 3D micro mould inserts for replication of polymer medical micro implants is described. A process chain earlier developed at DTU was applied, where the main steps include the fabrication of an aluminium master, anodizing, etching of aluminium oxide, nickel and copper electroplating and selective etching of the aluminium master. The resulting nanostructure consists of tightly packed hemispherical features with average diameter of approximately 400 nm. Characterization of the obtained nanostructure on the micro mould inserts was carried out by means of atomic force microscopy and scanning electron microscopy. Results show that the specific nano-pattern was successfully generated on the 3D mould inserts exploiting the proposed process chain.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Bissacco, G. (Intern), Biondani, F. G. (Intern), Tang, P. (Ekstern), Mischkot, M. (Intern), Hansen, H. N. (Intern), Zhang, Y. (Intern), Ravn, C. (Ekstern)
Number of pages: 4
Publication date: 2015
A predictive model for dimensional errors in fused deposition modeling
This work concerns the effect of deposition angle (α) and layer thickness (L) on the dimensional performance of FDM parts using a predictive model based on the geometrical description of the FDM filament profile. An experimental validation over the whole a range from 0° to 177° at 3° steps and two values of L (0.254 mm, 0.330 mm) was produced by comparing predicted values with external face-to-face measurements. After removing outliers, the results show that the developed two-parameter model can serve as tool for modeling the FDM dimensional behavior in a wide range of deposition angles.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Stolfi, A. (Intern)
Pages: 97-98
Publication date: 2015

A reverse engineering methodology for nickel alloy turbine blades with internal features
The scope of this work is to present a reverse engineering (RE) methodology for freeform surfaces, based on a case study of a turbine blade made of Inconel, including the reconstruction of its internal cooling system. The methodology uses an optical scanner and X-ray computed tomography (CT) equipment. Traceability of the measurements was obtained through the use of a Modular Freeform Gage (MFG). An uncertainty budget is presented for both measuring technologies and results show that the RE methodology presented is promising when comparing uncertainty values against common industrial tolerances.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Politecnico di Torino, Tecnologico de Monterrey, Degendorf Institute of Technology
Authors: Gameros, A. (Ekstern), De Chiffre, L. (Intern), Siller, H. (Ekstern), Hiller, J. (Ekstern), Genta, G. (Ekstern)
Pages: 116-124
Publication date: 2015
Main Research Area: Technical/natural sciences
Main Research Area: Technical/natural sciences

Publication information
Journal: CIRP Journal of Manufacturing Science and Technology
Volume: 9
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 2.049 SJR 1.377 CiteScore 2.78
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 2.76 SJR 1.107 SNIP 2.093
Web of Science (2016): Indexed yes
Calibration and Metrology for Micro/Nano Dimensional Quality Control. D3.5.: High Precision Micro Production Technologies - Collaborative project - Small or medium-scale focused research. 1.10.2012 – 30.9.2015

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Bremen, DESMA TEC
Authors: Quagliotti, D. (Intern), Tosello, G. (Intern), Agour, M. (Ekstern), Flosky, C. (Ekstern), Meier, A. (Ekstern), Riemer, O. (Ekstern), Dormann, B. (Ekstern)
Number of pages: 36
Publication date: 2015

Publication information
Publisher: Hi-Micro project
Original language: English
Main Research Area: Technical/natural sciences

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Projects:
Calibration and Metrology for Micro/Nano Dimensional Quality Control. D3.5.
Calibration and Metrology for Micro/Nano Dimensional Quality Control. D3.5.
Publication: Research › Report – Annual report year: 2015

Cellular scanning strategy for selective laser melting: Generating reliable, optimized scanning paths and processing parameters

Selective laser melting is yet to become a standardized industrial manufacturing technique. The process continues to suffer from defects such as distortions, residual stresses, localized deformations and warpage caused primarily due to the localized heating, rapid cooling and high temperature gradients that occur during the process. While process monitoring and control of selective laser melting is an active area of research, establishing the reliability and robustness of the process still remains a challenge. In this paper, a methodology for generating reliable, optimized scanning paths and process parameters for selective laser melting of a standard sample is introduced. The processing of the sample is simulated by sequentially coupling a calibrated 3D pseudo-analytical thermal model with a 3D finite element mechanical model. The optimized processing parameters are subjected to a Monte Carlo method based uncertainty and reliability analysis. The reliability of the scanning paths are established using cumulative probability distribution functions for process output criteria such as sample density, thermal homogeneity, etc. A customized genetic algorithm is used along with the simulation model to generate optimized cellular scanning strategies and processing parameters, with an objective of reducing thermal asymmetries and mechanical deformations. The optimized scanning strategies are used for selective laser melting of the standard samples, and experimental and numerical results are compared.

General information
State: Published
Cellwise conservative unsplit advection for the volume of fluid method

We present a cellwise conservative unsplit (CCU) advection scheme for the volume of fluid method (VOF) in 2D. Contrary to other schemes based on explicit calculations of the flux balances, the CCU advection adopts a cellwise approach where the pre-images of the control volumes are traced backward through the flow map. The donating regions of the fluxes are calculated via the streaklines of the grid intersections, represented as polygonal chains whose vertices are determined by backward tracing of particles injected in the flow at different times. High order accuracy is obtained from the fourth-order Runge–Kutta method, where intermediate velocities along pathlines are determined with quadratic temporal and bicubic spatial interpolations. The volumes of the donating regions are corrected in order to fulfill the discrete continuity of incompressible flows. Consequently, the calculation produces non-overlapping donating regions and pre-images with conforming edges to their neighbors, resulting in the conservativeness and the boundedness (liquid volume fraction inside the interval [0, 1]) of the CCU advection scheme. Finally, the update of the liquid volume fractions is computed from the intersections of the pre-image polygons with the reconstructed interfaces. The CCU scheme is tested on several benchmark tests for the VOF advection, together with the standard piecewise linear interface calculation (PLIC). The geometrical errors of the CCU compare favorably with other unsplit VOF-PLIC schemes. Finally, potential improvements of the VOF method with the use of more precise interface representation techniques and the future extension of the CCU scheme to 3D are discussed. ©2014 Elsevier Inc. All rights reserved.
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.23 SJR 2.047 SNIP 1.85
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.12 SJR 2.049 SNIP 1.818
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.054 SNIP 1.929 CiteScore 2.92
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.103 SNIP 2.164 CiteScore 3.12
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.156 SNIP 2.389 CiteScore 3.3
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.108 SNIP 2.014 CiteScore 2.69
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 2.001 SNIP 2.191 CiteScore 2.99
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 2.124 SNIP 2.068
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 2.394 SNIP 2.212
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.213 SNIP 1.998
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.35 SNIP 2.358
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 2.19 SNIP 2.263
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.431 SNIP 2.225
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.307 SNIP 2.229
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.299 SNIP 1.986
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.684 SNIP 1.947
Scopus rating (2001): SJR 2.192 SNIP 1.787
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.559 SNIP 1.714
Scopus rating (1999): SJR 1.528 SNIP 1.42
Original language: English
Volume of fluid, Unsplit advection scheme, Cellwise approach, Pre-image backward tracing, Donating region, Volume conservation

DOIs: 10.1016/j.jcp.2014.12.003
Source: PublicationPreSubmission
Source-ID: 103994381
Characterisation of demoulding parameters in micro-injection moulding

Condition monitoring of micro injection moulding is an effective way of understanding the processing effects of variable parameter settings. This paper reports an experimental study that investigates the characteristics of the demoulding behaviour in micro injection moulding (μ-IM) with a focus on the process factors that affect parts’ quality. Using a Cyclic Olefin Copolymer (COC) microfluidics demonstrator, the demoulding performance was studied as a function of four process parameters (melt temperature, mould temperature, holding pressure and injection speed), employing the design of experiment approach. The results provide empirical evidences on the effect that processing parameters have on demoulding conditions in μ-IM, and identifies combinations of parameters that can be used to achieve the optimal processing conditions in regards to demoulding behaviour of micro parts. It was concluded that there was a direct correlation between the applied pressure during part filling, holding phases and the demoulding characteristic factors of the μ-IM cycle such as ejection force, integral and time.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Manchester, University of Birmingham, Karlsruhe Institute of Technology KIT, Cardiff University, University of Bradford
Authors: Griffiths, C. (Ekstern), Tosello, G. (Intern), Dimov, S. (Ekstern), Scholz, S. (Ekstern), Rees, A. (Ekstern), Whiteside, B. (Ekstern)
Pages: 1677-1690
Publication date: 2015
Main Research Area: Technical/natural sciences

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Journal: Microsystem Technologies: Micro- and Nanosystems Information Storage and Processing Systems
Volume: 21
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.803 SJR 0.346 CiteScore 1.34
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.96 SJR 0.35 SNIP 0.756
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.386 SNIP 0.731 CiteScore 0.84
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.347 SNIP 0.794 CiteScore 0.92
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.44 SNIP 1.083 CiteScore 1.22
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.417 SNIP 0.91 CiteScore 1.14
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.501 SNIP 1.053 CiteScore 1.27
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.511 SNIP 1.039
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.526 SNIP 0.952
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.551 SNIP 1.062
Characterization method for blisters created in film insert moulding

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology
Authors: Wöhner, T. (Intern), Hansen, H. N. (Intern), Tosello, G. (Intern), Islam, A. (Intern)
Number of pages: 3
Publication date: 2015

Host publication information
Title of host publication: Proceedings of Euspen's 15th International Conference & Exhibition
Main Research Area: Technical/natural sciences
Conference: Euspen’s 15 th International Conference & Exhibition, Leuven, Belgium, 01/06/2015 - 01/06/2015
Film Insert Injection Moulding, Blister creation
Electronic versions:
Characterization_method_for_blisters_created_in_film_insert_injection_moulding_PrePrint.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Characterization methods of nano-patterned surfaces generated by induction heating assisted injection molding

An induction heating-assisted injection molding (IHAIM) process developed by the authors is used to replicate surfaces containing random nano-patterns. The injection molding setup is developed so that an induction heating system rapidly heats the cavity wall at rates of up to 10 °C/s. In order to enable the optimization of the IHAIM process for nano-patterm replication, it is necessary to develop robust methods for quantitative characterization of the replicated nano-patterns. For this purpose, three different approaches for quantitative characterization of random nano-patterns are applied and compared. Results show that the use of IHAIM is an efficient way to improve replication quality. All three measurement methods are capable of detecting the trend of the replication quality of the surface changing the process condition.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, IPU Innovation Factory
Authors: Tang, P. T. (Ekstern), Ravn, C. (Ekstern), Menotti, S. (Intern), Bissacco, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 7
Pages: 349-355
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Automation Technology
Volume: 9
Issue number: 4
ISSN (Print): 1881-7629
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Scopus rating (2016): SJR 0.348 SNIP 1.193 CiteScore 0.91
Characterizing Digital Light Processing (DLP) 3D Printed Primitives

The resolution and repeatability of 3D printing processes depend on a number of factors including the software, hardware, and material used. When printing parts with features that are near or below the nominal printing resolution, it is important to understand how the printer works. For example, what is the smallest unit shape that can be produced? And what is the reproducibility of that process? This paper presents a method for automatically detecting and characterizing the height, width, and length of micro scale geometric primitives produced via a digital light processing (DLP) 3D printing process. An upper limit, lower limit, and best estimate for each dimension is reported for each primitive. Additionally, the roughness, rectangularity, and tilt of the top of each primitive is estimated. The uncertainty of the best estimate is indicated using standard deviations for a series of primitives. The method generalizes to unseen primitives, and the results illustrate that the dimension estimates converge as the size of the primitives increases. The primitives’ rectangularity also increases as the size increases. Finally, the primitives specified with 5 to 68μm varying heights have been estimated to group into five different heights with fairly low variance of the best estimates of the heights. This reflects how the requested geometry is parsed and produced by the printer.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Statistics and Data Analysis, Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
Authors: Tyge, E. (Ekstern), Pallisgaard, J. J. (Ekstern), Lillethorup, M. (Ekstern), Hjaltalin, N. G. (Ekstern), Thompson, M. K. (Intern), Clemmensen, L. K. H. (Intern)
Pages: 302-313
Publication date: 2015

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Title of host publication: Proceedings of the 19th Scandinavian Conference on Image Analysis, SCIA 2015
Publisher: Springer
ISBN (Print): 978-3-319-19664-0
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Series: Lecture Notes in Computer Science
Volume: 9127
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BFI conference series: Scandinavian Conference on Image Analysis (5010789)
Main Research Area: Technical/natural sciences
Conference: 19th Scandinavian Conference on Image Analysis, Copenhagen, Denmark, 15/06/2015 - 15/06/2015
DOIs: 10.1007/978-3-319-19665-7_25
Source: PublicationPreSubmission
Source-ID: 110950589
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Comparative analysis of different process simulation settings of a micro injection molded part featuring conformal cooling
Process simulations are applied in all fields of engineering in order to support and optimize the design and quality of products and their manufacturing processes. Micro injection molding is not an exception in this regard. Simulations enable to investigate the process and the part quality. In the reported work, process simulations using Autodesk Moldflow Insight 2015® are applied to a micro mechanical part to be fabricated by micro injection molding and with over-all dimensions of 12.0 × 3.0 × 0.8 mm³ and micro features (micro hole, diameter of 580 μm, and sharp radii down to 100 μm). Three different simulation models are established: a version including the part without the surrounding mold block, an advanced version including the mold block and conventional cooling channels, and a third version alike the second with additional conformal cooling for efficient thermal management. The implementation strategy for these configurations is presented focusing on the application of a multi-scale mesh with mesh sizes of 100-800 μm, 50 μm, and 100 μm for feeding system, gate area, and the micro component, respectively. The three models are compared with each other to demonstrate the influence of the implementation of the actual mold block, conventional cooling, and conformal cooling. In the comparison, characteristic quality criteria for injection molding are studied, such as the filling behavior of the cavity, the injection pressure, the temperature distribution, and the resulting part warpage. Additionally, the analysis of the cooling channels exploiting computational fluid dynamics is introduced as helpful tool for the mold design process. It is observed that the
comprehensive implementation of the actual injection molding system and conditions is highly relevant at sub-mm/micro dimensional scales, and that the level of detail of the model influences the simulation outcome. Warpage of the micro component in the range of 85-105 μm could be simulated depending on the simulation configuration.

**Comparison of 3 methods on fabricating micro- /nano- structured surface on 3D mold cavity**
The methods to manufacture micro- or nano- structures on surfaces have been an area of intense investigation. Demands are shown for technologies for surface structuring on real 3D parts in many fields. However, most technologies for the fabrication of micro-structured functional surfaces are still limited to flat or simple shaped geometries. In this paper, 3 approaches for fabricating micro and nano- structured surfaces on a mold cavity for injection moulding are investigated and compared. The first approach is to use pre-fabricated plate with micro-structured surface as an insert for the mold, in this way micro holes (Ø4 μm) was obtained. The second approach is to produce the cavity part using anodizing process chain, and in this way sub-micro structures can be obtained all over the cavity surface. The third approach is to machine the surface inside the cavity directly by femtosecond laser combined with mask projection technique.

**Comparison of optical methods for surface roughness characterization**
We report a study of the correlation between three optical methods for characterizing surface roughness: a laboratory scatterometer measuring the bi-directional reflection distribution function (BRDF instrument), a simple commercial scatterometer (rBRDF instrument), and a confocal optical profiler. For each instrument, the effective range of spatial surface wavelengths is determined, and the common bandwidth used when comparing the evaluated roughness parameters. The compared roughness parameters are: the root-mean-square (RMS) profile deviation (Rq), the RMS profile slope (Rdq), and the variance of the scattering angle distribution (Aq). The twenty-two investigated samples were manufactured with several methods in order to obtain a suitable diversity of roughness patterns. Our study shows a one-to-one correlation of both the Rq and the Rdq roughness values when obtained with the BRDF and the confocal instruments, if the common bandwidth is applied. Likewise, a correlation is observed when determining the Aq value with the BRDF and the rBRDF instruments. Furthermore, we show that it is possible to determine the Rq value from the Aq value, by applying a simple transfer function derived from the instrument comparisons. The presented method is validated for surfaces with predominantly 1D roughness, i.e. consisting of parallel grooves of various periods, and a reflectance similar to stainless steel. The Rq values are predicted with an accuracy of 38% at the 95% confidence interval.

**Comparison of optical methods for surface roughness characterization**
We report a study of the correlation between three optical methods for characterizing surface roughness: a laboratory scatterometer measuring the bi-directional reflection distribution function (BRDF instrument), a simple commercial scatterometer (rBRDF instrument), and a confocal optical profiler. For each instrument, the effective range of spatial surface wavelengths is determined, and the common bandwidth used when comparing the evaluated roughness parameters. The compared roughness parameters are: the root-mean-square (RMS) profile deviation (Rq), the RMS profile slope (Rdq), and the variance of the scattering angle distribution (Aq). The twenty-two investigated samples were manufactured with several methods in order to obtain a suitable diversity of roughness patterns. Our study shows a one-to-one correlation of both the Rq and the Rdq roughness values when obtained with the BRDF and the confocal instruments, if the common bandwidth is applied. Likewise, a correlation is observed when determining the Aq value with the BRDF and the rBRDF instruments. Furthermore, we show that it is possible to determine the Rq value from the Aq value, by applying a simple transfer function derived from the instrument comparisons. The presented method is validated for surfaces with predominantly 1D roughness, i.e. consisting of parallel grooves of various periods, and a reflectance similar to stainless steel. The Rq values are predicted with an accuracy of 38% at the 95% confidence interval.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Marhöfer, D. M. (Intern), Tosello, G. (Intern), Islam, A. (Intern), Hansen, H. N. (Intern)
Number of pages: 2
Pages: 65-66
Publication date: 2015

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Main Research Area: Technical/natural sciences
Conference: Euspen's 15th International Conference & Exhibition, Leuven, Belgium, 01/06/2015 - 01/06/2015
Micro injection molding, Process simulation, Meshing, Conformal cooling
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

**Comparison of optical methods for surface roughness characterization**
We report a study of the correlation between three optical methods for characterizing surface roughness: a laboratory scatterometer measuring the bi-directional reflection distribution function (BRDF instrument), a simple commercial scatterometer (rBRDF instrument), and a confocal optical profiler. For each instrument, the effective range of spatial surface wavelengths is determined, and the common bandwidth used when comparing the evaluated roughness parameters. The compared roughness parameters are: the root-mean-square (RMS) profile deviation (Rq), the RMS profile slope (Rdq), and the variance of the scattering angle distribution (Aq). The twenty-two investigated samples were manufactured with several methods in order to obtain a suitable diversity of roughness patterns. Our study shows a one-to-one correlation of both the Rq and the Rdq roughness values when obtained with the BRDF and the confocal instruments, if the common bandwidth is applied. Likewise, a correlation is observed when determining the Aq value with the BRDF and the rBRDF instruments. Furthermore, we show that it is possible to determine the Rq value from the Aq value, by applying a simple transfer function derived from the instrument comparisons. The presented method is validated for surfaces with predominantly 1D roughness, i.e. consisting of parallel grooves of various periods, and a reflectance similar to stainless steel. The Rq values are predicted with an accuracy of 38% at the 95% confidence interval.

**General information**
State: Published
Organisations: Department of Micro- and Nanotechnology, Polymer Micro & Nano Engineering, Department of Mechanical Engineering, Manufacturing Engineering, Danish Fundamental Metrology
Authors: Feidenhans'l, N. A. (Intern), Hansen, P. E. (Ekstern), Pilny, L. (Intern), Madsen, M. H. (Ekstern), Bissacco, G. (Intern), Petersen, J. C. (Ekstern), Taboryski, R. J. (Intern)
Number of pages: 10
Comparison of residual stresses in sand- and chill casting of ductile cast iron wind turbine main shafts

In this work, simulations of pouring, solidification and cooling, and residual stress evolution of sand and chill cast wind turbine main shafts is performed. The models are made in the commercial software MAGMAsoft. As expected, the cooling rate of the sand casting is shown to be much lower than for the chill casting, resulting in a very course microstructure. From the simulations the nodule count is found to be 17 nodules per mm² and 159 nodules per mm² for the sand and chill casting, respectively, in the critical region of the main bearing seat. This is verified from nodule counts performed on the real cast main shafts. Residual stress evaluations show an overall increase of the maximum principal stress field for the chill casting, which is expected. However, the stresses are found to be in compression on the surface of the chill cast main shaft, which is unforeseen.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Global Castings A/S
Authors: Sonne, M. R. (Intern), Frandsen, J. O. (Ekstern), Hattel, J. H. (Intern)
Number of pages: 10
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Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.39 SJR 0.197 SNIP 0.535
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.197 SNIP 0.361 CiteScore 0.22
Scopus rating (2014): SJR 0.206 SNIP 0.362 CiteScore 0.18
Scopus rating (2013): SJR 0.205 SNIP 0.287 CiteScore 0.16
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.183 SNIP 0.257 CiteScore 0.14
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.23 SNIP 0.355 CiteScore 0.1
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.179 SNIP 0.155
Original language: English
Electronic versions:
1757_899X_84_1_012025.pdf
Comparison of two setups for induction heating in injection molding

To eliminate defects and improve the quality of molded parts, increasing the mold temperature is one of the applicable solutions. A high mold temperature can increase the path flow of the polymer inside the cavity allowing reduction of the number of injection points, reduction of part thickness, and moulding of smaller and more complex geometries. The last two aspects are very important in micro injection molding. In this paper, a new embedded induction heating system is proposed and validated and two different coil setups were tested and compared. An experimental investigation was performed based on a test geometry integrating different aspect ratios of small structures. Acrylonitrile butadiene styrene (ABS) was used as material, and different mold temperatures were tested. The replicated test objects were measured by means of an optical coordinate measuring machine (CMM). On the basis of the experimental investigation, the efficacy of the two induction embedded coils, with respect to improvement of replication quality, has been verified.
Contact mechanics, friction and adhesion with application to quasicrystals
We discuss the origin of friction and adhesion between hard solids such as quasicrystals. We emphasize the fundamental role of surface roughness in many contact mechanics problems, in particular for friction and adhesion between solid bodies. The most important property of rough surfaces is the surface roughness power spectrum $C(q)$. We present surface roughness power spectra of many surfaces of practical importance, obtained from the surface height profile measured using optical methods and the Atomic Force Microscope. We show how the power spectrum determines the contact area between two solids. We also present applications to contact mechanics and adhesion for rough surfaces, where the power spectrum enters as an important input.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Forschungszentrum Jülich GmbH, CEMeC Politecnico di Bari, Pirelli Tires, Samara State Technical University
Authors: Persson, B. (Ekstern), Carbone, G. (Ekstern), Samoilov, V. N. (Ekstern), Sivebæk, I. M. (Intern), Tartaglino, U. (Ekstern), Volokitin, A. I. (Ekstern), Yang, C. (Ekstern)
Number of pages: 39
Pages: 249-287
Publication date: 2015

Host publication information
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Publisher: Springer
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Series: NanoScience and Technology
ISSN: 1434-4904
Main Research Area: Technical/natural sciences
Condensed Matter Physics, Materials Science (all), Electrical and Electronic Engineering

DOIs: 10.1007/s00170-015-7224-x
Source: FindIt
Source-ID: 275096915
Publication: Research - peer-review › Journal article – Annual report year: 2015
CT Performance Evaluation Using Multi Material Assemblies
This paper concerns an investigation of the accuracy of Computed Tomography measurements using multi-material assemblies. In this study, assemblies involving similar densities for elementary parts were considered. The investigation includes dimensional and geometrical measurements of two 10 mm high cylindrical assemblies, where each item contained a male and a female part machined by turning.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Stolfi, A. (Intern), De Chiffre, L. (Intern)
Number of pages: 6
Publication date: 2015

Host publication information
Title of host publication: Proceedings of Digital Industrial Radiology and Computed Tomography (DIT 2015)
Main Research Area: Technical/natural sciences
Conference: Digital Industrial Radiology and Computed Tomography, Ghent, Belgium, 22/06/2015 - 22/06/2015
Computed Tomography, Multi-material assemblies, Polymer materials
Electronic versions:
50_Stolfi.pdf
Links:
http://www.ndt.net/events/DIR2015/app/content/index.php?eventID=29
Source: PublicationPreSubmission
Source-ID: 119116271
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

D1.1 Product/Tool/Process Simulation Report for PoT Components: High Precision Micro Production Technologies Collaborative project - Small or medium-scale focused research project 1.10.2012 – 30.9.2015

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, Sophion Bioscience A/S, Xaar, Formatec, KU Leuven, Technische Universität Chemnitz, Universität Bremen, University of Bremen
Number of pages: 26
Publication date: 2015

Publication information
Publisher: Hi-Micro project
Original language: English
Main Research Area: Technical/natural sciences

Bibliographical note
FP7-2012-NMP-ICT-FoF, Grant No.:314055

Relations
Projects:
D1.1 Product/Tool/Process Simulation Report for PoT Components
Publication: Research › Report – Annual report year: 2015

D 1.3 Standardized micro moulding simulation procedure and tolerance guidelines: High Precision Micro Production Technologies Collaborative project - Small or medium-scale focused research project 1.10.2012 – 30.9.2015

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology
Authors: Giannekas, N. (Intern), Islam, A. (Intern), Marhöfer, M. (Intern), Tosello, G. (Intern)
Number of pages: 3
Publication date: 2015

Publication information
Publisher: Hi-Micro project
Original language: English
Main Research Area: Technical/natural sciences

Bibliographical note
FP7-2012-NMP-ICT-FoF, Grant No.:314055

Relations
Projects:
D 1.3 Standardized micro moulding simulation procedure and tolerance guidelines
Source: PublicationPreSubmission
Source-ID: 118368115
Publication: Research › Report – Annual report year: 2015

D1.3 Standardized micro moulding simulation procedure and tolerance guidelines: High Precision Micro Production Technologies Collaborative project - Small or medium-scale focused research project 1.10.2012 – 30.9.2015

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology
Authors: Marhöfer, M. (Intern), Tosello, G. (Intern), Islam, A. (Intern), Giannekas, N. (Intern)
Number of pages: 61
Publication date: 2015

Publication information
Publisher: Hi-Micro project
Original language: English
Main Research Area: Technical/natural sciences

Bibliographical note
FP7-2012-NMP-ICT-FoF, Grant No.:314055

Relations
Projects:
D1.3 Standardized micro moulding simulation procedure and tolerance guidelines
Publication: Research › Report – Annual report year: 2015

D4.3 System integration technologies for Hi-Micro production platform with in-line quality control: High Precision Micro Production Technologies Collaborative project - Small or medium-scale focused research project 1.10.2012 – 30.9.2015

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Giannekas, N. (Intern), Tosello, G. (Intern)
Number of pages: 3
Publication date: 2015

Publication information
Publisher: Hi-Micro project
Original language: English
Main Research Area: Technical/natural sciences

Bibliographical note
FP7-2012-NMP-ICT-FoF, Grant No.:314055

Relations
Projects:
D4.3 System integration technologies for Hi-Micro production platform with in-line quality control
D5.3 Production and Validation of Hi-Micro Demonstrators: High Precision Micro Production Technologies Collaborative project - Small or medium-scale focused research project 1.10.2012 – 30.9.2015

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Sophion Bioscience A/S
Authors: Giannekas, N. (Intern), Marhöfer, M. (Intern), Tosello, G. (Intern), Homann, L. (Ekstern), Wilson, S. (Ekstern)
Number of pages: 4
Publication date: 2015

Publication information
Publisher: Hi-Micro project
Original language: English
Main Research Area: Technical/natural sciences

Bibliographical note
FP7-2012-NMP-ICT-FoF, Grant No.:314055

Relations
Projects:
D5.3 Production and Validation of Hi-Micro Demonstrators
Source: PublicationPreSubmission
Source-ID: 118368243
Publication: Research › Report – Annual report year: 2015

Defining Allowable Physical Property Variations for High Accurate Measurements on Polymer Parts.
Measurement conditions and material properties have a significant impact on the dimensions of a part, especially for polymers parts. Temperature variation causes part deformations that increase the uncertainty of the measurement process. Current industrial tolerances of a few micrometres demand high accurate measurements in non-controlled ambient. Most of polymer parts are manufactured by injection moulding and their inspection is carried out after stabilization, around 200 hours. The overall goal of this work is to reach ±5μm in uncertainty measurements a polymer products which is a challenge in today’s production and metrology environments. The residual deformations in polymer products at room temperature after injection molding are important when micrometer accuracy needs to be achieved. Numerical modelling can give a valuable insight to what is happening in the polymer during cooling down after injection molding. In order to obtain accurate simulations, accurate inputs to the model are crucial. In reality however, the material and physical properties will have some variations. Although these variations may be small, they can act as a source of uncertainty for the measurement. In this paper, we investigated how big the variation in material and physical properties are allowed in order to reach the 5 μm target on the uncertainty.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Mohammadi, A. (Intern), Sonne, M. R. (Intern), Madruga, D. G. (Intern), De Chiffre, L. (Intern), Hattel, J. H. (Intern)
Number of pages: 5
Publication date: 2015

Host publication information
Title of host publication: AIP Conference Proceedings
Volume: 1738
Publisher: AIP Publishing LLC
ISBN (Print): 978-0-7354-1392-4

Series: A I P Conference Proceedings Series
Volume: 1738
ISSN: 0094-243X
Main Research Area: Technical/natural sciences
Finite Element Analysis, Thermo-mechanical Model, Uncertainty Budgeting
Electronic versions:
Design of Test Parts to Characterize Micro Additive Manufacturing Processes

The minimum feature size and obtainable tolerances of additive manufacturing processes are linked to the smallest volumetric elements (voxels) that can be created. This work presents the iterative design of a test part to investigate the resolution of AM processes with voxel sizes at the micro scale. Each design iteration reduces the test part size, increases the number of test features, improves functionality, and decreases coupling in the part. The final design is a set of three test parts that are easy to orient and measure, and that provide useful information about micro additive manufacturing processes.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Thompson, M. K. (Intern), Mischkot, M. (Intern)
Pages: 223-228
Publication date: 2015
Conference: 9th International Conference on Axiomatic Design (ICAD 2015), Florence, Italy, 16/09/2015 - 16/09/2015
Main Research Area: Technical/natural sciences

Development of a multisensory arm for process monitoring in Robot Assisted Polishing

A multisensory polishing arm with integrated three component force sensor, a miniature acoustic emission (AE) sensor and an accelerometer was developed for process monitoring in Robot Assisted Polishing (RAP) process. The arm design was optimized for integration of a force and an AE sensor. The force sensor, consisted of semiconductor and metallic strain gauges, was calibrated by means of static application of defined loads. The sensor performance in a dynamic application was subsequently verified by comparison with a reference calibrated dynamometer on a dedicated test rig. To compensate for measurement bias caused by the inertial component due to the mass of the oscillating arm, acceleration is measured, inertia component calculated and subtracted from the measurements. The results demonstrate the suitability of the custom designed multisensory polishing arm for process monitoring in all RAP process configurations.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Development of a multisensory arm for process monitoring in Robot Assisted Polishing

Robot Assisted Polishing (RAP) process is capable of achieving surface roughness down to Sa 10 nm on industrial components. In RAP, a robot arm carries a polishing module with controlled contact force utilizing oscillating or rotating tools. In this work a multisensory polishing arm with integrated Acoustic Emission (AE), accelerometer and force sensors was developed and the reliability of force measurements for process monitoring in RAP was verified.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Pilny, L. (Intern), Dalla Costa, G. (Intern), Bissacco, G. (Intern), De Chiffre, L. (Intern)
Number of pages: 1
Publication date: 2015
Event: Poster session presented at Euspen’s 15th International Conference & Exhibition, Leuven, Belgium.
Main Research Area: Technical/natural sciences
Electronic versions:
euspen2015_P4_27.pdf

Bibliographical note
P4.07, Precision Mechatronic Systems and Control poster session
Publication: Research - peer-review › Poster – Annual report year: 2015

Development of the machine process monitoring and control strategy in Robot Assisted Polishing

Robot Assisted Polishing (RAP) can be used to polish rotational symmetric and free form components achieving surface roughness down to Sa 10 nm. With the aim to enable unmanned robust and cost efficient application of RAP, this paper presents the development of a monitoring and control strategy for automatic detection of process end point as well as on the machine total surface characterization and local defects identification. The approach is based on a multisensory polishing arm allowing measurement of Acoustic Emission and process forces and a scattered light sensor mounted on the machine. The multisensory approach was experimentally validated in polishing with bonded abrasives demonstrating its suitability for process control in RAP.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Pilny, L. (Intern), Bissacco, G. (Intern)
Pages: 313-316
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: C I R P Annals
Volume: 64
Issue number: 1
ISSN (Print): 0007-8506
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 2.055 SNIP 3.158
Polishing, Monitoring, Quality control

DOIs:
10.1016/j.cirp.2015.04.013

Source: PublicationPreSubmission

Original language: English

Publication: Research - peer-review › Journal article – Annual report year: 2015
Dimensional measurements with submicrometer uncertainty in production environment
The work concerns a laboratory investigation of a method to achieve dimensional measurements with submicrometer uncertainty under conditions that are typical of a production environment. The method involves the concurrent determination of dimensions and material properties from measurements carried out over time. A laboratory set-up was developed comprising a pair of electronic probes mounted on a Zerodur block featuring near zero thermal expansion. Three temperature sensors, data acquisition system, and a temperature regulated plate for heating the workpiece were implemented. Investigations with synchronous measurements of length and temperature during cooling from 25 °C to 20 °C were carried out, using two calibrated gauge blocks as workpieces, i.e., a steel gauge block and a tungsten carbide gauge block. Each measurement was repeated 9 times. Coefficients of thermal expansion (CTE) for the two gauge blocks along with their uncertainties were estimated directly from the measurements. The length of the two workpieces at the reference temperature of 20 °C was extrapolated from the measurements and compared to certificate values. The investigations have documented that the developed approach and laboratory equipment allow traceable length measurements with expanded uncertainties (k=2) below 1 μm.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: De Chiffre, L. (Intern), Gudnason, M. M. (Intern), Madruga, D. (Intern)
Pages: 163-4
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the 15th International Conference of the European Society for Precision Engineering and Nanotechnology
ISBN (Print): 9780956679079
Main Research Area: Technical/natural sciences
Conference: 15th euspen International Conference & Exhibition (2015), Leuven, Belgium, 01/06/2015 - 01/06/2015
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Drying of water based foundry coatings: Innovative test, process design and optimization methods
This work has been carried out in in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy (PhD) at the Technical University of Denmark. Associate Professor Niels Skat Tiedje has been the university supervisor from March 2012 to February 2015. Casting Technology Director Bjørn Budolph Johansen has been the company supervisor from March 2012 to June 2014.
In this Industrial PhD Thesis we present the main results of several tests and simulations carried out from 2011 to 2014 at Global Castings A/S (former Vestas Wind Systems A/S) and at the Technical University of Denmark with the overall aim to optimize the drying process of water based foundry coatings.
Drying of foundry coatings is a relatively new process in the foundry industry that followed the introduction of water as a solvent. In order to avoid moisture related quality problems and reach production capacity goals there is a need to understand how to design, control and optimize drying processes. The main focus of this project was on the critical parameters and properties to be controlled in production in order to achieve a stable and predictable drying process. We propose for each of these parameters simple methods for testing both at laboratory and production scale so that material characterization and model validation can be carried out also for materials different from the ones considered in this study. Additionally, we present the application of calculation methods and advanced simulation tools on real industrial cases. These tools have been developed in order to simulate and optimize the drying process and reduce drying time and power consumption as well as production process design time and cost of expensive drying equipment. Results show that test methods from other industries can be used or adapted to better control drying processes of water based foundry coatings. Critical drying process related properties were obtained in the several laboratory tests performed and calculation and simulation methods were developed. Additionally, examples of improvement on full scale industrial production line are shown.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Global Castings A/S
Authors: Di Muoio, G. L. (Intern), Tiedje, N. S. (Intern), Johansen, B. B. (Ekstern)
Number of pages: 320
Publication date: 2015

Publication information
Publisher: DTU Mechanical Engineering
ISBN (Print): 978-87-7475-412-1
Original language: English
Main Research Area: Technical/natural sciences
Drying Process Design, Water Based Coating, Furan Sand, Test Methodologies, Simulation, Process Control
Electronic versions:
Giovanni_Luca_Di_Muoio.pdf
**Effect of Functional Nano Channel Structures Different Widths on Injection Molding and Compression Molding Replication Capabilities**

The present study investigates the capabilities of the two employed processes, injection molding (IM) and injection compression molding (ICM) on replicating different channel cross sections. Statistical design of experiment was adopted to optimize replication quality of produced polymer parts with the two different molding technologies. Focus of the experimental work was the assessment of the IM and ICM processes capabilities to replicate different channels widths (240 nm, 440 nm and 1040 nm) at different positions from the gate based on the deviations of their dimensions from the corresponding geometries measured in the nickel master. Results presented as main effect plot of channel depth deviation from ideal nickel master and polymer replicated features are reported.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Danish Fundamental Metrology
Authors: Calaon, M. (Intern), Tosello, G. (Intern), Garnaes, J. (Ekstern), Hansen, H. N. (Intern)
Number of pages: 1
Publication date: 2015
Event: Abstract from 31st International Conference of the Polymer Processing Society, Jeju Island, Korea, Republic of.
Main Research Area: Technical/natural sciences
Injection molding, Lab-on-a-chip, Nano metrology

Electronic versions: PPS_31_Extended_abstract_S03_35_Calaon_1.pdf

**Bibliographical note**


Source: PublicationPreSubmission
Source-ID: 118223362
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

**Elastic deflection and tilting effect in a multi-stage micro bulk former**

Previous studies have described a high performance transfer press for the application in micro forming. This research extends this finding by conducting a two-stage forming process for the machine tool in order to examine the efficiency of the machine in a real multi-stage process. In particular the analysis focuses on quantifying the effect the forming force has on the elastic deflection of the machine and the tools by examining the displacement of the moving plate under loaded and unloaded conditions. The results of the measurements were used to describe the tilting effect due to the off-center loading applied to the upper tool plate.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Mahshid, R. (Intern), Hansen, H. N. (Intern)
Pages: 325-334
Publication date: 2015

**Host publication Information**

Title of host publication: Proceedings of 11th International Conference and Exhibition on Laser Metrology, Coordinate Measuring Machine and Machine Tool Performance
Publisher: The European Society for Precision Engineering and Nanotechnology
ISBN (Print): 9780956679055
Main Research Area: Technical/natural sciences
Conference: Laser Metrology and Machine Performance (LAMDAMAP) 2015, Huddersfield, United Kingdom, 17/03/2015 - 17/03/2015
Source: FindIt
Source-ID: 2289324310
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

**Electrochemical based processes enabling different replication steps for large area low cost surface nano structuring**

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development, Danish Foundamental Metrology
Environmentally friendly joining of tubes by their ends

This paper proposes an environmentally friendly joining process for connecting tubes by their ends that has the potential to replace current solutions based on fastened, crimped, welded, brazed or adhesive bonded joints. The process is based on a new type of tubular lap joint produced by local plastic instability and compression beading that has a substantial overlap with the counterfacing surfaces of the mating tubes to be joined. The presentation combines independent characterization of the materials, experimentation and numerical simulation of the process in order to identify the modes of deformation and the process feasibility window, and destructive testing to establish the working limits of tubular lap joints under different type of loading conditions. Results demonstrate that the proposed joining process is a flexible and cost-effective technology for connecting tubes by their ends with a better performance than current environmentally friendly alternatives based on tubular butt joints produced by plastic deformation. © 2014 Elsevier Ltd. All rights reserved.
Experimental Investigation of a Basalt Fiber Reinforced Composite to Metal Joint

General Information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Solid Mechanics, National Oilwell Varco Denmark I/S
Authors: Costache, A. (Intern), Glejbøl, K. (Ekstern), Sivebæk, I. M. (Intern), Berggreen, C. (Intern)
Publication date: 2015
Event: Poster session presented at 7th International Conference on Composite Testing and Model Identification, Madrid, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions: poster_portrait.pdf

Relations
Activities:
7th International Conference on Composite Testing and Model Identification
Publication: Research › Poster – Annual report year: 2015

Failure by fracture in bulk metal forming
This paper revisits formability in bulk metal forming in the light of fundamental concepts of plasticity, ductile damage and crack opening modes. It proposes a new test to appraise the accuracy, reliability and validity of fracture loci associated with crack opening by tension and out-of-plane shear under loading conditions different from those found in conventional tests for bulk formability based on cylindrical, tapered and flanged specimens. The new formability test consists of expanding rings of various wall thicknesses with a stepped conical punch and allows investigating the onset of failure by cracking under three-dimensional states of stress subjected to various magnitudes of stress triaxiality. The presentation is
supported by finite element analysis and experimentation in aluminium AA2030-T4 and results show that failure by fracture under three-dimensional loading conditions can be easily and effectively characterized in the space of equivalent strain to fracture and stress triaxiality. © 2014 Elsevier B.V. All rights reserved.

**General information**

*State:* Published
*Organisations:* Department of Mechanical Engineering, Manufacturing Engineering, Universidade de Lisboa, Instituto Superior Técnico, University of Reading, University of Lisbon
*Authors:* Silva, C. (Ekstern), Alves, L. M. (Ekstern), Nielsen, C. V. (Intern), Atkins, A. (Ekstern), Martins, P. A. F. (Ekstern)
*Pages:* 287–298
*Publication date:* 2015
*Main Research Area:* Technical/natural sciences

**Publication information**

*Journal:* Journal of Materials Processing Technology
*Volume:* 215
*ISSN (Print):* 0924-0136
*Ratings:*  
BFI (2018): BFI-level 1  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 1  
Scopus rating (2017): SNIP 2.678 SJR 1.695 CiteScore 4.15  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): CiteScore 3.62 SJR 1.717 SNIP 2.646  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 1.385 SNIP 2.463 CiteScore 2.9  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 2.112 SNIP 3.708 CiteScore 3.43  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 1  
Scopus rating (2013): SJR 1.702 SNIP 3.455 CiteScore 2.87  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 1  
Scopus rating (2012): SJR 1.712 SNIP 3.726 CiteScore 2.71  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 1  
Scopus rating (2011): SJR 1.336 SNIP 3.206 CiteScore 2.52  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 1  
Scopus rating (2010): SJR 1.198 SNIP 2.366  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 1  
Scopus rating (2009): SJR 1.115 SNIP 1.747  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 2  
Scopus rating (2008): SJR 0.985 SNIP 1.74  
Scopus rating (2007): SJR 0.793 SNIP 1.55  
Scopus rating (2006): SJR 0.769 SNIP 1.372  
Web of Science (2006): Indexed yes  
Scopus rating (2005): SJR 0.758 SNIP 1.05  
Web of Science (2005): Indexed yes  
Scopus rating (2004): SJR 0.718 SNIP 1.215
Finite Element and Experimental Study of Shunting in Resistance Spot Welding
This research is focused on one of the problems frequently encountered in spot welding in industry. In many applications several spot welds are made close to each other. The spots made after the first spot may become smaller in size due to shunt effect. A numerical and experimental study has been conducted to investigate the effect of shunting on nugget size in spot welding of HSLA steel sheets. Different cases with different spacing between weld spots have been examined. The nugget sizes have been measured by metallographic examination and have been compared with 3D finite element simulations. The results of this study revealed that the shunt effect becomes negligible when the minimum weld spacing is about six times the electrode diameter. The results showed that the weld nugget diameter is more sensitive to shunt effect than the nugget height.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Seyyedian Choobi, M. (Intern), Nielsen, C. V. (Intern), Bay, N. (Intern)
Number of pages: 13
Publication date: 2015
Form measurements in an industrial CT scanner investigated using a polymer step gauge

Computed Tomography (CT) is a promising technology for both geometrical measurements and form measurements. However, a number of influence factors such as magnification, threshold determination strategies, and position of feature in the CT volume, have effect on the CT measurement performance. The present investigation concerns the measurement of flatness at different positions in the CT measurement volume using a milled miniature step gauge. The artifact is a 42 mm long step gauge with 11 grooves at 2 mm steps, made of polyphenylene sulphide PPS (\(\rho = 1.650\) g/cm\(^3\)), with limited form error and good surface finish. A total of 132 flatness measurements were performed on the left step gauge grooves. The linear distribution of the grooves pointed out a non-uniform CT performance over the step gauge length with max deviation up to 25 μm. However, an appropriate choice of parameters yielded a reduction of the max deviation along the step gauge length by approximately 13 μm.
Friction Joint Between Basalt-Reinforced Composite and Aluminum

The purpose of this study was to anchor basalt-reinforced polymers in an aluminum grip using dry friction. Dry friction clamping is considered the optimal solution for post-mounting of load-bearing terminations on composite structures. A new test method is presented for characterizing the frictional load transfer behavior of the grip. To carry out the study, a custom-built test rig was used to examine the relation between pullout force and clamping force. The anchoring method was found to be successful. The paper presents details on the custom-built test rig, along with the use of digital image correlation for displacement monitoring. Pullout results and validation tests are presented. In the discussion, the results and the importance of the grips surface finish with regard to pullout force are discussed. The discussion was backed by investigations on wear patterns using SEM.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Solid Mechanics, Technical University of Denmark
Authors: Costache, A. (Intern), Glejbøl, K. (Ekstern), Sivebæk, I. M. (Intern), Berggreen, C. (Intern)
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Tribology Letters
Volume: 59
Issue number: 2
Article number: 30
ISSN (Print): 1023-8883
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.236 SJR 1.204 CiteScore 2.33
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.04 SJR 1.04 SNIP 1.289
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.013 SNIP 1.197 CiteScore 1.96
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.291 SNIP 1.599 CiteScore 2.21
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.39 SNIP 1.687 CiteScore 2.53
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.339 SNIP 1.548 CiteScore 1.95
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.183 SNIP 1.562 CiteScore 1.74
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.131 SNIP 1.38
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.964 SNIP 1.289
Web of Science (2009): Indexed yes
Gate design in injection molding of microfluidic components using process simulations
Just as in conventional injection molding of plastics, process simulations are an effective tool in the area of micro injection molding. They are applied in order to optimize and aid the design of the micro plastic part, the mold and the actual process. Available simulation software is actually made for macroscopic injection molding, but by means of the correct implementation and modelling strategy it can also be applied to micro plastic parts, as it is shown in the presented work. Process simulations are applied to two microfluidic devices (a micro distributor and a micro mixer) which shall be manufactured by micro injection molding. One of the main goals of the simulations is the investigation of the filling of the parts. Great emphasis is also on the optimization of selected gate designs for both parts which was successfully carried out. The paper describes how the two devices were meshed in the simulations software to obtain a proper simulation model and where the challenges arose. Subsequently, the simulation results are used to answer the question which gate design is the most appropriate with regard to the process window, polymer flow, and part quality. Finally, the limitations of the simulation results are critically discussed and possible improvements are described.

Gate design in injection molding of microfluidic components using process simulations
Just as in conventional injection molding of plastics, process simulations are an effective tool in the area of micro injection molding. They are applied in order to optimize and aid the design of the micro plastic part, the mold and the actual process. Available simulation software is actually made for macroscopic injection molding, but by means of the correct implementation and modelling strategy it can also be applied to micro plastic parts, as it is shown in the presented work. Process simulations are applied to two microfluidic devices (a micro distributor and a micro mixer) which shall be manufactured by micro injection molding. One of the main goals of the simulations is the investigation of the filling of the parts. Great emphasis is also on the optimization of selected gate designs for both parts which was successfully carried out. The paper describes how the two devices were meshed in the simulations software to obtain a proper simulation model and where the challenges arose. Subsequently, the simulation results are used to answer the question which gate design is the most appropriate with regard to the process window, polymer flow, and part quality. Finally, the limitations of the simulation results are critically discussed and possible improvements are described.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology
Authors: Marhöfer, D. M. (Intern), Tosello, G. (Intern), Islam, A. (Intern), Hansen, H. N. (Intern)
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the 4M/ICOMM2015 Conference
Publisher: Research Publishing Services
Editors: Annoni, M., Fassi, I., Wiens, G. J., Dimov, S.
ISBN (Electronic): 978-981-09-4609-8
Main Research Area: Technical/natural sciences
Conference: 4M/ICOMM2015 Conference, Milan, Italy, 31/03/2015 - 31/03/2015
Micro injection molding, Simulation, Meshing, Microfluidic system
DOI: 10.3850/978-981-09-4609-8_136
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015
Gate design in injection molding of microfluidic components using process simulations

Process simulations are an effective design and optimization tool in conventional as well as micro injection molding (μIM). They can be applied to optimize and assist the design of the micro part, the mold, the micro cavity and the μIM process. Available simulation software is however developed for macroscopic plastic parts. By using the correct implementation and careful modelling though, it can also be applied to micro parts. In the present work, process simulations were applied to a microfluidic distributor and a microfluidic mixer of which features were in the 100 μm dimensional range. The meshing and the challenges of the two devices in the simulation software to obtain a proper simulation model were described. Focus of the investigation was on the filling pattern and the optimization of selected gate designs. Subsequently, the simulation results were used to find the most appropriate gate design with regard to moulding process window, polymer flow, and part quality. This finally led to an optimization of the design and the realization as actual steel mold. Additionally, the simulation results were critically discussed and possible improvements and limitations of the gained results and the deployed software are presented. Ultimately, the simulation results were validated by comparing the flow pattern behavior of the polymer flow predicted by the simulation with the actual flow front at different time steps. These were realized by molding short shots with the realized molds and were compared to the simulations at the global, i.e. part level, and at the local, i.e. feature level (see Figure 1).

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology
Authors: Marhöfer, D. M. (Intern), Tosello, G. (Intern), Islam, A. (Intern), Hansen, H. N. (Intern)
Number of pages: 1
Publication date: 2015
Event: Abstract from Micro/Nano Manufacturing Workshop, Teddington, United Kingdom.
Main Research Area: Technical/natural sciences
Electronic versions:
euspen2015_micronano_Abstract_Marh_fer_Final.pdf
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

Generalized requirements and decompositions for the design of test parts for micro additive manufacturing research

The design of experimental test parts to characterize micro additive manufacturing (AM) processes is challenging due to the influence of the manufacturing and metrology processes. This work builds on the lessons learned from a case study in the literature to derive generalized requirements and high level decompositions for the design of test parts and the design of experiments to characterize micro additive manufacturing processes. While the test parts and the experiments described are still work in progress, the generic requirements derived from them can serve as a starting point for the design of other micro additive manufacturing related studies and their decompositions can help structure future work.

General information

State: Published
Organisations: Department of Applied Mathematics and Computer Science , Department of Mechanical Engineering, Manufacturing Engineering, Statistics and Data Analysis
Authors: Thompson, M. K. (Intern), Clemmensen, L. K. H. (Intern)
Pages: 229-235
Publication date: 2015
Conference: 9th International Conference on Axiomatic Design (ICAD 2015), Florence, Italy, 16/09/2015 - 16/09/2015
Main Research Area: Technical/natural sciences

Publication information

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Volume: 34
ISSN (Print): 2212-8271
Ratings:
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Scopus rating (2016): CiteScore 1.6 SNIP 1.374 SJR 0.719
Scopus rating (2015): SJR 0.605 SNIP 1.075
Scopus rating (2014): SJR 0.755 SNIP 1.4
Scopus rating (2013): SJR 0.53 SNIP 1.373
ISI indexed (2013): ISI indexed no
Original language: English
Additive manufacturing, micro manufacturing, metrology, design of experiments, requirements, decomposition
Electronic versions:
Thompson_and_Clemmensen_2015.pdf
Hot embossing and mechanical punching of biodegradable microcontainers for oral drug delivery

A process has been developed to fabricate discrete three-dimensional microcontainers for oral drug delivery applications in Poly-L-Lactic Acid (PLLA) polymer. The method combines hot embossing for the definition of holes in a PLLA film and mechanical punching to penetrate the polymer layer around the holes, after filling them with drug. Here, we demonstrate the fabrication of microcontainers with a diameter of 340 μm and a height of 50 μm. The process is temperature benign so that the compositional integrity of the drug is preserved. It also provides good flexibility for creating different sizes and shapes of microcontainers. Finally, the process is compatible with roll-to-roll processing that could lead to low cost high volume production. © 2014 Elsevier B.V. All rights reserved.
Humidity insensitive step-index polymer optical fibre Bragg grating sensors

We have fabricated and characterized a humidity insensitive step-index (SI) polymer optical fibre (POF) Bragg grating sensors. The fibre was made based on the injection molding technique, which is an efficient method for fast, flexible and cost-effective preparation of the fibre preform. The fabricated SIPOF has a core made from TOPAS with a glass transition temperature of 134 degrees C and a cladding from ZEONEX with a glass transition temperature of 138 degrees C. The main advantages of the proposed SIPOF are the low water absorption and good chemical resistance compared to the conventional poly-methyl-methacrylate (PMMA) based SIPOFs. The fibre has a minimum loss of similar to 6dB/m at 770nm.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Department of Management Engineering
Authors: Woyessa, G. (Intern), Fasano, A. (Intern), Stefani, A. (Intern), Markos, C. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern)
Number of pages: 4
Publication date: 2015

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Volume: 9634
Publisher: SPIE - International Society for Optical Engineering
Article number: 96342L
ISBN (Print): 9781628418392
Series: Proceedings of the SPIE - The International Society for Optical Engineering
Volume: 9634
Main Research Area: Technical/natural sciences
Conference: 24th International Conference on Optical Fibre Sensors, Curitiba, Brazil, 28/09/2015 - 28/09/2015
ENGINEERING, OPTICS, PHYSICS, FEW-MODE, TOPAS, FABRICATION, Injection molding, Fibre fabrication, Polymer optical fibre, Fibre Bragg grating, Fibre optic sensor
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Improving resistance welding of aluminum sheets by addition of metal powder

In order to ensure good quality joints between aluminum sheets by resistance spot welding, a new approach involving the addition of metal powder to the faying surfaces before resistance heating is proposed. Three different metal powders (pure aluminum and two powders corresponding to the alloys AA2024 and AA7075) are investigated for the resistance spot welding of AA1050 aluminum sheets of three different thicknesses. Microstructural and mechanical analysis demonstrates that significant improvement in weld bead morphology and strength are obtained with the addition of metal powder. The improvement obtained is shown to be due to the development of a secondary bond in the joint beside the weld nugget increasing the total weld area. The application of powder additive is especially feasible, when using welding machines with insufficient current capacity for producing the required nugget size. In such cases the best results are obtained with pure aluminum powder.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Baghdad University
Authors: Al Naimi, I. K. (Ekstern), Al-Saadi, M. H. (Ekstern), Daws, K. M. (Ekstern), Bay, N. O. (Intern)
Pages: 493-502
Publication date: 2015
Main Research Area: Technical/natural sciences
**Industrial characterization of nano-scale roughness on polished surfaces**

We report a correlation between the scattering value "Aq" and the ISO standardized roughness parameter Rq. The Aq value is a measure for surface smoothness, and can easily be determined from an optical scattering measurement. The correlation equation extrapolates the Aq value from a narrow measurement range of ±16° from specular to a broader range of ±80°, corresponding to spatial surface wavelengths of 0.8 μm to 25 μm, and converts the Aq value to the Rq value for the surface.
Furthermore, we present an investigation of the changes in scattering intensities, when a surface is covered with a thin liquid film. It is shown that the changes in the angular scattering intensities can be compensated for the liquid film, using empirically determined relations. This allows a restoration of the “true” scattering intensities which would be measured from a corresponding clean surface. The compensated scattering intensities provide Aq values within 5.7 % ± 6.1 % compared to the measurements on clean surfaces.

**General information**

State: Published
Organisations: Department of Micro- and Nanotechnology, Polymer Micro & Nano Engineering, Department of Mechanical Engineering, Manufacturing Engineering, Danish Fundamental Metrology
Authors: Feidenhans'l, N. A. (Intern), Hansen, P. (Ekstern), Pilny, L. (Intern), Madsen, M. H. (Ekstern), Bissacco, G. (Intern), Petersen, J. C. (Ekstern), Taboryski, R. J. (Intern)
Number of pages: 8
Publication date: 2015
Conference: Optifab 2015, Rochester, NY, United States, 12/10/2015 - 12/10/2015
Main Research Area: Technical/natural sciences

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- BFI (2017): BFI-level 1
- Scopus rating (2017): CiteScore 0.43 SJR 0.243 SNIP 0.289
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 0.42 SNIP 0.258 SJR 0.226
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 0.212 SNIP 0.239 CiteScore 0.3
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 0.217 SNIP 0.249 CiteScore 0.3
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 0.234 SNIP 0.273 CiteScore 0.26
- ISI indexed (2013): ISI indexed no
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 0.219 SNIP 0.275 CiteScore 0.27
- ISI indexed (2012): ISI indexed no
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 0.217 SNIP 0.286 CiteScore 0.31
- ISI indexed (2011): ISI indexed no
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 0.233 SNIP 0.277
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 0.236 SNIP 0.312
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.245 SNIP 0.3
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 0.247 SNIP 0.376
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 0.323 SNIP 0.676
- Scopus rating (2005): SJR 0.162 SNIP 0.372
- Web of Science (2004): Indexed yes
- Web of Science (2002): Indexed yes
Influence of surface pretreatment in resistance spot welding of aluminum AA1050

Resistance spot welding (RSW) of aluminum alloys implies a major problem of inconsistent quality from weld to weld due to problems of varying thickness of the oxide layer. The high resistivity of oxide layer causes strong heat development, which has significant influence on electrode life and weld quality. An experimental study of the influence of pretreatment on weld quality in RSW of AA1050 sheets with three thicknesses, comparing welding of as-received sheet with pretreated sheet by either pickling in NaOH or glass-blasting were investigated. Different weld settings were applied with low-, medium-, and high-energy inputs. The as-received sheet showed higher electrical contact resistance because of thicker oxide layer. Lower values were noticed with pickled surfaces, whereas the lowest electrical contact resistance was obtained when glass blasting, resulting in the roughest surface topography, which facilitated breakdown the oxide layer. Highest strength and smaller scatter in strength were obtained by pickling in NaOH.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Al Naimi, I. K. (Ekstern), Al Saadi, M. H. (Ekstern), Daws, K. M. (Ekstern), Bay, N. O. (Intern)
Number of pages: 16
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Main Research Area: Technical/natural sciences

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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.094 SJR 0.558 CiteScore 1.54
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.443 SNIP 0.945 CiteScore 0.84
BFI (2015): BFI-level 1
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BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.354 SNIP 0.44
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DOIs:
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Source: Findit
Source-ID: 2264545954
Publication: Research - peer-review › Journal article – Annual report year: 2016

Integrated FEM-DBEM simulation of crack propagation in AA2024-T3 FSW butt joints considering manufacturing effects

This paper deals with a numerical and experimental investigation on the influence of residual stresses on fatigue crack growth in AA2024-T3 friction stir welded butt joints. An integrated FEM-DBEM procedure for the simulation of crack propagation is proposed and discussed. A numerical FEM model of the welding process of precipitation hardenable AA2024-T3 aluminum alloy is employed to infer the process induced residual stress field. The reliability of the FEM simulations with respect to the induced residual stresses is assessed comparing numerical outcomes with experimental data obtained by means of the contour method. The computed stress field is transferred to a DBEM environment and
superimposed to the stress field produced by a remote fatigue traction load applied on a friction stir welded cracked specimen. Numerical results are compared with experimental data showing good agreement and highlighting the predictive capability of the proposed method. Furthermore, the influence of the residual stress distribution on crack growth is evidenced.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Salerno
Authors: Sonne, M. R. (Intern), Carlone, P. (Ekstern), Citarella, R. (Ekstern), Hattel, J. H. (Intern)
Pages: 877-882
Publication date: 2015
Conference: 18th International ESAFORM Conference on Material Forming, Graz, Austria, 15/04/2015 - 15/04/2015
Main Research Area: Technical/natural sciences

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Journal: Key Engineering Materials
Volume: 651-653
ISSN (Print): 1013-9826
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.29 SJR 0.18 SNIP 0.303
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.172 SNIP 0.374 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.177 SNIP 0.436 CiteScore 0.22
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.184 SNIP 0.296
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.209 SNIP 0.24
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.192 SNIP 0.283
Scopus rating (2007): SJR 0.194 SNIP 0.366
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.221 SNIP 0.42
Scopus rating (2005): SJR 0.221 SNIP 0.373
Scopus rating (2004): SJR 0.225 SNIP 0.434
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.218 SNIP 0.32
Web of Science (2003): Indexed yes
Integrated Modelling of Crack Propagation in AA2024-T3 FSW Butt Joints Considering The Residual Stresses from the Manufacturing Process

This research is focused on one of the problems frequently encountered in spot welding in industry. In many applications several spot welds are made close to each other. The spots made after the first spot may become smaller in size due to shunt effect. A numerical and experimental study has been conducted to investigate the effect of shunting on nugget size in spot welding of HSLA steel sheets. Different cases with different spacing between weld spots have been examined. The nugget sizes have been measured by metallographic examination and have been compared with 3D finite element simulations. The results of this study revealed that the shunt effect becomes negligible when the minimum weld spacing is about six times the electrode diameter. The results showed that the weld nugget diameter is more sensitive to shunt effect than the nugget height.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Salerno
Authors: Sonne, M. R. (Intern), Carlone, P. (Ekstern), Citarella, R. (Ekstern), Hattel, J. H. (Intern)
Number of pages: 8
Publication date: 2015

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Main Research Area: Technical/natural sciences
Electronic versions:
INTEGRATED_MODELLING_OF_CRACK_PROPAGATION_IN_AA2024_T3_FSW_BUTT_JOINTS_CONSIDERING_THE_RESIDUAL_STRESSES_FROM_THE_MANUFACTURING_PROCESS.pdf
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Interchain tube pressure effect in the flow dynamics of bi-disperse polymer melts
The constitutive equation as reported by Rasmussen and Huang (Rheologica Acta 53:199–208, 2014b), explaining the flow dynamics of oligomer (containing a least two Kuhn step)-diluted narrow molecular weight-distributed polymers were extended to general bi-disperse polymer melt system. It was assumed that the Rouse time of a particular polymer chain is dependent on the total number of Kuhn steps of the polymers in direct contact with the considered polymer chain. This number of Kuhn steps is proportional to the weight average molecular weight, M_w, replacing the involved molecular weight in the equation as reported by Rasmussen and Huang (Rheologica Acta 53:199–208, 2014b). Two separate stretch evolution equations for the long and the short polymer respectively, were introduced to handle the two involved Rouse times. Experimentally, the bi-disperse polystyrene systems of Nielsen et al. (J Rheol 50:453–476, 2006) and polyisoprene systems as reported by Read et al. (J Rheol 56:823–873, 2012) were within quantitatively agreement with the derived model. This included both startup of extension as well as shear flow. One exception was observed. In the most diluted polyisoprene blend, the measured extensional viscosities were under predicted by the model.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Rasmussen, H. K. (Intern)
Number of pages: 10
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Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
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Volume: 54
BSW-spectrum, Polymer blend, Integral constitutive equation, Tube model, Polymer melt

DOIs:
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Source-ID: 273460259
Investigation of air entrapment and weld line defects in micro injection moulded thermoplastic elastomer micro rings
The micro injection moulding (μIM) process for the production of micro rings in thermoplastic elastomers (TPE) was investigated and optimized. The objective was to minimize the formation of air entraps and the depth of micro weld line created on the surface of the TPE micro moulded rings. The defects were investigated by both experiments and numerical simulations of the μIM process. The results obtained from the simulation software were verified by comparison with the actual moulded parts. It was found that the simulation was accurate in the prediction of air entraps and weld line placement. The μIM processing parameters had a large influence on the weld line depth and the air entrapment. In particular, it was found that low settings of the injection speed and of the clamping force increased the air evacuation from the cavity, thus minimizing the weld line depth and the presence of air entrapment defects.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Ortofon A/S
Authors: Hasnaes, F. (Ekstern), Tosello, G. (Intern), Calaon, M. (Intern), Elsborg, R. (Ekstern), Hansen, H. N. (Intern)
Pages: 266-267
Publication date: 2015

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Publisher: Research Publishing Services
Editors: Annoni, M., Fassi, I., Wiens, G. J., Dimov, S.
Article number: 065
ISBN (Electronic): 978-981-09-4609-8
Main Research Area: Technical/natural sciences
Conference: 4M/ICOMM2015 Conference, Milan, Italy, 31/03/2015 - 31/03/2015
Nano moulding, Nano metrology, Micro and nano tooling
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Investigation of process induced warpage for pultrusion of a rectangular hollow profile
A novel thermo-chemical–mechanical analysis of the pultrusion process is presented. A process simulation is performed for an industrially pultruded rectangular hollow profile containing both unidirectional (UD) roving and continuous filament mat (CFM) layers. The reinforcements are impregnated with a commercial polyester resin mixture (Atlac 382). The reactivity of the resin is obtained from gel tests performed by the pultruder. The cure kinetics parameters are estimated from a fitting procedure against the measured temperature. The cure hardening instantaneous linear elastic (CHILE) model is adopted for the evolution of the resin elastic modulus using the temperature-dependent elastic response provided by the resin supplier. The numerical model predictions for the warpage trend at the end of the process are found to agree well with the warpage observed in the real pultruded products. In addition, the calculated warpage magnitude is found to be in the measured range of warpage magnitude for the manufactured part.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Twente
Authors: Baran, I. (Ekstern), Hattel, J. H. (Intern), Akkerman, R. (Ekstern)
Number of pages: 10
Pages: 365-374
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Composites Part B: Engineering
Volume: 68
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Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
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Scopus rating (2017): SNIP 2.104 SJR 2.039 CiteScore 5.41
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.19 SJR 2.115 SNIP 2.378
Web of Science (2016): Indexed yes
Life Cycle Assessment of Injection Molding Inserts: Additively Manufactured, in Brass, and in Steel

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Management Engineering, Quantitative Sustainability Assessment, Technical University of Denmark
Authors: Mischkot, M. (Intern), Hofstätter, T. (Intern), Bey, N. (Intern), Lunzer, A. (Ekstern)
Number of pages: 1
Publication date: 2015
Event: Poster session presented at DTU Sustain Conference 2015, Lyngby, Denmark.
Main Research Area: Technical/natural sciences
Electronic versions:
LCA_Plakat.pdf

Abstract
Mechanical Modelling of Pultrusion Process: 2D and 3D Numerical Approaches

The process induced variations such as residual stresses and distortions are a critical issue in pultrusion, since they affect the structural behavior as well as the mechanical properties and geometrical precision of the final product. In order to capture and investigate these variations, a mechanical analysis should be performed. In the present work, the two dimensional (2D) quasi-static plane strain mechanical model for the pultrusion of a thick square profile developed by the authors is further improved using generalized plane strain elements. In addition to that, a more advanced 3D thermo-chemical-mechanical analysis is carried out using 3D quadratic elements which is a novel application for the numerical modelling of the pultrusion process. It is found that the 2D mechanical models give relatively reasonable and accurate stress and displacement evolutions in the transverse direction as compared to the 3D model. Moreover, the generalized plane strain model predicts the longitudinal process induced stresses more similar to the ones calculated in the 3D model as compared with the plane strain model.
Medium term stability investigation of polymer step gauges for CT scanner verification

A miniature step gauge fabricated using a material for dental applications was previously used at DTU as a reference object for instrument verification in optical 3D scanning and Computed Tomography (CT). Initial material investigations had indicated a good metrological compatibility but a later stability investigation showed that the material was not hard and stable enough to be used for reference objects. In order to achieve better performance mechanical properties and stability, two other polymer materials, polyetheretherketone (PEEK) and polyphenylene sulphide (PPS), were selected. Five miniature step gauges of each material were manufactured using milling. A tactile CMM and grade I steel gauge blocks were used for calibration. A practical approach inspired by the PUMA method was used for uncertainty estimation, as a simplification of the GUM approach. The long term stability of the step gauges was monitored through reproduced measurements of 10 groove distances for each step gauge, both uni-directionally and bi-directionally, carried out eight times over approximately one year. The stability investigation showed for PPS deviations below 3 μm and expanded uncertainties (k=2) below 5 μm while 4 μm and 7 μm, respectively, were obtained for PEEK. The En value normalised with respect to the estimated uncertainty was computed according to ISO 17043 guidelines. The estimated | En| values are generally in the acceptable range for both polymer materials, with a calculated average of | En| = 0.2.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Metrologic ApS
Authors: Cantatore, A. (Ekstern), Angel, J. (Ekstern), De Chiffre, L. (Intern)
Pages: 205-206
Publication date: 2015

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Title of host publication: Proceedings of the 15th International Conference of the European Society for Precision Engineering and Nanotechnology
Main Research Area: Technical/natural sciences
Conference: 15th euspen International Conference & Exhibition (2015), Leuven, Belgium, 01/06/2015 - 01/06/2015
Source: FindIt
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Metrological investigation of nanostructured polymer surfaces replication using atomic force microscopy: Uncertainty evaluation in the surface replication fidelity assessment of moulded specimens at the 100 nm scale

Polymer specimens have been manufactured by injection moulding and measured by atomic force microscopy (AFM) with the aim to investigate the possibility of replicating their surfaces with good fidelity at the sub-μm dimensional scale. Three different cases with surface features in the 100 nm amplitude range on the surface have been analysed: specimens with random and periodic surface examined in the same production batch and specimens with periodic surface produced in two different batches. The assessment of the AFM measurement uncertainty and its use in the replication analysis is
discussed. Results show that high replication fidelity of the polymer specimens can be achieved in all the cases examined.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Quagliotti, D. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Pages: 49-55
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Source-ID: 118076239
Publication: Research - peer-review › Book chapter – Annual report year: 2015

**Microfluidic chip designs process optimization and dimensional quality control**

The challenge of fabricating geometries with critical dimensions ranging from few microns down to 10 nm with high production rate is delaying the development of nanotechnology based products. Diverse research works have shown the capability of technologies such as UV lithography, nano imprint lithography and e-beam lithography to produce micro and nano features. However, their application for tooling purposes is relatively new and the potential to produce nanometer features with high volume and low cost is enormous. Considering possible implementation in a mass production environment the precision of measuring results and the accuracy of measurement relocation are very relevant. In this paper, the capability of producing with high volume Lab-on-chip devices through injection molding is evaluated. Preparation of master geometries was made in a Si wafer using e-beam lithography and reactive ion etching. Subsequent nickel electroplating was employed to replicate the obtained geometries on the tool, which was used to mold on transparent polymer substrates the functional structures. To assess the critical factors affecting the replication quality throughout the different steps of the proposed process chain, test geometries were designed and produced on the side of the functional features. The so-called “Finger Print” of the lithography and molding processes was qualitatively and quantitatively evaluated through scanning electron microscopy and atomic force microscopy respectively. The entire process chain is therefore characterized and the degree of replication among the different replication steps quantified with precise measurements using a high accuracy relocation technique on the produced key test geometries. Influence of injection molding process parameters, feature dimensions and orientation relative to the polymer flow direction have been assessed in respect of the replication fidelity of the produced micro/sub-μm channels. Finally the paper addresses product compliance with specifications, focusing on tolerances of vertical dimensions using a metrological approach: sub-μm features on silicon, nickel stampers and injection molded substrates are measured. Results of measurement uncertainty calculation, quantitative replication fidelity assessment, and dimensional tolerances at the nanometer scale verification are reported.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Danish Fundamental Metrology, NIL Technology ApS, National Institute of Metrology
Authors: Calaon, M. (Intern), Hansen, H. N. (Intern), Tosello, G. (Intern), Garnæs, J. (Ekstern), Nørregaard, J. (Ekstern), Li, W. (Ekstern)
Number of pages: 10
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**Publication information**

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ISSN (Print): 0946-7076
Ratings:
Micro injection moulding process validation for high precision manufacture of thermoplastic elastomer micro suspension rings

Micro injection moulding (μIM) is one of the most suitable micro manufacturing processes for flexible mass-production of multi-material functional micro components. The technology was employed in this research used to produce thermoplastic elastomer (TPE) micro suspension rings identified as critical component in micro acoustic applications (e.g. phono cartridges, see Figure 1a). The suspension ring holds in place the preassembled aluminium cantilever, magnet and diamond tip seen (see Figure 1b and 1c). The specific damping properties of the TPE material reduces vibrations differently depended on the frequency in order to improve the signal quality and assure acoustic reproduction fidelity. Production quality of the TPE rings drastically influence the product functionality.

In the present study, a procedure for μIM TPE micro rings production optimization has been established. The procedure entail using the tool geometry as reference calibrated artefacts to establish optimal process operating conditions, enabling production of parts within specification. The μIM process window with respect to the target tolerances and dimensions has
been verified (see nominal dimensions in Figure 1d) with respect to 3 main μIM process parameters (melt temperature, injection speed, packing pressure) using the Design of Experiment statistical technique. Measurements results demonstrated the importance of calibrating mould’s master geometries to ensure correct part production and effective quality conformance verification.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Ortofon A/S
Authors: Calaon, M. (Intern), Tosello, G. (Intern), Elsborg Hansen, R. (Ekstern), Hansen, H. N. (Intern)
Number of pages: 1
Publication date: 2015
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Main Research Area: Technical/natural sciences

Electronic versions:

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Source-ID: 118224344
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2015

**Modeling and simulation of the deformation process of PTFE flexible stamps for nanoimprint lithography on curved surfaces**

In the presented work, simulations of the deformation process of flexible stamps used for nanoimprint lithography on curved surfaces are presented. The material used for the flexible stamps was polytetrafluoroethylene (PTFE) whose material behavior was found to be viscoelastic-viscoplastic. This behavior was described in a temperature dependent constitutive model consisting of a Zener body for the viscoelastic deformation and the Johnson-Cook model for the description of the viscoplastic deformation. The constitutive model was implemented in the general purpose finite element software ABAQUS through a user material subroutine. In order to take the large strains and deformations during the imprinting manufacturing process into account, non-linear geometry was applied in the simulations. The model was first verified through a series of experiments, where nanoimprint lithography on a curved tool insert for injection molding were performed with various process parameters such as temperature, imprinting pressure and flexible stamp thickness. Good agreement between simulations and experimental results was found. The optimum process parameters were then used in the final application, where nanoimprint of a nanostructure giving a color effect was performed numerically and experimentally. Both experiment and simulation showed a mismatch between the defined and measured nanostructures as a result of stretching of the flexible stamp. The model was shown to predict the stretch of the nanostructures with a maximum error of 0.5%, indicating that the model is able to capture the physics of this manufacturing process and can be used to give an insight into the nanoimprinting procedure on curved surfaces. (C) 2014 Elsevier B.V. All rights reserved.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, NIL Technology ApS, Danish Fundamental Metrology
Authors: Sonne, M. R. (Intern), Smistrup, K. (Ekstern), Hannibal, M. (Ekstern), Thorborg, J. (Intern), Nørregaard, J. (Ekstern), Hattel, J. H. (Intern)
Pages: 418–429
Publication date: 2015
Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 2.678 SJR 1.695 CiteScore 4.15
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.62 SJR 1.717 SNIP 2.646
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.385 SNIP 2.463 CiteScore 2.9
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Modeling of damage in ductile cast iron – The effect of including plasticity in the graphite nodules

In the present paper a micro-mechanical model for investigating the stress-strain relation of ductile cast iron subjected to simple loading conditions is presented. The model is based on a unit cell containing a single spherical graphite nodule embedded in a uniform ferritic matrix, under the assumption of infinitesimal strains and plane-stress conditions. Despite the latter being a limitation with respect to full 3D models, it allows a direct comparison with experimental investigations of damage evolution on the surface of ductile cast iron components, where the stress state is biaxial in nature. In contrast to previous works on the subject, the material behaviour in both matrix and nodule is assumed to be elasto-plastic, described by the classical J2-flow theory of plasticity, and damage evolution in the matrix is taken into account via Lemaitre’s isotropic model. The effects of residual stresses due to the cooling process during manufacturing are also considered. Numerical solutions are obtained using an in-house developed finite element code; proper comparison with literature in the field is given.
Modelling architectures in multi-product oriented technology development

This thesis investigates the use of architecture modelling in a technology development context. This context presents greater uncertainties than more mature new product development. Applications—the use of products based on the technology being developed—are not fully identified and the requirements to be fulfilled are not completely defined. The products to be based on the technology are yet to be developed as the foundation for their development will be developed during the technology development. Furthermore, the production of a new technology is not defined as both the technology and derivative products are not completely defined. Yet, decisions need to be made during technology development on the capabilities to be provided through the development to fulfill future application requirements, provide a foundation for future products, and development of a production system capable of producing future products and supporting technology development through prototype production. To support technology development aimed at a broad range of application requirements, two modelling frameworks are introduced: the product technology architecture modelling framework and the production architecture modelling framework—both developed for implementation within a technology development context. Both frameworks model both structural aspects and functional aspects of their respective phenomena. The Product Technology Architecture modelling framework enables modelling a product technology architecture including the structure and breakdown of product technologies based on a generic product technology architecture as organs and organ alternatives and links these through product concepts to application concepts and requirements. The Production Architecture modelling framework enables modelling a Production Architecture from three perspectives: structure, capabilities, and expansions. These perspectives provide the means to model what the Production Architecture is, what the Production Architecture does, and what the Production Architecture has the potential...
to do within the planning horizon. The results of implementing the modelling frameworks in a technology development project are presented, along with descriptive results on the context of technology development gained through active participation in the case project.

**General information**

State: Published

Organisations: Engineering Design and Product Development, Department of Mechanical Engineering, Manufacturing Engineering, Department of Management Engineering, Management Science

Authors: Guðlaugsson, T. V. (Intern), Mortensen, N. H. (Intern), Hvam, L. (Intern)

Number of pages: 240

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Main Research Area: Technical/natural sciences

Architecture modeling, Product technology architecture, Product architecture, Production architecture, Technology development, Technology platforms

Electronic versions:

S192_Tomas_Vignir_Guðlaugsson.pdf

Publication: Research › Ph.D. thesis – Annual report year: 2016

*Modelling of composition and stress profiles in low temperature surface engineered stainless steel*

Thermochemical surface engineering by nitriding/carburizing of stainless steel causes a surface zone of expanded austenite, which improves the wear resistance of the stainless steel while preserving the stainless behavior. As a consequence of the thermochemical surface engineering, huge residual stresses are introduced in the developing case, arising from the volume expansion that accompanies the dissolution of high interstitial contents in expanded austenite. Modelling of the composition and stress profiles developing during low temperature surface engineering from the processing parameters temperature, time and gas composition is a prerequisite for targeted process optimization. A realistic model to simulate the developing case has to take the following influences on composition and stress into account:

- a concentration dependent diffusion coefficient
- trapping of nitrogen by chromium atoms
- the effect of residual stress on diffusive flux
- the effect of residual stress on solubility of interstitials
- plastic accommodation of residual stress.

The effect of all these contributions on composition and stress profiles will be addressed.

**General information**

State: Published

Organisations: Department of Mechanical Engineering, Materials and Surface Engineering, Manufacturing Engineering

Authors: Jespersen, F. N. (Intern), Hattel, J. H. (Intern), Somers, M. A. J. (Intern)

Number of pages: 6

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ISBN (Electronic): 978-1-62708-105-4

Main Research Area: Technical/natural sciences

Conference: 28th ASM Heat Treating Society Conference, Detroit. MI, United States, 20/10/2015 - 20/10/2015

Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

*Modelling residual stresses in friction stir welding of Al alloys - a review of possibilities and future trends*

Residual stresses are very important in any joining process of materials since they act as pre-stresses in the loading situation of the joint, thereby affecting the final mechanical performance of the component. This is also the case for friction stir welding (FSW) which is a complex solid-state joining process characterized by a pronounced multiphysical behaviour involving phenomena such as change of temperature, material flow, change of microstructures and formation of residual stresses. Thus, models of FSW are typically divided into thermal models, flow models, residual stress models and
microstructural models where the classification of the model normally originates from its purpose rather than from the modelling discipline applied. In the present paper, the focus is on presenting and classifying the most important residual stress models for FSW of aluminium alloys in terms of their background, numerical framework and application as well as putting them into proper context with respect to some of the new trends in the field, e.g. coupling with subsequent load analyses of the in-service situation or applying residual stress models of FSW in numerical optimization.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Michigan State University
Authors: Hattel, J. H. (Intern), Sonne, M. R. (Intern), Tutum, C. C. (Ekstern)
Number of pages: 13
Pages: 1793-1805
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Advanced Manufacturing Technology
Volume: 76
Issue number: 1-2
ISSN (Print): 0268-3768
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.8 SJR 0.994 SNIP 1.697
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.3 SJR 1.046 SNIP 1.608
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.889 SNIP 1.325 CiteScore 1.8
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.082 SNIP 1.841 CiteScore 2.03
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.134 SNIP 2.131 CiteScore 2.26
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.971 SNIP 2.099 CiteScore 1.75
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.817 SNIP 1.673 CiteScore 1.61
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.785 SNIP 1.445
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.797 SNIP 1.384
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.52 SNIP 1.029
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.441 SNIP 0.747
Modelling the residual stresses and microstructural evolution in Friction Stir Welding of AA2024-T3 including the Wagner-Kampmann precipitation model

In this work, a numerical finite element model for friction stir welding of 2024-T3 aluminum alloy, consisting of a heat transfer analysis and a sequentially coupled quasi-static stress analysis is proposed. Metallurgical softening of the material is properly considered and included in the calculations by means of the Wagner-Kampmann precipitation model.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Sonne, M. R. (Intern), Hattel, J. H. (Intern)
Number of pages: 1
Publication date: 2015
Main Research Area: Technical/natural sciences
Electronic versions:
Residual_stress_and_microstructural_evolution.pdf
Publication: Research - peer-review › Poster – Annual report year: 2015

Modelling the solidification of ductile cast iron parts with varying wall thicknesses

In the present paper modelling the solidification of cast iron parts is considered. Common for previous efforts in this field is that they have mainly considered thin walled to medium thickness castings. Hence, a numerical model combining the solidification model presented by Lesoult et al. [1] with a 2D FE solution of the heat conduction equation is developed in an in-house code and model parameters are calibrated using experimental data from representative castings made of ductile cast iron. The main focus is on the influence of casting thickness and resulting local cooling conditions on the solidification pattern and the relation to formation of degenerate graphite.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Magma Gießereitechnologie GmbH
Authors: Bjerre, M. K. (Intern), Tiedje, N. S. (Intern), Thorborg, J. (Intern), Hattel, J. H. (Intern)
Number of pages: 9
Publication date: 2015
Conference: 14th International Conference on Modelling of Casting, Welding and Advanced Solidification Processes, Awaji island, Hyogo, Japan, 21/06/2015 - 21/06/2015
Main Research Area: Technical/natural sciences
Publication information
Journal: I O P Conference Series: Materials Science and Engineering
Volume: 84
Article number: 012038
ISSN (Print): 1757-8981
Ratings:
BFI (2018): BFI-level 1
This paper presents the mould design for an injection moulding (IM) process for the production of a methanol container for the use in small, passive Direct Methanol Fuel Cell (DMFC) systems, which are intended to be used in behind-the-ear hearing aid systems. One of the crucial properties of this container is to enable venting of CO2, which is produced during the use of the DMFC system. This attribute is realized by a functional film insert in the form of a microporous, oleophobic membrane, which covers a venting hole in the injection moulded part of the container. The mould was designed to allow for the production of containers with different venting area and location of the venting holes and the use of different membrane thicknesses by using the same mould. Mould design and material selection are presented.
Efforts to develop a continuum theory based on atomistic models have so far been limited to zero temperature. The purpose of this work is to develop the theoretical framework needed to study the mechanical response in nanoscale components such as nanowires at finite temperatures. This is achieved up to a temperature of 1000 K by integrating Engineering Molecular Mechanics and the Cauchy-Born hypothesis. The proposed method is verified with Molecular Dynamics and Molecular Mechanics simulations reported in literature. Bending properties of nanowires at finite temperatures were studied with the proposed method. Thermomechanical properties were investigated by including surface effects.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Koc University
Authors: Esahani, M. N. (Ekstern), Sonne, M. R. (Intern), Hattel, J. H. (Intern), Alaca, B. E. (Ekstern)
Pages: 1547-1550
Publication date: 2015

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Main Research Area: Technical/natural sciences
Nanowire, Quasicontinuum, Molecular mechanics, Temperature, Bending rigidity
DOIs: 10.1109/NANO.2015.7388940
Source: PublicationPreSubmission
Source-ID: 115499788
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Numerical methods in simulation of resistance welding
Finite element simulation of resistance welding requires coupling between mechanical, thermal and electrical models. This paper presents the numerical models and their couplings that are utilized in the computer program SORPAS. A mechanical model based on the irreducible flow formulation is utilized to simulate plastic deformation and the resulting distribution of stress, a thermal model based on transient heat transfer is used to determine the distribution of temperature, and a steady-state electrical model is employed to calculate the distribution of electrical potential and current density. From a resistance welding point of view, the most essential coupling between the above mentioned models is the heat generation by electrical current due to Joule heating. The interaction between multiple objects is another critical feature of the numerical simulation of resistance welding because it influences the contact area and the distribution of contact pressure. The numerical simulation of resistance welding is illustrated by a spot welding example that includes subsequent tensile shear testing.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Instituto Superior Técnico, SWANTEC Software and Engineering ApS
Authors: Nielsen, C. V. (Intern), Martins, P. A. (Ekstern), Zhang, W. (Ekstern), Bay, N. O. (Intern)
Pages: 322-333
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Place of publication: Barcelona
Publisher: International Center for Numerical Methods in Engineering
Editors: Schrefler, B. A., Öñate, E., Papadrakakis, M.
Main Research Area: Technical/natural sciences
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Resistance Welding, Finite Element Method, Electro-Thermo-Mechanical, Phase Changes, Hardness, Damage
Electronic versions:
DOIs: 978-84-943928-3-2
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2015
Numerical modelling of damage evolution in ingot forging

The ingot forging process is numerically simulated applying both the Shima-Oyane porous plasticity model as a coupled damage model and the uncoupled normalized Cockcroft & Latham criterion. Four different cases including two different lower die angles (120º and 180º) and two different sizes of feed (400mm and 800mm) are analysed. Comparison of the simulation results with recommendations in literature on ingot forging, indicates the normalized Cockcroft & Latham damage criterion to be the most realistic of the two.
Numerical simulation of viscoelastic free-surface flows using a streamfunction/log-conformation formulation and the volume-of-fluid method

This thesis presents a new numerical algorithm for the simulation of two-dimensional multiphase viscoelastic flows. The simulation of viscoelastic flows has both a scientific importance and practical implications in polymer processing. This work has put the emphasis on the extrusion of polymeric materials, where viscoelastic effects cause dynamical instabilities, despite the very simple geometry. This thesis reviews the popular differential constitutive models derived from molecular theories of dilute polymer solutions, polymer networks, and entangled polymer melts, as well as the inelastic phenomenological models describing shear-thinning and viscoplastic (yield stress) fluids, based on the generalized Newtonian fluid model. In addition, the numerical issues related to the high Weissenberg number problem, and its remedy with the log-conformation representation, are discussed. The proposed algorithm utilizes a new streamfunction/log-conformation scheme. The drawbacks of the classical velocity-pressure decoupled method, which is by far the most popular approach, are remedied with the pure streamfunction formulation, which is derived from the pressureless vorticity-based methods. The implicit pure streamfunction formulation is formally more accurate than the velocity-pressure decoupled method, because it is immune of decoupling errors. Moreover, the absence of decoupling enhances the stability of the calculation. The governing equations (conservation laws and constitutive models) are discretized with the finite-volume method, on a Cartesian grid. Discrete curl operators are applied to the discretized momentum equations in order to obtain the matrix system of the discrete streamfunction variables. The coupling of the streamfunction/log-conformation scheme with adaptive under-relaxation and adaptive time-stepping yield a robust and efficient viscoelastic flow solver algorithm. The potential extension of the method to threedimensional simulations is also discussed in this thesis. Bi-phasic/free-surface flows are modelled with the Volume-of-Fluid (VOF) method, and the standard piecewise-linear-interface-construction technique. In addition, a new Cellwise Conservative Unsplit (CCU) advection scheme is presented. The CCU scheme updates the liquid volume fractions based on cellwise backward-tracking of the liquid volumes. The algorithm calculates non-overlapping and conforming adjacent donating regions, which ensures the boundedness and conservativeness of the liquid volume. As a result, the CCU advection scheme is overall more accurate in classical benchmark tests, than the other state-of-the-art multidimensional VOF-advection schemes. In complex flows, the convergence rate of the CCU scheme with mesh refinements is between 2 and 3. Moreover, the remaining geometrical errors are mostly due to the inability of the standard piecewise linear interface to represent subgrid material topologies (i.e. high curvatures and thin material filaments), rather than the proposed CCU advection scheme. This thesis reports examples of numerical simulations of the Oldroyd-B liquid, calculated with the proposed streamfunction/log-conformation/VOF-CCU methodology, implemented in Matlab. A thorough investigation of the viscoelastic flow in the lid-driven cavity is conducted. The streamfunction/log-conformation shows secondorder accuracy and numerical stability at very large time-step increments, which demonstrates the robustness of the scheme. The numerical results at moderate Weissenberg numbers are in good agreement with the literature. Moreover, the enhancement of numerical stability, with the streamfunction/log-conformation scheme, makes it possible to simulate elastic instabilities at high Weissenberg numbers. Quasi-periodic elastic instabilities at the upstream corner appear to be a mechanism that dissipates the stored elastic energy. The simulations of viscoelastic flows in the planar 4:1 contraction are also in good agreement with data in the literature. Finally, preliminary simulations of extrudate swelling show that the fracture melt extrusion defect could be caused by instabilities in the stress layer at the surface of the die, triggered at moderate Weissenberg numbers.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Energy Conversion and Storage, Electrofunctional materials
Authors: Comminal, R. B. (Intern), Hattel, J. H. (Intern), Pryds, N. (Intern), Spangenberg, J. (Intern)
Number of pages: 234
Publication date: 2015

Publication information
Optical characterization of roughness on polished steel surfaces

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Polymer Micro & Nano Engineering, Department of Mechanical Engineering, Manufacturing Engineering, Danish Fundamental Metrology
Authors: Feidenhans'l, N. A. (Intern), Hansen, P. (Ekstern), Pilny, L. (Intern), Petersen, J. C. (Ekstern), Taboryski, R. J. (Intern)
Number of pages: 1
Publication date: 2015
Main Research Area: Technical/natural sciences
Electronic versions:
Abstract_PRN_2015_2.pdf
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Source-ID: 123711363
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2016

Optical micro-metrology of structured surfaces micro-machined by jet-ECM
A procedure for statistical analysis and uncertainty evaluation is presented with regards to measurements of step height and surface texture. Measurements have been performed with a focus-variation microscope over jet electrochemical micro-machined surfaces. Traceability has been achieved using as reference contact measurements from a calibrated stylus instrument. A statistical analysis has been carried out and the method of least squares has been implemented to correct for systematic behaviours. The combined uncertainty has been evaluated accordingly and the expanded uncertainty has been finally calculated as the confidence interval of 95%. Results show that agreement within single digit micrometre (dimensional measurements) and tenths of micrometre (surface parameters measurements) can be achieved with the proposed methodology.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, Chemnitz University of Technology, University of Bremen
Number of pages: 1
Publication date: 2015
Event: Poster session presented at 15th International Conference of the European Society for Precision Engineering and Nanotechnology, Leuven, Belgium.
Main Research Area: Technical/natural sciences
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Relations
Projects:
Optical micro-metrology of structured surfaces micro-machined by jet-ECM
Source: PublicationPreSubmission
Source-ID: 110844146
Publication: Research - peer-review › Poster – Annual report year: 2015

Optical micro-metrology of structured surfaces micro-machined by jet-ECM
A procedure for statistical analysis and uncertainty evaluation is presented with regards to measurements of step height and surface texture. Measurements have been performed with a focus-variation microscope over jet electrochemical micro-machined surfaces. Traceability has been achieved using as reference contact measurements from a calibrated stylus instrument. A statistical analysis has been carried out and the method of least squares has been implemented to correct for systematic behaviours. The combined uncertainty has been evaluated accordingly and the expanded uncertainty has been finally calculated as the confidence interval of 95%. Results show that agreement within single digit micrometre (dimensional measurements) and tenths of micrometre (surface parameters measurements) can be achieved with the proposed methodology.
micrometre (dimensional measurements) and tenths of micrometre (surface parameters measurements) can be achieved with the proposed methodology

**General information**
State: Published  
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, Chemnitz University of Technology, University of Bremen  
Number of pages: 2  
Publication date: 2015

**Host publication information**
Title of host publication: Proceedings of the 15th International Conference of the European Society for Precision Engineering and Nanotechnology  
Main Research Area: Technical/natural sciences  
Conference: 15th International Conference of the European Society for Precision Engineering and Nanotechnology, Leuven, Belgium, 01/06/2015 - 01/06/2015  
Step height, Roughness, Micro-machining, Uncertainty, ISO GUM

**Relations**
Projects:  
Optical micro-metrology of structured surfaces micro-machined by jet-ECM  
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

**Outcomes of the DeepWind Conceptual Design**
DeepWind has been presented as a novel floating offshore wind turbine concept with cost reduction potentials. Twelve international partners developed a Darrieus type floating turbine with new materials and technologies for deep-sea offshore environment. This paper summarizes results of the 5 MW DeepWind conceptual design. The concept was evaluated at the Hywind test site, described on its few components, in particular on the modified Troposkien blade shape and airfoil design. The feasibility of upscaling from 5 MW to 20 MW is discussed, taking into account the results from testing the Deepwind floating 1 kW demonstrator. The 5 MW simulation results, loading and performance are compared to the OC3-NREL 5 MW wind turbine. Finally the paper elaborates the conceptual design on cost modelling.

**General information**
State: Published  
Organisations: Department of Wind Energy, Test and Measurements, Fluid Mechanics, Aeroelastic Design, Department of Mechanical Engineering, Manufacturing Engineering, SINTEF, Aalborg University, Delft University of Technology, Norwegian Marine Technology Research Institute, Nenuphar  
Pages: 329-341  
Publication date: 2015  
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Energy Procedia  
Volume: 80  
ISSN (Print): 1876-6102  
Ratings:  
BFI (2018): BFI-level 1  
BFI (2017): BFI-level 1  
Scopus rating (2017): CiteScore 1.44 SJR 0.495 SNIP 0.799  
BFI (2016): BFI-level 1  
Scopus rating (2016): CiteScore 1.16 SJR 0.464 SNIP 0.598  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 0.359 SNIP 0.562 CiteScore 0.92  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 0.429 SNIP 0.807 CiteScore 1.09
Performance evaluation of CT measurements made on step gauges using statistical methodologies

In this paper, a study is presented in which statistical methodologies were applied to evaluate the measurement of step gauges on an X-ray computed tomography (CT) system. In particular, the effects of step gauge material density and orientation were investigated. The step gauges consist of uni- and bidirectional lengths. By confirming the repeatability of measurements made on the test system, the number of required scans in the design of experiment (DOE) was reduced. The statistical model was checked using model adequacy principles; model adequacy checking is an important step in validating the applicability of a model to fitting experimental results. If the residuals after fitting the model are normally distributed (normality test), then the residuals represent random errors in the data. If the normality test is not satisfied, the model is said to fit the data poorly. If the model fits the data were correct, the residuals would approximate the random errors (also called normality). The most common significance level is α = 0.05; for normality to be satisfied, the P value for the residuals must not be smaller than 0.05. The initial results show that the residuals failed the normality test due to a small P value (P
Precision analysis in billet preparation for micro bulk metal forming

The purpose of this research is to fabricate billets for an automated transfer press for micro forming. High performance transfer presses are wellknown in conventional metal forming and distinguished from their automation and mass production. The press used in this research is a vertical mechanical press. When using a vertical mechanical press, the material is fed as billets into the forming zone. Therefore, a large number of highly uniform billets are required to run mass production in such a setup. Shearing technique was used for manufacturing the billets. The efficiency of the shearing tool is examined in terms of volume control, circularity, dimension and sheared surface quality. The shearing tool is based on holders for both bar and cutoff. The tool is fixed in dimensions, since the dimensions of billets are fixed throughout experiments of this research. The paper presents the experimental analysis of the precision of the billets prepared by the tool.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Mahshid, R. (Intern), Hansen, H. N. (Intern)
Pages: 53-54
Publication date: 2015

Host publication information
Title of host publication: Proceedings of Euspen's 15th International Conference & Exhibition
Publisher: The European Society for Precision Engineering and Nanotechnology
Main Research Area: Technical/natural sciences
Conference: Euspen's 15th International Conference & Exhibition, Leuven, Belgium, 01/06/2015 - 01/06/2015
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Precision manufacturing of polymer micro-nano fluidic systems

Lab-on-a-Chip (LoC) technologies require the possibility of fabricating devices which include micro down to sub-micrometre features with high production rate and low cost. In the present study precision injection moulding is performed using a COC Topas 5013 L10 polymer to produce LoC devices for DNA barcoding with functional features in the 100 nm to 10 μm range. Replication quality of produced features (from nickel to polymer) was assessed by calibrated atomic force microscope (AFM) measurements performed on multiple nanochannels test structures arrays placed at different positions in the sample. Design of experiment (DOE) was adopted to characterize the replication fidelity of produced polymer features. Results have shown the possibility of performing quality control of micro- and sub-μm features, taking into account the polymer shrinkage, depending on process conditions at both micro and nano dimensional scales.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Danish Fundamental Metrology
Authors: Garnæs, J. (Ekstern), Calaon, M. (Intern), Tosello, G. (Intern), Matusiewicz , K. (Intern), Hansen, H. N. (Intern)
Pages: 31-32
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the 15th International Conference of the European Society for Precision Engineering and Nanotechnology
Publisher: The European Society for Precision Engineering and Nanotechnology
ISBN (Print): 9780956679079
Main Research Area: Technical/natural sciences
Precision manufacturing of thermoplastic elastomer micro rings

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Ortofon A/S
Authors: Calaon, M. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern), Elsborg, R. (Ekstern)
Pages: 543-546
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the 30th ASPE Annual Meeting
Main Research Area: Technical/natural sciences
Conference: 30th ASPE Annual Meeting, Texas, United States, 01/11/2015 - 01/11/2015
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Predicting Color Output of Additive Manufactured Parts
In this paper we address the colorimetric performance of a multicolor additive manufacturing process. A method on how to measure and characterize color performance of said process is presented. Furthermore, a method on predicting the color output is demonstrated, allowing for previsualization of parts prior to print. Results show that color prediction can be achieved with an average color difference error of $\Delta E^*_{00} = 1.5$ and std.dev $\sigma = 0.75$, with similar order of magnitude as the literature defined threshold for „Just Noticeable Difference” (JND).

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Image Analysis & Computer Graphics, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Eiríksson, E. R. (Intern), Pedersen, D. B. (Intern), Aanæs, H. (Intern)
Pages: 95-99
Publication date: 2015

Host publication information
Title of host publication: Proceedings of Achieving Precision Tolerances in Additive Manufacturing : ASPE Spring Topical Meeting
Volume: 60
Publisher: ASPE – The American Society for Precision Engineering
ISBN (Print): 978-1-887706-67-4
Main Research Area: Technical/natural sciences
Electronic versions:
PREDICTING_COLOR_OUTPUT_OF_ADDITIVE_MANUFACTURED.pdf
Source: PublicationPreSubmission
Source-ID: 116622061
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

Prediction of grain size and mechanical properties in friction stir welded pure copper joints using a thermal model
In this study, a thermal model was developed and applied to simulate the friction stir welding of pure copper plates with the thickness of 2 mm. The different traverse speeds of 100, 200, 300, and 400 mm min$^{-1}$ and rotational speeds of 400, 700, 900 rev min$^{-1}$ were considered as welding parameters. Microstructural characterization, hardness measurement, tensile test, and fractography were conducted experimentally. The comparison between the numerical and experimental results showed that the developed model was practically accurate. In addition, the results confirmed that the peak temperature was the dominant factor controlling the grain size and mechanical properties, where the fine grains could be achieved at low rotational speed as well as high traverse speed. Consequently, lower peak temperature leads to the high ultimate tensile strength and hardness and the low elongation values.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Islamic Azad University, Chalmers University of Technology
Authors: Heidarzadeh, A. (Ekstern), Jabbaribehnam, M. (Intern), Esmaily, M. (Ekstern)
Preface to NORDTRIB 2014
The present special issue of WEAR contains selected papers from the 16th Nordic symposium on Tribology, NORDTRIB 2014, which was held in Denmark on June 10 – 13, 2014. The symposium was organised by Lars Pleth Nielsen, Lone Elly Larsen and Sascha Louring from the Tribology Centre, Danish Technological Institute, Sverd S. Eskildsen, MAN Diesel A/S and Ion Marius Sivebaek, Technical University of Denmark and Novo Nordisk A/S. More than hundred and forty delegates from more than 20 countries could besides several social events enjoy 114 oral presentations at the symposium, which took place at the Scandina- vian Congress Center, in the center of Aarhus the second largest city in Denmark. NORDTRIB 2014 covered numerous aspects on friction, wear and lubrication, and their practical and industrial applications, with presentations on environmental aspects of tribology, tribo- testing, tribology in metal working, materials tribology, tribology of machine elements, contact mechanics, lubricants and lubrica- tion, surface engineering, polymers and biotribology. The papers in this special issue of WEAR were selected from the symposium presentations by the Nordic Advisory Board of NORDTRIB and have subsequently undergone a normal peer review process. In addition to the papers presented in this journal, some papers were selected for publication in Journal of Engineering Tribology, Tribology International as well as the Finnish Journal of Tribology. The organising committee wishes to express their appreciation to all the authors and delegates who made NORDTRIB 2014 a success. The guest editors also want to acknowledge all the reviewers.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Danish Technological Institute
Authors: Sivebaek, I. M. (Intern), Nielsen, L. P. (Ekstern)
Pages: 1
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Wear
Volume: 340-141
ISSN (Print): 0043-1648
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 2.177 SJR 1.386 CiteScore 3.31
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3 SJR 1.588 SNIP 2.105
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.512 SNIP 1.997 CiteScore 2.73
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.711 SNIP 2.328 CiteScore 2.46
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.317 SNIP 2.382 CiteScore 2.37
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Process monitoring for intelligent manufacturing processes - Methodology and application to Robot Assisted Polishing

Process monitoring provides important information on the product, process and manufacturing system during part manufacturing. Such information can be used for process optimization and detection of undesired processing conditions to initiate timely actions for avoidance of defects, thereby improving quality assurance.

This thesis is aimed at a systematic development of process monitoring solutions, constituting a key element of intelligent manufacturing systems towards zero defect manufacturing.

A methodological approach of general applicability is presented in this concern. The approach consists of six consecutive steps for identification of product Vital Quality Characteristics (VQCs) and Key Process Variables (KPVs), selection and characterization of sensors, optimization of sensors placement, validation of the monitoring solutions, definition of the reference manufacturing performance and a data driven process validation for each manufactured part. The concept is based on conscious identification and monitoring of KPVs that are closely related to part VQCs and measurable during manufacturing, thereby enabling in–process quality control (QC).

The approach was applied during the development of process monitoring and control strategy for automatic process End Point Detection (EPD) and on the machine surface characterization in Robot Assisted Polishing (RAP) with oscillating tool. VQCs were identified in terms of surface roughness, defects and gloss. Polishing progression in terms of relative variation in surface roughness was indirectly monitored through identified KPVs in terms of Acoustic Emission (AE), friction forces and power consumption during polishing. A dedicated polishing arm with integrated strain gauge based force sensors and a miniature AE sensor was developed, enabling in–process measurements in RAP with stationary and rotating workpieces. A commercial scattered light sensor was used for on the machine characterization of polished surfaces. The developed monitoring solutions were validated in a number of experimental tests in coarse stone and fine paste polishing. The results demonstrate the suitability of indirect monitoring of surface generation through AE and friction forces during
polishing enabling automatic EPD. AE signal was found closely related to the Material Removal Rate (MRR). Stabilization in measured friction forces was observed to reflect the stabilization in the mean slope of the surface topography and the overall friction condition in the tool–workpiece interface. Real time AE and force measurements also enable monitoring of the process state, allowing early recognition of process malfunctions and initiation of timely actions to avoid occurrence of defects. Process control strategy was developed based on an automatic detection of steady-state levels of AE and friction forces, reflecting the stabilization of surface roughness. The on the machine scattered light measurement method was demonstrated to provide high measurement rate allowing 100% QC, recognition and localization of macro as well as nm rage surface defects. A robust correlation between the scattered light roughness parameter Aq and hybrid roughness parameter Sdq used to describe the surface gloss was found. Also the typical asymptotic trend in surface roughness during polishing was found in a good agreement with the trend in Aq parameter.

The developed solutions for in-process EPD, process state monitoring and on the machine characterization of polished surfaces enhance the process efficiency and enable robust methods for automation of RAP process. The solutions are expected to be implemented in the next generation of RAP machines, resulting in significant quality improvements and cost benefits for industrial users of the system.

**Production and Characterization of Polycarbonate Microstructured Polymer Optical Fiber Bragg Grating Sensor**

We present the fabrication and characterization of a polycarbonate (PC) microstructured polymer optical fiber (mPOF) and the writing of a fiber Bragg grating (FBG) in it to obtain a polymer optical FBG sen-sor. The manufacturing process of the PC mPOF consists of multiple consecutive stages, such as casting of polymer granulates into a solid rod, machining and drilling of a 3-ring hexagonal lattice of holes into it, and finally drawing into fiber. We demonstrate that the obtained PC mPOF is photosensitive and FBGs can be conveniently inscribed into it, thereby enabling FBG-based temperature and strain sensing. The PC optical fibers are for some applications an attractive alternative to conventional materials used in POF fabrication, such as polymethyl methacrylate (PMMA). In general, PC can be used at temperature up to 120 °C and breaks at considerably higher strains than PMMA.
temperature and cure degree distributions are predicted inside the heating die and in the post-die region where convective cooling prevails. The effects of varying process conditions on the part quality are investigated for two different heater configurations and with three different pulling speeds. Larger throughthickness gradients are obtained for the temperature and degree of cure as the pulling speed increases. This will affect the process induced residual stresses and distortions during manufacturing.
the end of the bending analysis. It is found that the process induced residual stresses have the potential to influence the internal stresses arise in the structural analysis.

**General information**

State: Published

Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Michigan State University, University of Twente

Authors: Baran, I. (Intern), Hattel, J. H. (Intern), Tutum, C. C. (Ekstern), Akkerman, R. (Ekstern)

Pages: 367-378

Publication date: 2015

Main Research Area: Technical/natural sciences

**Publication information**

Journal: International Journal of Material Forming

Volume: 8

Issue number: 3

ISSN (Print): 1960-6206

Ratings:

BFI (2018): BFI-level 1

Web of Science (2018): Indexed yes

BFI (2017): BFI-level 1

Scopus rating (2017): SNIP 1.378 SJR 0.536 CiteScore 1.53

Web of Science (2017): Indexed Yes

BFI (2016): BFI-level 1

Scopus rating (2016): SJR 0.496 SNIP 1.585 CiteScore 1.63

BFI (2015): BFI-level 1

Scopus rating (2015): SJR 0.553 SNIP 1.228 CiteScore 1.01

Web of Science (2015): Indexed yes

BFI (2014): BFI-level 1

Scopus rating (2014): SJR 0.812 SNIP 1.595 CiteScore 1.31

BFI (2013): BFI-level 1

Scopus rating (2013): SJR 0.608 SNIP 1.199 CiteScore 0.91

ISI indexed (2013): ISI indexed yes

BFI (2012): BFI-level 1

Scopus rating (2012): SJR 0.581 SNIP 0.88 CiteScore 0.58

ISI indexed (2012): ISI indexed no

BFI (2011): BFI-level 1

Scopus rating (2011): SJR 0.358 SNIP 0.573 CiteScore 0.38

ISI indexed (2011): ISI indexed no

BFI (2010): BFI-level 1

Scopus rating (2010): SJR 0.185 SNIP 0.367

Scopus rating (2009): SJR 0.149 SNIP 0.147

Original language: English

Pultrusion process, Residual/internal stress, Finite element analysis, Integrated modelling, Thermosetting resin

DOIs:

10.1007/s12289-014-1178-7

Source: PublicationPreSubmission

Source-ID: 92682464

Publication: Research - peer-review › Journal article – Annual report year: 2014

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**Quality Investigation of miniaturized Moulded Interconnect Devices (MIDs) for hearing aid applications**

Moulded Interconnect Devices (MIDs) are injection moulded plastic substrates with electrical infrastructures on the surfaces. The miniaturization of MIDs raises challenges in terms of materials, process chains, geometrical precision, etc. This paper discusses the precision limit of MIDs in terms of positioning accuracies, dimensional fidelity and surface topography of the metal tracks. The paper proposes a novel method for the corrosion protection of the MID metal surface. The results obtained from the tests demonstrate the feasibility of the use of MIDs in the hearing aid application and an efficient protection of the MIDs from corrosion induced by harsh application environment.

**General information**

State: Published
Quantitative analysis of scaling error compensation methods in dimensional X-ray computed tomography

X-ray Computed Tomography (CT) has become an important technology for quality control of industrial components. As with other technologies, e.g., tactile coordinate measurements or optical measurements, CT is influenced by numerous quantities which may have negative impact on the accuracy and repeatability of dimensional and geometrical measurements. The aim of this paper is to discuss different methods for the correction of scaling errors and to quantify their influence on dimensional measurements. Scaling errors occur first and foremost in CT systems with no built-in compensation of positioning errors of the manipulator system (magnification axis). This article also introduces a new compensation method for scaling errors using a database of reference scaling factors and discusses its advantages and disadvantages. In total, three methods for the correction of scaling errors – using the CT ball plate, using calibrated features measured by CMM and using a database of reference values – are presented and applied within a case study. The investigation was performed on a dose engine component of an insulin pen, for which several dimensional measurands were defined. The component has a complex geometry and is made of brass, which makes its measurements with CT challenging. It is shown that each scaling error correction method results in different deviations between CT measurements and reference measurements from a CMM. Measurement uncertainties were estimated for each method, taking into consideration the contributions related to the applied correction method. The newly suggested approach using the database appeared to work well, indicating, that if the properties of a CT system under investigation are monitored using a reference object (ball bar in our case), a correction factor based on individual selected magnification factors can be applied for scaling error correction of any object, and thus no additional scanning of a reference object is needed.
Scopus rating (2014): SJR 1.349 SNIP 1.863 CiteScore 2.46
Scopus rating (2013): SJR 0.992 SNIP 1.771 CiteScore 2.01
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.776 SNIP 1.799 CiteScore 1.69
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.941 SNIP 1.988 CiteScore 1.72
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 1.124 SNIP 2.324
Scopus rating (2009): SJR 0.917 SNIP 1.183
Original language: English
CT, Computed tomography, Correction method, Scaling errors, CT ball plate, Dimensional measurement, Measurement uncertainty
DOIs: 10.1016/j.cirpj.2015.04.004
Source: Findit
Source-ID: 275491001
Publication: Research - peer-review › Journal article – Annual report year: 2015

Real time electrode wear hybrid compensation strategies for micro electrical discharge milling of complex 3D features

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Puthumana, G. (Intern)
Number of pages: 4
Publication date: 2015

Host publication information
Title of host publication: Proceedings of DTU PhD Summer School - Micro Mechanical Systems Design & Manufacturing 2015
Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Main Research Area: Technical/natural sciences
Electronic versions: Govindan_presentation.pdf. Embargo ended: 01/02/2017
Publication: Research - peer-review › Article in proceedings – Annual report year: 2016

Real time power consumption monitoring for energy efficiency analysis in micro EDM milling

Sustainability has become a major concern in many countries and is leading to strict regulations regarding the impact of products and services during their manufacturing, use, and disposal. Power consumption monitoring in manufacturing companies can lead to a reduction of machine tools energy wastes and consequently to lower expenses. To this end, a complete transparency of energy usage among the entire manufacturing facilities is required. Despite the small volume of material processed, micro manufacturing processes are energy intensive and the optimization of energy usage becomes critical for manufacturing sustainability. Electrical discharge machining (EDM) is considered an attractive solution for the manufacturing of microcomponents. In this paper, a low cost and modular data acquisition system, based on open-hardware and open-source software, for online energy consumption monitoring, is presented. The system described is applied for energy efficiency analysis of the micro EDM milling process by using a state of the art commercial machine tool. A number of sensors is connected to the data acquisition system to measure the energy consumption of the main sub-systems of the machine tool, data is recorded through a microcontroller, and sent to the main computer via Wi-Fi for data storage and analysis. Results show that the process efficiency depends on machine parameters but it is always far below 0.01 %. Solutions are suggested to improve the energy efficiency of the machine tool considered in this work.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Padua, University of Ljubljana
Authors: Tristo, G. (Ekstern), Bissacco, G. (Intern), Lebar, A. (Ekstern), Valentinčič, J. (Ekstern)
Pages: 1511-1521
Publication date: 2015
Main Research Area: Technical/natural sciences
Replication Fidelity Assessment in Nano Moulding

Innovations in nanotechnology propose applications integrating micro and nanometer structures fabricated as master geometries for final replication on polymer substrates. The possibility for polymer materials of being processed with technologies enabling large volume production introduces solutions to remove technology barrier between lab-scale proof-of-principle and high-volume low-cost production of nanotechnology-based products. In the current study research work has been devoted to develop methods and approaches to process chain characterization for final polymer micro and nano structures replication. Fidelity between nickel master geometries replicated on polymer substrates and its dependency to process variation, process conditions and features geometries were considered and quantified.

Replication fidelity assessment of large area sub-μm structured polymer surfaces using scatterometry.

The present study addresses one of the key challenges in the product quality control of transparent structured polymer substrates, the replication fidelity of sub-μm structures over a large area. Additionally the work contributes to the development of new techniques focused on in-line characterization of large nanostructured surfaces using scatterometry. In particular an approach to quantify the replication fidelity of high volume manufacturing processes such as polymer injection moulding is presented. Both periodic channels and semi-spherical structures were fabricated on nickel shims used for later injection moulding of Cyclic-olefin-copolymer (COC) substrate were the sub-μm features where ultimately transferred. The scatterometry system was validated using calibrated atomic force microscopy measurements and a model based on scalar diffraction theory employed to calculate the expected angular distribution of the reflected and the transmitted intensity for the nickel surfaces and structured COC and, respectively.
Replication fidelity assessment of polymer large area sub-μm structured surfaces using fast angular intensity distribution measurements.

The present investigation addresses one of the key challenges in the product quality control of transparent polymer substrates, identified in the replication fidelity of sub-μm structures over large area. Additionally the work contributes to the development of new techniques focused on in-line characterization of large nanostructured surfaces. In particular the aim of the present paper is to introduce initial development of a metrology approach to quantify the replication fidelity of produced 500 nm diameter semi-spheres via anodizing of aluminum (Al) and subsequent nickel electroforming to COC injection molded polymer parts. Calibrated AFM measurements were used to develop a model based on scalar diffraction theory able to calculate the expected nickel and COC substrates angular distribution of reflected and transmitted intensity respectively.

Replication of Micro pillars by PEEK injection moulding with CrN coated Ni tool

A micro-structured nickel insert was investigated for polypolyether ether ketone (PEEK) injection moulding. The micro-features were circular holes 4 μm in diameter and 2 μm deep, with a 2-μm edge-to-edge distance. Six thousand moulding cycles were operated. Half of the insert was coated by approximately 200 nm CrN. PEEK parts produced by the coated side and uncoated side were compared. Coating thickness was measured at intervals of production and employed to characterize the coating wear. Pillar geometry at fixed locations on PEEK parts was studied by scanning electron microscope (SEM). Energy-dispersive X-ray spectroscopy (EDS) was conducted on the PEEK parts in order to study the possible nickel and silver contamination. The results show that the studied coating had a very low wear, and no nickel or silver contamination on PEEK was detected for both parts produced by coated and uncoated sides. Coating improved demoulding by reducing small indentations on pillars.
Replication of microstructures on three-dimensional geometries by injection moulding of liquid silicone rubber

In this paper, liquid silicon rubber (LSR) parts with micro pillars are studied. The LSR parts were produced by injection moulding and are used as anchoring device for electrode implants inside humans. Micro-structures with specific dimension on implant surfaces can reduce encapsulation by the human body, thereby improving implant performance. This paper presents a method of applying micro structure on 3D parts. A Ni-plate with micro holes on the surface was cut into inserts and stuck in a cavity for injection moulding. 1000 injection moulding cycles were performed. Key dimensions of the pillars were monitored at intervals of the production on LSR parts on different locations. This paper focuses on characterization methods for the dimensions of the pillars on LSR parts. Due to the transparency and elasticity of LSR material, conventional stylus or optical instruments cannot be used to measure the height of the pillars. A confocal microscope with infinite focus was used instead. Moreover, SEM was employed to illustrate the topography visually. It is believed that the uniformity of the height of the pillar array is critical for proliferation of human cells, hence the standard deviation of the height was studied with the aid of SPIP®. The replication degree of LSR pillars is calculated based on the height measurement. The injection moulding process is also discussed in this paper.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Danish National Metrology Institute
Authors: Zhang, Y. (Intern), Mischkot, M. (Intern), Hansen, H. N. (Intern), Hansen, P. (Ekstern)
Number of pages: 8
Publication date: 2015

Host publication information
Title of host publication: Proceedings of the 15th International Conference on Metrology and Properties of Engineering Surfaces, ASPE
Publisher: American Society for Precision Engineering
Main Research Area: Technical/natural sciences
Conference: 15th International Conference on Metrology and Properties of Engineering Surfaces, Charlotte, NC, United States, 02/03/2015 - 02/03/2015
Micro-structure, Liquid silicon rubber, Injection moulding

Robust simulations of viscoelastic flows at high Weissenberg numbers with the streamfunction/log-conformation formulation

A new streamfunction/log-conformation formulation of incompressible viscoelastic flows is presented. The log-conformation representation guarantees the positive-definiteness of the conformation tensor and obviates the high Weissenberg number problem. The streamfunction is defined as a vector potential of the velocity field, and provides a pressureless formulation of the conservation laws, which automatically enforces the incompressibility. The resulting numerical method is free from velocity-pressure decoupling errors, and can achieve stable calculations for large Courant numbers, which improve the robustness and the efficiency of the solver. The two-dimensional flow of an Oldroyd-B fluid inside the lid-driven cavity is simulated for a large range of Weissenberg numbers. The numerical results demonstrate the second-order accuracy of our scheme, and our solutions are in good agreement with the available data from the literature for Weissenberg number 3 and below. Finally, the simulations at higher Weissenberg numbers 5 and 10 reveal a structural mechanism that sustains quasi-periodic elastic instabilities arising at the upstream corner of the moving lid.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Comminal, R. (Intern), Spangenberg, J. (Intern), Hattel, J. H. (Intern)
Number of pages: 25
Pages: 37-61
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Non-Newtonian Fluid Mechanics
Volume: 223
ISSN (Print): 0377-0257
Ratings:
BFI (2018): BFI-level 2
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DOIs:
10.1016/j.jnnfm.2015.05.003
Simulation of a Downsized FDM Nozzle
This document discusses the simulation of a downsized nozzle for fused deposition modelling (FDM), namely the E3D HotEnd Extruder with manufactured diameters of 200-400 μm in the nozzle tip. The nozzle has been simulated in terms of heat transfer and fluid flow giving an insight into the physical behavior of the polymer inside the nozzle. The extruder contains a nozzle, a heater block, a heatbreak and a heatsink additionally cooled by a fan. The diameter is located in the sub-mm region allowing to reduce the size and surface roughness of the product. The simulation results were experimentally validated. This kind of simulations is facing multiple problems connected to the description of the material properties with temperature and pressure dependency.

General information
State: Published
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Simulative Winding of Roll Formed Profile in Carcass Production for Flexible Pipes
In carcass production for flexible pipe systems roll formed profiles are wound around a mandrel forming an interlocking, flexible structure able to withstand collapse from outside water pressure or mechanical crushing. Carcass is often produced in lengths of several kilometres, which implies numerous welds between coils of stainless steel, often duplex grades. The welds are a source of failure, since fracture from time to time occurs here in the winding stage. A simulative test in form of three-point-bending is developed, which shows promising results together with simplified air- and v-bent profiles allowing offline testing of welds for optimisation purposes. Comparative studies are shown possible but discrepancies in boundary conditions cause the maximum strains in the simulative test to differ from those in production. A study of weld failure is done applying the simulative test and tensile tests using GOM ARAMIS 4M system for strain measurements. The results show strain localization at the weld from onset of yielding caused by the soft, heat affected zone next to the weld seam resulting in a local thinning of the strip similar to what is observed in production.

General information
State: Published
Organisations: Department of Mechanical Engineering, Thermal Energy, Manufacturing Engineering, Technical University of Denmark, National Oilwell Varco Denmark I/S
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Spatial Accuracy of Embedded Surface Coloring in Color 3D Printing

Recent years, the industrial market for full-color AM is growing rapidly. In the AM industry, most of the major technology providers are developing new systems with improved color capabilities and with improved materials. In the last 12 months alone, 5 new technology platforms have been revealed capable of full-color printing in polymers[1]. Industrial service providers increasingly expand their product-range of full-color print services, and as of today, the industry for full-color parts has grown rapidly, into a million-dollar industry [2]. With a new market emerging at such pace, it is believed a necessity to consider a new surface-metrological issue. To what accuracy are colors embedded to the surface of geometries, with relation to where specified from input data? This paper investigate the accuracy of surface coloring, by adopting a well-known metrological approach from calibrating Coordinate Measurement Machines (CMM's) and Machine Tools, that already has been transferred to be applicable for AM machine tools, [3] in order to determine the spatial accuracy of embedded color features to artifacts printed on a zCorpor 650 color 3D Printer. The spatial color verification artifact is a flat plate with a series of checkered fields on the surface.

General information
Spot Feeding Spheroidal Graphite Iron with Exothermic and Insulating Ram-Up Sleeves in Vertically Parted Moulds: Efficiency, Microstructure, Dimensional Accuracy, Deformation, and Driving Force and Feeding Criteria Identification

Improvement of feeder technologies for energy savings in cast iron foundries is not only the title of the project behind this dissertation; it is a good idea that can improve casting yield and reduce production cost, and in turn strengthening the foundries competitive advantage. The approach to solving feeding problems today is for a large part based on methodologies and know-how developed more than 50 years ago. This dissertation addresses the state-of-the-art as it is used presently in the foundries, reviewing the fundamentals of spot feeding cast iron.

The findings presented in this dissertation is based on large-scale quantitative experiments with duplicates for statistical representation. The focus, as stated by the dissertation title, has been: 'Spot Feeding Spherical Graphite Iron with Exothermic and Insulating Ram-Up Sleeves in Vertically Parted Moulds'.

The application of spot feeders (ram-up sleeves) is investigated, showing that this new feeding approach can be used successfully to feed secluded sections inductile cast iron (EN-GJS-500-7). The feeder efficiency is tested using a high Silicon (Si) ductile iron (EN-GJS-450-10). The limits for the examined feeder configurations are documented, showing that the exothermic feeder combinations managed the task successfully, while the insulating feeder combinations were insufficient.

It is shown that the exothermic feeders do not influence the casting microstructure via comparing the microstructure of several colour etches samples from the castings, as well as the exothermic and insulating feeders. The thermal deformation related to the feeder combinations are investigated, and it is found that the thermal gradients created by the feeders could be signified by the deformation of the plane reverse side of the casting. The eutectoid phase transformation is found to be the governing factor. The main difference between the two alloys is that the pearlitic-ferritic EN-GJS-500-7 have twice as long a transformation interval as the fully ferritic EN-GJS-450-10. Knowledge of the deformation magnitude and variance can be used to reduce the machining allowance, subsequently reducing the melt cost and machining wear.

A series of different spot feeders with insulating or exothermic sleeves materials are investigated for three different modulus castings; 8mm, 12mm, and 15mm. It is proved that the required feeder modulus does not scale linearly with the casting modulus. Additionally, it is shown that horizontal spot feeder can feed against gravity by optimising the interplay of forces created by the solidifying casting and the feeder itself.

The investigation of the modulus relationship between the casting and the feeder leads to the formulation of a set of driving forces for feeding, accompanied by the pressure loss caused by the solidifying casting and the timing demanded by the feeding requirement. It is shown that the interplay of internal forces can drive a complete feeding process, but also that the frame of optimal function can be very narrow.

Numerical simulation of casting processes and the prediction of porosities are addressed, and it is found that some castings and alloys can be reliably simulated concerning porosities. However, it is also found that for high Si alloy EN-GJS-500-14 the simulation setup cannot provide prediction that corresponds to the porosities found in the porosity analysis.

Finally, it is shown how multiple feeders can influence each other’s performance even across solidified sections, and that two individual feeders that can retain a liquid connection can change the thermal gradients of the casting and the directions of solidification.

The dissertation provides a new approach to feeding secluded sections, a new characterisation of the underlying feeding forces, and new knowledge about the thermal deformation effects caused and controlled by feeding.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Vedel-Smith, N. K. (Intern), Tiedje, N. S. (Intern)
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Tapering of Polymer Optical Fibers for Compound Parabolic Concentrator Fiber Tip Fabrication

We propose a process for Polymer Optical Fiber (POF) Compound Parabolic Compound (CPC) tip manufacturing using a heat and pull fiber tapering technique. The POF, locally heated above its glass transition temperature, is parabolically tapered down in diameter, after which it is cut to the desired output diameter and finally polished to obtain the special CPC tip. The physical mechanism responsible for giving a CPC shape to the POF tip is also investigated. The fabrication process is shown to be sensitive to several manufacturing parameters, such as temperature of the heat source, thermal flux from the heat source, and heating time. We further consider the influence of the heating time latter parameter on the geometry of the obtained CPC fiber tips.

Temperature Dependence and Magnetic Properties of Injection Molding Tool Materials Used in Induction Heating

To analyze the heating phase of an induction heated injection molding tool precisely, the temperature-dependent magnetic properties, B–H curves, and the hysteresis loss are necessary for the molding tool materials. Hence, injection molding tool steels, core materials among other materials have, in this paper, been characterized for their temperature-dependent magnetic properties. The properties have been measured using a vibrating sample magnetometer, able to reach to 350 °C. The established material database comprises the B–H loops, from which the mean B–H curve, relative permeability versus magnetic flux density, and hysteresis loss versus magnetic flux density have been extracted and are presented.
Hysteresis loss, Induction heating, Injection molding tool materials, Temperature dependence of magnetic properties

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The influence of the graphite mechanical properties on the constitutive response of a ferritic ductile cast iron – A micromechanical FE analysis

In the present paper a micro-mechanical approach is used to investigate the influence of the graphite mechanical properties on the loading response in the early deformation range of ductile cast iron. A periodic unit cell composed by a single graphite nodule embedded in a uniform ferritic matrix is considered and elasto-plastic behavior of both constituents is assumed; damage evolution in the ductile matrix is taken into account via Lemaitre’s isotropic model. Full 3D and 2D plane-stress finite element analyses are performed to simulate the loading conditions experienced by nodules located in the bulk as well as on the material surface. The effects of residual stresses arising during the manufacturing process are also accounted for. It is shown that the constitutive response of the equivalent composite medium can match ductile cast iron only if the graphite Young’s modulus value lies within a certain interval, which differs from that reported in previous works on the subject. Experimental support for the numerical results is provided.

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Thermal distortion of disc-shaped ductile iron castings in vertically parted moulds

A disc-shaped casting with an inner boss and an outer rim, separated by a thin walled section, was examined. This measurable deformation varied with the feeding modulus. The influence of alloy composition, particularly Si content, was examined with a pearlitic ductile iron (EN-GJS-500-7) and a fully ferritic ductile iron (EN-GJS-450-10). The experiment showed that both the alloy composition and choice of feeder influenced the degree of deformation measured in the finished casting. It was found that the deformation of the pearlitic alloy was influenced controllably by changing the feeder modulus, whereas the deformation of the fully ferritic alloy was less affected by a change in thermal gradient. Both alloys underwent comparable deformations with respect to size, shape, and location. © 2014 Elsevier B.V. All rights reserved

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The sustainable future of packaging: A biodegradable paper beer bottle

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Organisations: Department of Mechanical Engineering, Engineering Design and Product Development, Manufacturing Engineering
Three-Dimensional Modeling of Glass Lens Molding

The required accuracy for the final dimensions of the molded lenses in wafer-based precision glass molding as well as the need for elimination of costly experimental trial and error calls for numerical simulations. This study deals with 3D thermo-mechanical modeling of the wafer-based precision glass lens molding process. First, a comprehensive 3D thermo-mechanical model of glass is implemented into a FORTRAN user subroutine (UMAT) in the FE program ABAQUS, and the developed FE model is validated with both a well-known sandwich seal test and experimental results of precision molding of several glass rings. Afterward, 3D thermo-mechanical modeling of the wafer-based glass lens manufacturing is performed to suggest a proper molding program (i.e., the proper set of process parameters including preset force-time and temperature-time histories) for molding a wafer to a desired dimension and quality. Moreover, the effect of some important process parameters such as cooling rate and pressing temperature on the final size and residual stress inside the wafer is evaluated. Finally, it is noted that the suggested molding program minimizes the costly empirical efforts and raises the process efficiency.
Towards development of a novel online tool wear compensation method for dry micro-electrical discharge milling

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Poster presentation

Validation of precision powder injection molding process simulations using a spiral test geometry

Like in many other areas of engineering, process simulations find application in precision injection molding to assist and optimize the quality and design of precise products and the molding process. Injection molding comprises mainly the manufacturing of plastic components. However, the variant of precision powder injection molding for the production of metallic and ceramic micro parts raises more and more interest though. Consequently, in the entire field the demand for simulation tools increases constantly, too. The present work reports the material characterization of feedstocks which are used for powder injection molding. This characterization includes measurements of rheological, thermal, and pvT behavior of the powder-binder-mixes. The acquired material data was used to generate new material models for the database of the commercially available Autodesk Moldflow® simulation software. The necessary data and the implementation procedure of the new material models are outlined. In order to validate the simulation studies and evaluate their accuracy, the simulation results are compared with experiments performed using a spiral test geometry

**General information**
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Acoustic Technology, Karlsruhe Institute of Technology KIT
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Authors: Sivebæk, I. M. (ed.) (Intern)
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Weld line optimization on thermoplastic elastomer micro injection moulded components using 3D focus variation optical microscopy
The presented study investigates weld line depth development across a micro suspension ring. A focus variation microscope was used to obtain 3D images of the weld line area. Suspension rings produced with different micro injection moulding process parameters were examined to identify the correlation between the weld lines depths and the different process settings. Results showed that injection speed and clamping force have a significant effect on the weld line depth dimensions. The undertaken optimization showed in general a reduction of 50 to 70% of the weld line depth over its entire length reducing maximum depth from 34 μm to 11 μm.

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Weld nugget formation in resistance spot welding of new lightweight sandwich material
Weldability of a new lightweight sandwich material, LITECOR®, by resistance spot welding is analyzed by experiments and numerical simulations. The spot welding process is accommodated by a first pulse squeezing out the non-conductive polymer core of the sandwich material locally to allow metal–metal contact. This is facilitated by the use of a shunt tool and is followed by a second pulse for the actual spot welding and nugget formation. A weldability lobe in the time-current space of the second pulse reveals a process window of acceptable size for automotive assembly lines. Weld growth curves are presented together with results of numerical simulations made in the finite element computer program SORPAS® 3D, which is based on an electro-thermo-mechanical formulation. The numerical models are presented together with the specific modeling conditions leading to numerical simulations in good agreement with experimental results in the range of welding parameters leading to acceptable weld nugget sizes. The validated accuracy of the commercially available software proves the tool useful for assisting the choice of welding parameters.
A Comparative Performance Analysis of FDM Machines Based on a Calibration Artefact
During the past ten years Additive Manufacturing (AM) technologies have been constantly developing in terms of materials and processes. This allows the use of the AM not only during the preproduction but also for the manufacturing of final components for commercial use [1], [2]. However one of the still existing challenges for AM concerns the quality of the final components. Every manufacturing process has a strict set of requirements that every component has to meet in order to meet production tolerances, yet AM still shows a lack of industrial standards [3]. The advantage of AM to be able to manufacture components of very complex geometries with intricate internal features becomes in this case a drawback. In fact, the control of the quality and the verification of tolerances become difficult task to accomplish with traditional measuring equipment. Some features can be difficult to reach and there are no standards to compare them with. To overcome this problem, a method to evaluate the performance of AM machine tools based on the printing of an artefact and the subsequent measuring of its features is proposed and shown. This paper shows a validation of the method by means of a laser interferometer. Furthermore, different AM machines are tested using the printed artefact.

A Functional Thinking Approach to the Design of Future Transportation Systems: Taxis as a Proxy for Personal Rapid Transit in South Korea
For over 50 years, personal rapid transit (PRT) has been viewed as one of the most promising ways to provide sustainable, economical, and convenient transportation while reducing reliance on personal automobiles. However, despite concerted efforts around the world, the promise of PRT has yet to be realized. This work demonstrates that different physical means, such as the Korean taxi system, can be used to perform the same highest-level functional requirement, satisfy the same constraints, and provide many of the benefits that are expected of a city-scale personal rapid transit system. Thus, Korean taxis can be used as an alternative embodiment of personal rapid transit and can serve as a test bed to support PRT-related design, research, and development. The paper then explores the transportation patterns and characteristics of cities in South Korea and the United States in order to determine the conditions necessary to create and maintain a PRT-like taxi system and to demonstrate the differences between ‘normal’ and PRT-like taxi systems. Finally, the future of personal rapid transit as a functional and physical transportation paradigm is discussed.
Analysis and Optimisation of Carcass Production for Flexible Pipes

Un-bonded flexible pipes are used in the offshore oil and gas industry worldwide transporting hydrocarbons from seafloor to floating production vessels topside. Flexible pipes are advantageous over rigid pipelines in dynamic applications and during installation as they are delivered in full length on reels. Flexible pipes are constructed in a layer structure in which each layer adds specific properties to the pipe such as; collapse strength, fluid integrity, bursting strength, tensile strength etc. The inner-most layer of a flexible pipe is the carcass; a flexible interlocking stainless steel structure that provides mechanical and collapse strength for the flexible pipe. The manufacturing process of carcass is a combination of roll forming stainless steel strips and helical winding the profiles around a mandrel interlocking the profiles with themselves.

The focus of the present project is the analysis and optimisation of the carcass manufacturing process by means of a fundamental investigation in the fields of formability, failure modes / mechanisms, Finite Element Analysis (FEA), simulative testing and tribology.

A study of failure mechanisms in carcass production is performed by being present at the production floor when such incidents arise, the so-called ‘Gemba’ methodology. The outcome is a list of general failure mechanisms in the carcass process and it is noted that most issues are encountered in the winding stage.

Issues with carcass profile geometry is a recurring event and it was found that the degrees of freedom which the carcass profile experiences during interlock winding allow the profiles to minimise stresses and strains during winding by adjusting the profile geometry – the effect being more pronounced with decreasing mandrel size. This effect was effectively accounted for by changing the profile geometry in the roll forming stage.

LS-DYNA® is successfully used to construct simple winding models and a three-point-bend using shell elements. A convergence study is performed to ensure parameters for numerical stability. The simple winding models were in agreement with production measurements and they were successfully used in evaluation of weld relief-cut functionality. The three-pointbend FEA indicates possible problems with the shell elements when boundary conditions allow free-forming.

A simulative three-point-bend test is constructed to simulate profile tongue strains during winding. Preliminary testing shows promising results but problems in obtaining similar boundary conditions to the profile as in winding needs to be resolved. In the simulative test simple v-bent profiles shows comparable to roll formed profiles and seems to be a viable option for fully offline simulative testing of weld and weld relief-cut fracture.

Material characterisation of one austenitic and three duplex grade stainless steels is performed (EN 1.4404, EN 1.4162, EN 1.4462 and EN1.4410). Flow curves and anisotropy values are attained but problems with notched tensile specimens meant that only uni-axial tension FLC points were attained.

Analysis of weld fracture of duplex stainless steel EN 1.4162 is carried out determining strains with GOM ARAMIS automated strain measurement system, which shows that strain increases faster in the weld zone than the global strain of the parent material. Fracture in the weld zone occurs at an average global strain of 0.1 where the average fracture strain in the weld zone is 0.27. The reason is explained by lower hardness in the weld zone compared to the parent material.

Weld fracture can be suppressed with introduction of weld relief zones. However, production strain measurements and FEA analysis showed that cutting a relief zone creates high strains locally in the relief-cut itself – more than a factor two larger than the nominal highest strains elsewhere in the profile. Weld relief-cuts are optimised by moving the relief-cut next to the weld seam and only cutting 1 x strip thickness deep.

Simulative tribo-testing in the strip-reduction-test showed that biodegradable rapeseed oil is an acceptable lubricant for the carcass process. Testing of two lean duplex stainless steel surfaces showed that a EN 2E brushed surface had better lubricant entrapment capabilities than a EN 2B bright annealed surface.

Swarf was found to originate from either strip edge in contact with the forming tool or with another strip edge during interlocking or from pickup abrading the strip surface. An increase of tool curvature in contact with the strip edge is shown to have a positive effect on edge swarf.

Pickup was seen as an issue on the roll forming tools but it does not develop past a certain amount. It is, however,
Manuscript: Analysis of Cavity Pressure and Warpage of Polyoxymethylene Thin Walled Injection Molded Parts: Experiments and Simulations

Process analysis and simulations on molding experiments of 3D thin shell parts have been conducted. Moldings were carried out with polyoxymethylene (POM). The moldings were performed with cavity pressure sensors in order to compare experimental process results with simulations. The warpage was characterized by measuring distances using a tactile coordinate measuring machine (CMM). Molding simulations have been executed taking into account actual processing conditions. Various aspects have been considered in the simulation: machine barrel geometry, injection speed profiles, cavity injection pressure, melt and mold temperatures, material rheological and pvT characterization. Factors investigated for comparisons were: injection pressure profile, short shots length, flow pattern, and warpage. A reliable molding experimental database was obtained, accurate simulations were conducted and a number of conclusions concerning improvements to simulation accuracy are presented regarding: pvT data, mesh, short shots, cavity pressure for process control validation as well as molding machine geometry modelling. Eventually, a methodology for improved molding simulations of cavity injection pressure, filling pattern and warpage was established.

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Authors: Guerrier, P. (Intern), Tosello, G. (Intern), Hattel, J. H. (Intern)
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BFI (2013): BFI-level 1
An evaluation of interface capturing methods in a VOF based model for multiphase flow of a non-Newtonian ceramic in tape casting

The aim of the present study is to evaluate the different interface capturing methods as well as to find the best approach for flow modeling of the ceramic slurry in the tape casting process. The conventional volume of fluid (VOF) method with three different interpolation methods for interface capturing, i.e., the Geometric Reconstruction Scheme (GRS), High Resolution Interface Capturing (HRIC) and Compressive Interface Capturing Scheme for Arbitrary Meshes (CICSAM), are investigated for the advection of the VOF, both for Newtonian and non-Newtonian cases. The main purpose is to find the best method for the free surface capturing during the flow of a ceramic slurry described by a constitutive power law equation in the tape casting process. First the developed model is tested against well-documented and relevant solutions from literature involving free surface tracking and subsequently it is used to investigate the flow of a La0.85Sr0.15MnO3 (LSM) ceramic slurry modeled with the Ostwald de Waele power law. Results of the modeling are compared with corresponding experimental data and good agreement is found. © 2013 Elsevier Inc. All rights reserved.

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Authors: Jabbari, M. (Intern), Bulatova, R. (Intern), Hattel, J. H. (Intern), Bahl, C. R. (Intern)
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Journal: Applied Mathematical Modelling
A plateau–valley separation method for textured surfaces with a deterministic pattern

The effective characterization of textured surfaces presenting a deterministic pattern of lubricant reservoirs is an issue with which many researchers are nowadays struggling. Existing standards are not suitable for the characterization of such surfaces, providing at times values without physical meaning. A new method based on the separation between the plateau
and valley regions is hereby presented allowing independent functional analyses of the detected features. The determination of a proper threshold between plateaus and valleys is the first step of a procedure resulting in an efficient division of the two regions, which can be studied separately according to their specific function. The case of a turned multifunctional profile is presented depicting the lacks in efficacy of standardized methods and therefore studied with this new methodology. Limitations of the method are eventually presented, in particular its dependence on a proper leveling of the profile beforehand.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Image Metrology A/S
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Scopus rating (2002): SJR 0.714 SNIP 1.955
Applicability of chemical vapour polishing of additive manufactured parts to meet production-quality

The Fused Deposition Modelling (FDM) method is the most rapidly growing Additive Manufacturing (AM) method[1]. FDM employs a 2.5D deposition scheme which induce a step-ladder shaped surface definition [2], with seams of the individual layers clearly visible[3]. This paper investigate to which extend chemical vapour polishing can be applied to eliminate the layered surfaces from FDM, so that a polished surface quality is obtained. It is quantified to what extend parts can be vapour polished and how geometrical and mechanical properties alter. The fundamental question is whether the surfaces of FDM manufactured parts can be taken from their current quality into the precision engineering domain.

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Title of host publication: Proceedings of the 14th International Conference of the European Society for Precision Engineering and Nanotechnology
Main Research Area: Technical/natural sciences
Conference: 14th International Conference of the European Society for Precision Engineering and Nanotechnology, Dubrovnik, Croatia, 02/06/2014 - 02/06/2014
Source: FindIt
Source-ID: 2288603895
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

A reciprocating pin-on-plate test-rig for studying friction materials for holding brakes

This paper refers to testing of friction materials for holding brakes. In contrast to the more typical case of high energy brakes, holding brakes operate usually in a reciprocating sense, at very low sliding speeds and allow significantly higher clamping pressures. The design of a reciprocating pin-on-plate test-rig for studying the evolution of wear by monitoring the pin height reduction using Eddy-current proximity sensors is presented. Moreover, a new mechanism for recording the friction force is suggested. Apart from the design of the test-rig, friction force and wear rate measurements for two different friction materials running against an unhardened steel surface are presented as a usage case. © 2014 Elsevier B.V.

General information
State: Published
Organisations: Department of Mechanical Engineering, Solid Mechanics, Manufacturing Engineering
Authors: Poulios, K. (Intern), Drago, N. (Intern), Klit, P. (Intern), De Chiffre, L. (Intern)
Pages: 40-46
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Wear
Volume: 311
Issue number: 1-2
ISSN (Print): 0043-1648
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Assessment methods of injection moulded nano-patterned surfaces

Assessment of nano-patterned surfaces requires measurements with nano-metric resolution. In order to enable the optimization of the moulding process it is necessary to develop a robust method for quantitative characterization of the replication quality of random nano-patterned surfaces. In this work two different methods for quantitative characterization of random nano-patterned surfaces were compared and assessed. One method is based on the estimation of the roughness amplitude parameters Sa and Sz (ISO 25178). The second method is based on pore and particle analysis using the watershed algorithm for feature recognition. To compare the methods, the mould insert and a number of replicated nano-patterned surfaces, injection moulded with an induction heating aid, were measured on nominally identical locations by means of an atomic force microscope mounted on a manual CMM.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark
Authors: Menotti, S. (Intern), Bisacco, G. (Ekstern), Hansen, H. N. (Intern)
Pages: 186-189
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 14th International Conference of the European Society for Precision Engineering and Nanotechnology
Main Research Area: Technical/natural sciences
Conference: 14th International Conference of the European Society for Precision Engineering and Nanotechnology, Dubrovnik, Croatia, 02/06/2014 - 02/06/2014
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Assessment of injection moulded nano-patterned surfaces

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Menotti, S. (Intern), Bissacco, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 1
Publication date: 2014

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Publisher: euspen
Main Research Area: Technical/natural sciences
Conference: 14th euspen International Conference, Dubrovnik, Croatia, 02/06/2014 - 02/06/2014
Electronic versions:
Assessment_of_injection.pdf
Source: PublicationPreSubmission
Source-ID: 93452747
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2014

A study on the surface roughness of a thin HSQ coating on a fine milled surface

The paper discusses a novel application of a thin layer coating on a metallic machined surface with particular attention to roughness of the coating compared to the original surface before coating. The coating is a nominally 1 μm film of Hydrogen Silsesquioxane (HSQ) which is commonly used in the semiconductor industry in the manufacture of integrated circuits. The work piece is a fine peripheral-milled tool steel surface which is widely used in industrial applications. Roughness improvement after the application of HSQ coating is reported.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, InMold Biosystems A/S
Authors: Mohaghegh, K. (Intern), Hansen, H. N. (Intern), Pranov, H. (Ekstern), Kofod, G. (Ekstern)
Number of pages: 4
Publication date: 2014

Host publication information
A system boundary identification method for life cycle assessment

Life cycle assessment (LCA) is a useful tool for quantifying the overall environmental impacts of a product, process, or service. The scientific scope and boundary definition are important to ensure the accuracy of LCA results. Defining the boundary in LCA is difficult and there are no commonly accepted scientific methods yet. The objective of this research is to present a comprehensive discussion of system boundaries in LCA and to develop an appropriate boundary delimitation method. A product system is partitioned into the primary system and interrelated subsystems. The hierarchical relationship of flow and process is clarified by introducing flow- and process-related interventions. A system boundary curve model of the LCA is developed and the threshold rules for judging whether the system boundary satisfies the research requirement are proposed. Quantitative criteria from environmental, technical, geographical and temporal dimensions are presented to limit the boundaries of LCA. An algorithm is developed to identify an appropriate boundary by searching the process tree and evaluating the environmental impact contribution of each process while it is added into the studied system. The difference between a limited system and a theoretically complete system is presented. A case study is conducted on a color TV set to demonstrate and validate the method of boundary identification. The results showed that the overall environmental impact indicator exhibits a slow growth after a certain number of processes considered, and the gradient of the fitting curve trends to zero gradually. According to the threshold rules, a relatively accurate system boundary could be obtained. It is found from this research that the system boundary curve describes the growth of life cycle impact assessment (LCIA) results as processes are added. The two threshold rules and identification methods presented can be used to identify system boundary of LCA. The case study demonstrated that the methodology presented in this paper is an effective tool for the boundary identification.
A TEM Study on the Ti-Alloyed Grey Iron

The microstructure of graphite flakes in titanium alloyed cast iron is studied using electron microscopy techniques. Dual beam SEM/FIB has been used for TEM sample preparation. A TEM study has been carried out on graphite flakes in grey cast iron using selected area electron diffraction. Based on the selected area diffraction pattern analysis, crystallographic orientations are identified and compared. The orientation relationship between iron and graphite crystals at the interface is studied and discussed. It is found that graphite in the Ti-containing iron is extremely fine grained and that there is a high proportion of twins in the fine grained graphite. It appears that twinning and stacking faults are involved in the fine grained structure of the graphite. It is discussed how Ti addition affect crystal growth and may lead to formation of superfine graphite.

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Materials and Surface Engineering, Department of Wind Energy, Materials science and characterization
Authors: Moumeni, E. (Intern), Tiedje, N. S. (Intern), Grumsen, F. B. (Intern), Danielsen, H. K. (Intern), Horsewell, A. (Intern), Hattel, J. H. (Intern)
A Two-Phase Flow Solver for Incompressible Viscous Fluids, Using a Pure Streamfunction Formulation and the Volume of Fluid Technique

Accurate multi-phase flow solvers at low Reynolds number are of particular interest for the simulation of interface instabilities in the co-processing of multilayered material. We present a two-phase flow solver for incompressible viscous fluids which uses the streamfunction as the primary variable of the flow. Contrary to fractional step methods, the streamfunction formulation eliminates the pressure unknowns, and automatically fulfills the incompressibility constraint by construction. As a result, the method circumvents the loss of temporal accuracy at low Reynolds numbers. The interface is tracked by the Volume-of-Fluid technique and the interaction with the streamfunction formulation is investigated by examining the Rayleigh-Taylor instability and broken dam problem. The results of the solver are in good agreement with previously published theoretical and experimental results of the first and latter mentioned problem, respectively.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Princeton University
Authors: Comminal, R. (Intern), Spangenberg, J. (Ekstern), Hattel, J. H. (Intern)
Pages: 9-19
Publication date: 2014
Conference: 7th International Conference on Advanced Computational Engineering and Experimenting (ACE-X 2013), Madrid, Spain, 01/07/2013 - 01/07/2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Defect and Diffusion Forum
Volume: 348
ISSN (Print): 1012-0386
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.195 SJR 0.129 CiteScore 0.19
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.144 SNIP 0.251 CiteScore 0.2
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.234 SNIP 0.34 CiteScore 0.24
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.235 SNIP 0.415 CiteScore 0.29
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.214 SNIP 0.378 CiteScore 0.26
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.2 SNIP 0.4 CiteScore 0.27
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.204 SNIP 0.325 CiteScore 0.24
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.226 SNIP 0.365
Benefit quantification of interoperability in coordinate metrology

One of the factors contributing to limited reproducibility of coordinate measurements is the use of different inspection software. Time-consuming efforts for translation of part programmes are sometimes needed, and interoperability of inspection equipment has the potential to reduce these inefficiencies. The paper presents a methodology for an economic evaluation of interoperability benefits with respect to the verification of geometrical product specifications. It requires input data from testing and inspection activities, as well as information on training of personnel and licensing of software. The model is illustrated using an automotive case study and the related assessment of an investment in interoperability. © 2014 CIRP.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Padua
Authors: Savio, E. (Ekstern), Carmignato, S. (Ekstern), De Chiffre, L. (Intern)
Pages: 477-480
Publication date: 2014
Main Research Area: Technical/natural sciences

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Journal: CIRP Annals - Manufacturing Technology
Volume: 63
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ISSN (Print): 0007-8506
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 2.055 SNIP 3.158
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 3.294 CiteScore 3.83
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.123 SNIP 3.992 CiteScore 4.39
One of the most common processes used in manufacturing of multilayer ceramic packages, multilayer capacitors and large scale integration circuits is tape casting. In this process, the wet tape thickness is one of the single most determining parameters affecting the final properties of the product, and it is therefore of great interest to be able to control it. One way to control the tape thickness is to use a two doctor blade configuration in the tape casting machine. In this case, it becomes important to fix the height of the slurry in front of both doctor blades according to the desired tape thickness and casting speed (belt velocity). In the present work, the flow in both doctor blade regions of a slurry is described with a steady state momentum equation in combination with a Bingham
plastic constitutive equation, and this is integrated to a closed form analytical solution for both reservoirs based on the
desired wet tape thickness and casting speed. The developed model is used to investigate the impact of different material
parameters and machine designs on the required slurry height. The solution is compared with experimental findings from
the literature, and good agreement is found.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Jabbari, M. (Intern), Hattel, J. H. (Intern)
Pages: 283-288
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: Materials Science and Technology
Volume: 30
Issue number: 3
ISSN (Print): 0267-0836
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.89 SJR 0.889 SNIP 1.004
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.43 SJR 0.833 SNIP 0.859
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.623 SNIP 0.774 CiteScore 1.1
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.775 SNIP 0.996 CiteScore 1.1
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.631 SNIP 0.846 CiteScore 0.92
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.683 SNIP 0.965 CiteScore 0.86
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.667 SNIP 1.047 CiteScore 0.94
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.635 SNIP 0.776
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.882 SNIP 1.076
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.776 SNIP 1.036
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.754 SNIP 1.183
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.676 SNIP 0.994
Cellular Scanning Strategy for Selective Laser Melting: Capturing Thermal Trends with a Low-Fidelity, Pseudo-Analytical Model

Simulations of additive manufacturing processes are known to be computationally expensive. The resulting large runtimes prohibit their application in secondary analysis requiring several complete simulations such as optimization studies, and sensitivity analysis. In this paper, a low-fidelity pseudo-analytical model has been introduced to enable such secondary analysis. The model has been able to mimic a finite element model and was able to capture the thermal trends associated with the process. The model has been validated and subsequently applied in a small optimization case study. The pseudo-analytical modelling technique is established as a fast tool for primary modelling investigations.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Mohanty, S. (Intern), Hattel, J. H. (Intern)
Number of pages: 14
Publication date: 2014
Main Research Area: Technical/natural sciences
Centre for Industrial Application of CT scanning (CIA-CT) – Four years of results 2009-2013
The innovation consortium project, carried out September 2009 – August 2013, has aimed to help the participating companies and Danish industry with the introduction of CT scanning as measuring technology, carrying out research at international level. The project has operated through five main activities: Centre of Excellence, Dissemination, Collaboration, Research, and Initiation of new activities.
The consortium has consisted of nine partners, including three research institutions, two consultancy partners, two large companies, and two small / medium enterprises. The consortium has acted as a centre of excellence for industrial CT scanning, both nationally and internationally. A network with approx. 40 participants has been established, and a total of 22 students have been educated.
Dissemination activities have encompassed: a web page www.cia-ct.mek.dtu.dk , 8 newsletters, 4 topical conferences, 5 seminars and workshops, and 61 publications.
Collaboration has been established with a number of national and international actors in the field of CT, including societies and research organisations.
Five major research projects have been carried out: 1) CT scanning for coordinate metrology; 2) Data processing for high speed scanning; 3) New beam sources and signal conditioning; 4) Equipment with high stability beam source; 5) Quality assurance and automation.
A number of new activities have been initiated from the project, including participation in two new project proposals. The project represents a major step forward towards the industrial application of CT scanning in Denmark.

Challenges in Design of an Orientation free Micro Direct Methanol Fuel Cell (µDMFC)
The need for increasing the energy density of the power sources for portable electronic applications is getting increasingly important. Hearing aid devices are among the most demanding portable products and require power generators with high energy generation capability. In the current paper the challenges in design and manufacturing of a micro direct methanol fuel cell (µDMFC) as the power generator in hearing aid devices is investigated. Among the different challenges in design for µDMFC, the CO2 bubble management and orientation independency of the cell are addressed by proposing a spring loaded mechanism. Furthermore, the feasibility and manufacturability of the proposed design are examined and discussed. The main purpose of this paper is to address the constraints in design for micro manufacturing considering the available manufacturing possibilities.
Challenges in high accuracy surface replication for micro optics and micro fluidics manufacture

Patterning the surface of polymer components with microstructured geometries is employed in optical and microfluidic applications. Mass fabrication of polymer micro structured products is enabled by replication technologies such as injection moulding. Micro structured tools are also produced by replication technologies such as nickel electroplating. All replication steps are enabled by a high precision master and high reproduction fidelity to ensure that the functionalities associated with the design are transferred to the final component. Engineered surface micro structures can be either distributed, e.g., to create an optical pattern, or discretised, e.g., as micro channels for fluids manipulation. Key aspects of two process chains based on replication technologies for both types of micro structures are investigated: lateral replication fidelity, dimensional control at micro scale, edge definition. The parts investigated are a micro retroreflector and a micro fluidic system, typical applications of injection moulded parts with micro structured functional surfaces.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Lego Group
Authors: Tosello, G. (Intern), Hansen, H. N. (Intern), Calaon, M. (Intern), Gasparin, S. (Ekstern)
Pages: 122-144
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Precision Technology
Volume: 4
Issue number: 1/2
ISSN (Print): 1755-2060
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ISI indexed (2013): ISI indexed no
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Original language: English
Injection moulding, Tooling, Micro optics, Micro fluidics, Surface replication

Bibliographical note
This paper reports work undertaken in the context of the research projects COTECH and PolyNano. COTECH (Converging technologies for microsystems manufacturing) is a Large Scale Collaborative Project supported by the European Commission in the 7th Framework Programme (CP-IP 214491-2, http://www.fp7-cotech.eu/). PolyNano (Danish competence centre for production-ready fabrication of polymer nano-scale lab-on- a-chip) (http://www.polynano.org/) is supported by the Danish Council for Strategic Research.

Characterisation of surfaces produced by robot-assisted polishing (RAP)

A RAP sample with five belts was manufactured covering the range of (11-169) μm Rd. The belts were measured using a stylus, a variable focus microscope and a white light interferometer (WSI). Results show that such a cylindrical sample manufactured using RAP is a potential reference artefact for traceability purposes.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Mohaghegh, K. (Intern), De Chiffre, L. (Intern)
Number of pages: 4
Publication date: 2014

Host publication information
Title of host publication: Proceedings of the 14th euspen International Conference
euspen
Main Research Area: Technical/natural sciences
Characterization of fracture loci in metal forming

Fracture in metal forming can occur in three different modes: (i) tensile; (ii) in-plane shear; and (iii) out-of-plane shear (respectively the same as modes I, II and III of fracture mechanics). The circumstances under which each mode will occur are identified in terms of plastic flow and microstructural ductile damage by means of an analytical framework to characterize fracture loci under plane stress conditions that also takes anisotropy into consideration. Experimental results retrieved from the literature give support to the presentation and show that plastic flow and failure in sheet forming results from competition between modes I and II whereas in bulk forming fracture results from competition between modes I and III. © 2014 Elsevier Ltd.
Characterization of precision of a handling system in high performance transfer press for micro forming

Multi-step micro bulk forming is characterized by complex processes and high precision requirements. In particular the demands regarding handling accuracy between different forming steps are of the order of a few mm. The paper introduces a methodology for the analysis and characterization of this transfer system on component level and system level. Laser interferometry is used in combination with analytical models to predict the positioning ability of the actuator in a static as well as dynamic mode. In combination with an analysis of the grippers, a full description of the transfer precision inside the forming press is obtained. © 2014 CIRP.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Mahshid, R. (Intern), Hansen, H. N. (Intern), Arentoft, M. (Ekstern)
Pages: 497–500
Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
Journal: C I R P Annals
Volume: 63
ISSN (Print): 0007-8506
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 2.055 SNIP 3.158
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 3.294 CiteScore 3.83
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Comparability of the performance of in-line computer vision for geometrical verification of parts, produced by Additive Manufacturing

The field of Additive Manufacturing is growing at an accelerated rate, as prototyping is left in favor of direct manufacturing of components for the industry and consumer. A consequence of mass-customization and component complexity is an adverse geometrical verification challenge. Mass-customized parts with narrow geometrical tolerances require individual verification whereas many hyper-complex parts simply cannot be measured by traditional means such as by optical or mechanical measurement tools. This paper addresses the challenge by detailing how in-line computer vision has been employed in order to verify geometrical tolerances. The paper addresses to which precision, tolerance verification has
been achieved, by assessing the reconstruction capability against reference 3D scanning by a selected number of AM processes. Geometrical verification was achieved down to a precision of 20 μm for ideal AM processes, whereas the thermally driven SLM due to thermal warpage, resulting in a reconstruction accuracy of 400 μm.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Pedersen, D. B. (Intern), Hansen, H. N. (Intern)
Pages: 179-183
Publication date: 2014

**Host publication information**

Title of host publication: Proceedings of the 2014 ASPE Spring Topical Meeting : Dimensional Accuracy and Surface Finish in Additive Manufacturing
Publisher: American Society for Precision Engineering
ISBN (Print): 9781887706643
Main Research Area: Technical/natural sciences
Source: FindIt
Source-ID: 2288294903
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Comparison on Computed Tomography using industrial items

In a comparison involving 27 laboratories from 8 countries, measurements on two common industrial items, a polymer part and a metal part, were carried out using X-ray Computed Tomography. All items were measured using coordinate measuring machines before and after circulation, with reference measurement uncertainties in the range 1.5–5.5 μm, showing a good stability over the 6 months of the circulation. The comparison has shown that CT measurements on the industrial parts used lie in the range 6–53 μm, with maximum values up to 158 μm.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Angel, J. A. B. (Intern), De Chiffre, L. (Intern)
Pages: 473–476
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Main Research Area: Technical/natural sciences

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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 2.055 SNIP 3.158
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 3.294 CiteScore 3.83
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.123 SNIP 3.992 CiteScore 4.39
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.598 SNIP 3.818 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.088 SNIP 4.156 CiteScore 3.04
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.117 SNIP 3.46 CiteScore 2.81
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.12 SNIP 3.449
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.652 SNIP 2.219
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.056 SNIP 1.645
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.119 SNIP 1.55
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.892 SNIP 1.96
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.988 SNIP 1.904
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.591 SNIP 2.376
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.142 SNIP 1.823
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.866 SNIP 2.26
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.575 SNIP 2.161
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.788 SNIP 2.182
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.779 SNIP 2.611
Original language: English
Coordinate measuring machine (CMM), Measurement uncertainty, Computed Tomography (CT)
DOIs:
10.1016/j.cirp.2014.03.034
Source: PublicationPreSubmission
Source-ID: 93812123
Publication: Research - peer-review › Journal article – Annual report year: 2014

Coupling and Complexity in Additive Manufacturing Processes

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Reykjavik University
Authors: Thompson, M. K. (Intern), Foley, J. T. (Eksbern)
Pages: 177-182
Publication date: 2014

Host publication information
Title of host publication: Proceedings of ICAD2014 : The Eighth International Conference on Axiomatic Design
Publisher: ICAD
Article number: ICAD - 2014 - 02
Main Research Area: Technical/natural sciences
Axiomatic Design, Design rational, Product development, Decomposition
DeepWind - from Idea to 5 MW Concept

The DeepWind concept has been described previously on challenges and potentials, this new offshore floating technology can offer to the wind industry [1]. The paper describes state of the art design improvements, new simulation results of the DeepWind floating vertical axis wind turbine concept, which implies a high potential for cost saving. The most critical aspects of the concept are addressed in proving feasibility, and if it can be scaled up to 20 MW. Applying structural mechanics, generator, floater & mooring system, control system design, and rotor design using detailed integrated models, results have evolved to a 5 MW baseline design. This important outcome will be used as a reference for further improvements. Emphasis in this paper is made on the interplay between different components and some trade-offs. One such example is the rotational speed which largely influences the design of both the generator and the aerodynamic rotor. Another example is aerofoil design affecting energy capture, stall behaviour, structural dynamics and control design. Finally, the potential for up-scaling to 20 MW is discussed.

General information
State: Published
Organisations: Department of Wind Energy, Test and Measurements, Aeroelastic Design, Wind Turbines, Department of Mechanical Engineering, Manufacturing Engineering, Aalborg University, SINTEF, Marine Technology Centre
Authors: Schmidt Paulsen, U. (Intern), Aagaard Madsen, H. (Intern), Kragh, K. A. (Intern), Nielsen, P. H. (Intern), Baran, I. (Intern), Hattel, J. H. (Intern), Ritchie, E. (Forskerdatabase), Leban, K. (Ekstern), Svendsen, H. (Ekstern), Berthelsen, P. A. (Ekstern)
Number of pages: 11
Pages: 23-33
Publication date: 2014
Main Research Area: Technical/natural sciences

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Journal: Energy Procedia
Volume: 53
ISSN (Print): 1876-6102
Ratings:
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BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.44 SJR 0.495 SNIP 0.799
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.16 SJR 0.464 SNIP 0.598
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.359 SNIP 0.562 CiteScore 0.92
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.429 SNIP 0.807 CiteScore 1.09
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ISI indexed (2012): ISI indexed no
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DeepWind. From idea to 5 MW concept

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Organisations: Department of Wind Energy, Test and Measurements, Aeroelastic Design, Wind Turbines, Department of Mechanical Engineering, Manufacturing Engineering, Aalborg University, SINTEF, Marine Technology Centre
Authors: Schmidt Paulsen, U. (Intern), Aagaard Madsen , H. (Intern), Nielsen, P. H. (Intern), Kragh, K. A. (Intern), Baran, I. (Intern), Hattel, J. H. (Intern), Ritchie, E. (Ekstern), Leban, K. (Ekstern), Svenden, H. (Ekstern), Berthelsen, P. A. (Ekstern)
Number of pages: 24
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Design and Optimization of Air-Doped 3-dB Terahertz Fiber Directional Couplers
We present a thorough practical design optimization of broadband low loss, terahertz (THz) photonic crystal fiber directional couplers in which the two cores are mechanically down-doped with a triangular array of air holes.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Teraherts Technologies and Biophotonics
Authors: Bao, H. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)
Number of pages: 2
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Design and optimization of mechanically down-doped terahertz fiber directional couplers
We present a thorough practical design optimization of broadband low loss, terahertz (THz) photonic crystal fiber directional couplers in which the two cores are mechanically down-doped with a triangular array of air holes. A figure of merit taking both the 3-dB bandwidth and loss of the coupler into account, is used for optimization of the structure parameters, given by the diameter and pitch of the cladding (d and Λ) and of the core (d_c and Λ_c) air-hole structure. The coupler with Λ = 498.7 μm, d_c = 324.2 μm, Λ_c = 74.8 μm, and d = 32.5 μm is found to have the best performance at a center frequency of 1 THz, with a bandwidth of 0.25 THz and a total device loss of 9.2 dB. The robustness of the optimum coupler to structural changes is investigated. © 2014 Optical Society of America.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Fibers & Nonlinear Optics, Department of Mechanical Engineering, Manufacturing Engineering, Teraherts Technologies and Biophotonics
Authors: Bao, H. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.48 SJR 1.532 SNIP 1.544
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.91 SNIP 1.674 CiteScore 3.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.313 SNIP 2.124 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.337 SNIP 2.196 CiteScore 4.38
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.562 SNIP 2.108 CiteScore 3.85
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.58 SNIP 2.572 CiteScore 4.04
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.906 SNIP 2.428
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 3.039 SNIP 2.679
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 3.204 SNIP 2.423
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.284 SNIP 2.11
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 3.313 SNIP 2.336
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.819 SNIP 2.472
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.669 SNIP 2.217
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.745 SNIP 1.748
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.496 SNIP 1.42
Development of a Paraffin Wax deposition Unit for Fused Deposition Modelling (FDM)

During the last decade Additive Manufacturing (AM) witnessed a big development in terms of technologies, processes and possibilities. However of materials and their use still represents a big challenge. In fact availability of materials is rather limited if compared to conventional manufacturing. This project illustrates the redesign of an extrusion unit for the deposition of paraffin wax in Fused Deposition Modelling (FDM) instead of the conventional polymeric materials. Among the benefits and brought by the use of paraffin wax in such system are: the possibility to make highly complex and precise parts to subsequently use in a Lost Wax Casting process, multi-material Additive Manufacturing and the use of wax as support material during the production of complicated parts. Moreover it is believed that including waxes among the materials usable in FDM would promote new ways of using and exploring the technology and opening to new challenges. The design presented in this paper represents a step towards the development of a multi material deposition unit, able to selectively depose specific materials on demand in the same product, according to needs. In order to achieve that, waxes and respective designs are tested iteratively by alternating different methods in order to find the best configuration. The use of an open source platform, namely a Reprap Prusa Mendel allows to perform quick changes to the system without significant modifications to the major frame of the machine. During the design of the new extruder principles of modularity and reconfigurability are also taken into account in order to ease up a subsequent integration with a more complex system.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Applied Mathematics and Computer Science
Authors: D’Angelo, G. (Intern), Hansen, H. N. (Intern), Pedersen, D. B. (Intern)
Number of pages: 14
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Main Research Area: Technical/natural sciences
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Source: PublicationPreSubmission
Source-ID: 105849011
Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Dimensional quality control of Ti-ni dental file by optical coordinate metrology and computed tomography
Endodontic dental files usually present complex 3D geometries, which make the complete measurement of the component very challenging with conventional micro metrology tools. Computed Tomography (CT) can represent a suitable alternative solution to micro metrology tools based on optical and tactile techniques. However, the establishment of CT systems traceability when measuring 3D complex geometries is still an open issue. In this work, to verify the quality of the CT dimensional measurements, the dental file has been measured both with a µCT system and an optical CMM (OCMM). The uncertainty of measurements performed with both technologies is assessed. The estimated uncertainty is eventually compared with the component’s calibration and tolerances to validate the measuring capability of the µCT system.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Zaragoza, Defense University Center of Zaragoza
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Number of pages: 4
Effect of Feeder Configuration on the Microstructure of Ductile Cast Iron

Feeding and microstructure of a test casting rigged with different feeder combinations was studied. Castings were examined and classified by soundness and microstructure. Subsequently the casting macro- and microstructure was analyzed to study how differences in solidification and segregation influence the soundness of different sections of the castings. Moreover, the microstructural changes due to variations in thermal gradients are classified, and the variations in the mushy zone described. The paper discusses how solidification and segregation influence porosity and microstructure of ductile iron castings. The goal is to enable metallurgists and foundry engineers to more directly target mushy zone development to prolong the possibility to feed through this section. Keeping smaller section open for an extended period will make it possible to use fewer or smaller feeders, with reduced energy consumption and cheaper products as a result.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Vedel-Smith, N. K. (Intern), Tiedje, N. S. (Intern)
Pages: 113-120
Publication date: 2014

Effect of Uncertainty in Processing Parameters on the Microstructure of Single Melt Tracks Formed by Selective Laser Melting

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Mohanty, S. (Intern), Hattel, J. (Intern)
Publication date: 2014
Estimation of measurement uncertainties in X-ray computed tomography metrology using the substitution method

This paper presents the application of the substitution method for the estimation of measurement uncertainties using calibrated workpieces in X-ray computed tomography (CT) metrology. We have shown that this, well accepted method for uncertainty estimation using tactile coordinate measuring machines, can be applied to dimensional CT measurements. The method is based on repeated measurements carried out on a calibrated master piece. The master piece is a component of a dose engine from an insulin pen. Measurement uncertainties estimated from the repeated measurements of the master piece were transferred on to additionally scanned uncalibrated workpieces which provided the necessary link for achieving traceable measurements. © 2014 CIRP.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Novo Nordisk A/S
Authors: Müller, P. (Intern), Hiller, J. (Intern), Dai, Y. (Ekstern), Andreasen, J. L. (Ekstern), Hansen, H. N. (Intern), De Chiffre, L. (Intern)
Pages: 222-232
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BFI (2018): BFI-level 1
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Scopus rating (2016): CiteScore 2.76 SJR 1.107 SNIP 2.093
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 1.197 SNIP 1.847 CiteScore 2.55
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 1.349 SNIP 1.863 CiteScore 2.46
Scopus rating (2013): SJR 0.992 SNIP 1.771 CiteScore 2.01
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.776 SNIP 1.799 CiteScore 1.69
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.941 SNIP 1.988 CiteScore 1.72
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 1.124 SNIP 2.324
Scopus rating (2009): SJR 0.917 SNIP 1.183
Original language: English
Calibrated workpieces, CT, CT ball plate, ISO 15530-3, Master piece, Measurement uncertainty, Reference objects, Substitution method, X-ray computed tomography, Calibration, Computerized tomography, Measurements, Units of measurement, X rays, Ball plate, Uncertainty analysis
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Evaluation of the DeepWind concept
The report describes the DeepWind 5 MW conceptual design as a baseline for results obtained in the scientific and technical work packages of the DeepWind project. A comparison of DeepWind with existing VAWTs and paper projects are carried out and the evaluation of the concept in terms of cost, as well as the technical and scientific recommendations are performed. The work is a result of the contributions within the DeepWind project which is supported by the European Commission, Grant 256769 FP7 Energy 2010 - Future emerging technologies, and by the DeepWind beneficiaries: DTU(DK), AAU(DK), TUDELFT(NL), TUTRENTO(I), DHI(DK), SINTEF(N), MARINTEK(N), MARIN(NL), NREL(USA), STATOIL(N), VESTAS(D K) and NENUPHAR(F).
Recent improvements in the manufacturing process of camera lenses have introduced the use of a new technology involving wafer based precision glass moulding. The utilization of this technology has some important advantages such as cost reduction, supply chain simplification and higher image quality. However, the required accuracy for the final size and shape of the moulded lenses as well as the complexity of this technology call for a high level of process understanding and numerical simulation is a very important part of achieving this goal. The viscoelastic parameters of the optical glass as well as the glass/mould inter-face friction coefficient play a key role in deformation behaviour and stress distribution of the moulded glass lens. Therefore, a proper evaluation of these parameters is the first important step in numerical modelling of the precision glass moulding process. The current paper deals with characterization of the interfacial glass/mould friction coefficient and viscoelastic behaviour of the L-BAL42 glass material above the glass transition temperature. Several glass rings are pressed at three different temperatures to various thicknesses and the experimental force, displacements, internal diameter, and thickness of the rings are measured during the tests. Viscoelastic and structural relaxation behaviour of the glass are implemented into the ABAQUS FEM software through a FORTRAN material subroutine (UMAT) and the FE model is validated with a sandwich seal test. Then, by FE simulation of the ring compression test and comparison of the experimental creep with the simulated done in an iterative procedure, viscoelastic parameters of the glass material are characterized. Finally, interfacial glass/mould friction coefficients at different temperatures are determined through FEM based friction curves combined with experimental data points. The obtained viscoelastic parameters and interfacial friction coefficients can later be employed for prediction of the final shape/size as well as the stress distribution in the glass wafer during a real wafer based precision glass moulding process. © 2014 Elsevier B.V. All rights reserved.
Experimental and simulated strength of spot welds

Weld strength testing of single spots in DP600 steel is presented for the three typical testing procedures, i.e. tensile-shear, cross-tension and peel testing. Spot welds are performed at two sets of welding parameters and strength testing under
these conditions is presented by load-elongation curves revealing the maximum load and the elongation at break. Welding and strength testing is simulated by SORPAS® 3D, which allows the two processes to be prepared in a combined simulation, such that the simulated welding properties are naturally applied to the simulation of strength testing. Besides the size and shape of the weld nugget, these properties include the new strength of the material in the weld and the heat affected zone based on the predicted hardness resulting from microstructural phase changes simulated during cooling of the weld before strength testing. Comparisons between overall geometry, stiffness and load-elongation curves are presented.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark, Dortmund FuE-Pressfügen/Kleben, SWANTEC Software and Engineering ApS, Universidade de Lisboa
Authors: Nielsen, C. V. (Intern), Bennedbaek, R. A. (Ekstern), Larsen, M. B. (Ekstern), Bay, N. (Intern), Chergui, A. (Ekstern), Zhang, W. (Ekstern), Martins, P. A. (Ekstern)
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Experimental investigation on corrosion properties of LDS MID for Hearing Aid applications
The trend towards miniaturization is ever going in the hearing aid industry. The Moulded Interconnect Device (MID) technology can offer the unique possibility to reduce the size of the hearing aids by combining electrical and mechanical functions in the same components. On the other hand, one of the main concerns for MIDs in hearing aids is the corrosion of metal tracks. This paper investigates the corrosion of the MID parts based on different base materials, layer thickness and mechanical wear of the MIDs. The results presented in the paper will be useful for designing MIDs in hearing aids and other electro-mechanical applications.

General information
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Organisations: Department of Management Engineering, Department of Mechanical Engineering, Manufacturing Engineering, SONION Roskilde A/S, Institute for Product Development
Authors: Islam, A. (Intern), Hansen, H. N. (Intern), Risager, F. (Ekstern), Tang, P. (Ekstern)
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Experimental investigation on shrinkage and surface replication of injection moulded ceramic parts
Ceramic moulded parts are increasingly being used in advanced components and devices due to their unprecedented material and performance attributes. The surface finish, replication quality and material shrinkage are of immense importance for moulded ceramic parts intended for precision applications. The current paper presents a thorough investigation on the process of ceramic moulding where it systematically characterizes the surface replication and shrinkage behaviours of precision moulded ceramic components. The test parts are moulded from Catamold TZP-A which is Y2O3-stabilised ZrO2 having widespread uses in the advanced industrial applications. The influence of the sintering process on the achievable roughness and replication differences between the mould surface and the final parts are discussed based on the experimental findings. Moreover, an investigation on the morphology and porosity distribution for the moulded ceramic parts is presented.
Feeding Against Gravity with Spot Feeders in High Silicon Ductile Iron

A test pattern, with three different moduli castings was developed to investigate methods to optimise feeding of high silicon ductile cast irons. Different feeder types, modulus, and locations were investigated using both an insulating and an exothermal sleeve material. Porosities were analysed and classified using X-ray imaging and ultrasound analysis. The effect of the different feeder configurations were classified in reference to defect location, sleeve material, and feeder type, modulus, and location.

The analysis showed that exothermal feeder sleeves with the right configurations can feed up-hill against gravity. This effect may contribute to the thermal expansion created by the exothermal reaction. It was also found that the optimum feeder size does not scale linearly with the casting modulus but that larger casting modulus requires relatively smaller modulus feeders. The thermal gradient created by the feeders made with the insulating sleeve material was not sufficient to significantly improve feeding.

Flow of plastic - mechanics of a structured fluid

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Vedel-Smith, N. K. (Intern), Tiedje, N. S. (Intern)
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

Fluid flow modelling in tape casting of ceramics: analytical and numerical approaches

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Jabbari, M. (Intern), Hattel, J. H. (Intern)
Number of pages: 1
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Grasping devices and methods in automated production processes
In automated production processes grasping devices and methods play a crucial role in the handling of many parts, components and products. This keynote paper starts with a classification of grasping phases, describes how different principles are adopted at different scales in different applications and continues explaining different releasing strategies and principles. Then the paper classifies the numerous sensors used to monitor the effectiveness of grasping (part presence, exchanged force, stick-slip transitions, etc.). Later the grasping and releasing problems in different fields (from mechanical assembly to disassembly, from aerospace to food industry, from textile to logistics) are discussed. Finally, the most recent research is reviewed in order to introduce the new trends in grasping. They provide an outlook on the future of both grippers and robotic hands in automated production processes. (C) 2014 CIRP.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Pisa, University of Bremen, Karlsruhe Institute of Technology KIT, Norwegian University of Science and Technology, Technical University of Berlin, Technische Universität München, Friedrich-Alexander University Erlangen-Nuremberg, Institute for Control Engineering of Machine Tools and Manufacturing Units
Authors: Fantoni, G. (Ekstern), Santochi, M. (Ekstern), Dini, G. (Ekstern), Tracht, K. (Ekstern), Scholz-Reiter, B. (Ekstern), Fleischer, J. (Ekstern), Lien, T. K. (Ekstern), Seliger, G. (Ekstern), Reinhart, G. (Ekstern), Franke, J. (Ekstern), Hansen, H. N. (Intern), Verl, A. (Ekstern)
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BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 2.055 SNIP 3.158
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 3.294 CiteScore 3.83
Web of Science (2015): Indexed yes
High Performance Transfer Press for Precision Manufacturing of Micro Metal Parts: Micro Forming Technology, Precision Engineering

Micro forming technology has several notable benefits such as yielding remarkable accuracy, high production speed, material saving and good mechanical properties of formed parts which allows complex micro parts to be manufactured by this technology. There are also presses fabricated appropriately for this technology and are available already in the market. Similar to conventional forming processes, the presence of a handling system can significantly improve the
efficiency of the technology towards building a high performance transfer press for micro forming technology. To examine this possibility, it is important to investigate the process parameters such as billet preparation, automation, forming machine and forming process which influence on geometrical accuracy and surface quality of formed parts. Previous studies have indicated handling devices for micro forming based on different strategies and handling concepts. The aim of this research primarily is to develop an integrated solution for micro metal forming based on a flexible tool with integrated handling operations. The study herein extends these findings by designing and implementation of a multi-step micro metal forming process based on the above developed handling solution including a fully instrumented flexible tool for micro metal forming with the above mentioned characteristics. For this research, the 1050 Aluminum Alloy was used for forming material while it is originally in the form of coil. This original stock was sectioned into the necessary size for billet preparation. The analysis of the prepared specimens focused on establishing the effect the shearing process has on the precision of billet by examining the length and weight of sheared specimens. To observe possible defects on the cut edge, the sheared surfaces were tested for measuring the ovality of the sheared surfaces. An upsetting test was used to determine the flow stress curve of the material. Additionally, the initial condition of specimens were indicated for roughness and microstructure parameters.

A transport device was manufactured which consisted of a linear motor for actuation principle and mechanical grippers based on self-centering and friction principles. This study introduced a methodology for the analysis and characterization of this transfer system on component level and system level. Laser interferometry was used in combination with analytical models to predict the positioning ability of the actuator in a static as well as dynamic mode. In combination with an analysis of the grippers, a full description of the transfer precision inside the forming press was obtained. The current research involved integration of a handling system into an existing developed micro press in order to maximize the output rate up to 250 strokes per minute without compromising accuracy. A thorough investigation of machine’s layout and electrical circuit was conducted by combining two drives with ejection system for the new development of high performance transfer press. A transfer study was carried out on the basis of optimal dynamic parameters for the press and the manipulator. Through the application of high speed camera, the effect of proposed mechanism was studied on the flow of process in order to ensure an automated production as fast and smooth as possible for uninterrupted motions. Consequently, the capability of the newly developed machine tool was examined by implementing a proposed two-operation micro cold forging process. Empirical knowledge and developed methods were obtained for manufacturing optimal front profile of the grippers in respect to the geometry of forged parts in each forming operation. While introducing a two-step forming process, process parameters such as tooling material, forming force, surface roughness of forming tools, lubrication and material flow were investigated.

The work was concluded with a recent high performance transfer press for micro forming technology in which all operations are automatic: feeding and transportation of specimens, press force and stroke control, part ejection and extraction of finished parts as well as monitoring and control of the entire transfer press. The effectiveness of the machine was analyzed in conjunction with the dynamic performance of feed drive, off-center loading and elastic deflection while introducing the errors due to the tool wear and thermal behavior of the system. Finally, the machine tool proved to be successful with respect to the concepts applied to the whole system for automatic production.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Mahshid, R. (Intern), Hansen, H. N. (Intern), Arentoft, M. (Intern)
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Main Research Area: Technical/natural sciences
Publication: Research › Ph.D. thesis – Annual report year: 2015

Improvement of replication fidelity in injection moulding of nano structures using an induction heating system
In today’s industry, applications involving surface patterning with sub-μm scale structures have shown a high interest. The replication of these structures by injection molding leads to special requirements for the mold in order to ensure proper replication and an acceptable cycle time.

A tool insert with functional surface geometry in the sub-micrometer range was produced using aluminum anodization and subsequent nickel electroforming. For the complete replica of the pattern, elevated mold temperatures are required. For this purpose a new mould set-up was developed, which allows rapid heating of the cavity wall by an induction heating system. The capability of the injection molding process to replicate the patterned surfaces into polycarbonate was investigated. Process optimization was carried out in terms of mold temperature/time variation and injection velocity. The replicated surfaces were quantitatively characterized by atomic force microscopy comparing the measurement in the nickel insert with the corresponding polymer nano-features. The experimental results show that the use of the induction heating system is an efficient way to improve the pattern replication.

General information
Induction Heating System Applied to Injection Moulding of Micro and Nano Structures

The present Ph.D. thesis contains a study concerning induction heating system applied to injection moulding of micro and nano structures. The overall process chain was considered and investigated during the project including part design, simulation, conventional and non-conventional tooling, moulding, final verification of the mould part.

The main object of the project was to develop a system for fast heating of the cavity of an injection moulding mould. The technology adopted was an embedded induction heating system. This system was developed to increase the replication quality of the mould part. In fact one of the main problems in micro injection moulding is the premature freezing of the polymer flow inside the cavity and often is not possible to obtain a full replica of the nano/micro structures embed on the surfaces. Some other defects that can be avoided with the use of an additional source of heat in the cavity are; flow marks, sink marks, welding lines, is possible to release stresses and obtain a glossy surfaces.

Different tooling chains for creating the heating system were investigated. A series of experimental investigations were carried out for testing the induction system and for understanding the influence of the main process parameters on the quality of the parts.

The experiments were conducted on a manual injection machine for the first campaign and in a second phase on two different completely automatic injection moulding machines.

Metrology was performed to characterize the moulded parts. The polymer parts were mainly measured with atomic force microscopy (AFM) and an optical coordinate measurement machine (CMM). The results show that the main influencing factor on the replica quality is the mould temperature.

Another part of the project consisted in benchmarking of the developed embedded induction heating system with other heating systems suitable for injection moulding already available on the market. The two selected systems were a variothermal system based on the convective/conductive heating principle and one based on infrared light.

During the project simulation software for injection moulding (Moldflow) was used to predict the flow length of the polymer inside the cavity when the induction heating system was running. The simulations were running under different conditions and different optimization strategy.

Industrial applications of computed tomography

The number of industrial applications of Computed Tomography(CT) is large and rapidly increasing. After a brief market overview, the paper gives a survey of state of the art and upcoming CT technologies, covering types of CT systems, scanning capabilities, and technological advances. The paper contains a survey of application examples from the manufacturing industry as well as from other industries, e.g., electrical and electronic devices, inhomogeneous materials, and from the food industry. Challenges as well as major national and international coordinated activities in the field of industrial CT are also presented. (C) 2014 CIRP.
Influence of Injection and Cavity Pressure on the Demoulding Force in Micro-Injection Moulding

The paper reports an experimental study that investigates part demoulding behavior in micro-injection moulding with a focus on the effects of pressure and temperature on the demoulding forces. In particular, the demoulding performance of a representative microfluidics part was studied as a function of four process parameters, melt temperature, mould temperature, holding pressure, and injection speed, employing the design of experiment approach. In addition, the results obtained using different combinations of process parameters were analyzed to identify the best processing conditions in regards to demoulding behavior of microparts when utilizing a COC polymer to mould them. © 2014 by ASME.
Injection molding of nanopatterned surfaces in the sub-micrometer range with induction heating aid

Replication of sub-micrometer structures by injection molding leads to special requirements for the mold in order to ensure proper replica and acceptable cycle time. This paper investigates the applicability of induction heating embedded into the mold for the improvement of nanopattern replication. A tool insert having a surface containing functional geometries in the sub-micrometer range was produced using aluminum anodization and nickel electroplating. In order to provide elevated mold temperatures necessary for the complete replica of the pattern, a new mold setup was developed, which allows rapid heating of the cavity wall using an induction heating system. Temperature was measured using a thermocouple placed in the mold insert. The system was used to heat up the cavity wall with heating rates of up to 10 K/s. Acrylonitrile butadiene styrene (ABS) and polycarbonate (PC) were used as materials, and heating parameters were investigated after a preliminary optimization with standard heating conditions. The replicated surfaces were quantitatively characterized by atomic force microscopy using specific three-dimensional surface amplitude parameters and qualitatively inspected by scanning electron microscopy. The experimental results show that the use of the induction heating system is an efficient way for improving nanoreplication.
Integrated Design, an Approach Towards DfµMA

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Interchain tube pressure effect in extensional flows of oligomer diluted nearly monodisperse polystyrene melts

We have derived a constitutive equation to explain the extensional dynamics of oligomer-diluted monodisperse polymers, if the length of the diluent has at least two Kuhn steps. These polymer systems have a flow dynamics which distinguish from pure monodisperse melts and solutions thereof, if the solvent has less than two Kuhn steps, e.g. is not a chain. The constitutive equation is based on a phenomenological tube-based model within the methodology of the molecular stress function approach. The nonlinear dynamics have been explained as a consequence of a constant thermal interchain pressure originating from the short polymer chains (e.g. the oligomers) on the wall of the tube containing the long chains. The nonlinear dynamics are uniquely defined by the Rouse time and the maximal extensibility of the long polymer chains. Both are linked to the entanglement length. The relation between the Rouse times and entanglements have been established based on published extensional experiments on nearly monodisperse polystyrene melts. The constitutive equation has shown agreement with the experimental startup of and steady extension data from Huang et al. (Macromolecules 46:5026–5035, 2013a) based on 285 and 545 kg/mol polystyrenes diluted in styrene oligomers containing 3.3 (1.92 kg/mol) and 7.3 (4.29 kg/mol) Kuhn steps.

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Inter laboratory comparison on Computed Tomography for industrial applications in the slaughterhouses: CIA-CT comparison

An intercomparison on X-ray Computed Tomography (CT) for industrial applications in the slaughterhouses was organized by the Centre for Geometrical Metrology (CGM), Department of Mechanical Engineering, Technical University of Denmark (DTU) and carried out within the project “Centre for Industrial Application of CT scanning - CIA-CT”. In the comparison, 4 laboratories from 4 countries were involved, and CT scanned two synthetic phantoms, which were used instead of real pig
A phantom consists of several polymer components as Poly methyl methacrylate (PMMA), Polyethylene (PE) and Polyvinyl chloride (PVC). The polymer materials PMMA, PE and PVC represent tissue types as respectively: meat, fat, and bone. The one phantom represents a skinny pig carcass, when the other one represents a fat pig carcass with a higher content of fat (PE). The phantoms were produced through milling and cutting processes. The phantoms circulated among four participants and a total of six clinical CT scanners in Europe. The circulation took place between May 2011 and May 2012. Different volume measurands are considered, encompassing PMMA, PE, and PVC. The results of each participant are kept confidential. Each participant can identify their own results in this report using an anonymous identification number provided by the coordinator. Measuring instructions distributed by the coordinator were followed by all participants without problems. Participants carried out measurements and sent their results to the coordinator.

Reference values of both phantoms were measured by Danish Meat Research Institute (DMRI) before the circulation and determined by the coordinator using the principle of water displacement. A stability investigation on the phantoms was performed through 3 reproduced measurements over a 4 month period on a clinical CT scanner under the same conditions at DMRI. Investigations confirmed that the mean variation between the three time periods were quite small, below 30 mL. ANOVA tests demonstrated that the reproduced measurements were not significant ($\alpha=0.05$), and the materials were stable enough. Depending on phantom and material, reference expanded uncertainties ($k=2$) ranging from approx. 0 mL up to approx. 10 mL were estimated. The most participants did not have any experience of how to outline uncertainty budgets. The expanded uncertainties stated by the participants are in the range 0-18 mL for both phantoms and all materials. Results by the single participants were compared with the reference values provided by the coordinator through the En value, where $|En| < 1$ indicates agreement between measurement results while $|En| \geq 1$ shows disagreement. Out of a total of 6 single results obtained by the participants using CT scanning, 0% of the measurements yield $|En|$ values less than 1, and 100% larger than 1. Systematic errors were detected for some participants on some of the measured volumes. It could be due to the specified tolerances defined by the participants for segmentation of the polymer materials. It was found that scale error correction particularly should be considered for some participants. The comparison shows that CT scanning on phantoms, generally speaking, is connected with uncertainties in the range 1-1090 mL, as compared to an uncertainty range of 0-10 mL using the principle of water displacement. Each participant can use the comparison results in the report to investigate the presence of systematic errors or an underestimation of uncertainties. Statistics related to the used equipment and procedures show that participants, in general, have followed state of the art procedures for their measurements. The phantoms are suitable artefacts for CT measurements of this kind.
Investigation of process induced residual stresses and deformations for industrially pultruded parts having UD and CFM layers

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Investigation of the spring-in of a pultruded L-shaped profile for various processing conditions and thicknesses
In this study, a thermo-mechanical finite element model is developed to predict the spring-in of an industrially pultruded L-shaped profile made of glass/polyester composite. The resin curing kinetics are obtained from the differential scanning calorimetry (DSC) experiments. The development of the resin modulus is derived using the dynamic mechanical analysis (DMA) tests and the effective mechanical properties of the processing composite are calculated using a micromechanical model. The temperature and degree of cure distributions are obtained in a three dimensional (3D) thermo-chemical analysis using the finite element method (FEM). The predicted spring-in pattern at the end of the process is found to agree quite well with the observed for the real pultruded parts in a commercial pultrusion company. In addition, the effects of the pulling speed and the part thickness on the spring-in formations are investigated using the proposed numerical simulation tool. It is found that the magnitude of the spring-in increases with an increase in the pulling speed and part thickness.

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Increasing focus on environmental issues in industrial production has urged sheet metal stamping companies to look for new tribo-systems in order to substitute hazardous lubricants such as chlorinated paraffin oils. The efficiency of chlorinated paraffin is due to the fact that the lubricant reacts chemically with the tool and workpiece material forming thin films, which adhere strongly to the surfaces and reduce the tendency to metal-metal contact and material pick-up. Production tests of new, environmentally benign tribo-systems are, however, costly and laboratory tests are preferred as a preliminary simulative method to investigate alternative tribo-systems. The present paper presents a case study where an industrial process, consisting of deep drawing with two subsequent re-drawings, was selected and four potential new tribo-systems were tested including different workpiece materials, i.e. AHSSs and stainless steels. The performance of the tribo-systems was analyzed in the laboratory by means of a newly developed simulative test as well as in an industrial production process. The results obtained show a good agreement between the laboratory test and the industrial production process regarding the tribological performance, i.e. tendency to material pick-up and galling, of the evaluated tribo-systems. Moreover the SEM analysis shows that different workpiece materials result in different types of material pick-up.

Lubricant Film Breakdown and Material Pick-Up in Sheet Forming of Advanced High Strength Steels and Stainless Steels when Using Environmental Friendly Lubricants

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In the present work, the chemo-rheology of an industrial “orthophthalic” polyester system specifically prepared for a pultrusion process is characterized. The curing behaviour is first characterized using the differential scanning calorimetry (DSC). Isothermal and dynamic scans are performed to develop a cure kinetics model which accurately predicts the cure rate evolutions and describes the curing behaviour of the resin over a wide range of different processing conditions. The viscosity of the resin is subsequently obtained from rheological experiments using a rheometer. Based on this, a resin viscosity model as a function of temperature and degree of cure is developed and predicts the measured viscosity correctly. The evolution of the storage and loss moduli are also measured as a function of time using the rheometer which provides an information about the curing as well as the gelation. The temperature- and cure-dependent elastic modulus of the resin system is determined using a dynamic mechanical analyzer (DMA) in tension mode. A cure hardening and thermal softening model is developed and a least squares non-linear regression analysis is performed. The variation in elastic modulus with temperature and phase transition is captured for a fully cured resin sample.

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Measurement Uncertainty Evaluation in Dimensional X-ray Computed Tomography Using the Bootstrap Method

Industrial applications of computed tomography (CT) for dimensional metrology on various components are fast increasing, owing to a number of favorable properties such as capability of non-destructive internal measurements. Uncertainty evaluation is however more complex than in conventional measurement processes, e.g., with tactile systems, also due to factors related to systematic errors, mainly caused by specific CT image characteristics. In this paper we propose a simulation-based framework for measurement uncertainty evaluation in dimensional CT using the bootstrap.
In a case study the problem concerning measurement uncertainties was addressed with bootstrap and successfully applied to ball-bar CT measurements. Results obtained enabled extension to more complex shapes such as actual industrial components as we show by tests on a hollow cylinder workpiece.

Micro Injection Molding of Thin Walled Geometries with Induction Heating System

To eliminate defects and improve the quality of molded parts, increasing the mold temperature is one of the applicable solutions. A high mold temperature can increase the path flow of the polymer inside the cavity allowing reduction of the number of injection points, reduction of part thickness and moulding of smaller and more complex geometries. The last two aspects are very important in micro injection molding.

In this paper a new embedded induction heating system is proposed and validated. An experimental investigation was performed based on a test geometry integrating different aspect ratios of small structures. ABS was used as material and different combinations of injection velocity, pressure and mold temperature were tested. The replicated test objects were measured by means of an optical CMM machine. On the basis of the experimental investigation the efficacy of the embedded induction heating system with respect to improvement of replication quality, reduction of injection pressure and injection velocity as well as reduction of cycle time has been verified.
Micro Insert Moulding for the Production of 8 Pin RIC Socket for Hearing Aid Applications

This report presents the development of an 8 Pin RIC (Receiver in the canal) Socket for hearing instruments within the framework of the European project COTECH. There were 8 industrial demonstrators developed in COTECH based on the converged product and process design. Sonion’s 8 Pin RIC Socket was one of them. 8 Pin RIC Socket is a functionally versatile product which can combine many different functions in one single unit and presents many advantages compared with the previous 3 Pin RIC Socket. For the demonstrator production of the new Socket, two different production concepts were chosen—one based on semi-automated process and the other one is fully automated process. Current report presents the entire process chain for both the concepts and makes a comparative analysis based on the experimental investigation and validation. The work presented here can be a source of valuable information for industrial users and researchers working with micro production of metal-plastic hybrid components.

Modelling of defects in ingot forging: with the finite element flow formulation

The present report presents an investigation of the ingot forging process with special emphasis on modelling the influence of die geometry on the soundness of the ingot after hot forging. An investigation on how to model damage is also performed. The influence of the lower die angle is quantified experimentally by utilizing downscaled lead model ingots (billets) being compressed by a tool with different lower die angles. Centreline defects, occurring due to the ingot casting processes, are modelled by drilling holes through the centreline of the cast billets. The experiments showed a marked influence on centreline hole closure by the lower die angle. Of the utilized lower die angles, a 120° lower die gives the largest hole closure when applying same press stroke for all the experiments. The performed experiments are compared with both 2D and 3D FEM simulations. Both simulations are found to mimic the experiments reasonably correct. Therefore both models are subsequently applied for further investigations of the influence of the lower die angle on the evolution of centreline defects. 2D FEM single stroke simulations of ingots having different hardening behaviours yielded an approximately constant lower die angle of 130°-140° giving rise to the largest centreline porosity closure regardless of material hardening behaviour applied. Friction was found only to have minor influence on the optimum. Multi stroke forging operations have also been modelled since the ingot forging process consists of many forging strokes. Two different approaches to quantify ductile damage is applied: uncoupled ductile damage or a porous plasticity model. Lower die angles ranging from 60° to 180° with 30° intervals are used in the simulations. It is found that when applying the uncoupled ductile damage criterion normalized Cockcroft & Latham, a lower die angle of 120° was found to be best. “Best” is evaluated using a primitive average of damage and effective plastic strain measures. When applying porous plasticity as a model for the description of damage, a 90° lower die angle is found to be best closely followed by the applied, larger lower die angles. A preliminary investigation of the influence of feed size is performed. Only two different lower die angles of 120° and 180° are utilized with either 400mm or 800mm feed. Damage is modelled with porous plasticity while at the same time also computing normalized Cockcroft & Latham damage. It is found that when evaluating damage only
by relative density; feed size and lower die angle does not influence whether the hot forging process is successful or not. This is in disagreement with the general understanding of the ingot forging process. When evaluating ductile damage by the normalized Cockcroft & Latham criterion, marked differences is predicted depending on which lower die angle is applied. The damage is also affected by the feed size, indicating that the smallest of the two feed sizes should be utilized together with the 120° lower die in practice. These findings are in closer agreement with the general understanding of the ingot forging process. Therefore porous metal plasticity should not be used solely when evaluating the soundness of the final, forged ingot based on FEM simulations. Based on an analysis of forming fracture limit diagrams combined with uncoupled ductile damage criteria, it is found that the normalized Cockcroft & Latham criterion is most suited for modeling damage in bulk metal forming. If the forming fracture limit diagram can be described by a straight line having a slope of -1/2. A damage criterion independent of slope is presented. Often the forming fracture limit diagram consists of two straight lines intersecting one another in the principal strain space along a line corresponding to uniaxial tension. If the slopes of the two lines are -1/2 and -1, which is often encountered in practice, an uncoupled ductile damage criterion is introduced which predicts same damage value at fracture along both lines. A physical mechanism giving rise to different formability limits, depending on the applied stress state, is introduced. Further investigations of the mechanisms governing ductile fracture is still needed in order to confirm or reject the proposed damage criterion and damage mechanism.

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Modelling of Tape Casting for Ceramic Applications
Functional ceramics find use in many different applications of great interest, e.g. thermal barrier coatings, piezoeactuators, capacitors, solid oxide fuel cells and electrolysis cells, membranes, and filters. It is often the case that the performance of a ceramic component can be increased markedly if it is possible to vary the relevant properties (e.g. electrical, electrochemical, or magnetic) in a controlled manner along the extent of the component. Such composites in which ceramic layers of different composition and/or microstructure are combined provide a new and intriguing dimension to the field of functional ceramics research. Advances in ceramic forming have enabled low cost shaping techniques such as tape casting and extrusion to be used in some of the most challenging technologies. These advances allow the design of complex components adapted to desired specific properties and applications. However, there is still only very limited insight into the processes determining the final properties of such components. Hence, the aim of the present PhD project is to obtain the required knowledge basis for the optimized processing of multi-material functional ceramics components. Recent efforts in the domain of ceramic processing are generally focused on the control of the microstructure while the importance of shaping is often underestimated. Improved performance requires the design and shaping of both controlled architectures and microstructures. Novel functionally graded ceramic materials may be formed by multilayers or adjacent grading of different ceramic materials. Such grading is often desired for optimal performance. An example is when there is a gradient in temperature or chemical environment along the component during operation; in this case the properties of each section of the component should be optimized for the local environment by grading. The grading may be between entirely different ceramic materials or merely a minor compositional alteration within one type of material. However, there are several challenges to be met for the successful fabrication of such complex structures. Rheological properties play an extremely important role for the co-processing of more than one material. Only by matching the rheological properties of the different pastes, a reproducible and well defined gradient composite will be formed.
Tape casting involves the casting of a slurry onto a flat moving carrier surface. The slurry passes beneath a knife edge (doctor blade) as the carrier surface advances along a supporting table. The solvents evaporate to leave a relatively dense flexible sheet that may be stored on rolls or stripped from the carrier in a continuous process. Today, multilayers are achieved by laminating layers of different materials on top of each other. The challenge is to be able to tape cast layers of different materials simultaneously both stratified in the horizontal and in the lateral direction. Understanding how to achieve that and perfection of such a technique will open up a large variety of applications. General challenges with this process is, as mentioned, controlling the rheological properties of the slurries/pastes as they strongly affect the process and the quality of the final product, maintaining uniform composition during the process and controlling/understanding the shrinkage in drying and sintering. Furthermore, understanding the tape delamination and film cracking of multilayers as well as of interface fracture modes in multilayers is also an important topic that needs to be considered and understood.
In the present PhD thesis the focus is on the numerical modelling of the tape casting process of functionally graded
ceramic materials for fuel cell applications as well as magnetic refrigeration. Models to simulate the shaping of monolayer/multilayer and graded materials by tape casting are developed. The emphasis is on analyzing the entry flow of multiple slurries from the reservoir into the doctor-blade region as well as the exit region where a free surface (meniscus) forms. This encompasses a detailed fluid model capable of tracking the material flow/deformation taking the formation of the free surface into account. In the work it was chosen to focus on developing analytical/numerical flow solvers in both Ansys Fluent and Matlab.

Analytical approaches for fluid flow analysis in the tape casting process showed that a relative good agreement could be achieved between the results of the modelling and the experimental data. The study, furthermore, demonstrated that the aforementioned agreement was increased by improving the steady state model with a quasi-steady state analytical model. In order to control the most important process parameter, tape thickness, the two-doctor blade configuration was also modeled analytically. The model was developed to control the tape thickness based on the machine configuration and the material constants. Many of the affecting parameters in the process were embedded and they can easily be varied to evaluate their influence.

This study showed that using computational fluid dynamics (CFD) the process can be modeled with more details in order to better control the produced tapes. Very importantly, the free surface of the ceramic as leaving the doctor blade region was modeled. The rheological behavior of the ceramic slurry was also taken into account. The influence of the main process parameters, i.e. the substrate velocity, the initial slurry load, and the doctor blade height, were investigated.

Based on the developed model, one phenomenon inherit to the process called side flow was also modeled. The results showed that to reach a desired uniform tape the side flow factor should be kept as close as to the value of one. The impact of the process parameters were also discussed in details in order to control the side flow, and consequently the tape thickness. Moreover, a CFD model was developed to simulate multiple flow of the ceramic slurry in tape casting. The simulation was aimed to analyze the production of functionally graded ceramics (FGCs) which are used for magnetic refrigeration applications.

Numerical models were developed to track the migration of the particles inside the ceramic slurry. The results showed the presence of some areas inside the ceramic in which the concentration of the particles is higher compared to other parts, creating the resulting packing structure. And finally a numerical code was developed to simulate the drying process. The results showed that the mass loss due to the evaporation is increasing close to linearly with the drying time corresponding to an almost constant drying rate. However, the rate starts to decrease after some time in the simulation. This is in good agreement with the real life process where the drying categorized into two stages: (1) constant rate period (CRP), in which the rate of evaporation per unit area of the drying surface is independent of time, (2) falling rate period (FRP), in which the evaporation rate is reduced, as a consequence of low migration of the water from the bottom layers to the top ones due to diffusion (which is highly dependent to the temperature).

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**Modelling the deformation process of flexible stamps for nanoimprint lithography**

The present thesis is devoted to numerical modelling of the deformation process of flexible stamps for nanoimprint lithography (NIL). The purpose of those models is to be able to predict the deformation and stretch of the flexible stamps in order to take that into account when designing the planar 2D silicon master used in the NIL process. Two different manufacturing processes are investigated: (i) Embossing of an electroplated nickel foil into a hydrogen silsesquioxane (HSQ) polymer resist on a double-curved surface, (ii) NIL of a flexible polytetrafluoroethylene (PTFE) stamps into a polymethyl methacrylate (PMMA) resist. Challenges comprise several non-linear phenomena. First of all geometrical non-linearities arising from the inherent large strains and deformations during the process are modelled. Then, the constitutive behaviors of the nickel foil and the PTFE polymer during deformation are addressed. This is achieved by a general elasto-plastic description for the nickel foil and a viscoelastic-viscoplastic model for the PTFE material, in which the material parameters are found. Last, the contact conditions between the deforming stamp and the injection moulding tool insert are addressed. The different modelling phenomena for simulating the deformation process of the flexible foils are in this thesis added through a progression in complexity.

The importance of including non-linear geometry in the numerical models for simulation of nanoimprint lithography on curved surfaces is first investigated through a simple beam model, where a Timoshenko beam is deformed from 1D to 2D. Comparison with analytical solutions shows, that by including non-linear geometry, the deformations are in general smaller as compared to the linear theory for the same applied load. It is found, that for large deformations non-linear geometry has
to be taken into account in order to accurately calculate the displacements of the loaded geometry. A 2D axisymmetric numerical model for simulating the deformation of the nickel foil during embossing into HSQ on a double-curved surface is developed, utilizing non-linear material and geometrical behaviour. A nanostructure consisting of sinusoidal cross-gratings with a period of 426 nm is in an experiment successfully transferred to hemispheres with three different radii of 500 µm, 1000 µm and 2000 µm, respectively. Good agreement between measured and numerically calculated stretch ratios on the surface of the deformed nickel foil is found, and from the model it is also possible to predict the limits of the nanostructures on the curved surfaces, with decreasing radii. A combination of proper constitutive and frictional models for simulating the deformation of PTFE against steel on micro-scale is presented. The 3D axisymmetric model is verified through an experiment, in which a PTFE sheet with a predefined square grid pattern on the surface is deformed by a steel sphere mounted in a uniaxial tensile test machine. Good agreement between simulations and experimental results is found, both regarding force-displacement and principal strain measurements. The rheological representation of the constitutive model with a combination of a viscoelastic Zener-body and Johnson-Cook plasticity can be used to model the mechanical behavior of PTFE. Inclusion of the frictional behavior between the PTFE stamp and steel tool on micro-scale in the numerical model is shown to be of major importance in order to best simulate the strain field in the deformed PTFE sheet. Simulations in 3D of the deformation process of PTFE flexible stamps used for NIL on double-curved surfaces are presented. The constitutive model is implemented in ABAQUS through a user material subroutine. In order to take the large strains and deformations during the imprinting manufacturing process into account, non-linear geometry is applied in the simulations. The model is first verified through a series of experiments, where NIL on a curved tool insert for injection moulding is performed with various process parameters such as temperature, imprinting pressure and flexible stamp thickness. Good agreement between simulations and experimental results is found. The optimum process parameters are then used in the final application, where nanoimprint of a nanostructure giving a color effect is performed numerically and experimentally. Both experiment and simulation show a mismatch between the defined and measured nanostructures as a result of stretching of the flexible stamp. The model is shown to predict the stretch of the nanostructures with a maximum error of 0.5%, indicating that the model is able to capture the physics of this manufacturing process. The 3D model for simulating the imprint of the nanostructure giving a color effect is then used as the global model in the coupling to a local 2D model. The coupling between global and local model is performed defining the displacements at the edges of an element from the global model as boundary conditions for the local model. This was implemented in the subroutine DISP in ABAQUS. Both experiment and simulation show a mismatch also on nanoscale between the defined and measured nanostructures as a result of stretching of the flexible stamp. The model is shown to predict the stretch of the nanostructures with a maximum error of 0.5%, indicating that the model is able to capture the physics of this manufacturing process. The model is shown to predict the stretch of the nanostructures with a maximum error of 0.5%, indicating that the model is able to capture the physics of this manufacturing process. The model is shown to predict the stretch of the nanostructures with a maximum error of 0.5%, indicating that the model is able to capture the physics of this manufacturing process. The model is shown to predict the stretch of the nanostructures with a maximum error of 0.5%, indicating that the model is able to capture the physics of this manufacturing process.

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**Modelling the pultrusion process of an industrial L-shaped composite profile**

A numerical process simulation tool is developed for the pultrusion of an industrial L-shaped profile. The composite contains the combination of uni-directional (UD) roving and continuous filament mat (CFM) layers impregnated by a polyester resin system specifically prepared for the process. The chemo-rheology and elastic behavior of the resin are obtained by applying a differential scanning calorimetry (DSC) and a dynamic mechanical analyser (DMA), respectively. The process induced stresses and shape distortions are predicted in a 2D quasi-static mechanical analysis. The numerical process model predicts the residual spring-in angle which is found to be close to the one measured from the real pultruded L-shaped products. The residual spring-in angle is further analyzed using the developed simulation tool for different pulling rates. Through-thickness stress variations are found to prevail inside the part such that the UD and CFM layers have different stress levels at the end of the process. The predicted stress pattern is verified by performing a stress calculation using the classical laminate theory (CLT).

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Multi-objective optimization of die geometry in ingot forging

The soundness of an ingot after hot forging with different V-shaped lower dies is evaluated using finite element simulations. Two different modelling approaches that make use of uncoupled ductile damage and coupled ductile damage based on porousplasticity are employed. It is shown that the two approaches provide somewhat different results. A simple quantification scheme is suggested for ranking the overall performance of the different geometries of the V-shaped lower dies. Results show that a lower die angle in the range 90°-120° is capable of ensuring the best results.

Numerical and experimental analysis of resistance projection welding of square nuts to sheets

Projection welding of nuts to sheets is a widely utilized manufacturing process in the automotive industry. The process entails challenges due the necessity of joining different sheet thicknesses and nut sizes made from dissimilar materials, and due to the fact of experiencing large local deformations ranging from room temperature to above the melting point. Heating is facilitated by resistance heating and is highly influenced by the contact area resulting from the amount of deformation, which is also temperature dependent due to material softening and frictional conditions. Resort to new materials and applications require a new level of understanding of the process by combining finite element modelling and experimentation. This paper draws from the challenge of developing a three-dimensional computer program for electro-thermo-mechanical modeling of resistance welding and presents, as far as the authors are aware, the first ever three-dimensional simulation of the projection welding of square nuts to sheets by means of finite element analysis. Results are compared with experimental observations and measurements produced by the authors with the aim and objective of
assessing the accuracy, reliability and validity of the theoretical and numerical developments. Numerical simulations support the evaluation of the experiments by providing detailed information on the process like the initial heating location and the following temperature development, and allowing to analyze the weldability of the square nut to the sheet under different operating conditions. © 2014 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, SWANTEC Software and Engineering ApS, Universidade Técnica de Lisboa
Authors: Nielsen, C. V. (Intern), Zhang, W. (Ekstern), Martins, P. A. (Ekstern), Bay, N. (Intern)
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ISI indexed (2013): ISI indexed no
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Publication: Research - peer-review › Conference article – Annual report year: 2014

Numerical Model based Reliability Estimation of Selective Laser Melting Process
Selective laser melting is developing into a standard manufacturing technology with applications in various sectors. However, the process is still far from being at par with conventional processes such as welding and casting, the primary reason of which is the unreliability of the process. While various numerical modelling and experimental studies are being carried out to better understand and control the process, there is still a lack of research into establishing the reliability of the process. In this paper, a combined modelling-experimental approach is introduced to establish the reliability of the selective laser melting process. A validated 3D finite-volume alternating-direction-implicit numerical technique is used to model the selective laser melting process, and is calibrated against results from single track formation experiments. Correlation coefficients are determined for process input parameters such as laser power, speed, beam profile, etc. Subsequently, uncertainties in the processing parameters are utilized to predict a range for the various outputs, using a Monte Carlo method based uncertainty analysis methodology, and the reliability of the process is established.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Mohanty, S. (Intern), Hattel, J. H. (Intern)
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Numerical modeling of AA2024-T3 friction stir welding process for residual stress evaluation, including softening effects

In the present paper, a numerical finite element model of the precipitation hardenable AA2024-T3 aluminum alloy, consisting of a heat transfer analysis based on the Thermal Pseudo Mechanical model for heat generation, and a sequentially coupled quasi-static stress analysis is proposed. Metallurgical softening of the material is properly considered and included in the calculations by means of the Myhr and Grong model, implemented as a user subroutine in ABAQUS. Numerical outcomes are compared with experimental results, highlighting the intriguing predictive capabilities of the model for both temperatures and residual stresses. The contour method is employed to map the longitudinal residual stress distribution on a transverse cross section of the joint. The influence of the applied boundary conditions and of the release of the clamping system on residual stresses is also assessed.
Off-Line Testing of Tribo-Systems for Sheet Metal Forming Production

Off-line testing of new tribo-systems for sheet metal forming production is an important issue, when new, environmentally benign lubricants are to be introduced. To obtain useful results it is, however, vital to ensure similar conditions as in the production process regarding the main tribo-parameters, which are tool/workpiece normal pressure, sliding length, sliding speed and interface contact temperature. The paper describes a generic methodology for such tests exemplified on an industrial, multistage deep drawing example, where deep drawing is followed by two successive re-drawing operations leading to very high tool/workpiece interface pressure and temperature in the second re-draw. Under such conditions only the best lubricant systems work satisfactorily, and the paper shows how the performance of different tribo-systems in production may be predicted by off-line testing combined with numerical modelling in order to ensure proper test conditions.

General information
Optimum design of pultrusion process via evolutionary multi-objective optimization

Pultrusion is one of the most cost-effective manufacturing techniques for producing fiber-reinforced composites with constant cross-sectional profiles. This obviously makes it more attractive for both researchers and practitioners to investigate the optimum process parameters, i.e., pulling speed, power, and dimensions of the heating platens, length and width of the heating die, design of the resin injection chamber, etc., to provide better understanding of the process, consequently to improve the efficiency of the process as well as the product quality. Using validated computer simulations is "cheap" and therefore is an attractive and efficient tool for autonomous (numerical) optimization. Optimization problems in engineering in general comprise multiple objectives often having conflict with each other. Evolutionary multi-objective optimization (EMO) algorithms provide an ideal way of solving this type of problems without any biased treatment of objectives such as weighting constants serving as pre-assumed user preferences. In this paper, first, a thermochemical simulation of the pultrusion process has been presented considering the steady-state conditions. Following that, it is integrated with a well-known EMO algorithm, i.e., nondominated sorting genetic algorithm (NSGA-II), to simultaneously maximize the pulling speed and minimize “total energy consumption” (TEC) which is defined as a measure of total heating area(s) and associated temperature(s). Finally, the results of the evolutionary computation step is used as starting guesses for a serial application of a of gradient-based classical algorithm to improve the convergence. As a result, a set of optimal solutions are obtained for different trade-offs between the conflicting objectives. The trade-off solution, thus obtained, would remain as a valuable source for a multi-criterion decision-making task for eventually choosing a single preferred solution for the pultrusion process.
Performance verification of 3D printers

Additive Manufacturing continues to gain momentum as the next industrial revolution. While these layering technologies have demonstrated significant time and cost savings for prototype efforts, and enabled new designs with performance benefits, additive manufacturing has not been affiliated with 'precision' applications. In order to understand additive manufacturing's capabilities or short comings with regard to precision applications, it is important to understand the mechanics of the process. GE Aviation's Additive Development Center [ADC] is in a unique position to comment on additive metal processes and their dimensional capabilities. The former Morris Technologies has been producing Direct Metal Laser Melted parts since 2005 for a wide variety of industries. The retooled ADC now specializes in aerospace applications including GE's first production application: the LEAP fuel nozzle. This paper and presentation will take a deep dive into the hardware and mechanics of the modern-day DMLM machine from three of the largest equipment manufacturers. We will also look at typical post processes including the heat treats that are commonly applied to DMLM metal parts. Along the way, we'll mention several surface finish technologies that have been investigated including one that is known as MMP [micro-machining process] which has been used to controllably remove microns of material. Finally, the research will reveal one or two examples of techniques that have used to achieve tight tolerances at the ADC. These methodologies were employed to manufacture direct parts, where tolerances are not as tight as the conventional tools that would be used to produce such parts. Readers and attendees should walk away with a better understanding of Additive Manufacturing, specifically direct metal parts, and the tolerances obtainable today. It is believed that this background information can help engineers and tool makers make better decisions about when to pursue Additive Manufacturing in their industry.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Hansen, H. N. (Intern), Nielsen, J. S. (Intern), Rasmussen, J. (Intern), Pedersen, D. B. (Intern)
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Polymer Replication of a Randomly Nanostructured Insert with and without Induction Heating of the Mold

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Power Cycling and Thermal Stresses Analysis for High Efficiency DC/DC Converter (IFBBC) in Repetitive Avalanche Conditions

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Authors: Pittini, R. (Intern), Zhang, Z. (Intern), Staliulionis, Z. (Intern), Andersen, M. A. E. (Intern)
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Precision Glass Molding: Validation of an FE Model for Thermo-Mechanical Simulation

In precision glass molding process, the required accuracy for the final size and shape of the molded lenses as well as the complexity of this technology calls for a numerical simulation. The current paper addresses the development of an FE model for thermo-mechanical simulation of the precision glass molding process including heating, pressing, and cooling stages. Temperature- dependent viscoelastic and structural relaxation behavior of the glass material are implemented through a FORTRAN material subroutine (UMAT) into the commercial FEM program ABAQUS, and the FE model is validated with a sandwich seal test. Subsequently, precision molding of several glass rings is performed at three different pressing temperatures, and the experimental deformation of the glass rings at the end of the molding is compared with the predicted ones from FE simulation. Furthermore, the transient and residual stress distribution inside the glass rings are calculated by the developed FE model, and the effects of some important process parameters such as interface friction and mold temperature on the FE results are assessed. The developed FE model can be employed to predict the deformation behavior, final size/shape, and the residual stress state inside the glass lenses in a precision glass molding process.

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Authors: Sarhadi, A. (Intern), Hattel, J. H. (Intern), Hansen, H. N. (Intern)
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Organisations: Department of Civil Engineering, Section for Building Design, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Jensen, L. B. (ed.) (Intern), Thompson, M. K. (ed.) (Intern)
Process chain validation in micro and nano replication

Innovations in nanotechnology propose applications integrating micro and nanometer structures fabricated as master geometries for final replication on polymer substrates. The possibility for polymer materials of being processed with technologies enabling large volume production introduces solutions to remove technology barrier between lab-scale proof-of-principle and high-volume low-cost production of nanotechnology based products.

The aim of the current study was to develop methods and approaches to process chain validation for final polymer micro and nano structures replication. Fidelity between different process chain steps and its dependency to process variation, process conditions, tool accuracy, material behavior and features geometries were considered and quantified.

Nickel shims with different sub-µm topographies, for injection molding tooling purposes, were manufactured during the current project. Deterministic structures integrated in Lab-on-a-chip (LoC) devices were produced using the so-called DEEMO process (dry etching, electroplating and molding), enabling multilevel (from micro to sub-µm meter ranges) structures fabrication. Finger print test structures were introduced and fabricated aside of functional feature geometries consisting of different chip designs following same fabrication steps (DEEMO). Functional surface patterning method based on anodization of aluminum substrate to create alumina oxide connected membranes acting as template for later nickel electroplating were fabricated.

Replication fidelity of deterministic geometries over the entire process chain was quantified through traceable measurements on designed finger print test structures. Characteristic LoC critical geometries collected in different versions of the finger print test geometries allowed measurements relocation of calibrated AFM measurements of different replicated geometries. Degree of replication of produced pseudo hexagonal structures between nickel and polymer substrate was quantified through AFM height measurements and analysis of amplitude surface parameters. New approaches oriented to quantification of replication quality over large areas of surface topography based on areal detection technique and angular diffraction measurements were developed.

A series of injection molding and compression molding experiments aimed at process analysis and optimization showed the possibility to control features dimensional accuracy variation through the identification of relevant process parameters. Statistical design of experiment results, showed the influence of both process parameters (mold temperature, packing time, packing pressure) and design parameters (channel width and direction with respect to the polymer flow) on the final quality of replicated sub-µm features. For cross test structure with target design height dimension of 62 nm and width of 500 nm, the largest depth deviation was measured. For an average measured polymer channel depth corresponding to 94% replication of the corresponding nickel tranches a standard deviation of 4% around the calculated average value was assessed.

The work is concluded validating the deterministic test structures as a tool to predict, through relocation of measuring positions, replication quality of critical geometries of specific LoC devices. The study showed replication quality of the process monitoring geometries within the same dimensional variations of the functional structures fabricated in the same chip. Measurement results were evaluated in terms of process capability quantifying product accuracy to the target value (full replication) within a range of ±3 nm and process reproducibility within a range of ±8 nm. Therefore test structures provide a process calibration tool enabling definition of tolerance limits within micro and nano replication.
Process variations in surface nano geometries manufacture on large area substrates

The need of transporting, treating and measuring increasingly smaller biomedical samples has pushed the integration of far reaching number of nanofeatures over large substrates size in respect to the conventional processes working area windows. Dimensional stability of nano fabrication processes over large area is key to ensure the device functionality. In this research, the process variation of sub-μm lithography processes is evaluated for different positions and features orientations, identified by produced test structures on a 100 mm diameter, 525 μm thick silicon wafer. The deviations from the target designed dimensions are quantified through AFM measurements on the silicon and on the subsequently electroplated nickel geometries.

Quality assurance of CT scanning for industrial applications

X-ray computed tomography (CT) gives major possibilities by looking through the industrial parts with complex geometries, but one of the largest challenges is the quality assurance of measurements. This Ph.D. project at DTU Mechanical Engineering deals with the development of procedures for quality assurance of CT for industrial measurements both in the manufacturing and in the meat processing industries. Various methods and reference objects have been developed in this project to establish metrological traceability of measurements. Moreover investigations as well as international comparisons in the field of application on the two different areas have been carried out.

Different reference objects have been developed and introduced for the manufacturing industry: step gauge, step cylinder and a cylindrical multi-material assembly. These objects can be used for correction of measurement errors in the CT model. Moreover, two reference objects are calibrated objects from the manufacturing industry: a threaded tube from the medical industry and a LEGO brick from the toy industry. Establishment of traceability for all objects is performed using coordinate measuring machines (CMMs) with known uncertainty. The stability has been documented for all reference objects except for the step cylinder and the cylindrical multi-material assembly.

A design of experiment (DOE) was performed on measuring errors arising in a CT, in terms of material density and orientation of scanned step gauges. An analysis of variance (ANOVA) shows that all main factors and their interactions are significant. The maximum deviation from the reference value can be reduced by compensating for systematic errors, but it is more complicated to correct for vertical orientations in high density materials.

In an interlaboratory comparison involving 27 laboratories from 8 countries, measurements were carried out using CT on two common objects from the manufacturing industry, a threaded tube and a LEGO brick. The comparison has shown that CT measurements on the industrial parts used lie in the range 6-53 μm, with maximum values up to 158 μm, compared to average uncertainties below 5.5 μm using CMMs.

A test was performed to check if X-ray contrast modalities can be applied for metrological purposes. Traditionally, segmentation between multi-materials in CT scanning is done by using different edge detection techniques and threshold algorithms, but these are only available for multi-materials where the densities are not close to each other. X-ray contrast modalities overcome this problem by constructing dark field, phase contrast and transmission images. Measurement results show that further development related to stability issues on the used CT is needed to create a metrological tool using X-ray contrast modalities.

Two synthetic reference phantoms have been developed by Danish Meat Research Institute (DMRI) and introduced for the meat processing industry. The phantoms represent real pig carcasses and are made of several polymer components, representing tissue types such as lean meat, fat, and bone. Establishment of traceable volume measurements for the phantoms is performed using the gravimetric method (also called water displacement). The stability has been documented for the two phantoms.

For the meat processing industry concerned, a similar interlaboratory comparison using two reference phantoms from the meat processing industry was carried out using CT, and involved four laboratories from 4 countries. The comparison has shown that CT measurements on the phantoms used lie in the range 1-1090 mL, with maximum values up to 1348 mL, compared to average uncertainties below 10 mL using the gravimetric method.

DMRI and DTU Compute have previously developed advanced image analysis software (PigClassWeb) which performs virtual dissections in pig carcasses. A DOE was carried out to document the performance of PigClassWeb through volume
comparisons to real dissections of pig carcasses. For the real dissections, volumes of tissue types such as bone, lean meat and fat, are estimated using commercial VolumeGraphics software. It is detected that the ANOVA and the residuals from the virtual dissection fail the normality test. The reason can be that the simulation data has special problems and challenges which are difficult to overcome by using current regression software.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Angel, J. A. B. (Intern), De Chiffre, L. (Intern), Hansen, H. N. (Intern), Cantatore, A. (Intern)
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Quality_assurance_of_CT_scanning.pdf
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Rendering of surface-geometries at job-generation level for camouflaging the layered nature of Additively Manufactured parts
The layered nature of Additive Manufactured parts, specifically those given from the Fused Deposition Modelling (FDM) process, exhibit a distinct surface definition. The origin of this is from the 2.5D deposition scheme, which leaves the seam between the individual layers clearly visible.[1] It is proposed to camoufla ge these layers in order to produce parts with a better visual appeal, and to add functional surface structures. In order to generate such surface structures without adding a challenging computational overhead at job-generation, inspiration from Computer Generated Imaging (CGI) is found. An often used method for visualization of complex geometries within CGI is by producing a geometrical primitive after which the primitive is passed through a renderer.[2] Examples can be geometries with hair, leather structure and their like. Should the entire geometry including surface definition sought to be modelled as one three dimensional surface, the geometrical complexity of this would be of intangible proportions and force even the most modern computer clusters to depletion of computing power. The task is therefore handled with an abstraction layer between 3D geometry and texture. It is here the renderer handles the task of adding the surface to the geometry, as a part of the workflow of generating a deflated 2D image[3].

General information
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Source: FindIt
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2015

Replication of micro structured surface by injection moulding of PEEK
A micro-structured Ni insert was investigated for PEEK injection moulding. The micro features are circular holes 4 μm in diameter and 2 μm deep, with a 2 μm edge-to-edge distance. 6000 moulding cycles was operated. Half of the insert was coated by 200nm CrN. PEEK parts produced by the coated side and non-coated side were compared. Coating thickness was measured at intervals of production and employed to characterize the coating wear. Pillars geometry at fixed locations on PEEK parts was studied by SEM. EDS was conducted on the PEEK parts in order to study the Ni and Ag contamination. The results show the studied coating has a very low wear, and no Ni or Ag contamination on PEEK was detected for both parts produced by coated side and uncoated side. Coating improved demolding by reducing small indentations on pillars. The method to apply micro structured Ni plate on 3D parts injection moulding is proposed.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Report for the 2014 DCEE Working Group Meeting

The DCEE 2014 meeting at the Technical University of Denmark focused on interdisciplinarity in design processes while
embracing the central issues of the previous workshops: design tools / methods and design education in Civil and
Environmental Engineering (CEE).

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Section for Building Design
Authors: Jensen, L. B. (Intern), Thompson, M. K. (Intern)
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Integrated dynamic model, consequence based design, Parametric tool, Building performance simulation, Integrated design
Electronic versions:
DCEE_2014_eProceedings_186_188.pdf
Publication: Research - peer-review › Book chapter – Annual report year: 2014

Reproducibility of a reaming test
The reproducibility of a reaming test was analysed to document its applicability as a performance test for cutting fluids.
Reaming tests were carried out on a drilling machine using HSS reamers. Workpiece material was an austenitic stainless
steel, machined using 4.75 m•min⁻¹ cutting speed and 0.3 mm•rev⁻¹ feed. A mineral straight oil and a water–based
lubricant at two different oil concentrations were compared with respect to hole quality, evaluated in terms of surface finish
(conventional arithmetic mean roughness Ra and roughness profiles), and hole geometry (hole diameter and roundness).
Process reproducibility was assessed as the ability of different operators to ensure a consistent rating of individual
lubricants. Absolute average values as well as experimental standard deviations of the evaluation parameters were
calculated, and uncertainty budgeting was performed. Results document a built–up edge occurrence hindering a robust
evaluation of cutting fluid performance, if the data evaluation is based on surface finish only. Measurements of hole
geometry provide documentation to recognise systematic error distorting the performance test.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Pilny, L. (Intern), Müller, P. (Intern), De Chiffre, L. (Intern)
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Scopus rating (2017): SNIP 0.529 SJR 0.411 CiteScore 0.77
Simulation-aided investigation of beam hardening induced errors in CT dimensional metrology

Industrial x-ray computed tomography (CT) systems are being increasingly used as dimensional measuring machines. However, micron level accuracy is not always achievable, as of yet. The measurement accuracy is influenced by many factors, such as the workpiece properties, x-ray voltage, filter, beam hardening, scattering and calibration methods (Kruth et al 2011 CIRP Ann. Manuf. Technol. 60 821–42, Bartscher et al 2007 CIRP Ann. Manuf. Technol. 56 495–8, De Chiffre et al 2005 CIRP Ann. Manuf. Technol. 54 479–82, Schmitt and Niggemann 2010 Meas. Sci. Technol. 21 054008). Since most of these factors are mutually correlated, it remains challenging to interpret measurement results and to identify the distinct error sources. Since simulations allow isolating the different affecting factors, they form a useful complement to experimental investigations. Dewulf et al (2012 CIRP Ann. Manuf. Technol. 61 495–8) investigated the influence of beam hardening correction parameters on the diameter of a calibrated steel pin in different experimental set-ups. It was clearly shown that an inappropriate beam hardening correction can result in significant dimensional errors. This paper confirms these results using simulations of a pin surrounded by a stepped cylinder: a clear discontinuity in the measured diameter of the inner pin is observed where it enters the surrounding material. The results are expanded with an investigation of the beam hardening effect on the measurement results for both inner and outer diameters of the surrounding stepped cylinder. Accuracy as well as the effect on the uncertainty determination is discussed. The results are compared with simulations using monochromatic beams in order to have a benchmark which excludes beam hardening effects and x-ray scattering. Furthermore, based on the above results, the authors propose a case-dependent calibration artefact for beam hardening correction and edge offset determination. In the final part of the paper, the investigations are expanded with experiments of a new set-up that includes non-cylindrical features; the effectiveness of the proposed calibration artefact is also studied.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Katholieke Universiteit
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Number of pages: 1
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Main Research Area: Technical/natural sciences
Stray capacitances in the watt balance operation: electrostatic forces: Paper

In a watt balance, stray capacitances exist between the coil and the magnet. Since the electric current flowing in the coil creates a difference in electric potentials between the coil and magnet, their electrostatic interactions must be taken into account. This paper reports the results of a finite element analysis of the forces acting on the coil.

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Authors: Quagliotti, D. (Intern), Mana, G. (Ekstern)
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Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 1.001 SNIP 1.955 CiteScore 1.88
ISI indexed (2013): ISI indexed yes
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BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.153 SNIP 1.745 CiteScore 1.78
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.074 SNIP 1.726 CiteScore 1.64
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
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Scopus rating (2010): SJR 0.779 SNIP 1.62
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Testing new tribo-systems for sheet metal forming of advanced high strength steels and stainless steels

Testing of new tribo-systems in sheet metal forming has become an important issue due to new legislation, which forces industry to replace current, hazardous lubricants. The present paper summarizes the work done in a recent PhD project at the Technical University of Denmark on the development of a methodology for off-line testing of new tribo-systems for advanced high strength steels and stainless steels. The methodology is presented and applied to an industrial case, where different tribo-systems are tested. A universal sheet tribotester has been developed, which can run automatically repetitive Bending Under Tension tests. The overall results show that the methodology ensures satisfactory agreement between laboratory tests and production tests, although disagreement can occur, if tribological conditions are not the same in the two cases.

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Scopus rating (2014): SJR 0.3 SNIP 0.126
Scopus rating (2013): SJR 0.117 SNIP 0.019
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ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.236 SNIP 0.101
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.125 SNIP 0.055
The 5 MW DeepWind floating offshore vertical wind turbine concept design - status and perspective

Floating vertical-axis wind turbines for offshore wind energy present a concept with novelty and potentials for reducing COE. Cost reduction for offshore wind power plants is an industrial challenge, and DeepWind is - as the analysis of the current design shows - believed to be a good candidate in achieving this.

In the paper the current design status of the 5 MW DeepWind concept is presented. The intended siting for the turbine is off the Norwegian west coast at about 250 m of sea depth. Focus is set on the integrated design highlighting structural benefits of the light rotor, the hydrodynamic aspects of the floating hull, and new generator design embracing magnetic bearings.

Two important design tools were developed which allow the industry to analyze various VAWT (vertical Axis Wind Turbine) variants for offshore applications: a main design tool “HAWC2” for aeroelastic design of VAWTs, and a generator design tool “NESSI”. HAWC2 has been adopted for VAWT rotors by DTU Wind Energy in the project and is explained on its technical capability to embrace integrated modeling of the different physical aspects. NESSI, developed at AAU (Aalborg University) is presented with focus on key elements in generator design.

The paper presents new developments in the current design of a novel rotor shape with overspeed control. Rotor performance, design structural key figures and upscaling potential are reported. New results implemented on permanent magnets generator and - bearing technology show, that it is possible to achieve a competitive design ready for further industrial optimization. A preliminary analysis is provided on the emergency philosophy for this concept.

General information

State: Published

Organisations: Department of Wind Energy, Test and Measurements, Aeroelastic Design, Wind Turbines, Department of Mechanical Engineering, Manufacturing Engineering, Aalborg University, SINTEF, Marine Technology Centre, Wind Energy Research, TUDelft


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Title of host publication: Proceedings - EWEA 2014

Publisher: European Wind Energy Association (EWEA)

Main Research Area: Technical/natural sciences

Conference: European Wind Energy Conference & Exhibition 2014, Barcelona, Spain, 10/03/2014 - 10/03/2014

Vertical-axis wind turbine, Offshore floating platform, DeepWind, Aerodynamics, Hydrodynamics, Pultrusion, Structural Optimization, Floater, Permanent magnet generator, Magnetic bearings, Controls, Safety

Electronic versions:

The_5_MW_DeepWind.pdf

Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

The effect of mandrel configuration on the warpage in pultrusion of rectangular hollow profiles

Thermo-mechanical process simulation of an industrially pultruded rectangular hollow profile is presented. Glass/polyester is used for the continuous filament mat (CFM) and the uni-directional (UD) layers. The process induced residual distortions together with the temperature and degree of cure are predicted using a three dimensional (3D) thermo-chemical model sequentially coupled with a 2D quasi-static generalized plane strain mechanical model. The predicted deformation pattern at the end of the process is found to agree quite well with the one observed for the real pultruded
parts in a commercial pultrusion company. In addition, the predicted warpage behaviour is further analysed by adjusting the mandrel length as well as including the mandrel heating. Using the proposed process model, the effect of the mandrel configurations on the quality of the pultrusion is investigated in terms of temperature, degree of cure and distortions. These unwanted residual distortions may lead to not meeting the desired geometrical tolerances e.g. warpage of pultruded window frames and hollow profiles as well as spring-in of L-shaped profiles, etc.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Twente
Authors: Baran, I. (Intern), Hattel, J. H. (Intern), Akkerman, R. (Ekstern)
Pages: 250-256
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Main Research Area: Technical/natural sciences

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BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.29 SJR 0.18 SNIP 0.303
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Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.172 SNIP 0.374 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.177 SNIP 0.436 CiteScore 0.22
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.184 SNIP 0.296
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.209 SNIP 0.24
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.192 SNIP 0.283
Scopus rating (2007): SJR 0.194 SNIP 0.366
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.221 SNIP 0.42
Scopus rating (2005): SJR 0.221 SNIP 0.373
Scopus rating (2004): SJR 0.225 SNIP 0.434
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.218 SNIP 0.32
Web of Science (2003): Indexed yes
The Effect of Product Size on the Pulling Force in Pultrusion

In the present work, pultrusion of a composite rod is simulated for various part thicknesses using the finite element method. The pultrusion process set-up is taken from literature in which the temperature and the degree of cure evolutions inside the rod were measured. The predicted temperature and degree of cure profiles in the three dimensional (3D) thermo-chemical analysis are found to agree well with the measured data. The contact pressure between the part and the heating die is calculated using a mechanical contact formulation in the 2D mechanical process model for 9 different part thickness values. Using the contact pressure distribution along the die, the process induced pulling force is predicted. For the simulated cases, a non-linear relation is found between the total force and the product size.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Salerno, University of Twente
Authors: Baran, I. (Intern), Carlone, P. (Ekstern), Hattel, J. H. (Intern), Palazzo, G. S. (Ekstern), Akkerman, R. (Ekstern)
Pages: 1763-1770
Publication date: 2014
Main Research Area: Technical/natural sciences

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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.172 SNIP 0.374 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.177 SNIP 0.436 CiteScore 0.22
ISI indexed (2011): ISI indexed yes
The effect of scattered light sensor orientation on roughness measurement of curved polished surfaces

Light scattering is a method for surface roughness measurements well suitable for use in a production environment thanks to its fast measurement rate, insensitivity to vibrations and to small misalignments. The method is however affected by several other factors. In this paper, the effect of angular orientation of a commercial scattered light sensor on roughness measurements of polished cylindrical surfaces with crossed surface lay is investigated to document the robustness of the method.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Pilny, L. (Intern), Bissacco, G. (Intern), De Chiffre, L. (Intern)
Pages: 233-236
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title: euspen
Main Research Area: Technical/natural sciences
Conference: 14th euspen International Conference, Dubrovnik, Croatia, 02/06/2014 - 02/06/2014
Surface roughness, Measurement, Light scattering
Electronic versions:
The_effect_of_scattered_light.pdf
Source: PublicationPreSubmission
Source-ID: 93455049
Publication: Research - peer-review › Article in proceedings – Annual report year: 2014

The effect of scattered light sensor orientation on roughness measurement of curved polished surfaces
The effect of angular orientation of a scattered light sensor with respect to main curvature and surface lay on roughness measurements is evaluated. A commercial scattered light sensor OS 500-32 from Optosurf GmbH was used. The investigation was performed on polished cylindrical surfaces with crossed surface lay to document the robustness of the method. The instrument area-integrating measuring principle (figure 1) is based on a non-coherent light beam of $\varnothing$ 0.9 mm and 670 nm wavelength illuminating the measured surface, reflection of the incident light from the surface slopes in spatial directions, and its acquisition within $\pm 16^\circ$ angular range with a linear detector array. From the distribution of the acquired scattered light intensity, a number of statistical parameters describing the surface texture are calculated, where
the Aq parameter (variance of the scattered light distribution), is used to characterize the surface roughness.

The lubricity of diethyl ether (DEE)

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Sivebæk, I. M. (Intern), Jacobsen, J. (Ekstern)
Number of pages: 1
Pages: 41
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ISBN (Print): 978-87-92765-26-0
Main Research Area: Technical/natural sciences
Conference: 16th Nordic Symposium on Tribology, Aarhus, Denmark, 10/06/2014 - 10/06/2014
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Paper med titlen: The lubricity of ethers and alcohol-water blends vedhæftet
Source: PublicationPreSubmission
Source-ID: 100963726
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2014

The missing link between the extensional dynamics of polymer melts and solutions

Based on extensional viscosities measured on narrow molecular weight distributed (NMMD) polystyrenes and polystyrene oligomer dilutions thereof, we discuss the relation between the flow physics of polymer solutions and melts. A polymer solution is here characterized as a dilution where the diluent contains less than two Kuhn steps. At the same entanglement number (e.g. concentrations) its extensional viscosities are up to about 300% higher than the corresponding viscosities for polymer blends. A blend is understood as a polymer system diluted with polymer/oligomer containing active chain in term of Kuhn steps, e.g. at least two Kuhn steps. A similar disagreement is observed between blends and pure NMMD melts, both containing the same entanglement number. © 2013 Elsevier B.V.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Chemical and Biochemical Engineering, The Danish Polymer Centre
Authors: Rasmussen, H. K. (Intern), Huang, Q. (Intern)
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Publication date: 2014
Main Research Area: Technical/natural sciences

Publication information
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Volume: 204
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.509 SJR 1.14 CiteScore 2.44
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.43 SJR 1.145 SNIP 1.604
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.155 SNIP 1.505 CiteScore 2.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.988 SNIP 1.324 CiteScore 1.96
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.024 SNIP 1.606 CiteScore 2.09
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.101 SNIP 1.532 CiteScore 1.93
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.09 SNIP 1.408 CiteScore 1.93
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.232 SNIP 1.743
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.534 SNIP 1.504
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.519 SNIP 1.917
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.342 SNIP 1.477
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.439 SNIP 1.456
Scopus rating (2005): SJR 1.573 SNIP 1.52
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.288 SNIP 1.82
Scopus rating (2003): SJR 1.326 SNIP 1.312
Scopus rating (2002): SJR 1.755 SNIP 1.679
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.293 SNIP 1.155
Scopus rating (2000): SJR 1.354 SNIP 1.479
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.505 SNIP 1.629

Original language: English

Polymer solutions, Polystyrenes, Viscosity, Polymer melts

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Source: dtu
Source-ID: n:oai:DTIC-ART:compendex/428009996::36627
Thermal Analysis of Bending Under Tension Test

The tribological conditions in deep drawing can be simulated in the Bending Under Tension test to evaluate the performance of new lubricants, tool materials, etc. Deep drawing production with automatic handling runs normally at high rate. This implies considerable heating of the tools, which sometimes can cause lubricant film breakdown and galling. In order to replicate the production conditions in bending under tension testing it is thus important to control the tool/workpiece interface temperature. This can be done by pre-heating the tool, but it is essential that the interface temperature during testing is similar to the one in the production tool. A universal sheet tribo-tester has been developed, which can run multiple tests automatically from coil. This allows emulating the temperature increase as in production. The present work performs finite element analysis of the evolution and distribution of temperature in the bending under tension test by making use of boundary conditions and calibration values directly measured from experiments. The overall methodology combines 2D and 3D models of the bending under tension test with steady state and transient thermal and thermo-mechanical procedures. Results show that the proposed methodology applied to a single stroke can effectively and accurately predict the interface temperature in the test tool, thus avoiding the otherwise required thousands of thermo-mechanical FEM analyses of temperature development during testing before thermal steady state has been reached.

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Grundfos A/S, Universidade de Lisboa
Authors: Ceron, E. (Ekstern), Martins, P. A. (Ekstern), Bay, N. (Intern)
Pages: 1805-1810
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Conference: 11th International Conference on Technology of Plasticity, Nagoya, Japan, 19/10/2014 - 19/10/2014
Main Research Area: Technical/natural sciences

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Journal: Procedia Engineering
Volume: 81
ISSN (Print): 1877-7058
Ratings:
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Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 0.74
Scopus rating (2015): CiteScore 0.56
Scopus rating (2014): CiteScore 0.53
Scopus rating (2013): CiteScore 0.4
ISI indexed (2013): ISI indexed no
Scopus rating (2012): CiteScore 0.28
ISI indexed (2012): ISI indexed no
Scopus rating (2011): CiteScore 0.45
ISI indexed (2011): ISI indexed no
Web of Science (2010): Indexed yes
Original language: English
Sheet forming tribology, Bending under tension test, Thermal analysis
Electronic versions:
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Bibliographical note
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Publication: Research - peer-review › Conference article – Annual report year: 2014

Thermal Modeling and Design of On-board DC-DC Power Converter using Finite Element Method

Power electronic converters are widely used and play a pivotal role in electronics area. The temperature causes around 54 % of all power converters failures. Thermal loads are nowadays one of the bottlenecks in the power system design and the cooling efficiency of a system is primarily determined by numerical modeling techniques. Therefore, thermal design through thermal modeling and simulation is becoming an integral part of the design process as less expensive compared to the experimental cut-and-try approach. Here the investigation is performed using finite element method - based
modeling, and also the potential of such analysis was demonstrated by real-world measurements and comparison of obtained results. Thermal modeling was accomplished using finite element analysis software COMSOL and thermo-imaging camera was used to measure the thermal field distribution. Also, the improved configuration of power converter was proposed.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Electrical Engineering, Electronics, Kaunas University of Technology
Authors: Staliulionis, Z. (Intern), Zhang, Z. (Intern), Pittini, R. (Intern), Andersen, M. A. E. (Intern), Noreika, A. (Ekstern), Tarvydas, P. (Ekstern)
Number of pages: 6
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Main Research Area: Technical/natural sciences

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Ratings:
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- Scopus rating (2017): SJR 0.258 SNIP 0.631 CiteScore 1.03
- Web of Science (2017): Indexed Yes
- Scopus rating (2016): CiteScore 0.85 SJR 0.294 SNIP 0.677
- Web of Science (2016): Indexed yes
- Scopus rating (2015): SJR 0.337 SNIP 0.601 CiteScore 0.71
- Scopus rating (2014): SJR 0.305 SNIP 0.658 CiteScore 0.66
- Web of Science (2014): Indexed yes
- Scopus rating (2013): SJR 0.253 SNIP 0.656 CiteScore 0.53
- ISI indexed (2013): ISI indexed yes
- Scopus rating (2012): SJR 0.226 SNIP 0.756 CiteScore 0.49
- ISI indexed (2012): ISI indexed yes
- Scopus rating (2011): SJR 0.204 SNIP 1.075 CiteScore 0.84
- ISI indexed (2011): ISI indexed no
- Scopus rating (2010): SJR 0.216 SNIP 0.274
- Web of Science (2010): Indexed yes
- Scopus rating (2009): SJR 0.191 SNIP 0.101
- Web of Science (2004): Indexed yes
Original language: English

**Power electronic converters, Temperature measurement, Thermal modeling, Finite Element Method**

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Source: PublicationPreSubmission
Source-ID: 99522254
Publication: Research - peer-review › Journal article – Annual report year: 2014

**Thermal Modelling and Design of On-board DC-DC Power Converter using Finite Element Method**

Power electronic converters are widely used and play a pivotal role in electronics area. The temperature causes around 54% of all power converters failures. Thermal loads are nowadays one of the bottlenecks in the power system design and the cooling efficiency of a system is primarily determined by numerical modelling techniques. Therefore, thermal design through thermal modelling and simulation is becoming an integral part of the design process as less expensive compared to the experimental cut-and-try approach. Here the investigation is performed using finite element method-based modelling, and also the potential of such analysis was demonstrated by real-world measurements and comparison of obtained results. Thermal modelling was accomplished using finite element analysis software COMSOL and thermo-imaging camera was used to measure the thermal field distribution. Also, the improved configuration of power converter was proposed.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Electrical Engineering, Electronics, Kaunas University of Technology
Authors: Staliulionis, Z. (Intern), Zhang, Z. (Intern), Pittini, R. (Intern), Andersen, M. A. E. (Intern), Noreika, A. (Ekstern), Tarvydas, P. (Ekstern)
Numerical process simulation of an industrially pultruded rectangular hollow profile is presented. The product contains the continuous filament mat (CFM) and the uni-directional (UD) roving layers made of glass/polyester. The distortion and stress evolutions together with the temperature and degree of fields are predicted by the simulation tool developed by the authors. The predicted deformation pattern at the end of the process is found to agree quite well with the one for the real pultruded part in a commercial pultrusion company. A parametric study is also performed based on the total volumetric shrinkage of the resin system during curing. The process induced residual stresses are calculated in the in-plane directions which have the potential to influence the internal stress levels during the service loading conditions.

Thermo-mechanical process modelling of industrially pultruded parts having UD and CFM layers

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Twente
Authors: Baran, I. (Intern), Hattel, J. H. (Intern), Akkerman, R. (Ekstern)
Number of pages: 8
Publication date: 2014

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Publisher: European Society for Composite Materials
Main Research Area: Technical/natural sciences
Conference: 16th European Conference on Composite Materials, Seville, Spain, 22/06/2014 - 22/06/2014
Computational modelling, Curing, Pultrusion, Residual stresses, Warpage
Electronics versions:
The Shrinkage Behavior and Surface Topographical Investigation for Micro Metal Injection Molding

Metal injection molding (MIM) is a near net shape manufacturing technology that can produce highly complex and dimensionally stable parts for high end engineering applications. Despite the recent growth and industrial interest, micro metal molding is yet to be the field of extensive research especially when it is compared with micro molding of thermoplastics. The current paper presents a thorough investigation on the process of metal injection molding where it systematically characterizes the effects of important process conditions on the shrinkage and surface quality of molded parts with micro features. Effects of geometrical factors like feature dimensions and distance from the gate on the replication quality are studied. The influence of process conditions on the achievable roughness for the final metal parts is discussed based on the experimental findings. The test geometry is characterized by 2½D surface structures containing thin ribs of different aspect ratios and thicknesses in the sub-mm dimensional range. The test parts were molded from Catamold 316L with a conventional injection molding machine. Afterwards, the parts were de-binded and sintered to produce the final test samples. Among the different process parameters studied, the melt temperature was the most influential parameters for better replication and dimensional stability of the final part. The results presented in the paper clearly show that the shrinkage in metal part is not uniform in the micro scale. It depends on the feature dimensions and also on the process conditions. A thin section of the part exhibits higher relative shrinkage compared with a thicker section. Based on these findings, it can be concluded that a micro part molded by MIM process will have higher relative shrinkage compared to a macro part made with the same process.

General information
State: Published
Organisations: Department of Management Engineering, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Islam, A. (Intern), Giannekas, N. (Intern), Marhöfer, D. M. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 5
Pages: 110007
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Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.21 SJR 0.165 SNIP 0.246
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.18 SNIP 0.218 CiteScore 0.18
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.171 SNIP 0.202 CiteScore 0.17
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.164 SNIP 0.187 CiteScore 0.16
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.176 SNIP 0.193 CiteScore 0.14
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.161 SNIP 0.16 CiteScore 0.12
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Three-dimensional simulations of resistance spot welding

This paper draws from the fundamentals of electro-thermo-mechanical coupling to the main aspects of finite element implementation and three-dimensional modelling of resistance welding. A new simulation environment is proposed in order to perform three-dimensional simulations and optimization of resistance welding together with the simulations of conventional and special-purpose quasi-static mechanical tests. Three-dimensional simulations of resistance welding consider the electrical, thermal, mechanical and metallurgical characteristics of the material as well as the operating conditions of the welding machines. Simulations of the mechanical tests take into account material softening due to the accumulation of ductile damage and cover conventional tests, such as tensile–shear tests, cross-tension test and peel tests, as well as the possibility of special-purpose tests designed by the users. The overall presentation is supported by numerical simulations of electrode misalignment caused by the flexibility of the welding machine arms and electrical shunting due to consecutive welds in the resistance spot welding of two sheets.
Resistance welding, Electrode misalignment, Electrical shunting, Mechanical testing, Numerical simulations, Finite element method

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Source-ID: 100556602
Publication: Research - peer-review › Journal article – Annual report year: 2014

THz waveguides, devices and hybrid polymer-chalcogenide photonic crystal fibers
In this contribution, we review our recent activities in the design, fabrication and characterization of polymer THz waveguides. Besides the THz waveguides, we finally will also briefly show some of our initial results on a novel hybrid polymer photonic crystal fiber with integrated chalcogenide glass layers.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Fibers & Nonlinear Optics, Department of Management Engineering, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Bao, H. (Intern), Markos, C. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)
Pages: 2047-2051
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Main Research Area: Technical/natural sciences
Conference: 35th Progress In Electromagnetics Research Symposium, Guangzhou (Canton), China, 25/08/2014 - 25/08/2014
Electrical and Electronic Engineering, Electronic, Optical and Magnetic Materials, Chalcogenides, Crystal whiskers, Optical fiber fabrication, Polymers, Waveguides, Chalcogenide glass, Crystal fiber, Fabrication and characterizations,
THz Waveguides, Devices and Hybrid Polymer-chalcogenide Photonic Crystal Fibers

In this contribution, we review our recent activities in the design, fabrication and characterization of polymer THz waveguides. Besides the THz waveguides, we finally will also briefly show some of our initial results on a novel hybrid polymer photonic crystal fiber with integrated chalcogenide glass layers.

Towards Mass Production by High Performance Transfer Press in Micro Bulk Forming

Multi-step micro bulk forming is characterized by complex processes and high precision requirements. Several process parameters influence on accuracy of micro forged parts where small tolerances in the order of few μm are in demand. The paper introduces a high performance transfer press for micro cold bulk forming. A methodology for selection of linear motors on the bases of the process parameters was obtained. In order to examine the effectiveness of the machine, specific geometry was investigated for production. Kinematic parameters were found for a production rate of 200 strokes per minute. A forged part with three different diameters in height was produced in a two-stage forming process using the introduced transfer press.
Uncertainty of pin height measurement for the determination of wear in pin-on-plate test
The paper concerns measurement of pin height for the determination of wear in a pin-on-plate (POP) or pin-on-disc (POD) test, where a pin is mounted on a holder that can be fixed on the test rig and removed for measurements. The amount of wear is assessed as difference of pin height before and after the test, using the distance between holder plane and pin friction plane as measurand. A series of measurements were performed in connection with POP testing of different friction material pins mounted on an aluminium holder. Pin height measurements were carried out on a coordinate measuring machine (CMM), achieving an expanded measurement uncertainty (k = 2) better than 1 mm. A simple dedicated fixture adaptable to workshop environment was developed and its metrological capability investigated, estimating an average uncertainty of measurement in the order of 5 mm (k = 2). Fixture measurements were compared with CMM measurements using the normalised $En$ value. Acceptable $En$ values ($En < 1$) were obtained in 58% of the measurements, showing a discrepancy which was explained in terms of different probing patterns on CMM and fixture. © 2014 CIRP

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Solid Mechanics
Authors: Drago, N. (Intern), De Chiffre, L. (Intern), Poulis, K. (Intern)
Pages: 106-111
Validation of in-line surface characterization by light scattering in Robot Assisted Polishing

The suitability of a commercial scattered light sensor for in-line characterization of fine surfaces in the roughness range Sa 1 – 30 nm generated by the Robot Assisted Polishing (RAP) was investigated and validated. A number of surfaces were generated and directly measured with the scattered light sensor on the machine in a shop floor environment. Scattered
light roughness measurements of the whole surfaces were performed to investigate the measurement method suitability for 100% quality control. For comparison, the surfaces were measured with reference optical instruments in laboratory conditions. Comparison of the scattered light measurements results taken on the machine with the reference optical roughness measurements taken in laboratory demonstrate the capability of the scattered light sensor for robust in-line surface characterization. This allows for the RAP process control by proper process endpoint detection in a multi-step polishing sequence. The measurements of the whole polished surfaces demonstrate improved reliability of the measurements with fast measurement rate, well suitable for cost-efficient 100% quality assurance.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Pilny, L. (Intern), Bissacco, G. (Intern), De Chiffre, L. (Intern)
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Where is the 'Why' in Axiomatic Design?

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Thompson, M. K. (Intern)
Pages: 7-12
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3D Modeling and Testing of Contact Problems in Resistance Welding
A generic, electro-thermo-mechanically coupled finite element program is developed for three-dimensional simulation of resistance welding. The developed computer program has reached a level of a complete standalone software that can be utilized as a tool in the analysis of resistance welding processes. Contact between deformable objects is modeled by the penalty method to handle multiple objects that appear in joining processes. Two algorithms are implemented for the identification of contact pairs. Simulations are presented for two metal forming processes involving contact and a number of resistance welding processes, which cover a wide range of spot welding and projection welding applications. Three-dimensional simulation of spot welding enables the analysis of critical effects like electrode misalignment and shunt effects between consecutive spots. A single-sided spot welding case involving three-dimensional contact is also presented. This case was suggested by and discussed with a German steel manufacturer.

When it comes to projection welding, a natural need for three-dimensional analysis arises in many cases because of the involved geometries. Cross-wire welding and welding of square nuts to sheets by projection welding are presented by means of experiments and simulations. These two cases are used to explore the capabilities of the developed simulation software by comparing experiments and simulations. A number of other projection welding cases are presented for further application of the software. These include joining of parallel sheets by circular projections and joining of perpendicular sheets by longitudinal projections. In the former case, the effects of unequal projection heights are analyzed, and in the latter case, the simulations are compared to the corresponding experiment by a Japanese company that proposed the
Another industrial case, by a German company, is joining of micro components. The joining is based on mechanical locking, and the deformation is accommodated by resistance heating, which at the same time is used to melt a polymer coating locally for creating electrical contact necessary for the end-product.

All the above cases are modeled by meshing techniques included in the computer program. Structured, isoparametric meshing is utilized for setting up initial meshes of individual objects. Unstructured, all-hexahedral meshing is utilized for creating initial meshes of objects defined by CAD surfaces and is applied for remeshing of selected objects in order to carry on certain simulations. The all-hexahedral meshing procedures are enhanced by adaptive bounding boxes, facilities for handling multi-object simulations and overall improved by applying topology based criteria in the creation of hexahedral meshes. Simulation time is significantly reduced by a developed parallel skyline solver. The new solver is developed for shared memory and can be implemented in existing finite element codes by changing the call to the solver, as long as the system matrix is prepared in skyline format.

Finally, the above models and procedures are operated by a developed graphical interface including its own pre and post processing facilities. This combines the above into a new complete, standalone software: SORPAS 3D.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Nielsen, C. V. (Intern), Martins, P. A. F. (Ekstern), Bay, N. (Intern), Zhang, W. (Intern)
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**3D thermo-chemical-mechanical analysis of the pultrusion process**

In the present study, a 3D Eulerian thermo-chemical analysis is sequentially coupled with a 3D Lagrangian quasi static mechanical analysis of the pultrusion process. The temperature and degree of cure profiles at the steady state are first calculated in the thermo-chemical analysis. In the mechanical analysis, the developments of the process induced stresses and distortions during the process are predicted using the already obtained temperature and degree of cure profiles together with the glass transition temperature. The predictions of the transverse transient stresses and distortions are found to be similar as compared to the available data in the literature. Using the proposed 3D mechanical analysis, different mechanical behaviour is obtained for the longitudinal stress development as distinct from the stress development in the transverse directions. Even though the matrix material is in a liquid state before entering the die (the degree of cure is zero), it is found that there exists longitudinal stresses at the mid-section which indicates that the already pulled material has an effect on the longitudinal stress evolution even before entering the die.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Michigan State University
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ISI indexed (2013): ISI indexed no
A 3D edge detection technique for surface extraction in computed tomography for dimensional metrology applications

Many factors influence the measurement uncertainty when using computed tomography for dimensional metrology applications. One of the most critical steps is the surface extraction phase. An incorrect determination of the surface may significantly increase the measurement uncertainty. This paper presents an edge detection method for the surface extraction based on a 3D Canny algorithm with sub-voxel resolution. The advantages of this method are shown in comparison with the most commonly used technique nowadays, i.e. the local threshold definition. Both methods are applied to reference standards and industrial parts and the comparison of the uncertainties obtained by both methods is presented.
A capability study of micro moulding for nano fluidic system manufacture

With the present paper the authors analysed process capability of ultra-precision moulding used for producing nano crosses with the same critical channels dimensions of a nano fluidic system for optical mapping of genomic length DNA. The process variation focused on product tolerances is quantified through AFM measurements. Uncertainty assessment of measurements on polymer objects is described and quality control results of sub-micro injection moulded crosses are shown in respect of the tolerance range specified by the end user as limit value for functional design.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Danish Fundamental Metrology, NIL Technology ApS, National Institute of Metrology
Authors: Calaon, M. (Intern), Hansen, H. N. (Intern), Tosello, G. (Intern), Garnaes, J. (Ekstern), Nørregaard, J. (Ekstern), Li, W. (Ekstern)
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Accuracy of transferring microparts in a multi stage former

Many fasteners used in electromechanical systems are micro metal parts which should be manufactured with high accuracy and reliability and in large quantities. Micro forming is promising to fulfill these demands. This research focuses on investigating a gripping unit in a multi stage former, as the positioning unit was discussed earlier. The parameters which play important roles in the gripping unit will be discussed and the precision and reproducibility evaluated to show the performance of the unit. This includes two different tests. The first test will show how accurately the unit can locate the parts and the second one is intended to depict how the unit transfers the parts with different diameters with respect to the front profile of the fingers. The experiments showed that the manipulator can handle the parts with 7 μm accuracy, 2 μm reproducibility and 9μm uncertainty for a 20mm distance between two adjacent stations. Copyright © 2013 Trans Tech Publications Ltd.
A CFD Approach for Prediction of Unintended Porosities in Aluminum Syntactic Foam: A Preliminary Study

Aluminum Syntactic Foam (ASF) is a material with great potential in applications related to lightweight structures and structural damping. However, experimental investigations in literature report that the infiltration process to fabricate ASF often results in incomplete infiltration. Published studies on modeling the infiltration process are mainly based on a porous media/permeability approach. This approach focuses on the global porosity of ASF rather than local unintended porosity, since it does not include the infiltration pattern around the individual spherical particles. This paper reports a numerical approach that enables for the simulation of the flow through the porous corridors of the preform. The numerical approach is established in the commercial software FLOW-3D and consists of a finite volume based computational fluid dynamics solver and a volume of fluid algorithm which together calculates the pressure, velocity and free surface of the aluminum. The results of the numerical model illustrate that this method has great potential of predicting unintended porosities in ASF and thereby optimizing the parameters involved in the infiltration process.

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Publication: Research - peer-review › Journal article – Annual report year: 2013

A CFD-Model for prediction of unintended porosities in metal matrix composites: A preliminary study
This paper presents a numerical method that simulates the flow through the porous corridors of the preform, which in theory enables the prediction of unintended porosities at the end of the process.

General information
A comparative study on life cycle assessment of micro and macro components

Micro manufacturing is an extremely demanding technological field where very special materials are used, extreme production condition like clean room, super high temperature, toxic chemicals, etc. are employed. Due to these facts, micro products can be environmentally damaging even after their smaller dimensional scale. So performing of LCA for micro products is equally important as it is for macro products. Keeping this motivation in mind, current paper systematically performs the LCA of a micro Socket used in hearing aids. The analysis makes a guide line about how to use the conventional knowledge about LCA and tools for the efficient LCA analysis of the micro parts. A comparative study is made in the paper by comparing two different sockets of hearing aid and it shows well how to make a comparative study for LCA when the manufacturer makes a new product to replace an old one. Another comparative study is made in the paper for micro and macro which shows that scaled up effect of the micro product compared to macro counterpart. The critical finding of this comparative study shows that the relative environmental damage done by micro product is higher than the macro product and that is confirmed by the net impact analysis. Finally, the LCA procedure presented in the paper, and the knowledge documented can be a valuable source of information for the researchers and scientists who work with the LCA of micro and macro products.
A control scheme for filament stretching rheometers with application to polymer melts

We propose a new control scheme to maintain a constant strain rate of the mid-filament diameter in a filament stretching rheometer for polymer melts. The scheme is cast as a velocity algorithm and consists of a feed-back and a feed-forward contribution. The performance of the controller is demonstrated on a commercial low density polyethylene. Several strain rates and experimental conditions are tested to demonstrate the necessity of the control parameters and the limits of both the control scheme and the experimental apparatus. When the control parameters are properly tuned, the algorithm ensures that the applied strain stays within 2% of the set point and measurements can be made up to Hencky strains of 6.5.

General information

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Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Computer Aided Process Engineering Center, Department of Mechanical Engineering, Manufacturing Engineering, Coloplast Danmark A/S
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ISI indexed (2013): ISI indexed yes
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ISI indexed (2012): ISI indexed yes
Acoustic Emission Based In-process Monitoring in Robot Assisted Polishing

The applicability of acoustic emission (AE) measurements for in-process monitoring in the Robot Assisted Polishing (RAP) process was investigated. Surface roughness measurements require interruption of the process, proper surface cleaning and measurements that sometimes necessitate removal of the part from the machine tool. In this study, development of surface roughness during polishing rotational symmetric surfaces by the RAP process was inferred from AE measurements. An AE sensor was placed on a polishing tool, and a cylindrical rod of Vanadis 4E steel having an initial turned surface roughness Ra = 3.1 μm was polished using a silicon carbide stone of grit size 600 in 40 polishing passes down to Ra = 0.07 μm. The polishing task was performed in five steps and after 4, 8, 20, 30, and 40 passes the resulting surface roughness was measured. The results show that with proper AE signal processing, the development of surface roughness in the RAP process can be monitored by AE measurement. The AE based monitoring allows in-process determination of the right moment for changing a polishing tool when applying a given set of parameters is no longer effective to create smoother surface, thus improving the efficiency of the process. It also allows for intelligent process control and generally enhances the robustness and reliability of the automated RAP system in industrial applications.

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Strecon A/S
Authors: Pilny, L. (Intern), Bissacco, G. (Intern), De Chiffre, L. (Intern), Ramsing, J. (Ekstern)
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Main Research Area: Technical/natural sciences
Robot assisted polishing, Acoustic emission, In-process monitoring, Surface roughness

Electronic versions:
Additive Manufacturing: Multi Material Processing and Part Quality Control

This Ph.D dissertation, Additive Manufacturing: Multi Material Processing and Part Quality Control, deal with Additive Manufacturing technologies which is a common name for a series of processes that are recognized by being computer controlled, highly automated, and manufacture objects by a layered deposition of material. Two areas of particular interest is addressed. They are rooted in two very different areas, yet is intended to fuel the same goal. To help Additive Manufacturing technologies one step closer to becoming the autonomous, digital manufacturing method of tomorrow.

Vision systems

A paradox exist in the field of Additive Manufacturing. The technologies allow for close-to unrestrained and integral geometrical freedom. Almost any geometry can be manufactured fast, efficiently and cheap. Something that has been missing fundamental capability since the entering of the industrial age. Now, with the geometrical freedom given back to the designer and engineer, a technology stale-mate keep us from benefitting from this freedom. Parts can easily be designed and manufactured beyond the capabilities of all common industrial measurement and verification methods, the designer and engineer is left to design parts that from a geometric metrology point of are view possible to verify the tolerances of. A proposal of a method for altering the state-mate to a check-mate is given. An inline vision system is developed that allow for verification of parts of a complexity that leave the only industrial alternative to the field of CT scanning. The background knowledge to develop such system is synthesized from an analysis of existing additive manufacturing processes and vision systems. The system is implemented and benchmarked throughout the scope of this Ph.D dissertation.

The proposed inline vision system has been put through several tests against sev- eral additive manufacturing systems. Till now the system has proven to be up to the task of reconstructing geometries otherwise only possible by CT scanning. The system outcompeted a reference CT scan of a large metal part by an indisputable degree. The system finally showed promising results when applied indirectly to reconstruct geometries from a DLP system. In general, the system has a potential for being implemented in different AM machines and processes and provides traceable measurements of the complex parts. As the technology of inline layered reconstruction of additively manufactured parts has just been proposed within this thesis, the technology is at a dawning level, and there is an abundance of open questions to be answered and much yet to be investigated. It is impossible but leaving this part of the project open-ended. What is to hope is that future research will tie these ends with the emerge of a fully developed system.

Additive Multi Material Manufacturing

Additive Manufacturing share close family bonds with CNC machine tools. State-of-the-art CNC machine tools of today are multi-axis hybrid machines. Abendoflathes,mills,grindersinoneplatform. Ifhistoryrepeatitself, hybrid additive manufacturing machines will emerge as the field evolve. It is sought to fuel this, by developing a flexible multi material manufacturing platform that will permit fundamental research towards a second generation additive manufacturing system that truly will be a universally applicable manufacturing machine. A desktop sized factory. Not merely the development of such machine is undertaken, also examined is the possibility to additively manufacture complex electromechanical systems, as a step towards being able to autonomously additively manufacture readily functional complex products. Based upon a synthesis of the applicability for each industrially accepted additive manufacturing process, the platform deemed most suitable was selected. The result was an Open and fully customizable FDM based multi material platform. The design solicit flexibility and the ability to alter the platform to conform to a multitude of experiments involving multimaterial extrusion. The resultant platform is also able to reproduce itself and as such future generations of the platform can efficiently be iterated through. Two generations of this platform was realized within the scope of this project.

To empathize why, and how versatile the prospect of multi-material platforms is, a set of subsystems that can be realized by multi-material manufacturing using FDM extrusion has been conceived. A functional battery is built using multi material extrusion. Composites that allow for the additive manufacturing of electrical conductors and resistors are engineered. A proposed method for additive manufacturing of linear actuators is assessed and proved promising. It is proposed that a library of additively manufacturable subsystems are built as a part of a knowledge sharing network. This systems library can over time grow to an extend where it is applied in the same manner as traditional engineering elements such as ball bearings, nuts, screws, washers, guide-rails, wires, batteries, electrical components and their like are used today.

General information

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Pedersen, D. B. (Intern), De Chiffre, L. (Intern), Hansen, H. N. (Intern)
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Publication information

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Publisher: Technical University of Denmark (DTU)
Advancements on the simulation of the micro injection moulding process

Process simulations are applied in micro injection molding with the same purpose as in conventional injection molding: aiming at optimization and support of the design of mold, inserts, plastic products, and the process itself. Available software packages are however not well suited for micro injection molding, because they are developed for macro plastic parts and they are therefore limited in the capability of modeling the polymer flow in micro cavities properly. However, new opportunities for improved accuracy have opened up due to current developments of the simulation technology. Hence, new strategies and aspects for comprehensive simulation models which provide more precise results for micro injection molding are discussed. Modeling and meshing recommendations are presented, leading to a multi-scale mesh of all relevant units in the injection molding process. The implementation of the process boundary conditions is described, being followed by results illustrating their importance on the simulation output. Finally, the influence of the cooling simulation settings is analyzed.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Marhofer, D. M. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern), Islam, A. (Intern)
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Source: dtu
Source-ID: u::9707
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

A finite volume alternate direction implicit approach to modeling selective laser melting

Over the last decade, several studies have attempted to develop thermal models for analyzing the selective laser melting process with a vision to predict thermal stresses, microstructures and resulting mechanical properties of manufactured products. While a holistic model addressing all involved phenomena is yet to emerge, the existing partial models have already become computationally heavy. This is observed to go hand-in-hand with a trend across literature for the usage of finite element (FE) formulations for developing implicit 3D models. However, the 3D implicit FE models, though able to accurately simulate the process, are constrained by either the size or scale of the model domain. A second challenging aspect involves the inclusion of non-linear material behavior into the 3D implicit FE models. An alternating direction implicit (ADI) method based on a finite volume (FV) formulation is proposed for modeling single-layer and few-layers selective laser melting processes. The ADI technique is implemented and applied for two cases involving constant material properties and non-linear material behavior. The ADI FV method consume less time while having comparable accuracy with respect to 3D implicit FE models. Drawing on the comparative results, appropriate models are recommended for different scenarios and modeling domains.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Hattel, J. H. (Intern), Mohanty, S. (Intern)
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Series: ICALEO 2013 - 32nd International Congress on Applications of Lasers and Electro-Optics
All-hexahedral meshing and remeshing for multi-object manufacturing applications

All-hexahedral meshing and remeshing algorithms giving support to finite element modeling of manufacturing processes require continuous development for improving its overall robustness and applicability. This paper draws from a previous all-hexahedral algorithm presented by the authors and proposes new developments related to the construction of adaptive core meshes and processing of multi-objects that are typical of manufacturing applications. Along with the aforementioned improvements there are other developments that will also be presented due to their effectiveness in increasing the robustness of all-hexahedral algorithms. These include identification and simplification of boundary features, reconstruction of vertices and edges with minimum element distortion, smoothing of nodal points along edges and topology based mesh repair procedures to ensure completeness of edge representation. The presentation is enriched with examples taken from pure geometry and metal forming applications, and a resistance projection welding industrial test case consisting of four different objects is included to show the capabilities of selective remeshing of objects while maintaining contact conditions and local geometrical details that are critical for electro-thermo-mechanical numerical simulations. © 2013 Elsevier Ltd. All rights reserved.
A Methodology for Off-line Evaluation of New Environmentally Friendly Tribo-systems for Sheet Metal Forming

Increasing focus on environmental issues in industrial production has urged sheet stamping companies to look for new tribo-systems in order to substitute hazardous lubricants such as chlorinated paraffin oils. Production testing of new lubricants is, however, costly and makes industry reluctant towards testing alternative solutions. The present paper presents a methodology for off-line testing of new tribo-systems based on numerical modelling of production process as well as laboratory test to adjust the latter combined with testing of selected tribo-systems on a new automatic sheet-tribo-tester emulating typical sheet forming production processes. Final testing of the tribo-systems in production verifies the methodology. © 2013 CIRP.
A motion study of a manipulator for transferring microparts in a multi stage former

In the earlier studies, it was shown that a whole multi stage former can be divided into three major sub-sections, the positioning unit, the gripping unit and the forming unit. The two first units were investigated and related parameters and features of each were discussed. This research herein deals with the forming unit. For this research, the positioning unit and the gripping unit are applied to the forming unit including a micro press equipped with a die system. The analysis focuses on verifying the results already extracted from previous researches by implementing all mentioned units together. A motion study of the system gives an overview of different steps and movements inside the multi stage former. Significantly, increasing the production rate increases the acceleration and also causes the time frame tight. The time limitations put overlaps on the moving parts in terms of milliseconds. A high speed camera was used in the experiments with high resolution to show the details of the motion while enabling to detect any unwanted movement within milliseconds. Importantly, increasing the frequency of image capturing within the movement is another beneficial feature in
the high speed camera in order to give sufficient information on critical movements where they may need sensors and enough time to ensure getting at the right position as programmed. In this research the production rate raised to 169 strokes per minute. The results show that the concept introduced for the manipulator works very well at a real process implementation. This significantly approves the techniques already were given to evaluate the precision in the positioning unit and the gripping unit. Copyright © 2013 by ASME.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Maskinmester Skolen København, Institute for Product Development
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Forming, High speed cameras, Manipulators, Industrial research
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Analysis of demoulding in micro injection moulding of cyclic-olefin-copolymer microfluidic systems

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Manchester, University of Birmingham, Karlsruhe Institute of Technology KIT, University of Glamorgan, University of Bradford
Authors: Tosello, G. (Intern), Griffiths, C. (Ekstern), Dimov, S. (Ekstern), Scholz, S. (Ekstern), Rees, A. (Ekstern), Whiteside, B. (Ekstern)
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A new capillary gripper for mini and micro parts
In the assembly of microparts the grasping and releasing phases are key tasks. Since in the microdomain gravity becomes negligible in comparison with adhesion forces, several reliable grasping methods have been developed. On the contrary, the releasing phase is still very critical because the part tends to stick to the gripper. In this paper a novel strategy based on capillary forces both for grasping and releasing is proposed. This novel grasping-releasing strategy exploits the transition between hydrophobic and hydrophilic surfaces to change the grasping force. The paper starts from the releasing problem in microassembly, deals with the manufacturing of hydrophobic and hydrophilic surfaces and demonstrates the use of such structures to grasp and release delicate mini and microparts.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Pisa
Authors: Fantoni, G. (Ekstern), Hansen, H. N. (Intern), Santochi, M. (Ekstern)
A new multi-zone model for porosity distribution in Al–Si alloy castings

A new multi-zone model is proposed that explains how porosity forms in various regions of a casting under different conditions and leads to distinct zonal differences in pore shape, size and distribution. This model was developed by considering the effect of cooling rate on solidification and distribution of porosity in Al–Si alloys cast as plates in moulds made with silica, ilmenite or zirconia sand cores or steel chills facing the major plate faces. The alloys cast were Al–7wt.% Si and Al–12.5wt.% Si in unmodified and modified forms, the latter with either Na or Sr addition. It is found that, regardless of cooling condition, Si content and modification treatment, the microstructure can be divided into three zones of varying size (across the casting thickness) that are determined by the local cooling conditions and the nucleation and growth mode of the Al–Si eutectic. The zones are: (1) an outer shell-like zone where directional columnar dendritic grains and a fine-celled, coherent eutectic form a low-porosity shell at the casting surface; (2) a transitional zone where equiaxed, eutectic cells grow between columnar dendritic grains and irregular pores become trapped in the mush; and finally (3) a central zone where the thermal gradient is low and equiaxed dendritic grains and eutectic cells grow at the centre of the casting and larger, rounded pores tend to form. The paper discusses how Si content, modification type and cooling conditions influence the location and size (i.e. depth) of each of these zones and how the distribution of porosity is thus affected. © 2013 Acta Materialia Inc. Published by Elsevier Ltd. All rights reserved.
A new multi-zone model for porosity distribution in Al-Si alloy castings.pdf
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Publication: Research - peer-review › Journal article – Annual report year: 2013

A new numerical framework to simulate viscoelastic free-surface flows with the finite-volume method

A new method for the simulation of 2D viscoelastic flow is presented. Numerical stability is obtained by the logarithmic-conformation change of variable, and a fully-implicit pure-streamfunction flow formulation, without use of any artificial diffusion. As opposed to other simulation results, our calculations predict a hydrodynamic instability in the 4:1 contraction geometry at a Weissenberg number of order 4. This new result is in qualitative agreement with the prediction of a non-linear subcritical elastic instability in Poiseuille flow. Our viscoelastic flow solver is coupled with a volume-of-fluid solver in order to predict free-surfaces in extrusion.

General information
A new PI tuning method for an industrial process: A case study from a micro-cogeneration system

Small scale strain gradient plasticity is coupled with a model of grain boundaries that take into account the energetic state of a plastically strained boundary and the slip and separation between neighboring grains. A microstructure of hexagonal grains is investigated using a plane strain finite element model. The results show that three different microstructural deformation mechanisms can be identified. The standard plasticity case in which the material behaves as expected from coarse grained experiments, the nonlocal plasticity region where size of the microstructure compared to some intrinsic length scale enhances the yield stress and a third mechanism, active only in very fine grained microstructures, where the grains deform mainly in relative sliding and separation.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, TUBITAK Marmara Research Center, Energy Institute, Istanbul Technical University
Authors: Saglam, G. (Ekstern), Tutum, C. C. (Intern), Kurtulan, S. (Ekstern)
Pages: 226-239
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Energy Conversion and Management
Volume: 67
ISSN (Print): 0196-8904
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 6.04 SJR 2.232 SNIP 2.109
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 2.023 SNIP 2.079 CiteScore 5.24
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.789 SNIP 2.791 CiteScore 5.35
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.613 SNIP 2.534 CiteScore 4.49
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.674 SNIP 2.242 CiteScore 3.72
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
A new procedure for characterizing textured surfaces with a deterministic pattern of valley features

In recent years there has been the development of a high number of manufacturing methods for creating textured surfaces which often present deterministic patterns of valley features. Unfortunately, suitable methodologies for characterizing them are lacking. Existing standards cannot in fact properly characterize such surfaces, providing at times unreasonable values.

In this paper, a new procedure for characterizing such surfaces is proposed, relying on advanced filtering and feature recognition and separation. Existing advanced filtering methods do not always eliminate all distortions, therefore some modifications are investigated. In particular the robust Gaussian regression filter has been modified providing an envelope first-guess in order to always fit the mean line through the plateau region. Starting from a filtered and aligned profile, the feature thresholds recognition and separation is therefore made possible. In particular the plateau and valley regions can be detected, separated and independently analyzed according to their function. The example of a multifunctional profile is presented. The profile is analyzed using the new procedure, which demonstrates outputting a correctly aligned roughness profile and permitting comprehensive feature analyses.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Image Metrology A/S
Authors: Godi, A. (Intern), Kühle, A. (Ekstern), De Chiffre, L. (Intern)
Number of pages: 8
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Measurement Science and Technology
Volume: 24
Issue number: 8
Article number: 085009
A New Rig for Testing Textured Surfaces in Pure Sliding Conditions

Throughout the years, it has become more and more important to find new methods for reducing friction and wear occurrence in machine elements. A possible solution is found in texturing the surfaces under tribological contact, as demonstrated by the development and spread of plateau-honed surface for cylinder liners. To prove the efficacy of a particular textured surface, it is paramount to perform experimental tests under controlled laboratory conditions. In this paper, a new test rig simulating pure sliding conditions is presented, dubbed axial sliding test. It presents four major components: a rod, a sleeve, a housing and a stripwound container. The rod and the sleeve are the two surfaces in relative sliding motion; the stripwound container maintains a constant, but adjustable normal pressure, and the housing serves as interface between the sleeve and the container. For carrying out the test, two machineries are necessary: a press to provide the normal pressure and a tensile machine to perform the axial movements. The test is calibrated so that the correspondence between the normal pressure and the container advancement is found. Preliminary tests are carried out involving a multifunctional and a fine-turned rod against a mirror-polished sleeve. Qualitatively, the multifunctional surfaces improve the friction conditions, but a more structured test campaign is required. It is furthermore assessed the repeatability of the test device, in order to rely on the results obtained. Ten repetitions made at the same pressure using the fine-turned rod displayed good repeatability of the force results both in terms of average values and trends.
An explanation of the mechanism for laser induced selective activation using diffusion theory

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Zhang, Y. (Intern), Hansen, H. N. (Intern), Hattel, J. H. (Intern), Tang, P. T. (Intern), Nielsen, J. S. (Intern), Tutum, C. C. (Intern)
Pages: 97-104
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Nami Jishu yu Jingmi Gongcheng
Volume: 11
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Scopus rating (2017): SNIP 0.312 SJR 0.212 CiteScore 0.27
Scopus rating (2016): SJR 0.191 SNIP 0.29 CiteScore 0.25
Scopus rating (2015): SJR 0.252 SNIP 0.377 CiteScore 0.29
Scopus rating (2014): SJR 0.278 SNIP 0.428 CiteScore 0.33
A non-contact 3D method to characterize the surface roughness of castings

A non-contact technique using a 3D optical system was used to measure the surface roughness of two selected standard surface roughness comparators used in the foundry industry. Profile and areal analyses were performed using scanning probe image processor (SPIP) software. The results show that the surface quality of the standard comparators was successfully evaluated and it was established that the areal parameters are the most informative for cast components. The results from the surface comparators were compared with the results from a stylus instrument. Sand cast components were also evaluated and the surface roughness parameter (Sa) values were compared with those of the standards. Sa parameter suffices for the evaluation of casting surface texture. The S series comparators showed a better description of the surface of castings after shot blasting than the A series.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Nwaogu, U. C. (Intern), Tiedje, N. S. (Intern), Hansen, H. N. (Intern)
Pages: 59-68
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Materials Processing Technology
Volume: 213
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 2.678 SJR 1.695 CiteScore 4.15
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.62 SJR 1.717 SNIP 2.646
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.385 SNIP 2.463 CiteScore 2.9
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.112 SNIP 3.708 CiteScore 3.43
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.702 SNIP 3.455 CiteScore 2.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Application of nanometrology to polymer production

General information
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Number of pages: 1
Publication date: 2013
Event: Abstract from 16th International Congress of Metrology, Parisf, France.
Main Research Area: Technical/natural sciences
Source: dtu
Source-ID: u::9779
Accurate multi-phase flow solvers at low Reynolds number are of particular interest for the simulation of interface instabilities in the co-processing of multilayered material. We present a two-phase flow solver for incompressible viscous fluids which uses the streamfunction as the primary variable of the flow. Contrary to fractional step methods, the streamfunction formulation eliminates the pressure unknowns, and automatically fulfills the incompressibility constraint by construction. As a result, the method circumvents the loss of temporal accuracy at low Reynolds numbers. The interface is tracked by the Volume-of-Fluid technique and the interaction with the streamfunction formulation is investigated by examining the Rayleigh-Taylor instability and broken dam problem. The results of the solver are in good agreement with previously published theoretical and experimental results of the first and latter mentioned problem, respectively.

Bio-inspired functional surfaces for advanced applications
Over millions of years, biological subjects have been in continuous combat with extreme environmental conditions. The fittest have survived through continuous evolution, an ongoing process. In particular, biological surfaces, which are the active interfaces between subjects and the environment, are being evolved to a higher state of intelligent functionality. These surfaces became more efficient by using combinations of available materials, along with unique physical and chemical strategies. Noteworthy physical strategies include features such as texturing and structure, and chemical strategies such as sensing and actuation. These strategies collectively enable functional surfaces to deliver extraordinary adhesion, hydrophobicity, multispectral response, energy scavenging, thermal regulation, antibiofouling, and other advanced functions. Production industries have been intrigued with such biological surface strategies in order to learn clever surface architectures and implement those architectures to impart advanced functionalities into manufactured consumer products. This keynote paper delivers a critical review of such inspiring biological surfaces and their nonbiological product analogs, where manufacturing science and engineering have adopted such advanced functional surface architectures.
**Capability Handbook- offline metrology**

This offline metrological capability handbook has been made in relation to HiMicro Task 3.3. The purpose of this document is to assess the metrological capability of the HiMicro partners and to gather the information of all available metrological instruments in the one single document. It provides a quick overview of what is possible today by the state of the art, what the HiMicro consortium can do and what metrological requirements we have concerning the HiMicro industrial demonstrators.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Islam, A. (Intern), Marhöfer, D. M. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 73
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Original language: English
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Source: dtu
Source-ID: u::7772
Publication: Research - peer-review › Book – Annual report year: 2013

**Catastrophic failure of polymer melts during extension**

Numerical flow modeling has been applied to study the break of monodisperse polymer melts during extension. These continuum mechanical based computations are within the ideas of the microstructural ‘interchain pressure’ theory. Calculated breaks, a result of small initial sample imperfections, agree with experimental observations.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Rasmussen, H. K. (Intern)
Pages: 136-140
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**Publication information**

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BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.509 SJR 1.14 CiteScore 2.44
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.43 SJR 1.145 SNIP 1.604
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.155 SNIP 1.505 CiteScore 2.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.988 SNIP 1.324 CiteScore 1.96
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.024 SNIP 1.606 CiteScore 2.09
ISI indexed (2013): ISI indexed yes
Cellular scanning strategy for selective laser melting: Evolution of optimal grid-based scanning path & parametric approach to thermal homogeneity

Selective laser melting, as a rapid manufacturing technology, is uniquely poised to enforce a paradigm shift in the manufacturing industry by eliminating the gap between job- and batch-production techniques. Products from this process, however, tend to show an increased amount of defects such as distortions, residual stresses and cracks; primarily attributed to the high temperatures and temperature gradients occurring during the process. A unit cell approach towards the building of a standard sample, based on literature, has been investigated in the present work. A pseudo-analytical model has been developed and validated using thermal distributions obtained using different existing scanning strategies. Several existing standard and non-standard scanning methods have been evaluated and compared using the empirical model as well as a 3D-thermal finite element model. Finally, a new grid-based scan strategy has been developed for processing the standard sample, one unit cell at a time, using genetic algorithms, with an objective of reducing thermal asymmetries. © 2013 SPIE.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Management Engineering
Authors: Mohanty, S. (Intern), Tutum, C. C. (Intern), Hattel, J. H. (Intern)
Challenges and Opportunities for Establishing Design as a Research Discipline in Civil and Environmental Engineering

There are a number of fields including architecture, industrial design, and urban planning and design, where design is the discipline upon which all research and teaching activities are based. In other fields such as aerospace and mechanical engineering, design is a sub-discipline with its own faculty, research and education communities, conferences, and journals. However, design remains an emerging sub-discipline in civil and environmental engineering – practiced, valued, and taught but not subject to rigorous academic research. This paper presents some of the challenges associated with the establishment of design as a research discipline within civil and environmental engineering, some of the benefits and opportunities that will come from that establishment, and some evidence for the fact that this process has already begun.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Thompson, M. K. (Intern)
Number of pages: 6
Publication date: 2013

Characterisation and Testing of Multifunctional Surfaces

Surface texturing is considered an effective way for reducing friction losses and wear occurrence in mechanical systems. A large number of surfaces with textures artificially engineered has been proposed by researchers worldwide and among them lie a new developed typology: MUFU surfaces, where the acronym stands for multifunctional. Produced by hard-turning followed by a highly controllable Robot Assisted Polishing process, MUFU surfaces feature reservoirs for providing extra-lubrication between the contacting parts as well as uppermost flat regions for ensuring the bearing capability. The introduction of MUFU surfaces is however bound with a series of challenges constituting the topic of the present work. The exploration touches a number of disciplines encompassing metrology, tribology and modelling. The metrological investigation represents the core of the work as further researches are bound to a clear and comprehensive description of the surfaces analysed. Robust filtering methods are adopted, extended, coded and implemented in the commercial software SPIP™. These methods prove to be extremely suitable in handling the raw data coming out from a measuring instrument and yield a correctly filtered and aligned roughness profile that would be unrealistically distorted if current practice methods were used. Once an aligned profile is obtained, a further operation is introduced: feature separation. The surface features are separated with a newly developed algorithm and analysed independently according to their function. In the present case, the roughness of the plateaus is investigated independently from the valleys, which on their turn are described by the amount of lubricant they can contain. These methods are applied throughout the whole experimental work in assessing the performances of MUFU surfaces in different applications. In machine elements, characterised by lower normal pressures, a new test rig is designed and developed studying the friction between bodies in pure sliding contact. Tests with this new device display how the employment of MUFU surfaces can reduce friction up to 50% compared to regularly machined surfaces. In metal forming tools, experimental tests are run in different processes. In deep drawing applications MUFU surfaces reduce the likelihood of galling occurrence compared to a highly polished surface. The presence of the valley impedes the galling propagation especially in real production conditions and test can run smoothly without failures. In ironing applications the severity of the conditions makes instead the texture being more harmful than useful and is therefore not advised.

Both analytical and numerical models are considered for studying the functionality of the surfaces. The analytical models, depending on the approach adopted, can give underestimations or overestimations of the results obtained with the same texture and an improvements and extension are needed in the future with the modification of the assumptions made. The road to be trodden seems though numerical modelling, whose implementation is still at an early stage. Numerical models are necessary for studying the functionality of MUFU surfaces in metal forming applications. Numerical models exist but they require ameliorations and extensions before they can be reliably used.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Solid Mechanics
Authors: Godi, A. (Intern), De Chiffre, L. (Intern), Hansen, H. N. (Intern), Klit, P. (Intern)
Pultrusion is a continuous manufacturing process used to produce high strength composite profiles with constant cross section. The mutual interactions between heat transfer, resin flow and cure reaction, variation in the material properties, and stress/distortion evolutions strongly affect the process dynamics together with the mechanical properties and the geometrical precision of the final product. In the present work, pultrusion process simulations are performed for a unidirectional (UD) graphite/epoxy composite rod including several processing physics, such as fluid flow, heat transfer, chemical reaction, and solid mechanics. The pressure increase and the resin flow at the tapered inlet of the die are calculated by means of a computational fluid dynamics (CFD) finite volume model. Several models, based on different homogenization levels and solution schemes, are proposed and compared for the evaluation of the temperature and the degree of cure distributions inside the heating die and at the postdie region. The transient stresses, distortions, and pull force are predicted using a sequentially coupled three-dimensional (3D) thermochemical analysis together with a 2D plane strain mechanical analysis using the finite element method and compared with results obtained from a semianalytical approach.
Computed tomography as a tool for tolerance verification of industrial parts

Computed tomography (CT) is becoming an important technology for industrial applications, enabling fast and accurate control of manufactured parts. In only a few minutes, a complete 3D model of a part may be obtained, allowing measurements of external and internal features. This paper presents results of tolerance verification of a plastic housing for an insulin pen manufactured by Novo Nordisk A/S. Calculation of measuring uncertainties was taken into account in decision making regarding the specified tolerance limits. Variables in terms of CT systems, data sets, and evaluation software are considered in this study.

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Concentrated Polymer Solutions are Different from Melts: Role of Entanglement Molecular Weight

We compare viscoelastic properties of several polystyrene solutions and melts with the same number of entanglements. It is demonstrated that the modulus and time can be shifted such that the linear viscoelastic properties are identical provided the number of entanglements are identical. However the nonlinear properties in strong extensional flow are different with polymer solutions showing markedly stronger extensional hardening than the corresponding melts. While increased chain extensibility for solutions may provide part of the explanation, it is demonstrated that other mechanisms are needed for a full explanation for the differences between solutions and melts.

General information

State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Micro- and Nanotechnology, Amphiphilic Polymers in Biological Sensing, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Huang, Q. (Intern), Mednova, O. (Intern), Rasmussen, H. K. (Intern), Javier Alvarez, N. (Intern), Skov, A. L. (Intern), Almdal, K. (Intern), Hassager, O. (Intern)
Number of pages: 10
Pages: 5026–5035
Coordinate Metrology by Traceable Computed Tomography

X-ray computed tomography (CT) is a measuring technique which has become an important technology in the production environment over the last years. Due to a number of advantages of CT compared to, e.g., coordinate measuring machines (CMMs), CT has been recently spread in the field of manufacturing metrology and coordinate metrology and is currently becoming more and more important measuring technique for dimensional measurements. This is mainly due to the fact that with CT, a complete three-dimensional model of the scanned part is in a relatively short time visualized using a computer, and measurements of outer as well as inner geometries can be performed with a micrometer accuracy. The result of every dimensional CT measurement, as of every other measuring instrument, has to be accompanied with a statement about measurement uncertainty. The knowledge about measurement uncertainty is an important factor for decision making about manufactured parts. However, due to many influences in CT, estimation of the uncertainty is a challenge, also because standardized procedures and guidelines are not available yet.

In this thesis, several methods for uncertainty estimation were applied in connection with a number of industrial components as well as calibrated workpieces. Measurement uncertainty was often used as a parameter for quantification of a selected influence quantity. Uncertainty estimation using the substitution method appeared to be well applicable to CT measurements in production environment. By performing repeated measurements of the calibrated workpiece, characterization of a CT system under study for a specific task part was achieved. The task-specific measurement uncertainty from repeated measurements was then transferred to other uncalibrated workpieces. It was documented in the thesis that CT is a well-established technique for tolerance verification of manufactured parts.

Two reference objects for performance characterization of industrial CT systems were developed within the scope of the Ph.D. thesis. Namely, CT ball plate and CT tree, which were further used for identification, characterization and correction of measurement errors in the CT volume. Their application appeared to be suitable for this task. Because the two objects consist of ruby spheres and carbon fibre, CT scans did not produce image artifacts, and evaluation of sphere-to-sphere distances was robust.

Several methods for scale error correction were implemented to correct original reconstructed volume data sets. This was done using the CT ball plate, the CT tree, the calibrated features measured by CMM and the "data base" approach considering a previous characterization of the CT system with a number of CT measurements using a calibrated ball bar. As, for example, methods using the two reference objects consisting of spheres, is a classical way for correction of the voxel size, when the distance between centres of spheres measured by CT is compared to calibrated measures, the application of calibrated features was documented on a metallic as well as on a plastic part and resulted in comparable observations. The last mentioned method using the "data base" approach seemed to work well, but its applicability shall be further validated.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Müller, P. (Intern), De Chiffre, L. (Intern), Hansen, H. N. (Intern), Cantatore, A. (Intern)
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Publisher: Technical University of Denmark (DTU)
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Electronic versions:
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Design Optimization of a 5 MW Floating Offshore Vertical-axis Wind Turbine
This paper outlines results of a proposed layout of a light 2-bladed rotor, with a driving torque constraint matching the generator design, and shows details of the pultruded blade – and rotor geometry. In comparison with the 1st baseline
design of a 5 MW VAWT concept this present development provides during standstill and operation significant less mass with a comparable level of loading strain in the blades and in the junctions between blade and tower. Optimized blade profile having a low weight and high stiffness is obtained according to the design evaluations based on the standstill calculations in ANSYS software. The selected profiles are used in the aero dynamic simulation. Furthermore the simulation code will be demonstrated to show the fully development model, integrating the simulation of turbulent wind inflow, actuator cylinder flow model, power controls, hydraulic floater - and mooring line systems implementation.

General information
State: Published
Organisations: Department of Wind Energy, Test and Measurements, Aeroelastic Design, Department of Mechanical Engineering, Manufacturing Engineering, Wind Turbines
Authors: Schmidt Paulsen, U. (Intern), Aagaard Madsen, H. (Intern), Hattel, J. H. (Intern), Baran, I. (Intern), Nielsen, P. H. (Intern)
Pages: 22-32
Publication date: 2013
Main Research Area: Technical/natural sciences

Determination of friction in sheet metal forming by means of simulative tribo-tests
Numerical modeling of complex sheet stamping operations is well developed and implemented in industry. The weakest link now seems to be appropriate modeling of friction and to some extent also material properties especially when it comes to new lubricants and materials. In modeling of 3-D stamping operations a coefficient of friction $\mu$ is often determined by calibration of the simulation results with experimental observations of material flow and/or measured load. In case of modeling of new stamping operations $\mu$ is typically selected based on former experience. These
procedures are, however, not appropriate when introducing new tribo-systems (lubricant, workpiece material, tool material or tool coating). In order to determine friction under the very varied conditions in sheet stamping simulative testing may be applied, e.g., Plane-Strip-Testing (PST), Draw-Bead-Testing (DBT) and Bending-Under-Tension testing (BUT) but these tests should be analyzed and carefully tuned with the production process in question to ensure useful results. The present paper illustrates how the BUT test combined with classical analytical modeling may lead to very large errors in estimation of the coefficient of friction, whereas detailed numerical simulation of the test can give useful friction values as demonstrated in comparative analysis of an industrial, multistage deep drawing.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Ceron, E. (Intern), Bay, N. (Intern)
Pages: 415-422
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BFI (2017): BFI-level 1
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.172 SNIP 0.374 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.177 SNIP 0.436 CiteScore 0.22
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.184 SNIP 0.296
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.209 SNIP 0.24
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.192 SNIP 0.283
Scopus rating (2007): SJR 0.194 SNIP 0.366
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.221 SNIP 0.42
Scopus rating (2005): SJR 0.221 SNIP 0.373
Scopus rating (2004): SJR 0.225 SNIP 0.434
Web of Science (2004): Indexed yes
Dimensional verification of high aspect micro structures using FIB-SEM

Micro-structured surfaces are increasingly used for advanced functionality. In particular, micro-structured polymer parts are interesting due to the manufacturing via injection moulding. A micro-structured nickel surface was characterized by focussed ion beam-scanning electron microscope (FIB-SEM) assisted by Spip®. The micro features are circular holes 10μm in diameter and 20μm deep, with a 20μm pitch. Various inspection methods were attempted to obtain dimensional information. Due to the dimension, neither optical instrument nor atomic force microscope (AFM) was capable to perform the measurement. A cross sectioned sample was prepared for conventional SEM in order to inspect the geometry of the holes, but the cutting angle used when making the cross section had a significant influence on the obtained results. Via FIB-SEM, the process was recorded by images when slicing the sample layer by layer by ion-beam. In this way, the dimension and the geometry of the holes are characterized.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Zhang, Y. (Intern), Hansen, H. N. (Intern)
Number of pages: 4
Publication date: 2013

Dimensional verification of high aspect ratio micro structures using FIB-SEM

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Zhang, Y. (Intern), Hansen, H. N. (Intern)
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Finally, the parts were characterized to investigate mechanical properties like density, ultimate tensile strength, shrinkage etc. The results are discussed in the paper. The main conclusion from this study is unlike plastic moulding, the tensile properties of MIM parts don't vary based on the flow direction of the melt, and tensile properties are sensitive to holding pressure and process temperatures. In order to achieve higher tensile strength, higher holding pressure is required. It was also observed that the samples shrunk more in thickness than in the width and length.
Extensional rheology of entangled polystyrene solutions suggests importance of nematic interactions

Local correlations in the orientation of neighboring molecules have been shown to exist both experimentally and theoretically for polymer melts, blends and networks. Such nematic interactions alter the stress-optic coefficient, but predict no change in the overall stress in long time scales in the linear viscoelastic regime. The impact of nematic effects on the extensional stress-strain response of concentrated polymer solutions has not been experimentally investigated. In this work, we consider the influence of several solvents on the linear and nonlinear rheological responses of concentrated polymer solutions in extensional flow. We prepared three polystyrene (PS) solutions with identical concentrations of the same PS sample (with the molecular weight $M = 545k$), but diluted with three different solvents, oligomeric styrene (OS) with $M = 1k$, $2k$, and $4k$. The three solutions have exactly the same physical tube model parameters when compared in the same, normalized time scale. Although the three solutions behave identically in small amplitude oscillatory shear flow, their behavior is markedly different in extensional flow covering large strains. The solution in OS $1k$ solvent is significantly more strain hardening than the solution in OS $4k$ under similar conditions. The experimental observations presented here directly demonstrate that the tube model and its governing parameters are insufficient to describe the nonlinear extensional behavior of entangled polymer solutions. We propose a hypothesis that the nematic interactions among the polymers and between polymer and solvent are in part responsible for the nonlinear rheological response of concentrated polymer solutions in strong extensional flow.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Huang, Q. (Intern), Javier Alvarez, N. (Intern), Matsumiya, Y. (Ekstern), Rasmussen, H. K. (Intern), Watanabe, H. (Ekstern), Hassager, O. (Intern)
Publication date: 2013
Event: Abstract from 85th Annual Meeting of The Society of Rheology, Montreal, Que., Canada.
Main Research Area: Technical/natural sciences
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2013

Extensional Rheology of Entangled Polystyrene Solutions Suggests Importance of Nematic Interactions

We compare the linear and nonlinear rheological response of three entangled polystyrene solutions with the same concentration of polymer, but diluted using different solvents. The three solutions have exactly the same physical tube model parameters when normalized to the same time scale. Although the three solutions behave identically in small amplitude oscillatory shear flow, they behave markedly different in large strain extensional flow. The experimental observations presented here directly demonstrate that the tube model and its governing parameters are insufficient to describe the nonlinear rheological behavior of entangled polymer solutions. We introduce a new hypothesis that relates the observed nonlinear behavior of three different polymer solutions to the existence of nematic interactions between polymer–solvent and polymer–polymer molecules.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Mechanical Engineering, Manufacturing Engineering, Kyoto University
Authors: Huang, Q. (Intern), Javier Alvarez, N. (Intern), Matsumiya, Y. (Ekstern), Rasmussen, H. K. (Intern), Watanabe, H. (Ekstern), Hassager, O. (Intern)
Pages: 741-744
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Fabrication and characterization of porous-core honeycomb bandgap THz fibers

We have fabricated a porous-core honeycomb fiber in the cyclic olefin copolymer (COC) Topas® by drill-draw technology [1]. A cross-sectional image of the fabricated fiber is shown in the left Panel of Fig. 1. Simulation of the electromagnetic properties of the fiber shows two wide bandgaps within the frequency range 0.1 to 2 THz, and numerous sharp resonant features are visible in the core power ratio, indicative of resonant coupling between the reflected field from the outer interface of the fiber and the core mode. The fiber is experimentally characterized with a commercial fiber-coupled THz-TDS system (Picometrix T-Ray 4000). The reference pulse before coupling into the fiber is shown in Fig. 1(a) and the time trace of the THz pulse after propagation through a 5-cm long segment of fiber is shown in Fig. 1(b) (blue curve). After adding some water on the outside of the fiber surface, the transmitted pulse experiences less pronounced oscillations at times later than 20 ps (red curve in Fig. 1(b)). Figs. 1(c) and (d) show the short-time Fourier transforms of the two time-domain traces in Fig. 1(b), overlaid with the calculated group delay in the two bandgaps (black squares). The frequencies below approximately 0.6 THz are attenuated by adding a layer of water on the outside of the fiber surface, while the transmission in the two band gaps in the 0.7-1.1 THz and 1.3-1.7 THz regions are unaffected by the water. This observation demonstrates that the absorptive water layer effectively strips the cladding modes from the fiber. The propagation loss is measured in a cut-back experiment. The fundamental bandgap at 0.75-1.05 THz is found to have losses lower than 1.5 dB/cm, whereas the loss is below 1.0 dB/cm in the reduced bandgap 0.78-1.02 THz, as shown in Fig. 1(g).

Name: Bao, H. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)

Number of pages: 1

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Main Research Area: Technical/natural sciences

Final report on RMO key comparison EURAMET.L-K6: CMM 2-D artifact: ball plate

An industrial standard steel ball plate of dimension 420 mm with 25 ceramic balls in a 5 × 5 arrangement was circulated among 12 European NMIs. The measurement task was the calibration of the centres of the 25 balls. The measurements were conducted between 2004 and 2006. One NMI withdrew from the comparison. The other 11 NMIs measured the ball plate and delivered data. The artifact was found to be stable during the duration of the comparison. For the analysis both the deviations from the KCRV and the En numbers were calculated. Most results agreed very well within the claimed uncertainty. A few results showed some larger deviations, e.g. length periodic modulations of the differences from the KCRV which still were within the claimed uncertainty, but might be a basis for some optimization of the measurement process. However, because of the significant length of time between the measurements and the final report, the optimization was already completed in most cases. Main text. To reach the main text of this paper, click on Final Report. Note that this text is that which appears in Appendix B of the BIPM key comparison database kcdb.bipm.org/. The final report can be found at http://kcdb.bipm.org/.

Bibliographical note

Poster presentation.
report has been peer-reviewed and approved for publication by the CCL, according to the provisions of the CIPM Mutual Recognition Arrangement (CIPM MRA).

**General information**

**State:** Published  
**Organisations:** Department of Mechanical Engineering, Manufacturing Engineering, Physikalisch-Technische Bundesanstalt, National Office of Measures, VSL Dutch Metrology, Centre for Metrology and Accreditation, National Physical Laboratory, Central Office of Measures, Laboratório de Metrologia, Swiss Federal Office of Metrology, National Metrology Laboratory, Czech Metrological Institute  
**Authors:** Jusko, O. (Ekstern), Banreti, E. (Ekstern), Bergmans, R. (Ekstern), De Chiffre, L. (Intern), Lassila, A. (Ekstern), Lewis, A. (Ekstern), Ramotowski, Z. (Ekstern), Saraiva, F. (Ekstern), Thalmann, R. (Ekstern), Turner, P. (Ekstern), Zeleny, V. (Ekstern)  
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- Web of Science (2017): Indexed yes  
- BFI (2016): BFI-level 1  
- Scopus rating (2016): CiteScore 2.47 SJR 0.88 SNIP 1.789  
- Web of Science (2016): Indexed yes  
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- Scopus rating (2015): SJR 0.813 SNIP 1.611 CiteScore 1.96  
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- Scopus rating (2014): SJR 0.997 SNIP 2.119 CiteScore 2.49  
- Web of Science (2014): Indexed yes  
- BFI (2013): BFI-level 1  
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- ISI indexed (2012): ISI indexed yes  
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- ISI indexed (2011): ISI indexed yes  
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- BFI (2010): BFI-level 1  
- Scopus rating (2010): SJR 0.779 SNIP 1.62  
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- Scopus rating (2009): SJR 0.842 SNIP 1.615  
- BFI (2008): BFI-level 1  
- Scopus rating (2008): SJR 0.773 SNIP 1.712  
- Scopus rating (2007): SJR 0.966 SNIP 1.823  
- Web of Science (2007): Indexed yes  
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- Web of Science (2006): Indexed yes
Forming of shape memory composite structures

A new forming procedure was developed to produce shape memory composite structures having structural composite skins over a shape memory polymer core. Core material was obtained by solid state foaming of an epoxy polyester resin with remarkably shape memory properties. The composite skin consisted of a two-layer unidirectional thermoplastic composite (glass filled polypropylene). Skins were joined to the foamed core by hot compression without any adhesive: a very good adhesion was obtained as experimental tests confirmed. The structure of the foam core was investigated by means of computer axial tomography. Final shape memory composite panels were mechanically tested by three point bending before and after a shape memory step. This step consisted of a compression to reduce the panel thickness up to 60%. At the end of the bending test the panel shape was recovered by heating and a new memory step was performed with a higher thickness reduction. Memory steps were performed at room temperature and 120 °C so as to test the foam core in the glassy and rubbery state, respectively. Shape memory tests revealed the ability of the shape memory composite structures to recover the initial shape also after severe damaging (i.e. after room temperature compression). Compressing the panel at a temperature higher than the foam resin glass transition temperature minimally affects composite stiffness. Copyright © 2013 Trans Tech Publications Ltd.
The purpose of this document is to summarize the information about the laser welding of plastic. Laser welding is a matured process nevertheless laser welding of micro dimensional plastic parts is still a big challenge. This report collects the latest information about the laser welding of plastic materials and provides an extensive knowhow on the industrial plastic welding process. The objectives of the report include:
- Provide the general knowhow of laser welding for the beginners
Summary:
- Summarize the state-of-the-art information on the laser welding of plastics
- Find the technological limits in terms of design, materials and process
- Find the best technology, process and machines adaptive to Sonion's components
- Provide the skills to Sonion's Design Engineers for successful design of the plastic components suitable for the laser welding. The ultimate goal of this report is to serve as a knowledge handbook for laser welding of plastic components. This document should provide the information for all aspects of plastic laser welding and help the design engineers to take all critical issues into consideration from the very beginning of the design phase.

Highly photosensitive polymethyl methacrylate microstructured polymer optical fiber with doped core
In this Letter, we report the fabrication of a highly photosensitive, microstructured polymer optical fiber using benzyl dimethyl ketal as a dopant, as well as the inscription of a fiber Bragg grating in the fiber. A refractive index change in the core of at least $3.2 \times 10^{-4}$ has been achieved, providing a grating with a strong transmission rejection of $-23\,\text{dB}$ with an inscription time of only 13 min. The fabrication method has a big advantage compared to doping step index fiber since it enables doping of the fiber without using extra dopants to compensate for the index reduction in the core introduced by the photosensitive agent.

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Authors: Islam, A. (Intern)
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Highly photosensitive polymethyl methacrylate microstructured polymer optical fiber with doped core
In this Letter, we report the fabrication of a highly photosensitive, microstructured polymer optical fiber using benzyl dimethyl ketal as a dopant, as well as the inscription of a fiber Bragg grating in the fiber. A refractive index change in the core of at least $3.2 \times 10^{-4}$ has been achieved, providing a grating with a strong transmission rejection of $-23\,\text{dB}$ with an inscription time of only 13 min. The fabrication method has a big advantage compared to doping step index fiber since it enables doping of the fiber without using extra dopants to compensate for the index reduction in the core introduced by the photosensitive agent.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Aston University
Authors: Sáez-Rodríguez, D. (Ekstern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Bang, O. (Intern), Webb, D. J. (Ekstern)
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BFI (2010): BFI-level 2
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Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 3.077 SNIP 2.658
Web of Science (2009): Indexed yes
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Scopus rating (2008): SJR 3.354 SNIP 2.384
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 3.443 SNIP 2.157
Web of Science (2007): Indexed yes
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Web of Science (2006): Indexed yes
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Web of Science (2005): Indexed yes
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Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 3.725 SNIP 2.626
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 3.571 SNIP 2.415
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 3.776 SNIP 2.273
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 4.157 SNIP 1.716
Web of Science (2000): Indexed yes
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Publication: Research - peer-review › Journal article – Annual report year: 2013

High-Tg TOPAS mPOF strain sensing at 110 degrees
We demonstrate a mPOF made of high-Tg TOPAS grade 5013 with Tg = 135°C. We inscribe FBGs into the fiber and demonstrate strain sensing of 2.5% strain at 98°C, further we also demonstrate strain sensing at a record high temperature of 110°C. The Bragg wavelengths of the FBGs are around 860 nm, where the propagation loss is 5.1dB/m, close to the fiber loss minimum of 3.67dB/m at 787nm.
High-T_g TOPAS microstructured polymer optical fiber for fiber Bragg grating strain sensing at 110 degrees

We present the fabrication and characterization of fiber Bragg gratings (FBGs) in an endlessly single-mode microstructured polymer optical fiber (mPOF) made of humidity-insensitive high-T_g TOPAS cyclic olefin copolymer. The mPOF is the first made from grade 5013 TOPAS with a glass transition temperature of T_g = 135°C and we experimentally demonstrate high strain operation (2.5%) of the FBG at 98°C and stable operation up to a record high temperature of 110°C. The Bragg wavelengths of the FBGs are around 860 nm, where the propagation loss is 5.1dB/m, close to the fiber loss minimum of 3.67dB/m at 787nm.
Improving the accuracy of micro injection moulding process simulations

Process simulations in micro injection moulding aim at the optimization and support of the design of the mould, mould inserts, the plastic product, and the process. Nevertheless, dedicated software packages for micro injection moulding are not available. They are developed for macro plastic parts and are therefore limited in the capability of modelling the polymer flow in micro cavities. Hence, new strategies for comprehensive simulation models which provide more precise
results open up new opportunities and will be discussed. Modelling and meshing recommendations are presented, leading to a multi-scale mesh of all relevant units of the injection moulding system. The implementation of boundary conditions, e.g. machine and venting, and results illustrating their importance on the simulation accuracy are presented.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Marhofer, D. M. (Intern), Tosello, G. (Intern), Islam, A. (Intern), Hansen, H. N. (Intern)
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**Improving the requirements process in Axiomatic Design Theory**
This paper introduces a model to integrate the traditional requirements process into Axiomatic Design Theory and proposes a method to structure the requirements process. The method includes a requirements classification system to ensure that all requirements information can be included in the Axiomatic Design process, a stakeholder classification system to reduce the chances of excluding one or more key stakeholders, and a table to visualize the mapping between the stakeholders and their requirements.

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Authors: Thompson, M. K. (Intern)
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Web of Science (2016): Indexed yes
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Web of Science (2015): Indexed yes
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Influence of process parameters on edge replication quality of lab-on-a-chip micro fluidic systems geometries

The growing demand to manufacture, with high accuracy, structures enabling transportation, treatments and measurements of minuscule biomedical samples on polymer substrates is pushing the process capability of technologies such as injection molding to their limits. To characterize and assess the replication quality of molded micro-features on cyclic olefin copolymer (COC) a tool insert collecting critical channel cross sections was manufactured. The master was made by UV lithography and subsequent nickel electroplating. Effect of packing phase parameters (packing time, packing pressure) and mold temperature were investigated. Moreover, consequences of different positions, directions and nominal channels width were considered. Edge replication quality was quantitatively characterized, analyzing calibrated scanning electron microscope (SEM) images with a digital imaging processing software. Results showed better replication fidelity mainly influenced by the higher mold temperature and also by higher packing pressure, whereas poor edges quality was observed for the smallest replicated test structures.
Molding of thin and long parts by injection molding leads to special requirements for the mold in order to ensure proper filling and acceptable cycle time. This paper investigates the applicability of embedded induction heating for the improvement of the filling of thin long parts. The object selected for the investigation is a thin spiral. For the complete molding of the component, elevated mold temperatures are required. For this propose a new injection molding set-up was developed, which allows rapid heating of the cavity wall by an induction heating system. The temperature was measured by two thermocouples placed in the die insert. The system was used to heat up the cavity wall with heating rates of up to 10 °C/s. Experiments were carried out with ABS material. The lengths of the object were measured by a suitable measurement set up. The experimental result show that the use of the induction heating system process is an efficient way for improving the filling of the cavity.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Menotti, S. (Intern), Hansen, H. N. (Intern), Bissacco, G. (Intern), Tang, P. T. (Ekstern), Ravn, C. (Ekstern)
Number of pages: 5
Pages: 1485-1489
Publication date: 2013
In-process 3D geometry reconstruction of objects produced by direct light projection

Additive manufacturing allows close-to unrestrained geometrical freedom in part design. The ability to manufacture geometries of such complexity is however limited by the difficulty of verifying the tolerances of these parts. Tolerances of features that are inaccessible with traditional measuring equipment such as coordinate measuring machines cannot be verified easily. This problem is addressed by developing an in-line reverse engineering and 3D reconstruction method that allows a true-to-scale reconstruction of a part being additively manufactured. In earlier works (Pedersen et al. 2010; Hansen et al. 2011), this method has shown its potential with 3D printing (3DP) and selective laser sintering additive manufacturing processes, where it is possible to directly capture the geometrical features of each individual layer during a build job using a digital camera. When considering the process of direct light projection (DLP), the possibility of directly capturing the geometrical features of the object during a build job is limited by the specific machine design and the fact that photoactivated monomers often do not change optical characteristics in the polymerization process. Therefore, a variant of the previously tested and verified method has been implemented on DLP machine, where instead of capturing the geometrical features of the produced objects during the build job directly, these features are captured indirectly by capturing the reflection of the projected light projected during the build job. Test series were made, and a reconstruction of two octave spheres were produced and compared with the input CAD file and scans of the produced objects. The comparison showed a good correlation between the reconstructions and the scans considering the resolution of the images used for the reconstruction, and it was thereby concluded that the method has a promising potential as a verification method for DLP machines.
Interface Behavior in Functionally Graded Ceramics for the Magnetic Refrigeration: Numerical Modeling

The active magnetic regenerator refrigerator is currently the most common magnetic refrigeration device for near room temperature applications, and it is driven by the magnetocaloric effect in the regenerator material. In order to make this efficient, a graded configuration of the magnetocaloric material is needed. Tape casting is a common process in producing functional ceramics, and it has recently been established for producing side-by-side (SBS) functionally graded ceramics (FGCs). The main goal of the present work is to study the multiple material flows in SBS tape casting and analyze the influence of the different material properties, i.e. the density and the viscosity, on the interface between the flows, since this is highly important for the efficiency of the device. The Newtonian flow behavior with relatively high viscosity is assumed for each fluid and used in the simulation with a commercial CFD code (ANSYS FLUENT). The results show that the density change does not affect the interface between the adjacent fluids. The viscosity of the fluids plays the most important role in the behavior of the interface. Moreover, increasing the viscosity difference of the adjacent flows, $\Delta \mu$, leads to increasing the diffusive region between the two fluids.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Jabbari, M. (Intern), Spangenberg, J. (Intern), Hattel, J. H. (Intern)
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Journal: Applied Mechanics and Materials
Inter-laboratory comparison of medical computed tomography (CT) scanners for industrial applications in the slaughterhouses

Using computed tomography (CT) in the calibration of online grading equipment has been demonstrated to be beneficial over the last years by several institutions using medical CT scanners. The difference in makes and models calls for a standardized (and calibrated) method to be able to quantify differences in CT performance. The presented Round Robin scheme has demonstrated its potential as such a method.

The benefit of the phantom set is that it provides a convenient way of comparing volume determination between different CT scanners. The suggested phantoms are mimicking important carcass features, conventionally recognized to be challenging to medical CT scanners.

The web based classification software PigClassWeb has been demonstrated to be a convenient way of handling and comparing CT data in a transparent way, across regions and over time.

The phantom set may be used to compare regional differences in analyzing software.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Danish Meat Research Institute
Authors: Christensen, L. B. (Ekstern), Angel, J. A. B. (Intern)
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Inter laboratory comparison on Industrial Computed Tomography: CIA-CT comparison. Final Report
An interlaboratory comparison on industrial X-ray Computed Tomography (CT) was organized by the Centre for Geometrical Metrology (CGM), Department of Mechanical Engineering, Technical University of Denmark (DTU) and carried out within the project “Centre for Industrial Application of CT scanning - CIA-CT”. In the comparison, 27 laboratories from 8 countries were involved, and CT scanned two items selected among common industrial parts: a
polymer part and a metal part. Altogether, 27 sets of items were circulated in parallel to the participants. Different measurands are considered, encompassing diameters, roundness, and lengths. The results of each participant are kept confidential. Each participant can identify their own results in this report using an anonymous identification number provided by the coordinator. Measuring instructions distributed by the coordinator were followed by all participants without problems. Participants carried out measurements and sent their results to the coordinator. All single items were measured by the coordinator using coordinate measuring machines before and after circulation. Both the metal item and the plastic item have shown a good stability over the total period of approx. 6 months. Depending on item and measurand, reference expanded uncertainties (k=2) ranging from approx. 1.5 μm up to approx. 5.5 μm were estimated. The expanded uncertainties stated by the participants are in the range 8-12 μm for both items and all measurands. Results by the single participants were compared with the reference values provided by the coordinator through the En value, where |En| < 1 indicates agreement between measurement results while |En| ≥ 1 shows disagreement. Out of a total of 167 single results obtained by the participants using CT scanning, 55% of the measurements yield |En| values less than 1, and 45% larger than 1. Systematic errors were detected for some participants on the diameters and lengths, for both plastic and metal items. The roundness measured by the participants for both plastic and metal was higher than the unfiltered reference value. A clear influence from the surrounding wall thickness on the measurement of roundness was documented for the metal item. The comparison shows that CT scanning on small industrial parts, generally speaking, is connected with uncertainties in the range 8-53 μm, as compared to an uncertainty range of 1.5-5.5 μm using CMMs. Each participant can use the comparison results in the report to investigate the presence of systematic errors or an underestimation of uncertainties. Statistics related to the used equipment and procedures show that participants, in general, have followed state of the art procedures for their measurements. The industrial items are suitable artefacts for CT measurements of this kind, and each participant has been offered to keep a set used for the measurements in the comparison.
Investigation on the Effect of Sulfur and Titanium on the Microstructure of Lamellar Graphite Iron

The goal of this work was to identify the inclusions in lamellar graphite cast iron in an effort to explain the nucleation of the phases of interest. Four samples of approximately the same carbon equivalent but different levels of sulfur and titanium were studied. The Ti/S ratios were from 0.15 to 29.2 and the Mn/S ratios from 4.2 to 48.3. Light and electron microscopy were used to examine the unetched, color-etched, and deep-etched samples. It was confirmed that in irons with high sulfur content (0.12 wt pct) nucleation of type-A and type-D graphite occurs on Mn sulfides that have a core of complex Al, Ca, Mg oxide. An increased titanium level of 0.35 pct produced superfine interdendritic graphite (~10 μm) at low (0.012 wt pct) as well as at high-S contents. Ti also caused increased segregation in the microstructure of the analyzed irons and larger eutectic grains (cells). TiC did not appear to be a nucleation site for the primary austenite as it was found mostly at the periphery of the secondary arms of the austenite, in the last region to solidify. The effect of titanium in refining the graphite and increasing the austenite fraction can be explained through the widening of the liquidus-eutectic temperature interval (more time for austenite growth) and the decrease in the growth rate of the graphite because of Ti absorption on the graphite. The fact that Ti addition produced larger eutectic cells supports the theory that Ti is not producing finer graphite because of a change in the nucleation potential, but because of lower growth rate of the graphite in between the dendrite arms of a larger fraction of austenite. In the presence of high-Ti and S, (MnTi)S star-like and rib-like inclusions precipitate and act as nuclei for the austenite.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Ohio State University, IK4-Azterlan Metallurgical Centre
Authors: Moumeni, E. (Intern), Stefanescu, D. M. (Ekstern), Tiedje, N. S. (Intern), Larrañaga, P. (Ekstern), Hattel, J. H. (Intern)
Pages: 5134-5146
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.91 SJR 1.206 SNIP 1.336
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.267 SNIP 1.407 CiteScore 1.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.659 SNIP 1.848 CiteScore 2.06
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.513 SNIP 1.656 CiteScore 1.9
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.426 SNIP 1.75 CiteScore 1.76
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.498 SNIP 1.721 CiteScore 1.78
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Joining by plastic deformation
As the scale and complexity of products such as aircraft and cars increase, demand for new functional processes to join mechanical parts grows. The use of plastic deformation for joining parts potentially offers improved accuracy, reliability and environmental safety as well as creating opportunities to design new products through joining dissimilar materials. This paper aims to provide an overview of the state of the art in such joining processes, including cold welding, friction stir welding, self-pierce riveting, mechanical clinching and joining by forming. The paper includes description of the mechanism of joint formation, and analysis of joint performance and applicability. © 2013 CIRP.
Financial involving forging of multiple objects in contact

Finite element modeling of multi-object manufacturing processes is presented with supporting experiments. The underlying finite element implementation is based on the flow formulation and further coupled with thermal and electrical...
models to accomplish electro-thermo-mechanical simulation. All three models are implemented with contact algorithms that can take care of the interactions between multiple objects. Focusing on the mechanical aspects, this presentation includes simulations and experiments designed for testing mechanical contact between plastically deforming parts of similar and dissimilar materials. While being plastically deformed against each other under increasing forging load, the parts dynamically develop their mutual contact interfaces. Comparisons of the final geometry as well as force-displacement curves are evaluated. The potential of simulated applications are discussed for the purpose of joining technologies involving plastic deformation and contact.
Modeling constitutive and micro-scale frictional behavior of PTFE

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, NIL Technology ApS
Authors: Sonne, M. R. (Intern), Narregaard, J. (Ekstern), Hattel, J. H. (Intern)
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Oral presentation. The work was presented under the session title: "D3II: Multiscale and Thermodynamics Modeling - from Atomic-Scale Properties to Macroscopic Behavior".

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Modeling of the interface behavior in tape casting of functionally graded ceramics for magnetic refrigeration parts
The main goal of this work is to study the multiple material flows in side-by-side (SBS) tape casting and analyze the influence of the different material properties, i.e. the density and the viscosity, on the interface between the fluids, since this is highly important for the efficiency of a graded configuration of the magnetocaloric materials. The Newtonian flow behavior with relatively high viscosity is assumed for each fluid and used in the simulation with a commercial CFD code (ANSYS FLUENT). The results show that the density difference does not affect the interface between the adjacent fluids, whereas the viscosity of the fluids plays the most important role in the behavior of the interface. Moreover, increasing the viscosity difference of the adjacent fluids, Δμ, leads to increasing the diffusive region between them. However, this can be counteracted by decreasing the velocity by the substrate. © 2013 Elsevier Ltd and IIR. All rights reserved.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Jabbari, M. (Intern), Spangenberg, J. (Intern), Hattel, J. H. (Intern)
Pages: 2403–2409
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Ratings:
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.888 SJR 1.471 CiteScore 3.46
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.06 SJR 1.371 SNIP 1.607
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.349 SNIP 1.532 CiteScore 2.44
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.619 SNIP 2.086 CiteScore 2.6
Web of Science (2014): Indexed yes
Modeling the constitutive and frictional behavior of PTFE flexible stamps for nanoimprint lithography

In the present work, the deformation on micro-scale of PTFE flexible stamps for nanoimprint lithography is modeled. This is achieved via a combination of proper models for the constitutive behavior as well as the frictional conditions between the deforming PTFE stamp and the steel tool. The model was verified through an experiment, where a PTFE sheet was deformed by a steel sphere mounted in a tensile test machine. Good agreement between simulations and experimental results is found, both regarding force–displacement and corresponding principal strain measurements. As expected, applying the correct frictional behavior between PTFE and steel on micro-scale is shown to be of major importance in order to accurately simulate the strain field in the deformed PTFE stamp.

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Authors: Sonne, M. R. (Intern), Hattel, J. H. (Intern)
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Main Research Area: Technical/natural sciences

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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 0.937 SJR 0.604 CiteScore 1.87
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.69 SJR 0.589 SNIP 0.949
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.507 SNIP 0.796 CiteScore 1.35
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.586 SNIP 0.86 CiteScore 1.44
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.595 SNIP 0.964 CiteScore 1.45
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.737 SNIP 0.949 CiteScore 1.44
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.813 SNIP 1.148 CiteScore 1.8
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.934 SNIP 1.093
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.834 SNIP 1.098
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.027 SNIP 1.06
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.045 SNIP 1.138
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.966 SNIP 1.093
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.952 SNIP 0.989
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1 SNIP 1.1
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.812 SNIP 0.956
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.712 SNIP 0.711
Scopus rating (2001): SJR 0.558 SNIP 0.645
Modeling the mechanical deformation of nickel foils for nanoimprint lithography on double-curved surfaces

In the present work, a manufacturing process for transferring nano-structures from a glass wafer, to a double-curved insert for injection moulding is demonstrated. A nano-structure consisting of sinusoidal cross-gratings with a period of 426 nm is successfully transferred to hemispheres on an aluminium substrate with three different radii; 500 μm, 1000 μm and 2000 μm, respectively. The nano imprint is performed using a 50 μm thick nickel foil, manufactured using electroforming. During the imprinting process, the nickel foil is stretched due to the curved surface of the aluminium substrate. Experimentally, it is possible to address this stretch by counting the periods of the cross-gratings via SEM characterization. A model for the deformation of the nickel foil during nanoimprint is developed, utilizing non-linear material and geometrical behaviour. Good agreement between measured and numerically calculated stretch ratios on the surface of the deformed nickel foil is found, and it is shown, that from the model it is also possible to predict the geometrical extend of the nano-structured area on the curved surfaces.

Modeling the mechanical deformation of PTFE flexible stamps for nanoimprint lithography on double-curved surfaces

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Micro- and Nanotechnology, Polymer Micro & Nano Engineering
Authors: Sonne, M. R. (Intern), Cech, J. (Intern), Hattel, J. H. (Intern), Taboryski, R. J. (Intern)
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Main Research Area: Technical/natural sciences

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Modeling_the_mechanical_deformation.pdf
Source: dtu
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Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2013
Modelling Eutectic Growth in Unmodified and Modified Near-Eutectic Al-Si Alloy

A numerical model that describes solidification of primary aluminium grains and nucleation and growth of eutectic cells is used to analyse the solidification of an Al-12.5wt% Si alloy. Nucleation of eutectic cells is modelled using an Oldfield-type nucleation model where the number of nuclei in the melt is determined by the amount of active nuclei and the local undercooling from the surface to the centre of a plate casting. Eutectic grains are modelled as spheres growing between the dendrites. The growth velocity of the eutectic cells is a function of undercooling. Experimentally determined growth parameters from the literature that depend on the type of modification (unmodified, Na-modified or Sr-modified) are used to describe differences in growth of the alloys. Modelling results are compared with solidification experiments where an Al-12.5wt%Si alloy was cast in unmodified, Na modified and Sr modified forms. The model confirms experimental observations of how modification and alloy composition influence nucleation, growth and finally the size of eutectic cells in the alloys. Modelling results are used to explain how cooling conditions in the casting act together with the nuclei density in the liquid and the growth velocity of the eutectic cells to determine the size and distribution of eutectic cells in the solidified material.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Queensland, Monash University
Authors: Tiedje, N. S. (Intern), Hattel, J. H. (Intern), Taylor, J. A. (Ekstern), Easton, M. A. (Ekstern)
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Journal: Materials Science Forum
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Ratings:
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BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.3 SJR 0.18 SNIP 0.317
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.28 SJR 0.188 SNIP 0.302
BFI (2015): BFI-level 1
Scopus rating (2015): SNIP 0.326 SJR 0.218 CiteScore 0.29
BFI (2014): BFI-level 1
Scopus rating (2014): SNIP 0.414 SJR 0.261 CiteScore 0.33
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SNIP 0.338 SJR 0.238 CiteScore 0.28
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SNIP 0.467 SJR 0.279 CiteScore 0.34
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SNIP 0.415 SJR 0.248 CiteScore 0.33
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SNIP 0.406 SJR 0.273
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SNIP 0.389 SJR 0.343
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.298 SNIP 0.358
Modelling of Damage During Hot Forging of Ingots

Ductile damage modelling in the ingot forging process is discussed. Advantages and disadvantages of both coupled and uncoupled ductile damage models are presented. Some uncoupled damage models are examined in greater detail regarding their applicability to different processes, where hydrostatic compression as well as tension, combined with shear stresses, are present. It is shown that the numerical implementation can influence the results substantially and therefore lead to software user dependent conclusions. It may be advantageous for the user of commercial finite element programs to base the damage analysis on the Cockcroft & Latham criterion, since this with changing cut-off value does not inconsistently change the location of damage, in contradiction to the other investigated criteria, and since it is able to predict damage in processes, which are slightly compressive.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Instituto Superior Técnico
Authors: Christiansen, P. (Intern), Hattel, J. H. (Intern), Bay, N. (Intern), Martins, P. A. (Ekstern)
Number of pages: 12
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Christiansen_P_T6.pdf
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Multi-Criteria Optimization in Friction Stir Welding Using a Thermal Model with Prescribed Material Flow
Friction stir welding (FSW) is an innovative solid-state joining process providing products with superior mechanical properties. It utilizes a rotating tool being submerged into the joint line and traversed while stirring the two pieces of metal together to form the weld. The temperature distribution in the weld zone, as a function of the heat generation, highly affects the evolution of the microstructure and the residual stresses, and also the performance of the weld. Therefore, thermal models play a crucial role in detailed analysis and improvement of this process. In this study, a three-dimensional steady state thermal model of FS welding of AA2024-T3 plates has been simulated. The effect of the tool rotation on the
temperature distribution has been also taken into account. This thermal model has been integrated with the non-
dominated sorting genetic algorithm (NSGA-II) to solve a common manufacturing problem having conflicting objectives,
i.e., maximization of production rate and tool lifetime. The resulting multiple trade-off solutions are then investigated to
unveil any design rules which have a strong potential in industrial use. © 2013 Taylor and Francis Group, LLC.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Indian Institute of Technology, Kanpur
Authors: Tutum, C. C. (Intern), Deb, K. (Ekstern), Hattel, J. H. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.399 SJR 0.948 CiteScore 2.62
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.91 SJR 0.76 SNIP 1.237
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.737 SNIP 1.006 CiteScore 1.63
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.953 SNIP 1.385 CiteScore 1.84
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.9 SNIP 1.419 CiteScore 1.89
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.719 SNIP 1.283 CiteScore 1.51
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.589 SNIP 0.924 CiteScore 1.23
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.401 SNIP 0.613
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.438 SNIP 0.692
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.365 SNIP 0.633
Scopus rating (2007): SJR 0.346 SNIP 0.731
Scopus rating (2006): SJR 0.404 SNIP 0.829
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.356 SNIP 0.634
Scopus rating (2004): SJR 0.218 SNIP 0.527
Scopus rating (2003): SJR 0.311 SNIP 0.588
Scopus rating (2002): SJR 0.175 SNIP 0.639
Scopus rating (2001): SJR 0.292 SNIP 0.735
Scopus rating (2000): SJR 0.316 SNIP 0.421
Scopus rating (1999): SJR 0.305 SNIP 0.504
Nanopatterning of Polymer Replication Tools

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Polymer Micro & Nano Engineering, Department of Mechanical Engineering, Manufacturing Engineering, InMold Biosystems A/S, Nanyang Technological University
Authors: Cech, J. (Intern), Sonne, M. R. (Intern), Pranov, H. (Ekstern), Kofod, G. (Ekstern), Matschuk, M. (Ekstern), Murthy, S. (Ekstern), Lam, Y. C. (Ekstern), Hattel, J. H. (Intern), Taboryski, R. J. (Intern)
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Publication: Research - peer-review › Poster – Annual report year: 2013

New Tribo-systems for Cold Forming of Steel, Stainless Steel and Aluminium Alloys

Globalisation of industrial production and increasing demands for environmentally benign solutions has forced cold forging industry to search for new, economically optimized tribo-systems, which are less harmful to the working as well as the global environment. The present paper describes efforts to find new alternatives, which fulfill these demands including new lubrication systems, new tool coatings and introduction of tailored tool and workpiece surfaces. The large costs involved in testing of new tribo-systems in production have emphasized the necessity of developing appropriate off-line testing methods to evaluate these new alternatives. Examples of such tests are presented.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Bay, N. (Intern)
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Title of host publication: Proceedings of 46th International Cold Forging Group (ICFG) Plenary Meeting
Publisher: International Cold Forging Group
Article number: 7-04
Main Research Area: Technical/natural sciences
Cold forging, Lubricants, Tool coatings, Surface texturing, Testing
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New_Tribo_systems.pdf
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Numerical and semi-analytical modelling of the process induced distortions in pultrusion

The geometrical changes of the processed material (process induced distortions) are a critical issue in pultrusion, since they affect the process dynamics (mainly the pull force), as well as the mechanical properties and geometrical precision of the final product. Hence, a detailed understanding of the mechanical behavior generating the distortions during the process is eventually required. In the present study, two different modelling approaches are implemented and compared to calculate the development of the distortions during the pultrusion of a graphite/epoxy composite rod. In both cases, the temperature and the degree of cure distributions are obtained from the thermo-chemical analysis, using a finite element and a finite volume approach, respectively. Process induced distortions have been computed solving a sequential stress-strain finite element model, in the former case. In the latter, the transient distortions are inferred adopting a semi-analytical procedure, i.e. post processing numerical results by means of analytical methods. The predictions of the process induced distortion development using the aforementioned methods are found to be qualitatively close to each other. Furthermore, the location of the detachment between the heating die and the part due to shrinkage is also investigated.
Numerical modeling of magnetic induction and heating in injection molding tools

Injection molding of parts with special requirements or features such as micro- or nanostructures on the surface, a good surface finish, or long and thin features results in the need of a specialized technique to ensure proper filling and acceptable cycle time. The aim of this study is to increase the temperatures as close as possible to the cavity surface, by means of an integrated induction heating system in the injection molding tool, to improve the fluidity of the polymer melt hereby ensuring that the polymer melt will continue to flow until the mold cavity is completely filled. The presented work uses numerical modeling of the induction heating in the mold to investigate how the temperature in the mold will be distributed and how it is affected by different material properties.

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Authors: Guerrier, P. (Intern), Hattel, J. H. (Intern)
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Main Research Area: Technical/natural sciences
Induction heating, Injection molding, Finite element, Coupled
Electronic versions:
Numerical_modeling_of_magnetic_induction.pdf
Numerical Modeling of the Side Flow in Tape Casting of a Non-Newtonian Fluid

One of the most common ways used to produce multilayer ceramics (MLC) is tape casting. In this process, the dried tape thickness is of great interest to control the desired products and applications. One of the parameters that influences the final tape thickness is the side flow factor (a) which is mostly measured at the end of the process by a volumetric comparison of the tape which flowed outside the casting width to the tape within the casting width. This phenomenon has not been predicted theoretically yet in the literature. In this study, the flow of (La0.8Sr0.15)0.9MnO3 (LSM) slurry in the tape casting process is modeled numerically with ANSYS FLUENT in combination with an Ostwald-de Waele power law constitutive equation. Based on rheometer experiments, the constants in the Ostwald-de Waele power law are identified for the considered LSM material and applied in the numerical modeling. This model is then used for different values of substrate velocity, initial doctor blade height and material load in the reservoir, to investigate their effect on a. It is found that this factor mostly ranges between 0.8 and 0.9. Results of the modeling are compared with experimental findings and good agreement is found.
Numerical optimization of die geometry in open die forging

This paper deals with numerical optimization of open die forging of large metallic ingots made by casting implying risk of defects, e.g. central pores. Different material hardening properties and die geometries are combined in order to investigate, which geometry gives rise to maximum closure of a centreline hole in a single compression operation. Friction is also taken into account.

The numerical analysis indicates that a lower die angle of approximately 140° results in the largest centreline hole closure for a wide range of material hardening. The value of optimum die angle is not influenced by friction, which was found only to change the degree of centreline porosity closure in case of small lower die angle.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Instituto Superior Técnico
Authors: Christiansen, P. (Intern), Hattel, J. H. (Intern), Bay, N. (Intern), Martins, P. A. (Ekstern)
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Title of host publication: Proceedings of International Conference on Advanced Manufacturing Engineering and Technologies (NEWTECH 2013)
Publisher: Kungl. Tekniska högskolan I Stockholm
Main Research Area: Technical/natural sciences
Ingot forging, Centreline porosity closure, Numerical simulation, Die design
Electronic versions:
Numerical_optimization_of_die_geometry_in_open_die_forging.pdf
Publication: Research - peer-review » Article in proceedings – Annual report year: 2013

Numerical simulations of viscoelastic flows with free surfaces

We present a new methodology to simulate viscoelastic flows with free-surfaces. These simulations are motivated by the modelling of polymers manufacturing techniques, such as extrusion and injection moulding. One of the consequences of viscoelasticity is that polymeric materials have a “memory” of their past deformations. This generates some numerical
difficulties which are addressed with the log-conformation transformation. The main novelty of this work lies on the use of the volume-of-fluid method to track the free surfaces of the viscoelastic flows. We present some preliminary results of test case simulations where the different features of the model are tested independently.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Comminal, R. (Intern), Spangenberg, J. (Intern), Hattel, J. H. (Intern)
Number of pages: 6
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**Host publication information**

Title of host publication: 21ème Congrès Français de Mécanique
Publisher: Congrès Français de Mécanique
Main Research Area: Technical/natural sciences
Conference: 21ème Congrès Français de Mécanique (CFM 2013), Bordeaux, France, 26/08/2013 - 26/08/2013
Electronic versions:
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Source: dtu
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**Off-line testing af friktion og smøring i pladeformgivning**

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Bay, N. (Intern), Ceron, E. (Intern)
Number of pages: 24
Publication date: 2013

**Publication information**

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Original language: Danish
Publisher: Dansk Metallurgisk Selskab
Main Research Area: Technical/natural sciences
Electronic versions:
Vm_bogen_2013.pdf

**Bibliographical note**

Præsentationen er publiceret i: Karakterisering på alle længdeskalaer, Foredrag præsenteret ved Vintermødet 16. til 18. januar 2013
Publication: Research › Sound/Visual production (digital) – Annual report year: 2013

**Off-line testing of alternative of industrial lubricants and different tool materials for cold rolling of stainless steel**

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Dalarna University, Jernkontoret, Åkers AB
Authors: Tahir, M. (Ekstern), Jonsson, N. (Ekstern), Lagergren, J. (Ekstern), Ceron, E. (Intern)
Number of pages: 12
Publication date: 2013
Event: Paper presented at 9th international and 6th European Rolling Conference, Venice, Italy.
Main Research Area: Technical/natural sciences
Electronic versions:
Paper_123_Rolling_2013.pdf
Source: dtu
Open die forging of large shafts with porosity defects – physical and numerical modelling

The aim and scope of this paper is centered to analyze the influence of the geometry of V-shaped dies on the closure of internal centerline porosity defects in ingots during multistep open-die forging. The investigation is performed with small scale physical models made from lead using V-shaped dies with 90º and 120º and a reference pair of flat parallel platens. Holes drilled through the center of these preforms are produced to mimic centerline porosity in full scale cast ingots and intermediate rotation of the preforms replicate a multi-stage forging sequence under laboratory testing conditions. The presentation is supported by finite element modelling using an in-house developed computer program and the overall investigation shows that better results in closure of centerline defects are obtained with a V-shaped die with 120º die angle.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Instituto Superior Técnico
Authors: Christiansen, P. (Intern), Hattel, J. H. (Intern), Bay, N. (Intern), Alves, L. M. (Ekstern), Martins, P. A. F. (Ekstern)
Pages: 2145-2155
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Key Engineering Materials
Volume: 554-557
ISSN (Print): 1013-9826
Ratings:
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BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.29 SJR 0.18 SNIP 0.303
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.172 SNIP 0.374 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.177 SNIP 0.436 CiteScore 0.22
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.184 SNIP 0.296
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.209 SNIP 0.24
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.192 SNIP 0.283
Scopus rating (2007): SJR 0.194 SNIP 0.366
Optimization of Grooved Micromixer for Microengineering Technologies

Due to the absence of turbulent flow and the slow diffusion process, mixing of solutions at micro-scale is a difficult task. This paper describes the optimization route towards the efficient design of a bottom grooved micromixer. Based on thoroughly discussed mixing mechanisms, the optimization was performed using FEM numerical simulations and the starting geometry was a Staggered Herringbone Mixer (SHM) groove design. Optimization procedure consists of two sequences: (I) one SHM groove geometry is optimized based on the magnitude of transversal velocity at the end of the groove and (II) different configurations of six grooves are investigated taking into account capabilities and limitations of microengineering technologies (MET). Newly developed designs were benchmarked against the established SHM design and a better efficiency was achieved. Additionally, a good mixing efficiency was also achieved with a modified Slanted Groove Micromixer (SGM). A SGM prototype was machined by micro electrical discharge milling (EDM) technology. The simulation results were experimentally verified with flow visualization and a good agreement was observed. Due to simple 2.5D geometry and efficient mixing properties the proposed micromixer design is adequate to be used in the Lab-On-A-Chip (LOC) systems.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Ljubljana, University of Padua
Authors: Sabotin, I. (Ekstern), Tristo, G. (Ekstern), Bissacco, G. (Intern), Valentincic, J. (Ekstern)
Pages: 3-13
Publication date: 2013
Main Research Area: Technical/natural sciences

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Journal: Informacije MIDEM
Volume: 43
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Scopus rating (2017): SNIP 0.265 SJR 0.172 CiteScore 0.61
Web of Science (2017): Indexed Yes
Scopus rating (2016): SJR 0.177 SNIP 0.519 CiteScore 0.6
Scopus rating (2015): SJR 0.175 SNIP 0.396 CiteScore 0.61
Scopus rating (2014): SJR 0.171 SNIP 0.404 CiteScore 0.41
Scopus rating (2013): SJR 0.175 SNIP 0.376 CiteScore 0.4
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 0.187 SNIP 0.215 CiteScore 0.33
ISI indexed (2012): ISI indexed yes
Optimization of the Thermosetting Pultrusion Process by Using Hybrid and Mixed Integer Genetic Algorithms

In this paper thermo-chemical simulation of the pultrusion process of a composite rod is first used as a validation case to ensure that the utilized numerical scheme is stable and converges to results given in literature. Following this validation case, a cylindrical die block with heaters is added to the pultrusion domain of a composite part and thermal contact resistance (TCR) regions at the die-part interface are defined. Two optimization case studies are performed on this new configuration. In the first one, optimal die radius and TCR values are found by using a hybrid genetic algorithm based on a sequential combination of a genetic algorithm (GA) and a local search technique to fit the centerline temperature of the composite with the one calculated in the validation case. In the second optimization study, the productivity of the process is improved by using a mixed integer genetic algorithm (MIGA) such that the total number of heaters is minimized while satisfying the constraints for the maximum composite temperature, the mean of the cure degree at the die exit and the pulling speed.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Baran, I. (Intern), Tutum, C. C. (Intern), Hattel, J. H. (Intern)
Pages: 449-463
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: Applied Composite Materials
Volume: 20
Issue number: 4
ISSN (Print): 0929-189X
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.56 SJR 0.58 SNIP 1.011
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.49 SJR 0.551 SNIP 1.11
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Performance Evaluation of a Software Engineering Tool for Automated Design of Cooling Systems in Injection Moulding

This paper presents a software tool for automating the design of cooling systems for injection moulding and a validation of its performance. Cooling system designs were automatically generated by the proposed software tool and by applying a best practice tool engineering design approach. The two different design methods (i.e. automatic and manual) were applied to the mould design of two thin-walled products, namely a rectangular flat box and a cylindrical container with a flat base. Injection moulding process simulations based on the finite element method were performed to assess the quality of the moulded parts. Results indicate the tool is capable of generating feasible cooling solutions. Recommendations are provided for improving the performance of the tool.

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Twente
Authors: Jauregui-Becker, J. M. (Ekstern), Tosello, G. (Intern), van Houten, F. J. (Ekstern), Hansen, H. N. (Intern)
Pages: 270-275
Prediction of process induced shape distortions and residual stresses in large fibre reinforced composite laminates: With application to Wind Turbine Blades

The present thesis is devoted to numerical modelling of thermomechanical phenomena occurring during curing in the manufacture of large fibre reinforced polymer matrix composites with thick laminate sections using vacuum assisted resin transfer moulding (VARTM). The main application of interest in this work is modelling manufacturing induced shape distortions and residual stresses in commercial wind turbine composite blades. Key mechanisms known to contribute to shape distortions and residual stress build-up are reviewed and the underlying theories used to model these mechanisms are presented. The main mechanisms of thermal-, chemical- and mechanical origin are; (i) the thermal expansion mismatch of the constitutive composite materials, layer and tooling, (ii) chemical cure shrinkage of the composite matrix material and (iii) the tooling (i.e. the mould, inserts etc.) influence on the composite part.

In the modelling approach taken in the current study, 1D and 3D thermomechanical models are utilized. A 1D thermomechanical model in a finite difference (FD) framework, capable of predicting heat transfer, internal heat generation, cure degree development, as well as process induced in-plane strains and residual stresses is initially presented. This 1D model is the framework for the first attempt at a void growth model, capable of predicting the laminate through-thickness discretized void size distribution, as a function of processing parameters. Using a 3D thermomechanical finite element (FE) model in ABAQUS, different constitutive modelling approaches are investigated, including a cure hardening instantaneous linear elastic (CHILE) approach, a viscoelastic approach and a path-dependent approach. The latter is a limiting case of viscoelasticity. These approaches are investigated with regards to their accuracy in predicting process induced strain and stress development in thick section laminates during curing, and more precisely regarding the evolution of the composite thermoset polymer matrix mechanical behaviour during the phase transitions experienced during curing. The different constitutive approaches are utilized in various case studies and compared, where possible, to experimental results from measured in situ internal total strains in laminates using embedded fibre Bragg grating (FBG) sensors. Due to reasonable model accuracy, ease of implementation and use of relatively simple obtained material characterization data, the CHILE and path-dependent approaches are found to be most favorable. It is shown that use of the viscoelastic approach to accurately predict process induced strains and stresses in modelling manufacturing cases where mild tooling constraints on the composite part exist, is not viable. In a final case study, process induced shape distortions in a commercial wind turbine blade root subsection, courtesy of LM Wind Power A/S, are analyzed using the CHILE constitutive approach. It is shown how large non-uniform through-thickness part thermal- and corresponding cure gradients are the main driving factors for process induced shape distortions.
The strategic research centre PolyNano aims at becoming the Danish competence centre for production-ready fabrication of polymer, nano-scale lab-on-a-chip (LoC) devices. In order to provide a competitive edge for Danish biotech companies launching LoC products by removal of the technology barrier between lab-scale proof-of-principle and high-volume low-cost production of LoCs, the PolyNano project will develop a readily accessible fabrication platform for those companies aiming at developing and manufacturing their LoCs design.
Process chain for nano surface texture of metal and polymer micro structures

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Tosello, G. (Intern), Calaon, M. (Intern), Tang, P. (Ekstern), Ravn, C. (Ekstern), Hansen, H. N. (Intern)
Pages: 249-250
Publication date: 2013

Host publication information
Title of host publication: Book of abstracts
Main Research Area: Technical/natural sciences
Source: dtu
Source-ID: u::7837
Publication: Research - peer-review » Conference abstract in proceedings – Annual report year: 2013

Process induced residual stresses and distortions in pultrusion
In the present study, a coupled 3D transient Eulerian thermo-chemical analysis together with a 2D plane strain Lagrangian mechanical analysis of the pultrusion process, which has not been considered until now, is carried out. The development of the process induced residual stresses and strains together with the distortions are predicted during the pultrusion in which the cure hardening instantaneous linear elastic (CHILE) approach is implemented. At the end of the process, tension stresses prevail for the inner region of the composite since the curing rate is higher here as compared to the outer regions where compression stresses are obtained. The separation between the heating die and the part due to shrinkage is also investigated using a mechanical contact formulation at the die-part interface. The proposed approach is found to be efficient and fast for the calculation of the residual stresses and distortions together with the temperature and the cure distributions.

General information
Process validation and standardization: PolyNano Project Report Milestone 6.2.2 (WP6 Process Chain Validation, Task 6.2 standards)

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Calaon, M. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 24
Publication date: 2013

Quality control and process capability assessment for injection-moulded micro mechanical parts
Quality control of micro components is an increasing challenge. Smaller mechanical parts are characterized by smaller tolerance to be verified. This paper focuses on the dimensional verification of micro injection-moulded components selected from an industrial application. These parts are measured using an optical coordinate measuring machine, which guarantees fast surface scans suitable for inline quality control. The uncertainty assessment of the measurements is calculated and three analyses are carried out and discussed in order to investigate the influence parameters in optical coordinate metrology. The estimation of the total variability of the optical measurements and the instrument repeatability are reported; moreover, the measurement system capability is evaluated according to the measurement system capability indices $C_g$ and $C_{gk}$.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Gasparin, S. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern), Islam, A. (Intern)
Pages: 1295–1303
Publication date: 2013
Main Research Area: Technical/natural sciences
Quantification of Feeding Effects of Spot Feeding Ductile Iron Castings made in Vertically Parted Moulds

In vertically parted molds it is traditionally difficult to feed heavy sections that cannot be reached by traditional side/top feeders or other conventional methods. This project aims at quantifying the effects of using molded-in ram-up spot feeders as a means of feeding isolated sections in castings made in vertically parted molds and it gives directions towards the effectiveness of this technology.

The casting examined is a disc-shaped casting with an inner boss and an outer ring, separated by a thin walled section. Thus, both boss and ring are prone to porosities.

The experimental work analyses the effect of different exothermic and insulating spot feeders and their interaction with traditional parting line feeders, with respect to porosities and surface shrinkage. Experiments were performed using EN-GJS-500-7 and EN-GJS-450-10 alloys.

The experiment shows that the geometry cannot be cast successfully without the use of both a top and a spot feeder. Leaving out one or both feeders, results in porosities and surface shrinkage. For EN-GJS-500-7 any combination with both feeders present produced sound castings. For the more demanding EN-GJS-450-10 the exothermic spot feeder produced sound castings. All other combinations displayed some degree of porosities.
Quasi-steady state power law model for flow of $(La_{0.85}Sr_{0.15})_{0.9}MnO_3$ ceramic slurry in tape casting

One of the most common ways used to produce multilayer ceramics is tape casting. In this process, the wet tape thickness is one of the single most determining parameters affecting the final properties of the product, and it is therefore of great interest to be able to control it. In the present work, the flow in the doctor blade region of a slurry containing $(La_{0.85}Sr_{0.15})_{0.9}MnO_3$ (LSM) material is described with a simple quasi-steady momentum equation in combination with an Ostwald–de Waele power law constitutive equation. Based on rheometer experiments, the constants in the Ostwald–de Waele power law are identified for the considered LSM material and applied in the analytical solution for the tape thickness. This solution is then used for different values of substrate velocity and doctor blade height and compared with experimental findings of the wet tape thickness, and good agreement is found.
Rayleigh Number Criterion for Formation of A-Segregates in Steel Castings and Ingots
A Rayleigh number-based criterion is developed for predicting the formation of A-segregates in steel castings and ingots. The criterion is calibrated using available experimental data for ingots involving 27 different steel compositions. The critical Rayleigh number above which A-segregates can be expected to form is found to be 17 ± 8. The primary source of uncertainty in this critical value is the dendrite arm spacing. The Rayleigh number criterion of the current study is implemented in a casting simulation code and used to predict A-segregates in three case studies involving steel sand castings. By comparing the predictions with observations made in the actual castings, the Rayleigh number criterion is shown to correctly predict the regions where no A-segregates form. However, the regions where A-segregates do form are somewhat over-predicted. Based on the results of the three case studies, the primary reason for this over-prediction is presumed to be the presence of a central zone of equiaxed grains in the casting sections. A-segregates do not form when the grain structure is equiaxed. © The Minerals, Metals & Materials Society and ASM International 2013

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Iowa
Authors: Rad, M. T. (Ekstern), Kotas, P. (Intern), Beckermann, C. (Ekstern)
Pages: 4266-4281
Publication date: 2013
Reliability Estimation of the Pultrusion Process Using the First-Order Reliability Method (FORM)

In the present study the reliability estimation of the pultrusion process of a flat plate is analyzed by using the first order reliability method (FORM). The implementation of the numerical process model is validated by comparing the deterministic temperature and cure degree profiles with corresponding analyses in the literature. The centerline degree of cure at the exit (CDOCE) being less than a critical value and the maximum composite temperature (Tmax) during the process being greater than a critical temperature are selected as the limit state functions (LSFs) for the FORM. The cumulative distribution functions of the CDOCE and Tmax as well as the correlation coefficients are obtained by using the FORM and the results are compared with corresponding Monte-Carlo simulations (MCS). According to the results obtained from the FORM, an increase in the pulling speed yields an increase in the probability of Tmax being greater than the resin degradation temperature. A similar trend is also seen for the probability of the CDOCE being less than 0.8.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Baran, I. (Intern), Tutum, C. C. (Intern), Hattel, J. H. (Intern)
Pages: 639-653
Publication date: 2013
Main Research Area: Technical/natural sciences

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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.56 SJR 0.58 SNIP 1.011
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.49 SJR 0.551 SNIP 1.11
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.704 SNIP 1.204 CiteScore 1.22
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.738 SNIP 1.228 CiteScore 1.45
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.697 SNIP 1.858 CiteScore 1.44
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.496 SNIP 1.128 CiteScore 0.92
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Reliability of electrode wear compensation based on material removal per discharge in micro EDM milling

This paper investigates the reliability of workpiece material removal per discharge (MRD) estimation for application in electrode wear compensation based on workpiece material removal. An experimental investigation involving discharge counting and automatic on the machine measurement of removed material volume was carried out in a range of process parameters settings from fine finishing to roughing. MRD showed a decreasing trend with the progress of the machining operation, reaching stabilization after a number of machined layers. Using the information on MRD and discharge counting, a material removal simulation tool was developed and validated.

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Ljubljana, University of Padua
Authors: Bissacco, G. (Intern), Tristo, G. (Ekstern), Hansen, H. N. (Intern), Valentincic, J. (Ekstern)
Pages: 179-182
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information

Journal: C I R P Annals
Volume: 62
Issue number: 1
ISSN (Print): 0007-8506
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Report for Working Group 1: Design Research in Civil and Environmental Engineering

The first 2013 DCEE working group meeting focused on issues associated with design research in civil and environmental engineering. It addressed some of the motivation for establishing design as a research discipline in CEE and some of the challenges and outstanding questions about how to do so.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Thompson, M. K. (Intern), Paradisi, I. (Ekstern)
Pages: 145-147
Publication date: 2013

Host publication information
Title of host publication: Proceedings of the 2nd International Workshop on Design in Civil and Environmental Engineering
Publisher: DCEE
Editor: Thompson, M. K.
ISBN (Electronic): 978-0-9894658-1-6
Main Research Area: Technical/natural sciences
Electronic versions:
Report_for_Working_Group_1.pdf
Links:
http://books.google.dk/books?id=NRT4AAAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false
Publication: Research › Book chapter – Annual report year: 2013

Report for Working Group 2: Design Education in Civil and Environmental Engineering

The theme for the second working group was design education in civil and environmental engineering. Issues discussed during this meeting included the current state of the art of civil design education, the importance of civil design education, tools and techniques that can be used to build design competencies, the importance of balancing hard and soft skills, and the role that culture and context play and will continue to play in civil design in the future.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Civil Engineering, Section for Building Design
Authors: Bjerregaard Jensen, L. (Intern), Thompson, M. K. (Intern)
Pages: 148-149
Publication date: 2013
Simulation-aided investigation of beam hardening induced errors in CT dimensional metrology

Industrial X-ray CT systems are increasingly used as dimensional measuring machines. However, micron level accuracy is not always achievable yet. The measurement accuracy is influenced by many factors, such as workpiece properties, X-ray settings, beam hardening and calibration methods [1-4]. Since most of these factors are mutually correlated, it remains challenging to interpret measurement results and to identify the distinct error sources. Since simulations allow isolating the different affecting factors, they form a useful complement to experimental investigations.

Dewulf et al. [5] investigated the influence of beam hardening correction parameters on the diameter of a calibrated steel pin in different experimental set-ups. It was clearly shown that inappropriate beam hardening correction can result in significant dimensional errors. This paper confirms these results using simulations of a pin surrounded by a stepped cylinder: a clear discontinuity in the measured diameter of the inner pin is observed where it enters the surrounding material. The results are expanded with an investigation of the beam hardening effect on the measurement results for both inner and outer diameters of the surrounding stepped cylinder. Accuracy as well as the effect on the uncertainty determination are discussed. The results are compared with simulations using monochromatic beams in order to have a benchmark which excludes beam-hardening effects.

In the final part of the paper, the investigations are expanded with experiments and simulations of new set-ups that include non-cylindrical features.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Katholieke Universiteit, Katholieke Universiteit Leuven
Authors: Tan, Y. (Ekstern), Kiekens, K. (Ekstern), Welkenhuyzen, F. (Ekstern), Angel, J. A. B. (Intern), De Chiffre, L. (Intern), Kruth, J. (Ekstern), Dewulf, W. (Ekstern)
Number of pages: 7
Publication date: 2013

Host publication information
Size effects in winding roll formed profiles: A study of carcass production for flexible pipes in offshore industry

Carcass production of flexible offshore oil and gas pipes implies winding and interlocking of a roll formed stainless steel profile around a mandrel in a spiral shape. The location of the dividing point between the left and right half of the s-shaped profile in the finished carcass is very important as it directly influences carcass flexibility. The target location of the dividing point can be difficult to achieve since undesired degrees of freedom in the winding stage allows the profile to change geometry. The present work investigates this issue by performing production tests of a single carcass profile size on three mandrel sizes showing a size effect to be evident; smaller mandrel size increases a shift of the dividing point during initial mandrel contact in the winding stage. The cause is high strains in the open profile, which are minimized by the material moving closer to profile neutral plane. Other parameters such as profile entry angle on the mandrel and spiral pitch are likely to have significant importance. Proper dividing point position is shown to be obtainable by adjusting the profile in the roll forming stage. The profile rolling is successfully modeled by Finite Element Analysis (FEA), whereas a simplified FE-model of the subsequent winding operation shows that full interlock modeling is required for proper prediction of profile deformation. © (2013) Trans Tech Publications.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, National Oilwell Varco Denmark I/S
Authors: Nielsen, P. S. (Intern), Nielsen, M. S. (Ekstern), Bay, N. (Intern)
Pages: 117-124
Publication date: 2013
Conference: 15th International Conference on Sheet Metal, Belfast, Ireland, 25/03/2013 - 25/03/2013
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BFI (2017): BFI-level 1
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.172 SNIP 0.374 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Solidification of cast iron - A study on the effect of microalloy elements on cast iron

The present thesis deals with the heat transfer and solidification of ductile and microalloyed grey cast iron. Heterogeneous nucleation of nodular graphite at inclusions in ductile iron during eutectic solidification has been investigated. A series of ductile iron samples with two different inoculants in four different thicknesses has been produced and studied; chemical analysis, metallographic investigation and thermal analysis of the specimens have been carried out.

A numerical model for solidification of ductile iron has been implemented and the results (i.e. cooling curve, cooling rate, nodule count and fraction of solid phases) have shown a good agreement with experimental studies; following this, inoculation parameters in the model have been studied and discussed.

The effect of Ti and S on the microstructure of grey iron is studied. Optical and electron microscopy are used to examine the unetched, colour-etched and deep-etched samples. It was confirmed that in irons with high sulphur content (0.12 wt%) nucleation of type-A and type-D graphite occurs on Mn sulphides that have a core of complex Al, Ca, Mg oxide. An increased titanium level of 0.35% produced superfine interdendritic graphite (~10µm) at low (0.012 wt%) as well as at high S contents. Ti also caused increased segregation in the microstructure of the analysed irons and larger eutectic grains (cells). The inclusions have been identified in an effort to explain the nucleation of the phases of interest. The reasons for increase in the fraction of primary austenite and formation of superfine interdendritic graphite have been investigated using Thermocalc simulations and metallographic studies. TiC did not appear to be a nucleation site for the primary austenite as it was found mostly at the periphery of the secondary arms of the austenite, in the last region to solidify.

The superfine graphite which forms in this type of irons is short (10-20µm) and stubby. The microstructure of this kind of graphite flakes in titanium alloyed cast iron is studied using electron microscopy techniques. The methods to prepare samples of cast iron for comprehensive transmission electron microscopy of graphite and the surrounding iron matrix have been developed and explained. Dual beam microscopes are used for sample preparation. A TEM study has been carried out on graphite flakes in grey cast iron using selected area electron diffraction (SAED). Based on the SAED pattern analysis, crystallographic orientations are identified and compared. Subsequently, the orientation relationship between iron and graphite crystals at the interface is studied and discussed.

Based on this information, growth models for the platelets in the fine graphite flakes in cast iron are suggested and discussed.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Materials and Surface Engineering
**Statistical Outlier Detection for Jury Based Grading Systems**

This paper presents an algorithm that was developed to identify statistical outliers from the scores of grading jury members in a large project-based first year design course. The background and requirements for the outlier detection system are presented. The outlier detection algorithm and the follow-up procedures for score validation and appeals are described in detail. Finally, the impact of various elements of the outlier detection algorithm, their interactions, and the sensitivity of their numerical values are investigated. It is shown that the difference in the mean score produced by a grading jury before and after a suspected outlier is removed from the mean is the single most effective criterion for identifying potential outliers but that all of the criteria included in the algorithm have an effect on the outlier detection process.

**Stress relaxation of entangled polystyrene solution after constant-rate, uniaxial elongation**

For an entangled solution of linear polystyrene (PS 545k; M = 545k) in dibutyl phthalate (DBP), the stress relaxation after constant-rate uniaxial elongation was examined with an extensional viscosity fixture mounted on ARES (TA Instruments). The PS concentration, c = 52 wt%, was chosen in a way that the entanglement density M/Me of the solution coincided with that of PS 290k melt (M = 290k). After the elongation at the Rouse-based Weissenberg number Wi(R) ~ 3 up to the Hencky strain of 3, the short time stress relaxation of the solution was accelerated by a factor of ~4, which was less significant compared to the acceleration (by a factor of ~ 10) noted for PS melt under a similar condition. This result, being in harmony with the mild acceleration found for a 52 wt% blend of PS 545k with an oligomeric styrene (M = 1k), suggested that the segmental friction is reduced when the chain is highly stretched and oriented but this reduction weakens on an increase of the concentration of un-stretchable solvent molecules. This change of the stretch/orientation reduction of the friction with the solvent concentration appears to be consistent with the monotonic thinning of the steady-state elongational viscosity seen for melts and the lack of monotonic thinning observed for the semifidilute solutions. Results for less concentrated solutions will be also presented on site.
Stress relaxation of entangled polystyrene solution after constant-rate, uniaxial elongation

Surface replication assessment of sub-µm structures by atomic force microscopy

Surface roughness characterization of cast components using 3D optical methods.

Testing of newly developed functional surfaces under pure sliding conditions

A novel method that applies a non-contact technique using a 3D optical system to measure the roughness of selected standard surface roughness comparators used in the foundry industry is presented. This method is described in detail in the paper. Profile and area analyses were performed using scanning probe image processor (SPIP) software and the results of the surface roughness parameters obtained were subjected to statistical analyses. The bearing area ratio was introduced and applied to the surface roughness analysis. From the results, the surface quality of the standard comparators is successfully characterised and it was established that the areal parameters are more informative for sand cast components. The roughness values of the standard visual comparators can serve as a control for the cast components and for order specifications in the foundry industry. A series of iron castings were made in green sand moulds and the surface roughness parameter (Sa) values were compared with those of the standards. Sa parameter suffices for the evaluation of casting surface texture. The S series comparators showed a better description of the surface of castings after shot blasting than the A series. The experiments also show that it is possible to measure the effect of pressure heights on the casting surface roughness.

Testing of newly developed functional surfaces under pure sliding conditions

The employment of surface texturing for improved tribological contacts has spread over the years. The possibilities of designing and manufacturing textured surfaces with predetermined geometries have multiplied as well as the need of performing experimental laboratory tests before applying the surfaces in an industrial context. In this paper, a number of experimental tests were performed using a novel test rig, called axial sliding test, simulating the contact of surfaces under pure sliding conditions. The aim of the experiments is to evaluate the frictional behavior of a new typology of textured surfaces, the so-called multifunctional surfaces, characterized by a plateau area able to bear loads and a deterministic pattern of lubricant pockets. Six surface typologies, namely three multifunctional and three machined using classical processes, were chosen to slide against a mirror-polished counterpart. A number of experiments were carried out at
different normal pressures employing for all specimens the same reciprocating movement and the same lubrication. The measured friction forces were plotted against the incremental normal pressure, and the friction coefficients were calculated. The results comparison showed clearly how employing multifunctional surfaces can reduce friction forces up to 50 \% at high normal loads compared to regularly ground or turned surfaces. Friction coefficients approximately equal to 0.12 were found for classically machined surfaces, whereas the values were 0.06 for multifunctional ones. All the specimens were characterized before and after testing. Wear occurrence was not detected on the tested surfaces except for the mirror-polished one which underwent all the experiments.

General information
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Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Solid Mechanics, Strecon A/S
Authors: Godi, A. (Intern), Mohaghegh, K. (Intern), Grønbæk, J. (Ekstern), Klit, P. (Intern), De Chiffre, L. (Intern)
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.04 SJR 1.04 SNIP 1.289
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.013 SNIP 1.197 CiteScore 1.96
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.291 SNIP 1.599 CiteScore 2.21
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.39 SNIP 1.687 CiteScore 2.53
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.339 SNIP 1.548 CiteScore 1.95
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.183 SNIP 1.562 CiteScore 1.74
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.131 SNIP 1.38
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.964 SNIP 1.289
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.204 SNIP 1.243
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.199 SNIP 1.344
Web of Science (2007): Indexed yes
The effect of hardening laws and thermal softening on modeling residual stresses in FSW of aluminum alloy 2024-T3

In the present paper, a numerical model consisting of a heat transfer analysis based on the Thermal Pseudo Mechanical (TPM) model for heat generation, and a sequentially coupled quasi-static stress analysis with a built-in metallurgical softening model was implemented in ABAQUS. Both isotropic and kinematic rules of hardening were used in order to study the effect of the hardening law on the residual stresses as well as on the final yield stress. This numerical model was then applied in two different cases. Firstly, a very simple 1D Satoh test was modeled. Different combinations of either isotropic or kinematic hardening together with the metallurgical softening model were applied in order to give a first impression of the tendencies in residual stresses in friction stir welds when choosing different hardening and softening behaviors. Secondly, real friction stir butt welding of aluminum alloy 2024-T3 were simulated and compared with experimentally obtained results for both temperatures and residual stresses (using the slitting method). The comparisons showed good agreement regarding temperatures whereas the residual stress comparisons indicated different sensitivities for the cold and hot welding conditions toward the choice of hardening rules and especially whether including the softening model or not.
The effect of mandrel heating on the quality of the pultrusion process

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Baran, I. (Intern), Hattel, J. H. (Intern)
Number of pages: 2
The Effect of Rubric Rating Scale on the Evaluation of Engineering Design Projects

This paper explores the impact of the rubric rating scale on the evaluation of projects from a first year engineering design course. A small experiment was conducted in which twenty-one experienced graders scored five technical posters using one of four rating scales. All rating scales tested produced excellent results in terms of inter-rater reliability and validity. However, there were significant differences in the performance of each of the scales. Based on the experiment's results and past experience, we conclude that increasing the opportunities for raters to deduct points results in greater point deductions and lower overall scores. Increasing the granularity of the scale can reduce this effect. Rating scales that use letter grades are less reliable than other types of scale. Assigning weights to individual criteria can lead to problems with validity if the weights are improperly balanced. Thus, heavily weighted rubrics should be avoided if viable alternatives exist. Placing more responsibility for the final score on the grader instead of the rubric seems to increase the validity at the cost of rater satisfaction. Finally, rater discomfort can lead to intentional misuse of a rating scale. This, in turn, increases the need to perform outlier detection on the final scores. Based on these findings, we recommend rating scale rubrics that use simple 3 or 4-point ordinal rating scales (augmented checks) for individual criteria and that assign numerical scores to groups of criteria.

General information

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Applied Mathematics and Computer Science, Statistics and Data Analysis
Authors: Thompson, M. K. (Intern), Clemmensen, L. K. H. (Intern), Ahn, B. (Ekstern)
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Scopus rating (2017): SNIP 0.905 SJR 0.433 CiteScore 0.92
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 0.404 SNIP 0.989 CiteScore 0.96
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.465 SNIP 1.13 CiteScore 0.95
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.533 SNIP 0.662 CiteScore 0.76
BFI (2013): BFI-level 2
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ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.762 SNIP 0.804 CiteScore 0.63
ISI indexed (2012): ISI indexed yes
The effect of thermal contact resistance on the thermosetting pultrusion process

In the present study the control volume based finite difference (CV/FD) method is utilized to perform thermo-chemical simulation of the pultrusion process of a composite rod. Preliminary, the model is applied for a simple setup without die and heaters and the results match well with those obtained experimentally in the literature. In order to study the effects of the thermal contact resistance (TCR), which can also be expressed by the heat transfer coefficient (HTC), on the pultrusion process, a cylindrical die block and heaters are added to the original problem domain. The significance of using the TCR in the numerical model is investigated by comparing constant and variable TCR (i.e. position dependent) at the interface. Results show that the use of a variable TCR is more reliable than the use of a constant TCR for simulation of the process.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Baran, I. (Intern), Tutum, C. C. (Intern), Hattel, J. H. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.19 SJR 2.115 SNIP 2.378
The impact of process parameters on the residual stresses and distortions in pultrusion
The Internal Stress Evaluation of Pultruded Blades for a Darrieus Wind Turbine
This paper investigates the integrated modeling of a pultruded NACA0018 blade profile which is a part of the FP7 EU project DeepWind. The pultrusion process simulation is combined with the preliminary subsequent in-service load scenario. In particular, the process induced residual stresses and distortions are predicted by using a new approach combining a 3D Eulerian thermochemical analysis, in which the temperature and the cure degree distributions are obtained, and a 2D quasi-static plane strain mechanical analysis. The post-die region where convective cooling prevails is also included in the process model. The bending into shape of the pultruded blade profile is simulated with and without taking the residual stresses into account. The internal stress distribution in the profile is evaluated after the bending analysis and it is found that the process induced residual stresses have the potential to promote or to demote the internal stresses in the structural analysis.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Baran, I. (Intern), Tutum, C. C. (Intern), Hattel, J. H. (Intern)
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.172 SNIP 0.374 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.177 SNIP 0.436 CiteScore 0.22
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.184 SNIP 0.296
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.209 SNIP 0.24
Web of Science (2009): Indexed yes
Thermo-Chemical Modelling Strategies for the Pultrusion Process

In the present study, three dimensional (3D) numerical modeling strategies of a thermosetting pultrusion process are investigated considering both transient and steady state approaches. For the transient solution, an unconditionally stable alternating direction implicit Douglas-Gunn (ADI-DG) scheme is implemented as a first contribution of its kind in this specific field of application. The corresponding results are compared with the results obtained from the transient fully implicit scheme, the straightforward extension of the 2D ADI and the steady state approach. The implementation of the proposed approach is described in detail. The calculated temperature and cure degree profiles at steady state are found to agree well with results obtained from similar analyses in the literature. Detailed case studies are carried out investigating the computational accuracy and the efficiency of the 3D ADI-DG solver. It is found that the steady state approach is much faster than the transient approach in terms of the computational time and the number of iteration loops to obtain converged results for reaching the steady state. Hence, it is highly suitable for automatic process optimization which often involves many design evaluations. On the other hand sometimes the transient regime may be of interest and here the proposed ADI-DG method shows to be considerably faster than the transient fully implicit method which is generally used by the general purpose commercial finite element solvers. Finally, using the proposed steady-state approach, a design of experiments is carried out for the curing characteristic of the product based on pulling speed and part thickness.

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Authors: Baran, I. (Intern), Hattel, J. H. (Intern), Tutum, C. C. (Intern)
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Web of Science (2016): Indexed yes
Transient overshoot extensional rheology of long-chain branched polyethylenes: Experimental and numerical comparisons between filament stretching and cross-slot flow

This work analyses the high-strain extensional behavior of long-chain branched polyethylenes, employing two novel extensional rheometer devices, the filament stretching rheometer and the cross-slot extensional rheometer. The filament stretching rheometer uses an active feedback loop to control the imposed strain rate on a filament, allowing Hencky strains of around 7 to be reached. The cross-slot extensional rheometer uses optical birefringence patterns to determine the steady-state extensional viscosity from planar stagnation point flow. The two methods probe different strain-rate regimes and in this paper we demonstrate the agreement when the operating regimes overlap and explore the steady-state extensional viscosity in the full strain-rate regime that these two complimentary techniques offer. For long-chain branched materials, the cross-slot birefringence images show a double cusp pattern around the outflow centre line (named W-cusps). Using constitutive modeling of the observed transient overshoot in extension seen in the filament stretching rheometer and using finite element simulations we show that the overshoot explains the W-cusps seen in the cross-slot extensional rheometer, further confirming the agreement between the two experimental techniques. © 2013 The Society of
Two-component injection moulding simulation of ABS-POM micro structured surfaces

Multi-component micro injection moulding (μIM) processes such as two-component (2k) μIM are the key technologies for the mass fabrication of multi-material micro products. 2k-μIM experiments involving a miniaturized test component with micro features in the sub-mm dimensional range and moulding a pair of thermoplastic materials (ABS and POM) were conducted. Three dimensional process simulations based on the finite element method have been performed to explore the capability of predicting filling pattern shape at component-level and surface micro feature-level in a polymer/polymer overmoulding process. Flow front predictions are compared with experimental results using the short shots technique over the whole miniaturized component and within the surface micro structures.

Utilizing multiple objectives for the optimization of the pultrusion process based on a thermo-chemical simulation

Pultrusion is one of the most cost-effective manufacturing techniques for producing fiber reinforced composites with constant cross sectional profiles. This obviously makes it more attractive for both researchers and practitioners to investigate the optimum process parameters, i.e. pulling speed, power and dimensions of the heating platens, length and width of the heating die, design of the resin injection chamber, etc., to provide better understanding of the process, consequently to improve the efficiency of the process as well as the product quality. Using validated computer simulations is a 'cheap', therefore attractive and efficient tool for autonomous (numerical) optimization. Optimization problems in engineering in general comprise multiple objectives often having conflict with each other. Evolutionary multi-objective optimization (EMO) algorithms provide an ideal way of solving this type of problems without any biased treatment of objectives such as weighting constants serving as pre-assumed user preferences. In this paper, first, a thermochemical simulation of the pultrusion process has been presented considering the steady-state conditions. Following that, it is
integrated with a well-known EMO algorithm, i.e. non-dominated sorting genetic algorithm (NSGA-II), to simultaneously maximize the pulling speed and minimize a so-called criterion of 'total energy consumption' (TOC) which is defined as a measure of total heating area(s) and associated temperature(s). As a result, a set of optimal solutions are obtained for different trade-offs between these conflicting objectives. Having this set of trade-off solutions obviously makes the decision-making much easier at the end. Finally, a pair of solutions are selected considering their process parameters and heating die configuration.

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Authors: Tutum, C. C. (Intern), Baran, I. (Intern), Hattel, J. H. (Intern)
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.172 SNIP 0.374 CiteScore 0.19
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Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.177 SNIP 0.436 CiteScore 0.22
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.184 SNIP 0.296
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.209 SNIP 0.24
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.192 SNIP 0.283
Scopus rating (2007): SJR 0.194 SNIP 0.366
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.221 SNIP 0.42
Scopus rating (2005): SJR 0.221 SNIP 0.373
Scopus rating (2004): SJR 0.225 SNIP 0.434
Web of Science (2004): Indexed yes
In this article, laser-induced selective activation (LISA) for subsequent autocatalytic copper plating is performed by several types of industrial scale lasers, including a Nd:YAG laser, a UV laser, a fiber laser, a green laser, and a short pulsed laser. Based on analysis of all the laser-machined surfaces, normalized bearing area curves and parameters are used to characterize the surface quantitatively. The range of normalized bearing area curve parameters for plate-able surface is suggested. PBT/PET with 40 % glass fiber was used as the substrate material. For all of the studied lasers, the parameters were varied in a relatively large range, and matrixes of the laser-machined surface were obtained. The topography of those laser-machined surfaces was examined by scanning electronic microscope (SEM). For each sample examined by SEM, there was an identical workpiece plated by for 90 min. The obtained copper thickness was measured. It is confirmed that copper only deposits on the surface that has a porous structure. The bonding strength between the copper layer and the substrate was also measured.
Verification of thickness and surface roughness of a thin film transparent coating

Thin film coatings are extremely interesting for industries, where there is a need to protect a highly accurate surface which has tight dimensional tolerances. The topic is important both in the production of new metallic tools and repair applications. In both applications it is vital to have a specific knowledge about coating thickness and roughness. In the present paper a novel application of a transparent HSQ coating is presented. Furthermore the thickness and roughness of the transparent coating with nominal thickness of 1 μm is measured in the presence of surface roughness of the substrate. Measurements were done using AFM and a precision 3D mechanical stylus instrument.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, InMold Biosystems A/S
Authors: Mohaghegh, K. (Intern), Hansen, H. N. (Intern), Pranov, H. (Ekstern), Kofod, G. (Ekstern)
Number of pages: 5
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2013
Visualizing and simulating flow conditions in concrete form filling using pigments

Flow variation at surfaces and reinforcement during form filling was visualized with grey and black SCC. The border between grey and black (pigmented) SCC was captured as frozen images on hardened sawn- and formwork surfaces in a flow box experiment. Maximum velocity occurred at the centre of the closed box, and lowest velocity near the formwork, particularly with reinforcement parallel to formwork. Smooth formwork gave shorter flow profiles (higher surface velocity) than rough formwork. The pigmented mixes had similar workability though somewhat increased yield stress. Flow pattern depended on mix rheology, surface roughness and reinforcement: one mix showed plug flow between reinforcement and smooth vertical formwork whereas most mixes mainly had sheared flow. Numerical simulations mostly agreed with observed flow profiles and could be used to model flow at varying formwork surface roughness with a slip velocity. Future investigations should study the conditions causing plug- and wavetype flow, lubrication and surface finish. (C) 2013 Elsevier Ltd. All rights reserved.
1st DeepWind 5 MW Baseline design

The first 5MW baseline design of the DeepWind concept is presented for a Darrieus type floating wind turbine system for water depths of more than 150 m. This design will be used as design reference to test the next technological improvements of sub-component level, being based as much as possible on existing technology. The iterative design process involves all sub-components and the potential constraints, and the most important dependencies are highlighted and the selected design presented. The blades are designed with constraints to minimize the gravitational loads and to be produced in a controlled pultrusion process. The floating platform is a slender cylindrical structure (i.e. spar buoy) rotating along with the rotor. The stability of the platform is achieved by adding counter weight at the bottom of the structure. During operations, the rotor is tilted and acts as a gyro, describing an elliptical trajectory on the water plane. The generator is placed at the bottom of the platform and uses 5MW direct drive technology. The conceptual design is evaluated with numerical simulations in the time domain using the aero-elastic code HAWC2. In order to investigate the concept, a double-disc blade element momentum (BEM) code for VAWTs has been included in the numerical solver through a dll. The analysis of the design is carried out in two different steps: 1) to estimate natural frequencies of the platform in order to avoid major resonance problems, 2) to evaluate the baseline concept for certain load cases. A site has been chosen for the floating turbine off Norway as representative for external conditions. The structure is verified according to an ultimate strength analysis, including loads from wind, waves and currents. The stability of the platform is investigated, considering the displacements of the spar buoy and the maximum inclination angle, which is kept lower than 15 degrees.

General information

State: Published
Organisations: Department of Wind Energy, Test and Measurements, Aeroelastic Design, Department of Mechanical Engineering, Manufacturing Engineering, Fluid Mechanics, Coastal and Maritime Engineering, Aalborg University, Marine Technology Centre
Authors: Schmidt Paulsen, U. (Intern), Vita, L. (Intern), Aagaard Madsen, H. (Intern), Hattel, J. H. (Intern), Ritchie, E. (Forskerdatabase), Leban, K. M. (Forskerdatabase), Berthelsen, P. A. (Ekstern), Carstensen, S. (Intern)
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Ratings:
8 Pin RIC Socket for Hearing Aid Applications

The current paper presents the development of an 8 Pin RIC (Receiver in the canal) Socket for hearing instruments within the framework of the COTECH project. There are 8 industrial demonstrators developed in COTECH based on the converged product and process design. Sonion’s 8 Pin RIC Socket is one of them. 8 Pin RIC Socket is a functionally versatile product which can combine many different functions and presents many advantages compared with the previous 3 Pin RIC Socket. For the demonstrator production of the new Socket, two different production concepts were chosen—one based on semi-automated process and the other one is fully automated process. This paper presents the entire process chain for both the concepts and makes a comparative analysis based on the experimental investigation and validation. The work presented here can be a source of valuable information for industrial users and researchers working with micro production of metal-plastic hybrid components.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Sonion A/S
Authors: Islam, A. (Intern), Hansen, H. N. (Intern), Davids, S. (Ekstern), Kristensen, L. (Ekstern)
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Editors: Noll, H., Adamovic, N., Dimov, S.
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Main Research Area: Technical/natural sciences
Conference: 9th International Conference on Multi-Material Micro Manufacture (4M2012), Vienna, Austria, 09/10/2012 - 09/10/2012
8 Pin RIC Socket, Hearing aid, Injection moulding, Metal insert
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10.3850/978-981-07-3353-7 325
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Addressing the mechanical deformation of flexible stamps for nanoimprint lithography on double-curved surfaces

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Micro- and Nanotechnology, Optofluidics
Authors: Sonne, M. R. (Intern), Hattel, J. H. (Intern), Kristensen, A. (Intern)
Publication date: 2012
Event: Abstract from NNT 2012, Napa, CA, United States.
Main Research Area: Technical/natural sciences
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Publication: Research › Conference abstract for conference – Annual report year: 2012

Addressing the mechanical deformation of flexible stamps for nanoimprint lithography on double-curved surfaces

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Micro- and Nanotechnology, Optofluidics
Authors: Sonne, M. R. (Intern), Hattel, J. H. (Intern), Kristensen, A. (Intern)
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Event: Poster session presented at NNT 2012, Napa, CA, United States.
Main Research Area: Technical/natural sciences
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Publication: Research › Poster – Annual report year: 2012

Analysis of fluid lubrication mechanisms in metal forming at mesoscopic scale

The lubricant entrapment and escape phenomena in metal forming are studied experimentally as well as numerically. Experiments are carried out in strip reduction of aluminium sheet applying a transparent die to study the fluid flow between mesoscopic cavities. The numerical analysis involves two computation steps. The first one is a fully coupled fluid-structure Finite Element computation, where pockets in the surface are plastically deformed leading to the pressurization of the entrapped fluid. The second step computes the fluid exchange between cavities through the plateaus of asperity contacts with the plane tool, one cavity at a time.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Valenciennes and Hainaut Cambresis
Authors: Dubar, L. (Ekstern), Hubert, C. (Ekstern), Christiansen, P. (Intern), Bay, N. (Intern), Dubois, A. (Ekstern)
Pages: 271-274
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: CIRP Annals
Volume: 61
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ISSN (Print): 0007-8506
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Analysis of nucleation modelling in ductile cast iron

Heterogeneous nucleation of nodular graphite at inclusions in ductile iron during eutectic solidification has been investigated. The experimental part of this work deals with casting of ductile iron samples with two different inoculants in four different thicknesses. Chemical analysis, metallographic investigation and thermal analysis of the specimens have been carried out. A numerical model [1] has been implemented and the results (i.e. cooling curve, cooling rate, nodule count and solid fraction) have shown a good agreement with experimental studies; following this, inoculation parameters in the model have been studied and discussed.

An Axial Sliding Test for machine elements surfaces

Throughout the years, it has become more and more important to find new methods for reducing friction and wear occurrence in machine elements. A possible solution is found in texturing the surfaces under tribological contact, hence the development and spread of plateau-honed surface for cylinder liners. To prove the efficacy of a particular textured surface, it is paramount to perform experimental tests under controlled laboratory conditions. In this paper a new test rig simulating pure sliding conditions is presented, dubbed Axial Sliding Test. It presents four major components: a rod, a sleeve, a housing and a stripwound container. The rod and the sleeve are the two surfaces in relative sliding motion; the stripwound container maintains a constant, but adjustable normal pressure and the housing serves as interface between the sleeve and the container. For carrying out the test, two machineries are necessary: a press to provide the normal pressure and a tensile machine to perform the axial movements. The test is calibrated so that the correspondence between the normal pressure and the container advancement is found. Finally, preliminary tests are carried out involving a multifunctional and a fine turned rod against a mirror-polished sleeve. Qualitatively the multifunctional surfaces improve the friction conditions, but a more structured test campaign is required.
A New Approach for Handling of Micro Parts in Bulk Metal Forming

During last 10 years a lot of research has been done in micro forming processes. In spite of the challenges micro forming has in process, material properties, tooling technology and machines, micro forming technology yields remarkable accuracy and good mechanical properties with high rate of production [1]. This can fulfill the demands for mass production and miniaturization in industries and academic communities. According to the recent studies, topics related to materials, process and simulation have been investigated intensively and well documented. Machines, forming tools and handling systems are critical elements to complete micro forming technology for transferring knowledge to industries and toward miniature manufacturing systems (micro factory) [2]. Since most metal forming processes are multi stage, making a new handling system with high reliability on accuracy and speed is required. The handling system for micro parts should provide good precision and reproducibility with high speed and acceleration for gripping and positioning micro parts in the right place within few micron tolerances. Nowadays, many handling systems have been developed; either the conventional systems have been optimized or handling systems based on new concepts for gripping and releasing micro parts have been proposed. Making a handling system for micro parts made by sheet metals or foils is easier than those in bulk metal forming because parts are attached to the sheet during the forming process. Geiger made a prototype with vacuum gripper which enables transport of 260 parts per minute; with the length of 25 mm and the part diameter 0.85 mm and the accuracy of 5μm in positioning [3]. Wafios AG built up a multi station former with output rate of 400 strokes per minute and parts with diameter down to 5mm [4]. In addition IPU made a manipulator for micro parts for a multi stage bulk metal forming process [5]. This handling system works based on tension forces of viscous lubricant. Generally, conventional systems do not meet the requirements for accuracy in the micro domain, not only sticking forces are predominant compared to the weight of parts, but also small surfaces make gripping more difficult. Moreover, they have to position micro parts above forming dies in high acceleration within few microns. Backlashes and clearances which are not so important in the conventional handling systems must be considered in the manipulators for micro parts. So currently the trend for the design of micro manipulators is to reduce the size of them, simplify their design and make them more flexible to be able to include a wide range of products. This paper presents an approach for making a linear transportation system for bulk micro parts in a multi station bulk metal former. The system is analyzed with respect to accuracy and repeatability.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Mahshid, R. (Intern), Hansen, H. N. (Intern), Arentoft, M. (Ekstern)
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Source: PublicationPreSubmission
Source-ID: 103381797
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

An investigation on the effect of surface characteristics on adhesion between polymer melts and replication tools

Understanding interfacial characteristics between a polymer and its associated tool surface is critical to successful optimization of processes such as injection moulding, embossing and extrusion used to produce polymer parts. One of the factors characterizing the strength of the polymer-tool interaction is the adhesion energy and it is specific for a particular polymer-tool pair. Its magnitude depends upon the tool material, tool coating and surface contamination, where relevant, polymer chemical structure, processing conditions and the surface roughness of the tool substrate. This paper presents the results of an experimental study aimed at determining the effect of selected tool surface characteristics on the work of adhesion, by measuring contact angles of polymer droplets on the surfaces. The experimental set-up, selection of test parameters and main challenges faced to date are described and experimental results presented.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Delaney, K. D. (Ekstern), Kennedy, J. D. (Forskerdatabase), Bissacco, G. (Intern), Moore, E. (Ekstern)
Pages: 1847-1852
Publication date: 2012

Host publication information
A plateau-valley separation method for multifunctional surfaces characterization

Turned multifunctional surfaces are a new typology of textured surfaces presenting a flat plateau region and deterministically distributed lubricant reservoirs. Existing standards are not suitable for the characterization of such surfaces, providing at times values without physical meaning. A new method based on the separation between the plateau and valley regions has been developed. After properly determining a threshold between plateaus and valleys, the two regions are divided in two distinct profiles, which can be studied separately according to the specific function.

Are Entangled Polymer Melts Different From Solutions?

The possible existence of a qualitative difference on extensional steady state viscosity between polymer melts and polymer solutions is still an open question. Recent experiments [1-4] showed the extensional viscosity of both polymer melts and solutions decayed as a function of strain rate with an exponent of -0.5. When the strain rate became higher than the order of inverse Rouse time, the polymer solutions showed an upturn [1, 4]. However, in the same regime for polymer melts, the experiments were contrary: some of the experiments showed an upturn [4, 5], while others did not [2, 3].

In order to further investigate the extensional steady state viscosity of polymer melts, we carefully synthesized two monodisperse polystyrenes with molar masses of 248 and 484 kg/mole. The start-up and steady uniaxial elongational viscosity have been measured for the two melts using a filament stretching rheometer. We then compared the measurements with the bi-disperse polystyrene melts made from the above two polymers. The influence and sensitivity of impurities were studied by adding different percentages of 484k into 248k polystyrene melt. Furthermore a polydisperse polystyrene with weight average molecular weight 230 kg/mole was also measured for comparison. Possible reasons for the differences shown in the previously mentioned experiments are discussed.
A solidification model for unmodified, Na-modified and Sr-modified Al-Si alloys

An addition of small amounts of Na and Sr is commonly used in the industry to modify the eutectic in Al-Si alloys. Both Na and Sr suppress nucleation of the eutectic forcing nucleation and growth to take place at higher undercooling than in the unmodified material. Thus the scale of the eutectic and the shape of the Si crystals are modified to a fine fibrous form so that the ductility of the material is increased. In the present work a one-dimensional numerical model is proposed that describes nucleation and growth of both primary dendrites and eutectic grains as a function of cooling conditions and modification. The model assumes that dendrites nucleate easily when the liquidus temperature is reached and that they grow as heat is extracted by the mould. Nucleation of the eutectic grains depends on local undercooling and growth is governed by a balance between growth of the eutectic grains and the rate at which heat is extracted by the mould. Experimental data is used to determine constants in the nucleation function. It is shown how cooling conditions and mode of modification influence nucleation and growth conditions.

A Structured Review and Classification of Demolding Issues and Proven Solutions

The demolding of replicated parts can result in damage to both the replication tooling and finished parts and is a particular problem for the replication of smaller parts which can be quite fragile. Various techniques have been proposed in the literature to solve such problems by reducing the overall demolding force. This paper presents the challenge of demolding replicated parts and reviews the proven solutions from the literature which have been developed. A summary chart of these solutions is presented which may be used to implement plans to solve demolding problems with replicated parts. Such a rationalization of existing knowledge will enable replication tool developers to systematically select and apply proven solutions to solve, and ultimately prevent, demolding problems.
A study on evaluation strategies in dimensional X-ray computed tomography by estimation of measurement uncertainties

Computed tomography has entered the industrial world in 1980’s as a technique for nondestructive testing and has nowadays become a revolutionary tool for dimensional metrology, suitable for actual/nominal comparison and verification of geometrical and dimensional tolerances. This paper evaluates measurement results using different measuring
strategies applied in different inspection software packages for volume and surface data analysis. The strategy influence is
determined by calculating the measurement uncertainty. This investigation includes measurements of two industrial items,
an aluminium pipe connector and a plastic toggle, a hearing aid component. These are measured using a commercial CT
scanner. Traceability is transferred using tactile and optical coordinate measuring machines, which are used to produce
reference measurements. Results show that measurements of diameter for both parts resulted in smaller systematic
errors compared to distance and height measurements. It was found that uncertainties of all measurands evaluated on
surface data were generally greater compared to measurements
performed on volume data.

A TEM Study on the Microstructure of Fine Flaky Graphite
In this investigation the microstructure of the graphite flakes in titanium alloyed cast iron is studied using electron
microscopy techniques. Based on this information, growth models for the plates in the fine graphite flakes in cast iron
are considered. Detailed crystallographic analysis of the defects observed such as multiple twin boundaries and possible
spiral growth configurations are required.
Benchmarking of direct and indirect friction tests in micro forming

The sizeable increase in metal forming friction at micro scale, due to the existence of size effects, constitutes a barrier to the realization of industrial micro forming processes. In the quest for improved frictional conditions in micro scale forming operations, friction tests are applied to qualify the tribological performance of the particular forming scenario. In this work the application of a simulative sliding friction test at micro scale is studied. The test setup makes it possible to measure the coefficient of friction as a function of the sliding motion. The results confirm a sizeable increase in the coefficient of friction when the work piece size is scaled down. © (2012) Trans Tech Publications.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Eriksen, R. S. (Intern), Calaon, M. (Intern), Arentoft, M. (Ekstern), Bay, N. (Intern)
Pages: 581-586
Publication date: 2012
Conference: 15th International ESAFORM Conference on Materials Forming, Erlangen, Germany, 14/03/2012 - 14/03/2012
Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1
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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.24 SJR 0.164 SNIP 0.257
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.173 SNIP 0.226 CiteScore 0.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.21 SNIP 0.34 CiteScore 0.23
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.192 SNIP 0.302 CiteScore 0.21
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.172 SNIP 0.374 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.177 SNIP 0.436 CiteScore 0.22
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.184 SNIP 0.296
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.209 SNIP 0.24
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.192 SNIP 0.283
Casting traceability with direct part marking using reconfigurable pin-type tooling based on paraffin–graphite actuators

Green sand moulding machines for cast iron foundries are presently unable to uniquely identify individual castings. An insert tool concept is developed and tested via incremental mock-up development. The tool is part of the pattern plate and changes shape between each moulding, thus giving each mould a unique ID by embossing a Data Matrix symbol into the sand. In the process of producing the mould, each casting can be given a unique (DPM), enabling part tracking throughout the casting's life cycle. Sand embossing is achieved with paraffin-actuated reconfigurable pin-type tooling under simulated processing conditions. The marker geometry limitations have been tested using static symbol patterns, both for sand embossing and actual casting marking. The marked castings have successfully been identified with decoding software. The study shows that the function of each element of this technology can be successfully applied within the foundry industry.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Engineering Design and Product Development
Authors: Vedel-Smith, N. K. (Intern), Lenau, T. A. (Intern)
Pages: 113-120
Publication date: 2012
Main Research Area: Technical/natural sciences

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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.988 SJR 1.548 CiteScore 4.15
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 1.383 SNIP 2.155 CiteScore 3.46
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.067 SNIP 2.299 CiteScore 3.05
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.158 SNIP 2.432 CiteScore 2.79
Characterization and analysis of micro channels and sub-micron surface roughness of injection moulded microfluidic systems using optical metrology

Precision injection moulding of miniaturized products with micro features such as channels for microfluidic applications poses the greatest challenges in terms of tooling technology and process optimization. The injection moulding process window of polypropylene was validated using a metrological approach for the production of a microfluidic substrate. Dimensional accuracy of micro channels 48 µm wide and 110 µm deep, as well as quality surface topography replication (surface roughness from 30 nm to 360 nm) were investigated using non-contact measuring instruments such as an optical coordinate measuring machine and a white light interferometer respectively. The effect of the dimensional scale range on the micro/nano features replication was evaluated and it was found to be the dominant parameter if compared with the effect of the other process-related parameters investigated (melt and mould temperature, injection speed).

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Padua
Authors: Tosello, G. (Intern), Marinello, F. (Ekstern), Hansen, H. N. (Intern)
Pages: 29-39
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Plastics, Rubber & Composites
Volume: 41
Issue number: 1
ISSN (Print): 1465-8011
Ratings:
A surface characterisation study has been developed to validate an innovative tool making solution for nano patterning large areas via anodizing of aluminium (Al) and subsequent nickel electroforming. A surface topography characterization through atomic force microscopy (AFM) indicated a decreased magnitude of the 3D surface amplitude parameters chosen for the analysis, when increasing the Al purity from 99.5% to 99.999%. AFM was then employed to evaluate the periodical arrangements of the nano structured cells. Image processing was used to estimate the average areas value, the height variation relative to an average plane and the coefficient of variation of the fitted features curvature radius.

Characterization of large area nanostructured surfaces using AFM measurements
A surface characterisation study has been developed to validate an innovative tool making solution for nano patterning large areas via anodizing of aluminium (Al) and subsequent nickel electroforming. A surface topography characterization through atomic force microscopy (AFM) indicated a decreased magnitude of the 3D surface amplitude parameters chosen for the analysis, when increasing the Al purity from 99.5% to 99.999%. AFM was then employed to evaluate the periodical arrangements of the nano structured cells. Image processing was used to estimate the average areas value, the height variation relative to an average plane and the coefficient of variation of the fitted features curvature radius.
Clean forming of stainless steel and titanium products by lubricious oxides

Big social benefits can be attained through increased use of stainless steel or titanium in new sheet metal applications. Unfortunately, forming of these materials is often a challenging and costly operation, that can lead to environmental and health problems when solving the technical limitations. One possible method to overcome these problems is to use an oxide layer with optimised properties to reduce friction during forming, either as a substitute to lubricants, or acting as a conversion layer for environmental friendly lubricants. The most beneficial group of oxides for low friction is called lubricious oxides with a rutile crystal structure. Oxides of Ti, Mo, V, and Zn can build rutiles under certain contact temperatures during rolling and forming. The aim of this investigation is to evaluate if oxides designed on metal sheets display a lubricious effect under conditions similar to industrial forming processes. Preliminary evaluations show a beneficial influence of two oxides types, on stainless steel and on titanium. More work is needed to test the lubricating effect in other forming operations and to analyse the sustainability aspects for products manufactured with this alternative surface.

Cleaving of TOPAS and PMMA microstructured polymer optical fibers: Core-shift and statistical quality optimization

We fabricated an electronically controlled polymer optical fiber cleaver, which uses a razor-blade guillotine and provides independent control of fiber temperature, blade temperature, and cleaving speed. To determine the optimum cleaving conditions of microstructured polymer optical fibers (mPOFs) with hexagonal hole structures we developed a program for cleaving quality optimization, which reads in a microscope image of the fiber end-facet and determines the core-shift and the statistics of the hole diameter, hole-to-hole pitch, hole ellipticity, and direction of major ellipse axis. For 125μm in diameter mPOFs of the standard polymer PMMA we found the optimum temperatures to be 77.5°C for both blade and fiber. For 280μm in diameter mPOFs of the humidity insensitive polymer TOPAS® (grade 8007) the optimum temperature was 40° for both blade and fiber. A 100μm thick flat-edge blade was found to minimize the core-shift by the cleaving to only 298nm or 5% of the pitch for the PMMA mPOF at the optimal temperature.
Demonstrator realization with basic process: COTECH Deliverable 7.2.1 (CP-IP 214491-2)

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State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Islam, A. (Intern), Albertin, T. (Eksterne)
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Main Research Area: Technical/natural sciences

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Publication: Research - peer-review › Report – Annual report year: 2012

Demoulding force in micro-injection moulding
The paper reports an experimental study that investigates part demoulding behavior in micro injection moulding (MIM) with a focus on the effects of pressure (P) and temperature (T) on the demoulding forces. Demoulding of a microfluidics part is conducted and the four processing parameters of melt temperature (Tb), mould temperature (Tm), holding pressure (Ph) and injection speed (Vi) are analysed. The result using different combinations of process parameters were used to identify the best processing conditions in regards to demoulding forces when moulding micro parts.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Cardiff University, University of Birmingham
Authors: Griffiths, C. (Eksterne), Dimov, S. (Eksterne), Scholz, S. (Eksterne), Tosello, G. (Intern), Rees, A. (Eksterne)
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Source: dtu
Source-ID: u::6580
Publication: Research › Article in proceedings – Annual report year: 2012

Design and production of a novel sand materials strength testing machine for foundry applications
In the foundry, existing strength testing machines are used to measure only the maximum fracture strength of mould and core materials. With traditionally used methods, the loading history to ascertain deformation of the material is not available. In this paper, a novel moulding material strength testing machine was designed and built for both green sand and chemically-bonded sand materials. This machine measures and presents the loading response as a force-displacement profile from which the mechanical properties of the moulding materials can be deduced. The system was
interfaced to a computer with a commercial PC based-control and data acquisition software. The testing conditions and operations are specified in the user interface and the data acquisition is made according to specifications. The force and displacements were calibrated to ensure consistency and reliability of the measurement data. The force was calibrated using an Amsler Hydraulic Press while the displacements were calibrated with and without loading using a displacement calibrator (Heidenhain Digitaler). The calibration results showed that the data obtained are stable and reliable and the machine can be used for the measurement of the strength of chemically-bonded sand materials.

**General information**
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Nwaogu, U. C. (Intern), Hansen, K. S. (Ekstern), Tiedje, N. S. (Intern)
Publication date: 2012
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Volume: 64
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**Dimensional measurement of micro-moulded parts by computed tomography: Paper**
Computed tomography (CT) is progressively assuming an important role in metrology applications and great efforts are being made in order to turn it into a reliable and standardized measuring technology. CT is typically used for non-destructive tests, but it is currently becoming very popular for dimensional metrology applications due to its strategic advantages such as the capability of performing measurements on both the component's surface and volume, allowing inspection possibilities to otherwise non-accessible internal features. This paper focuses on the dimensional verification of two micro-injection moulded components, selected from actual industrial productions, using CT metrological tools. For this purpose, several parts have been measured with two different CT machines, and the results have been compared with the measurements obtained by other measuring systems. The experimental work carried out and the analysis of the results provide valuable conclusions about the advantages and drawbacks of using CT metrology in comparison with other measuring systems when these techniques are employed for the quality control of micro-moulded parts.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Zaragoza, University of Padua
Authors: Ontiveros, S. (Ekstern), Yagüe-Fabra, J. (Ekstern), Jiménez, R. (Ekstern), Tosello, G. (Intern), Gasparin, S. (Intern), Pierobon, A. (Ekstern), Carmignato, S. (Ekstern), Hansen, H. N. (Intern)
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**Scopus rating (2016): CiteScore 1.75 SJR 0.672 SNIP 1.234**
**BFI (2015): BFI-level 2**
Effective viscosity of confined hydrocarbons

We present molecular dynamics friction calculations for confined hydrocarbon films with molecular lengths from 20 to 1400 carbon atoms. We find that the logarithm of the effective viscosity $\eta_{eff}$ for nanometer-thin films depends linearly on the logarithm of the shear rate: $\log \eta_{eff} = C - n \log \dot{\gamma}$, where $n$ varies from 1 (solidlike friction) at very low temperatures to 0 (Newtonian liquid) at very high temperatures, following an inverse sigmoidal curve. Only the shortest chain molecules melt, whereas the longer ones only show a softening in the studied temperature interval 0.
General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Forschungszentrum Jülich GmbH
Authors: Sivebæk, I. M. (Intern), Samoilov, V. (Ekstern), Persson, B. (Ekstern)
Pages: 036102
Publication date: 2012
Main Research Area: Technical/natural sciences

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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 4.656 SNIP 2.538 CiteScore 5.76
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 5.232 SNIP 2.71 CiteScore 6.62
Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 5.675 SNIP 2.781 CiteScore 7.46
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 6.292 SNIP 2.867 CiteScore 7.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 6.314 SNIP 2.905 CiteScore 7.02
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 5.95 SNIP 2.738
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.781 SNIP 2.443
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.082 SNIP 2.101
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.847 SNIP 2.122
Effect of titanium on the near eutectic grey iron
The effect of Titanium on the microstructure of grey iron was investigated experimentally in this work. Tensile test bars of grey cast iron of near eutectic alloys containing 0.01, 0.1, 0.26 and 0.35% Ti, respectively were made in green sand moulds.
Chemical analysis, metallographic investigation and thermal analysis of the specimens were carried out thoroughly.
An SEM and TEM study were performed in order to observe the effect of Ti on the microstructure of the alloys in smaller
scale. Furthermore, the microstructure and thermal analysis are related and discussed.

**General information**
**State:** Published
**Organisations:** Department of Mechanical Engineering, Manufacturing Engineering
**Authors:** Moumeni, E. (Intern), Tiedje, N. S. (Intern), Hattel, J. H. (Intern)
**Number of pages:** 10
**Publication date:** 2012
**Event:** Abstract from 12th International Foundrymen Conference, Opatija, Croatia.
**Main Research Area:** Technical/natural sciences
**Grey iron, Titanium, SEM, TEM**
**Electronic versions:**
Iron-2-after review.pdf
Source: dtu
Source-ID: u::4060
**Publication:** Research › Conference abstract for conference – Annual report year: 2012

**Elimination of Hot Tears in Steel Castings by Means of Solidification Pattern Optimization**
A methodology of how to exploit the Niyama criterion for the elimination of various defects such as centerline porosity, macrosegregation, and hot tearing in steel castings is presented. The tendency of forming centerline porosity is governed by the temperature distribution close to the end of the solidification interval, specifically by thermal gradients and cooling rates. The physics behind macrosegregation and hot tears indicate that these two defects also are dependent heavily on thermal gradients and pressure drop in the mushy zone. The objective of this work is to show that by optimizing the solidification pattern, i.e., establishing directional and progressive solidification with the help of the Niyama criterion, macrosegregation and hot tearing issues can be both minimized or eliminated entirely. An original casting layout was simulated using a transient three-dimensional (3-D) thermal fluid model incorporated in a commercial simulation software package to determine potential flaws and inadequacies. Based on the initial casting process assessment, multiobjective optimization of the solidification pattern of the considered steel part followed. That is, the multiobjective optimization problem of choosing the proper riser and chill designs has been investigated using genetic algorithms while simultaneously considering their impact on centerline porosity, the macrosegregation pattern, and primarily on hot tear formation.

**General information**
**State:** Published
**Organisations:** Department of Mechanical Engineering, Manufacturing Engineering
**Authors:** Kotas, P. (Intern), Tutum, C. C. (Intern), Thorborg, J. (Intern), Hattel, J. H. (Intern)
**Pages:** 609-626
**Publication date:** 2012
**Main Research Area:** Technical/natural sciences

**Publication information**
**Journal:** Metallurgical and Materials Transactions B - Process Metallurgy and Materials Processing Science
**Volume:** 43
**Issue number:** 3
**ISSN (Print):** 1073-5615
**Ratings:**
- BFI (2018): BFI-level 1
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 1
- Scopus rating (2017): SJR 1.17 SNIP 1.457 CiteScore 2.05
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): SJR 0.803 SNIP 1.584 CiteScore 1.74
- BFI (2015): BFI-level 1
- Scopus rating (2015): SNIP 1.648 SJR 0.681 CiteScore 1.54
- BFI (2014): BFI-level 1
- Scopus rating (2014): SNIP 2.045 SJR 0.796 CiteScore 2.41
- BFI (2013): BFI-level 1
- Scopus rating (2013): SNIP 1.829 SJR 0.783 CiteScore 1.81
- ISI indexed (2013): ISI indexed yes
- BFI (2012): BFI-level 1
Estimating the workpiece-backingplate heat transfer coefficient in friction stirwelding

Purpose - The purpose of this paper is to determine the magnitude and spatial distribution of the heat transfer coefficient between the workpiece and the backingplate in a friction stir welding process using inverse modelling.

Design/methodology/approach - The magnitude and distribution of the heat transfer coefficient are the variables in an optimisation problem. The objective is to minimise the difference between experimentally measured temperatures and temperatures obtained using a 3D finite element model. The optimisation problem is solved using a gradient based optimisation method. This approach yields optimal values for the magnitude and distribution of the heat transfer coefficient. Findings - It is found that the heat transfer coefficient between the workpiece and the backingplate is non-uniform and takes its maximum value in a region below the welding tool. Four different parameterisations of the spatial distribution of the heat transfer coefficient are analysed and a simple, two parameter distribution is found to give good results. Originality/value - The heat transfer from workpiece to backingplate is important for the temperature field in the workpiece, and in turn the mechanical properties of the welded plate. Accurate modelling of the magnitude and distribution of the heat transfer coefficient is therefore an essential step towards improved models of the process. This is the first study using a gradient based optimisation method and a non-uniform parameterisation of the heat transfer coefficient in an inverse modeling approach to determine the heat transfer coefficient in friction stir welding. © Emerald Group Publishing Limited.

General information
State: Published
Organisations: Applied functional analysis, Department of Mathematics, Manufacturing Engineering, Department of Mechanical Engineering
Authors: Larsen, A. (Ekstern), Stolpe, M. (Intern), Hattel, J. H. (Intern)
Pages: 65-82
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Engineering Computations
Volume: 29
Issue number: 1
ISSN (Print): 0264-4401
Friction stir welding, Inverse modelling, Friction welding, Heat transfer coefficient, Optimisation

Evaluation of metrology technologies for free form surfaces
This research work describes a novel approach for comparing different technologies for free form surface metrology: computerized tomography (CT), photogrammetry and coordinate measuring machines (CMM). The comparison has the aim of providing relevant information for the selection of metrology equipment when measuring free form components. Results demonstrate that there is the imperative need to assess the uncertainty and reproducibility of CT and photogrammetry measurements by applying some calibration procedures taking into account some recommendations for work piece alignment. This article also deals with costs issues, required standards, and necessary additional information when selecting inspection equipment.
**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Tecnologico de Monterrey
Authors: Arámbula, K. (Ekstern), Siller, H. (Ekstern), De Chiffre, L. (Intern), Rodríguez, C. (Ekstern), Cantatore, A. (Intern)
Pages: 55
Publication date: 2012
Main Research Area: Technical/natural sciences

**Publication information**
Journal: International Journal of Metrology and Quality Engineering
Volume: 3
Issue number: 1
ISSN (Print): 2107-6839
Ratings:
Scopus rating (2017): SNIP 0.434 SJR 0.223 CiteScore 0.34
Scopus rating (2016): SJR 0.248 SNIP 0.541 CiteScore 0.52
Scopus rating (2015): SJR 0.171 SNIP 0.806 CiteScore 0.53
Scopus rating (2014): SJR 0.193 SNIP 0.344 CiteScore 0.36
Scopus rating (2013): SJR 0.186 SNIP 0.43 CiteScore 0.25
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.106 SNIP 0.011 CiteScore 0.05
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.125 SNIP 0.167
ISI indexed (2011): ISI indexed no
Original language: English
Freeform, Metrology, Computed tomography, CMM, Photogrammetry
Source: dtu
Source-ID: n::oai:DTIC-ART:swets/370329051::25146
Publication: Research - peer-review › Journal article – Annual report year: 2012

**Experimental Determination and Numerical Modelling of Process Induced Strains and Residual Stresses in Thick Glass/Epoxy Laminate**

In this work, a cure hardening instantaneous linear elastic (CHILE) model and a path dependent (PD) constitutive approach are compared, for the case of modelling strain build-up during curing of a thick composite laminate part. The PD approach is a limiting case of viscoelasticity with path dependency on temperature and cure degree. Model predictions are compared to experimentally determined in-situ strains, determined using FBG sensors. It was found that both models offer good approximations of internal strain build-up. A general shortcoming is the lack of capturing rate-dependent effects such as creep.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Wind Energy, Composites and Materials Mechanics, Wind Turbines
Authors: Nielsen, M. W. (Intern), Hattel, J. H. (Intern), Løgstrup Andersen, T. (Intern), Branner, K. (Intern), Nielsen, P. H. (Intern)
Number of pages: 8
Publication date: 2012

**Host publication information**
Title of host publication: ECCM15 - 15th European Conference On Composite Materials
Main Research Area: Technical/natural sciences
Conference: ECCM15, Venica, Italy, 24/06/2012 - 24/06/2012
Numerical modeling, Shape distortions, FBG sensoring, Curing
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

**Experimental investigation of new manufacturing process chains to create micro-metal structures on polymer substrates for lab-on-chip sensors**

Over the last two decades, lab-on-a-chip devices have emerged as a leading technology for life sciences, drug development, medical diagnostics, food safety, agricultural and environmental monitoring. The conventional methods used nowadays to manufacture these micro- and nano-functional surface topography are very expensive, and they do not fit the requirements for industrial production. In particular, we report an experimental investigation to link technologies as structuring process and replication processes by establishing through the proposed low-cost-based approaches new manufacturing process chains to process non-silicon materials devices, which integrate sub-μ periodic structures.
Moreover, we introduce a prototype of new testing equipment working in a non-clean environment based on photolithographic procedures. μ-trenches with feature size in the order of 10 μm are integrated on cyclic olefin co-polymer substrates. The achievements authorize to consider the proposed process chain a valid option to fabricate structured surface topography in the sub-μ range for biological applications.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Institute for Product Development
Authors: Calaon, M. (Intern), Islam, A. (Intern), Hansen, H. N. (Intern), Ravn, C. (Intern)
Pages: 101-109
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Advanced Manufacturing Technology
Volume: 59
Issue number: 1-4
ISSN (Print): 0268-3768
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.8 SJR 0.994 SNIP 1.697
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.3 SJR 1.046 SNIP 1.608
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.889 SNIP 1.325 CiteScore 1.8
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.082 SNIP 1.841 CiteScore 2.03
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.134 SNIP 2.131 CiteScore 2.26
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.971 SNIP 2.099 CiteScore 1.75
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.817 SNIP 1.673 CiteScore 1.61
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.785 SNIP 1.445
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.797 SNIP 1.384
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.52 SNIP 1.029
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.441 SNIP 0.747
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.477 SNIP 1.109
Extended FEM modeling of crack paths near inclusions

The extended FEM is applied to model crack growth near inclusions. A procedure to handle different propagation rates at different crack tips is presented. The examples considered investigate uniform tension as well as equibiaxial tension under plane strain conditions. A parameter study analyzes the effects on the crack path when changing the relative stiffness between inclusion and matrix material, the relative distance between initial crack and inclusion, and the size of the inclusion. Both edge cracks and internal cracks are studied. An example with an internal crack near an inclusion is presented, where both crack tips propagate at different growth rates until one crack tip eventually stops growing, as the related energy release rate drops below the critical value. In another example, only one crack tip propagates initially, but eventually, the energy release rate of the second crack tip becomes critical, and both crack tips propagate. Finally, an example of two cracks near an inclusion is presented in which up to four crack tips propagate simultaneously.
Fabrication and characterization of porous-core honeycomb bandgap THz fibers
We present a numerical and experimental investigation of a low-loss porous-core honeycomb fiber for terahertz wave guiding. The introduction of a porous core with hole size of the same dimension as the holes in the surrounding honeycomb cladding results in a fiber that can be drawn with much higher precision and reproducibility than a corresponding air-core fiber. The high-precision hole structure provides very clear bandgap guidance and the location of the two measured bandgaps agree well with simulations based on finite-element modeling. Fiber loss measurements reveal the frequency-dependent coupling loss and propagation loss, and we find that the fiber propagation loss is much lower than the bulk material loss within the first band gap between 0.75 and 1.05 THz.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Terahertz Technologies and Biophotonics
Authors: Bao, H. (Intern), Nielsen, K. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern)
Pages: 29507-29517
Publication date: 2012
Main Research Area: Technical/natural sciences
Feeding and Distribution of Porosity in Cast Al-Si Alloys as Function of Alloy Composition and Modification

Unmodified, Na-modified, and Sr-modified castings of Al-7 pct Si and Al-12.5 pct Si alloys were cast in molds in which it was possible to create different cooling conditions. It is shown how solidification influences the distribution of porosity at the surface and the center of the castings as a function of modification and Si content in sand- and chill-cast samples. Eutectic modification, Si content, and cooling conditions have a great impact on the distribution of porosity. Unmodified and Na-modified castings are more easily fed with porosity tending to congregate near the centerline of the casting, while Sr-modified castings solidify in a mushy manner that creates a more homogeneous distribution of porosity in the casting. The amount of porosity was highest in the Sr-modified alloys, lower in the Na-modified alloys, and lowest in the unmodified alloys. The size of the porosity-free layer and the effectiveness of the feeders were greater in the castings made with the steel chills due to the increased thermal gradients and consequent increase in the directionality of solidification.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Queensland, Monash University
Authors: Tiedje, N. S. (Intern), Taylor, J. A. (Ekstern), Easton, M. A. (Ekstern)
Pages: 4846-4858
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Metallurgical and Materials Transactions A - Physical Metallurgy and Materials Science
Volume: 43
Issue number: 12
ISSN (Print): 1073-5623
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.28 SJR 1.093 CiteScore 2.08
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.91 SJR 1.206 SNIP 1.336
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.267 SNIP 1.407 CiteScore 1.78
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.659 SNIP 1.848 CiteScore 2.06
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Flow and Failure in Extension of Monodisperse Polymer Melts

It is well known that failure or rupture phenomenon appears in the extension of polymer melts. These appear not only as failure in extension rheometers, but also as sharkskin, developments of holes in thin polymeric films etc. Sometime these ruptures appear spontaneous as well. The rupture is commonly referred to be of either brittle (e.g. cohesive type) or of liquid (e.g. necking type) nature. Here the focus will be on monodisperse polymers, to study numerically the sample flow dynamics in dual wind-up extensional rheometers. The computations are within the ideas of the microstructural 'interchain pressure' theory based on the molecular stress function constitutive model for the polymer melt flow. The purpose is twofold. Primarily to present to what extend the experimentally observed failure, appearing during or after (e.g. as a
spontaneous failure) extension, can be explained within this recent theoretical understandings of polymer fluid dynamics. Secondarily to discuss the consequences of the theoretical/computational appearance of the necking type of failure for the understanding of the cohesive type of failure.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Rasmussen, H. K. (Intern)
Publication date: 2012
Event: Abstract from 16th International Congress on Rheology, Lisbon, Portugal.
Main Research Area: Technical/natural sciences

**Bibliographical note**
Oral Presentation.
Source: dtu
Source-ID: u::5579
Publication: Research › Conference abstract for conference – Annual report year: 2012

**Flow induced particle migration in fresh concrete: Theoretical frame, numerical simulations and experimental results on model fluids**
In this paper, we describe and compare the various physical phenomena which potentially lead to flow induced particle migration in concrete. We show that, in the case of industrial casting of concrete, gravity induced particle migration dominates all other potential sources of heterogeneities induced by flow. We then show, from comparisons between experiments using model materials, dimensional analysis and numerical simulations, that, from a quantitative point of view, the viscous drag force, which prevents particles from migrating during a casting process, shall neither be computed from the apparent viscosity nor from the plastic viscosity of the suspending phase but from its tangential viscosity. Finally, the transfer of this type of numerical prediction tool to real concrete is discussed.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Civil Engineering, Section for Structural Engineering, Section for Construction Materials, Universite Paris-Est
Authors: Spangenberg, J. (Intern), Roussel, N. (Ekstern), Hattel, J. (Intern), Stang, H. (Intern), Skocek, J. (Intern), Geiker, M. (Intern)
Pages: 633-641
Publication date: 2012
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Cement and Concrete Research
Volume: 42
Issue number: 4
ISSN (Print): 0008-8846
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 3.191 SJR 4.223 CiteScore 6.08
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.15 SJR 3.462 SNIP 3.2
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 3.549 SNIP 3.162 CiteScore 4.54
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 4.128 SNIP 3.583 CiteScore 4.44
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 4.219 SNIP 3.873 CiteScore 4.54
ISI indexed (2013): ISI indexed yes
Hole quality and burr reduction in drilling aluminium sheets

Optimization of the metal drilling process requires creation of minimum amount of burrs and uniform appearance of the drilled holes. In this paper, an experimental investigation was performed on 2 mm sheets of wrought aluminium alloy Al99.7Mg0.5Cu-H24, using 1.6 and 2 mm diameter drills. Cutting data, clamping conditions, and drill geometry were varied in order to optimize the process and reach the desired quality. The results revealed possible reduction of burr occurrence on both the entry and exit side of the sheet, requiring no additional deburring. The demand on the uniform appearance of drilled holes was fulfilled as well as high productivity achieved. Such optimized process results in a noticeable production cost reduction.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Brno University of Technology, Bang & Olufsen A/S
Authors: Pilný, L. (Intern), De Chiffre, L. (Intern), Piska, M. (Ekstern), Villumsen, M. F. (Ekstern)
Pages: 102-107
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
In situ measurement using FBGs of process-induced strains during curing of thick glass/epoxy laminate plate: experimental results and numerical modelling

For large composite structures, such as wind turbine blades, thick laminates are required to withstand large in-service loads.

During the manufacture of thick laminates, one of the challenges met is avoiding process-induced shape distortions and residual stresses. In this paper, embedded fibre Bragg grating sensors are used to monitor process-induced strains during vacuum infusion of a thick glass/epoxy laminate. The measured strains are compared with predictions from a cure hardening instantaneous linear elastic (CHILE) thermomechanical numerical model where different mechanical boundary conditions are employed. The accuracy of the CHILE model in predicting process-induced internal strains, in what is essentially a viscoelastic boundary value problem, is investigated. A parametric study is furthermore performed to reveal the effect of increasing the laminate thickness. The numerical model predicts the experimental transverse strains well when a tied boundary condition at the tool/part interface is used and the tool thermal expansion is taken into account.

However, the CHILE approach is shown to overestimate residual strains after demoulding because of the shortcomings of the model in considering viscoelastic effects. The process-induced strain magnitude furthermore increases when the
laminate thickness was increased, owing mainly to a decrease in through-thickness internal transverse stresses.
Interface Oscillation in the Side-by-Side (SBS) Tape Casting of Functionally Graded Ceramics (FGCs)

Room temperature magnetic refrigeration is a new highly efficient and environmentally protective technology. Although it has not been maturely developed, it shows great applicable prosperity and seems to be a potential substitute for the traditional vapor compression technology. Tape Casting is a common process in producing multilayer ceramics, which now is used for producing side-by-side (SBS) functionally graded ceramics (FGCs). These FGCs are mostly used in the magnetic refrigeration sectors due to the varying composition of the magnetocaloric materials so that the magnetic transition temperature of the magnetic regenerator varies along the paths. The main goal of this research is to study the multiple material flow in SBS tape casting and analyze its influence on the interface between the stripes. The materials used for the experimental part are $\text{La}_{0.85}\text{Sr}_{0.15}\text{MnO}_3$ and $\text{Ce}_{0.9}\text{Gd}_{0.1}\text{O}_2$ ceramic slurries. The rheological behavior of the slurries are extracted from experiments and used in the ANSYS FLUENT commercial code to develop a fluid flow model for the non-Newtonian ceramic slurries and evaluate the interface oscillation between the stripes in SBS tape casting. The Numerical results show reasonable agreement with corresponding experimental results.

General information
State: Published
Organisations: Department of Mechanical Engineering, Department of Energy Conversion and Storage, Ceramic Engineering & Science, Manufacturing Engineering, Electrofunctional materials
Authors: Jabbari, M. (Intern), Bulatova, R. (Intern), Hattel, J. H. (Intern), Bahl, C. (Intern)
Pages: H7.00002
Publication date: 2012
Conference: 65th Annual Meeting of the APS Division of Fluid Dynamics, San Diego, CA, United States, 18/11/2012 - 18/11/2012
Main Research Area: Technical/natural sciences

Publication information
Volume: 57
Issue number: 17
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ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Electronic versions:
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Links:
Source: dtu
Source-ID: u::6520
Publication: Research › Conference abstract in journal – Annual report year: 2012

Inter laboratory comparison of industrial CT scanners: CIA-CT audit. Final report
In this report results from an intercomparison of industrial CT scanners are presented. Three audit items, similar to common industrial parts, were selected for circulation: a single polymer part with complex geometry (Item 1), a simple
geometry part made of two polymers (Item 2) and a miniature step gauge produced using a polymer replica material (Item 3). The items circulated among six participants in Denmark and Germany. The circulation took place between March 2011 and June 2011. The items were measured according to a given protocol.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Angel, J. A. B. (Intern), Cantatore, A. (Intern), De Chiffre, L. (Intern)
Number of pages: 52
Publication date: 2012

**Publication information**

Original language: English
Main Research Area: Technical/natural sciences
Electronic versions: CIA_CT_Final_Report_version_046.pdf

**Bibliographical note**

Technical report
Publication: Research › Report – Annual report year: 2012

**Inter laboratory comparison on Industrial Computed Tomography: CIA-CT comparison. Technical Protocol**

The “CIA-CT comparison - Inter laboratory comparison on industrial Computed Tomography” is organized by DTU Department of Mechanical Engineering within the Danish project “Centre for Industrial Application of CT scanning - CIA-CT”. The project is co-financed by the Danish Ministry of Science, Technology and Innovation. The comparison aims to collect information about measurement performance in state-of-the-art industrial CT (Computed Tomography) scanning. Since CT scanning has entered the field of manufacturing and coordinate metrology, evaluation of uncertainty of measurement with assessment of all influence contributors has become the most important challenge related to the establishment of measurement traceability. This investigation focuses mainly on operator influences on the measurement result.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Angel, J. A. B. (Intern), De Chiffre, L. (Intern), Larsen, E. (Ekstern), Rasmussen, J. (Intern)
Number of pages: 12
Publication date: 2012

**Publication information**

Publisher: DTU Mechanical Engineering
Original language: English
Main Research Area: Technical/natural sciences
Publication: Research › Report – Annual report year: 2012

**Inter-RMO Key Comparison EUROMET.L-K5.2004: Calibration of a step gauge: Final report**

The results of the inter-RMO key comparison EUROMET.L-K5.2004 on the calibration of a step gauge are reported. Eighteen National Metrology Institutes and one Designated Institute from four different metrological regions all over the world participated in this comparison which lasted three years, from December 2004 to December 2007. A lack of stability was observed through the shifting of some of the inserted gauges. In order to save the comparison and get valuable and useful conclusions, it was agreed to exclude four gauges from calculation and assume that only seven gauges were reasonably stable so as to get the corresponding reference values. It was also agreed to divide the participants into two groups, analyze separately their results and, taking the pilot as the linking laboratory, refer the results to common reference values. The inverse-variance weighted mean was taken as reference value. Due to the significant instability of the step it was also considered an artefact uncertainty. The reported uncertainties ranged from 0.045 µm to 1.2 µm (k = 1). The uncertainty of the artefact ranged from 0.018 µm (for the 20 mm face) to 0.176 µm (for the 400 mm face). The compatibility of all participants for measuring step gauges was demonstrated with the only exception of a participant showing very high systematic (both positive and negative) errors. Five participants communicated higher uncertainties than the corresponding approved CMCs. A set of Recommendations and Actions were agreed therefore. Main text. To reach the main text of this paper, click on Final Report. Note that this text is that which appears in Appendix B of the BIPM key comparison database kcdb.bipm.org/. The final report has been peer-reviewed and approved for publication by the CCL, according to the provisions of the CIPM Mutual Recognition Arrangement (CIPM MRA).

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Centro Español de Metrología, National Measurement Institute, Centre for Metrology and Accreditation, Bundesamt für Eich- und Vermessungswesen,
Publication Information


Number of pages: 106
Pages: 04008
Publication date: 2012
Main Research Area: Technical/natural sciences

Journal: Metrologia
Volume: 49
Issue number: 1A
ISSN (Print): 0026-1394

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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.69 SJR 0.614 SNIP 1.448
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.47 SJR 0.88 SNIP 1.789
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.813 SNIP 1.611 CiteScore 1.96
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.997 SNIP 2.119 CiteScore 2.49
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.001 SNIP 1.955 CiteScore 1.88
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.153 SNIP 1.745 CiteScore 1.78
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.074 SNIP 1.726 CiteScore 1.64
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.779 SNIP 1.62
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.842 SNIP 1.615
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.773 SNIP 1.712
Scopus rating (2007): SJR 0.966 SNIP 1.823
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.636 SNIP 1.989
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.343 SNIP 1.866
Scopus rating (2004): SJR 0.802 SNIP 1.349
Web of Science (2004): Indexed yes
Investigation of the thermal contact resistance in thermosetting pultrusion process

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Baran, I. (Intern), Tutum, C. C. (Intern), Hattel, J. H. (Intern)
Number of pages: 2
Publication date: 2012

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Main Research Area: Technical/natural sciences
Conference: ICCE-20, Beijing, China, 22/07/2012 - 22/07/2012

Bibliographical note

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Source: dtu
Source-ID: u::5614
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

Investigation on the influence of image quality in X-ray CT metrology

This paper presents a method for evaluating measuring errors in a CT system using information from quality of reconstruction images. In particular, spatial resolution and pixel noise are considered in this work. Both factors can be theoretically described using formulas, and can be expressed as a combination of scanning setting parameters. A 32 full factorial design of experiment (DOE) was carried out to determine the influence of the two factors on dimensional measurements. For quantification of the influence, an evaluation parameter sphere distance error was selected. Results show that the spatial resolution is a dominant factor. Analysis of the reconstruction images is carried out, showing image artifacts occurring on the spheres visible under large opening angle, which are usually more significant for CT scans at high magnification. Theoretical formulation of pixel noise was validated through the experimentation.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Physikalisch-Technische Bundesanstalt
Authors: Müller, P. (Intern), Hiller, J. (Intern), Cantatore, A. (Intern), Bartscher, M. (Ekstern), De Chiffre, L. (Intern)
Number of pages: 10
Publication date: 2012
Main Research Area: Technical/natural sciences
Computed tomography, Image quality, Pixel noise, Spatial resolution, Dimensional CT measurement
Electronic versions:
müller_Wels(2012).pdf
Source: dtu
Liquid lubrication in sheet metal forming at mesoscopic scale
The lubricant entrapment and escape phenomena in metal forming are studied experimentally as well as numerically.
Experiments are carried out in strip reduction of aluminium sheet applying a transparent die to study the fluid flow between mesoscopic cavities. The numerical strategy is based on a weak fluid/structure coupling involving the Finite Element Method and analytical calculations. It allows to quantify the final shape of the lubricant pockets.

Manufacture of functional surfaces through combined application of tool manufacturing processes and Robot Assisted Polishing
The tool surface topography is often a key parameter in the tribological performance of modern metal forming tools. A new generation of multifunctional surfaces is achieved by combination of conventional tool manufacturing processes with a novel Robot Assisted Polishing process. This novel surface texturing method allows for a large degree of freedom in specifying surface characteristics and facilitates a high degree of reproducibility between samples surfaces. A series of strip reduction tests, equivalent to a metal forming ironing process, are conducted to benchmark the tribological performance of 15 generated tool surfaces.
Material investigation for manufacturing of reference step gauges for CT scanning verification

This work deals with the study of stability and material investigation for manufacturing of step gauges for CT scanning verification. Four replica step gauges were fabricated using a bisacryl material for dental applications and the stability over five months was monitored using a tactile CMM. The material was unstable, probably due to a modification of the chemical
composition which lowered the hardness. New step gauges were manufactured through milling. Polyetheretherketone (PEEK) and Polyp-phenylenesulphide (PPS with 40% glass) fulfil the requirements regarding hardness and mechanical properties and two series of five step gauges (one series for each material) were manufactured by milling. Results show a significant improvement in terms of form stability and surface geometry quality of the new step gauges with respect to the replica step gauges in Luxabite, as reported below.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Cantatore, A. (Intern), Angel, J. A. B. (Intern), De Chiffre, L. (Intern)
Number of pages: 4
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Main Research Area: Technical/natural sciences
Conference: 12th euspen International Conference, Stockholm, Sweden, 04/06/2012 - 04/06/2012
Electronic versions:
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Publication: Research › Article in proceedings – Annual report year: 2012

**Measurement capability overview in PolyNano: Final**
A measurement capability overview has been conducted to evaluate, among the most used instruments in the field of nanometrology, where the PolyNano project should focus its research. The deliverable presents the most relevant instruments to achieve the best possible measurements accuracy matching requirements such as low uncertainty, high repeatability and resolution, adequate measuring range and availability among the different project partners.
Based on the present measurement capability overview and in relation to the objective of PolyNano to "remove the technology barrier between lab-scale proof of principle and high volume low cost production", WP6 future work will be on standardizing new measuring methods through traceable procedures which will enable product quality control implemented in-line with micro/nano manufacturing processing technologies.

**General information**
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Calaon, M. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 16
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**Publication information**
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Main Research Area: Technical/natural sciences
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Publication: Research › Report – Annual report year: 2012

**Mechanical properties of chemically bonded sand core materials dipped in sol-gel coating impregnated with filter: novel approach to improve casting quality**
A novel sol-gel coating impregnated with filter dust was applied on chemically bonded sand core materials by dipping. After curing, the strengths of the core materials were measured under uniaxial loading using a new strength testing machine (STM). The STM presents the loading history as a force-displacement curve from which the mechanical properties of the materials are deduced. The fracture surfaces were examined using a stereomicroscope and a scanning electron microscope. From the results, the strengths of the core materials were slightly reduced by the coating in tensile and flexural modes, while the strengths were increased under compression. The mode of fracture of the chemically bonded sand core materials was observed to be intergranular through the binder. The stiffness of the chemically bonded sand core materials was determined. For better understanding of the mechanical properties of the chemically bonded sand core materials, a combination of flexural and compression tests is suggested for improving the casting quality. © 2012 W. S. Maney & Son Ltd.
### General information
State: Published  
Organisations: Department of Mechanical Engineering, Manufacturing Engineering  
Authors: Nwaogu, U. C. (Intern), Tiedje, N. S. (Intern)  
Pages: 307-317  
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Main Research Area: Technical/natural sciences

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Volume: 25  
Issue number: 5  
ISSN (Print): 1364-0461  
Ratings:  
BFI (2018): BFI-level 1  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 1  
Scopus rating (2017): SNIP 0.671 SJR 0.387 CiteScore 0.79  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): CiteScore 0.74 SJR 0.382 SNIP 0.857  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 0.325 SNIP 0.597 CiteScore 0.65  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 0.425 SNIP 0.846 CiteScore 0.73  
BFI (2013): BFI-level 1  
Scopus rating (2013): SJR 0.5 SNIP 0.96 CiteScore 0.67  
ISI indexed (2013): ISI indexed yes  
BFI (2012): BFI-level 1  
Scopus rating (2012): SJR 0.374 SNIP 0.714 CiteScore 0.52  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 1  
Scopus rating (2011): SJR 0.576 SNIP 0.996 CiteScore 0.75  
ISI indexed (2011): ISI indexed yes  
BFI (2010): BFI-level 1  
Scopus rating (2010): SJR 0.501 SNIP 0.857  
BFI (2009): BFI-level 1  
Scopus rating (2009): SJR 0.261 SNIP 0.393  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 1  
Scopus rating (2008): SJR 0.298 SNIP 0.493  
Scopus rating (2007): SJR 0.538 SNIP 0.881  
Web of Science (2007): Indexed yes  
Scopus rating (2006): SJR 0.559 SNIP 0.789  
Scopus rating (2005): SJR 0.409 SNIP 0.736  
Scopus rating (2004): SJR 0.359 SNIP 0.556  
Web of Science (2004): Indexed yes  
Scopus rating (2003): SJR 0.285 SNIP 0.874  
Scopus rating (2002): SJR 0.366 SNIP 0.712  
Scopus rating (2001): SJR 0.476 SNIP 0.695  
Scopus rating (2000): SJR 0.505 SNIP 0.619  
Scopus rating (1999): SJR 0.801 SNIP 1.334  
Original language: English  
DOIs:
Mechanism of spontaneous hole formation in thin polymeric films
We show computationally that (molten) thin polymeric film containing nonequilibrium configurations originating from a solvent evaporation may develop holes spontaneously in the molten state, and that they appear delayed. Polymers above the glass transition temperature are liquids where the flow depends solely on the nonequilibrium configurations of the molecules.
Modelling of Thermo-Electro-Mechanical Manufacturing Processes with Applications in Metal Forming and Resistance Welding: Applications in Metal Forming and Resistance Welding

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, SWANTEC Software and Engineering ApS, Instituto Superior Técnico
Authors: Nielsen, C. V. (Intern), Zhang, W. (Ekstern), Alves, L. (Ekstern), Bay, N. (Intern), Martins, P. F. (Ekstern)
Number of pages: 120
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Series: Springer Briefs in Applied Sciences and Technology: Manufacturing and Surface Engineering
Main Research Area: Technical/natural sciences
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Source-ID: u::5821
Publication: Research - peer-review › Book – Annual report year: 2012

Modelling and simulation of A-segregates in steel castings using a thermal criterion function: Part I - Background and validation

The present paper is the first out of two papers in which thermal criteria for modelling and optimising, i.e. minimising, the formation of A segregates are investigated. One specific thermal criterion has been incorporated into a transient three-dimensional thermal fluid model inside a commercial simulation software package. It is then used for predicting A segregates inside a large steel casting, i.e. a forging ram. In part I, experimental data obtained from a foundry serve to validate the given criterion and to evaluate the critical value for A segregate initiation for one alloy composition on the forging ram. In part II, the criterion forms the basis of shape optimisation of the original casting layout for the ram. More specifically, unknown optimal shapes and sizes of the top riser and chills are sought by means of autonomous optimisation to establish a better solidification pattern, which would eliminate the likelihood of centreline porosity and A segregates.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Kotas, P. (Intern), Hattel, J. H. (Intern)
Modelling injection moulding machines for micro manufacture applications through functional analysis

The paper presents the analysis of an injection moulding machine using functional analysis to identify both its critical components and possible working problems when such a machine is employed for the production of polymer-based micro products. The step-by-step procedure starts from the study of the process phases of a machine and then it employs functional analysis to decompose the phases and attributes functions to part features. Part features are subsequently analyzed to understand the causal chains bringing either to the desired behaviour or to failures to avoid. The assessment of the design solution is finally performed by gathering quantitative data from experiments. The case study investigates the design motivations and functional drivers of a micro injection moulding machine. The analysis allows identifying the correlations between failures and advantages with the design of the machine parts.

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State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Pisa
Pages: 107-112
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Scopus rating (2016): CiteScore 1.6 SNIP 1.374 SJR 0.719
Scopus rating (2015): SJR 0.605 SNIP 1.075
Scopus rating (2014): SJR 0.755 SNIP 1.4
Scopus rating (2013): SJR 0.53 SNIP 1.373
ISI indexed (2013): ISI indexed no
Original language: English
Functional analysis, Micro injection moulding
DOIs: 10.1016/j.procir.2012.05.050
Source: dtu
Source-ID: n::oai:DTIC-ART:elsevier/369520079::19269
Publication: Research - peer-review › Conference article – Annual report year: 2012

Modelling the void deformation and closure by hot forging of ingot castings

After solidification and cooling cast ingots contain voids due to improper feeding and volume shrinkage. Such voids are normally unwanted, so besides of forming the ingot to the desired shape, one of the purposes of the post processing of the ingot by hot forging is to close such voids by mechanical deformation. The aim of this paper is to analyze numerically if and to what degree the voids are closed by the forging. Using the commercial simulation software ABAQUS, both simplified model ingots and physically manufactured ingots containing prescribed void distributions are deformed and analyzed. The analysis concerns both the void density change and the location of the voids in the part after deformation. The latter can be important for the subsequent reliability of the parts, for instance regarding fatigue properties. The analysis incorporates the Gurson yield criterion for metals containing voids and focuses on how the voids deform depending on their size and distribution in the ingot as well as how the forging forces are applied.

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Publication: Research - peer-review › Journal article – Annual report year: 2012
New reference object for metrological performance testing of industrial CT systems
This paper presents a new reference object, so called "CT ball plate", used for metrological performance testing of industrial CT systems, and discusses both the calibration procedure using a tactile coordinate measuring machine and the first results carried out using an industrial CT scanner. This artefact can be used to determine several characteristics of the CT system like, probing errors of spheres, length measuring errors between sphere centers, measurement errors in the whole CT volume and effects in connection with image artefacts.

Numerical modeling of the conduction and radiation heating in precision glass moulding
Heating the glass wafer until the moulding temperature is the first important step in the glass moulding process and any reduction in time of this heating stage increases the production efficiency, considerably. Depending on the requirements for heating time and temperature uniformity in the glass wafer, heating can be performed by either conduction or radiation. The numerical simulation of these two heating mechanisms in the wafer based glass moulding process is the topic of the present paper. First, the transient heating of the glass wafer is simulated by the FEM software ABAQUS. Temperature dependent material data of the glass wafer are taken into account in the simulation to have a more realistic model of the material. Heating curves depicting temperature as a function of time inside the glass wafer are predicted for both radiation and conduction heating and based on that the heating time and the temperature uniformity in the glass wafer are evaluated for both heating mechanisms. Subsequently, the approximate radiation heat loss from the glass wafer during cooling is calculated using both numerical and analytical methods and the temperature change in the glass wafer versus time is obtained for this stage. The achieved results make way for an increased understanding of the heating process in precision glass moulding and hence a possible improvement of the heating system.
Numerical Modeling of the Flow of a Power Law Ceramic Slurry in the Tape Casting Process

Multilayer ceramics and their application have increased recently. One of the most common ways used to produce these products is tape casting. In this process the wet tape thickness is one of the most determining parameters affecting the final properties of the product and it is therefore of great interest to be able to control it. In the present work the flow of La_{0.85}Sr_{0.15}MnO_{3} (LSM) material in the doctor blade region is modelled numerically with ANSYS Fluent in combination with an Ostwald power law constitutive equation. Based on rheometer experiments the constants in the Ostwald power law are identified for the considered LSM material and applied in the numerical modelling for the tape thickness. This model is then used for different values of substrate velocity and material load in the reservoir and compared with experimental findings of the wet tape thickness and good agreement is found.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Jabbari, M. (Intern), Hattel, J. H. (Intern)
Pages: 151-157
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Publisher: Advanced Engineering Solutions
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Tape casting, Doctor blade, Fluid flow, Non-Newtonian, power law
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

Packing parameters effect on injection molding of polypropylene nanostructured surfaces

In today’s industry, applications involving surface patterning of sub-μm to nanometer scale structures have shown a high growth potential. To investigate the injection molding capability of replicating sub-μm surface texture on a large scale area, a 30x80 mm² tool insert with surface structures having a diameter of 500 nm was employed. The tool insert surface was produced using chemical-based-batch techniques such aluminum anodization and nickel electroplating. During the injection molding process, polypropylene (PP) was employed as material and packing phase parameters (packing time, packing pressure) were investigated. The replicated surface topographies were quantitatively characterized by atomic force microscopy using specific three-dimensional surface parameters and qualitatively inspected by scanning electron microscopy. Results showed that the degree of replication from the tool to the polymer part was mainly influenced by packing pressure level and distance from the gate.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development
Authors: Calaon, M. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern), Ravn, C. (Ekstern), Islam, A. (Intern)
Number of pages: 6
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PACKING PARAMETERS EFFECT ON INJECTION MOLDING OF POLYPROPYLENE NANOSTRUCTURED SURFACES_Matteo Calaon.pdf
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Patterns of gravity induced aggregate migration during casting of fluid concretes

In this paper, aggregate migration patterns during fluid concrete castings are studied through experiments, dimensionless approach and numerical modeling. The experimental results obtained on two beams show that gravity induced migration is primarily affecting the coarsest aggregates resulting in a decrease of coarse aggregates volume fraction with the horizontal distance from the pouring point and in a puzzling vertical multi-layer structure. The origin of this multi layer structure is discussed and analyzed with the help of numerical simulations of free surface flow. Our results suggest that it finds its origin in the non Newtonian nature of fresh concrete and that increasing casting rate shall decrease the magnitude of gravity induced particle migration.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Civil Engineering, Section for Construction Materials, Norwegian University of Science and Technology
Authors: Spangenberg, J. (Intern), Roussel, N. (Ekstern), Hattel, J. H. (Intern), Sarmiento, E. (Ekstern), Zirgulis, G. (Ekstern), Geiker, M. R. (Intern)
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 3.191 SJR 4.223 CiteScore 6.08
Web of Science (2017): Indexed Yes
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Scopus rating (2016): CiteScore 5.15 SJR 3.462 SNIP 3.2
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 3.549 SNIP 3.162 CiteScore 4.54
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 4.128 SNIP 3.583 CiteScore 4.44
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 4.219 SNIP 3.873 CiteScore 4.54
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 3.54 SNIP 3.875 CiteScore 3.92
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.079 SNIP 3.397 CiteScore 3.77
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.549 SNIP 2.785
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.361 SNIP 2.577
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Polymer wear plays an increasing role in manufacturing of machine parts for e.g. medical devices. Some of these have an expected lifetime of five to eight years during which very little wear of the components is acceptable. Too much wear compromises the dosage accuracy of the device and thereby the safety of the patients. Prediction of the wear of polymers is complicated by the low thermal conductivity of this kind of material. It implies that any acceleration of testing conditions by increased contact pressure and/or sliding velocity will make the polymer fail due to exaggerated heat buildup. This is not the kind of wear observed in medical devices. In the present work a method was developed capable of evaluating the wear progression in polymer-polymer contacts. The configuration of the setup is injection moulded specimens consisting of an upper part having a toroid shape and a lower flat part. The sliding contact is then a line contact deformed by the load. In this way it is possible to have a pressure distribution ranging from a very high value in the middle to zero at the borders according to Hertzian contact mechanics. The wear is evaluated after 10 s of sliding in the beginning increasing to 30 min. at the end. One test has a duration of maximum two hours. The wear is initiate in the highly loaded centerline of the contact. It then propagates to the lower pressure areas. The width of the wear track then expresses the wear extent. The method was calibrated with both wear resistant and easily worn polymers and it showed good ability to predict the wear extent seen in medical devices after five years of use.
An extensive state-of-the-art research has been conducted in the field of replication of micro/nano geometries in order to assess the currently available capability both at research and application level. As it emerged from the investigation, polymers for devices and deposited metals for tool making are the main materials employed in surface micro/nano manufacturing process chains. Hence, the result from this overview is particularly important for PolyNano and its associated process chain.

This deliverable describes available concepts of replication, reports on different degree of replication assessment methods, and presents measuring procedures/techniques suitable for replication fidelity studies. The report reviews state-of-the-art research results regarding replication obtained at different scales, tooling technologies based on surface replication, process validation thorough design of experiment and uncertainty analysis. The focus is on polymeric materials and deposited metals; for completeness glass and bulk metallic glasses (BMG) are briefly described as well as they are also employed for surface micro/nano replication. As a mean of replication assessment, simulation for surface replication modelling and evaluation is also reviewed for the presented material categories.

As far as polymer replication is concerned, the currently available replication capability in terms of obtainable lateral and vertical dimensions is compared with the typical dimensional range target of the PolyNano project. Methods for replication process validation are presented and will be further investigated in WP6 “Process Chain Validation” and applied to PolyNano study cases. Based on the available information, effective best practice standard process validation will be defined and implemented in the subsequent WP6 future work.

The possibility of producing with high volume Lab-on-Chip (LoC) devices through injection moulding is presented. Preparation of master geometries was made by etching a Si wafer by e-beam lithography. Subsequent nickel electroplating was employed to replicate the obtained geometries on the tool, which was used to mould on transparent polymer substrates the functional structures. To assess the critical factors affecting the replication quality throughout the different steps of the proposed process chain, test geometries were designed and produced on the side of the functional features. The so called “Finger Print” of the lithography and moulding processes was qualitatively and quantitatively evaluated through scanning electron microscopy and atomic force microscopy respectively. The entire process chain is therefore characterized and the degree of replication among the different replication steps quantified with precise measurements using a high accuracy relocation technique on the produced key test geometries.

Based on the obtained results the second generation of finger print will be designed and produced strictly following geometrical requirements of the different biomedical applications. This will improve the knowledge of the different fabrication processes involved in PolyNano and their capabilities on producing the required nanostructures. Moreover the needs of ensure reproducibility and provide traceable geometrical measuring methods will be developed in parallel with the new specifications/standards rules to design LoC devices.
Prediction of internal strains during curing, post-curing and demoulding of thick glass/epoxy composite - Analysis of different constitutive models

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Civil Engineering, Section for Building Design
Authors: Nielsen, M. W. (Intern), Schmidt, J. W. (Intern), Hattel, J. H. (Intern)
Number of pages: 2
Publication date: 2012
Event: Abstract from 6th International Conference on Advanced Computational Engineering and Experimenting, Istanbul, Turkey.
Main Research Area: Technical/natural sciences
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Source: dtu
Source-ID: u::4730
Publication: Research › Conference abstract for conference – Annual report year: 2012

Preliminary results of a proficiency testing of industrial CT scanners using small polymer items
This work presents preliminary results concerning a proficiency testing for intercomparison of industrial CT scanners. Two audit items, similar to common industrial parts, were selected for circulation. The two items were a single polymer complex geometry part and a simple geometry item made of two polymers. The items circulated among six participants in Denmark and Germany. The circulation took place between March 2011 and June 2011. This paper presents stability investigation of reference measurements carried out using tactile CMM and preliminary results from the intercomparison.

General information
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Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Angel, J. A. B. (Intern), Cantatore, A. (Intern), De Chiffre, L. (Intern)
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Main Research Area: Technical/natural sciences
Conference: 12th euspen International Conference, Stockholm, Sweden, 04/06/2012 - 04/06/2012
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Source-ID: u::4221
Publication: Research › Article in proceedings – Annual report year: 2012

Probabilistic thermo-chemical analysis of a pultruded composite rod
In the present study the deterministic thermo-chemical pultrusion simulation of a composite rod taken from the literature [7] is used as a validation case. The predicted centerline temperature and cure degree profiles of the rod match well with those in the literature [7]. Following the validation case, the probabilistic design of the pultrusion process, which has not been considered until now, is performed. The effect of statistical variations in the material (i.e. fiber and resin) and resin kinetic properties, as well as process parameters such as pulling speed and inlet temperature on the product quality (degree of cure) are examined by means of Monte Carlo Simulation (MCS) with Latin Hypercube Sampling (LHS) technique. The variations in the activation energy as well as the density of the resin are found to have a strong influence on the centerline degree of cure at the exit whereas the other process parameters have smaller influences. Moreover, different MCS options are examined to investigate their effects on the accuracy of the random output parameter.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Baran, I. (Intern), Tutum, C. C. (Intern), Hattel, J. H. (Intern)
Number of pages: 8
Publication date: 2012
Host publication information
Title of host publication: Proceedings of the 15th European Conference on Composite Materials
Process Simulation of Resistance Weld Bonding and Automotive Light-weight Materials
This paper presents the latest developments in numerical simulation of resistance welding especially with the new functions for simulation of microstructures, weld bonding and spot welding of new light-weight materials. The fundamental functions in SORPAS® are built on coupled modeling of mechanical, electrical, thermal and metallurgical processes, which are essential for simulation of resistance welding process to predict the welding results and evaluate the weldability of materials. These functions have been further extended with new functions for optimization of welding process parameters and predicting welding process window, for weld planning with optimal welding parameter settings, and for modeling microstructures and hardness distribution after welding. Latest developments have been made on simulation of resistance welding with nonconductive materials for applications in weld bonding with combination of adhesive bonding and spot welding, and in spot welding of the new lightweight sandwich steels.

Production Quality Control Of Microfluidic Chip Designs
The challenge of fabricating geometries with critical dimensions ranging from few microns down to 10 nanometers with high production rate is delaying the development of nanotechnology based products. Diverse research works have shown the capability of technologies such as UV lithography, nano imprint lithography and e-beam lithography to produce micro and nano features. However, their application for tooling purposes is relatively new and the potential to produce nanometer features with high volume low cost production is enormous. Considering possible implementation in a mass production environment the precision of measuring results and the accuracy of measurement relocation are very relevant. In this paper, the possibility of producing with high volume Lab-on-chip devices through injection molding are presented. Preparation of master geometries was made by etching a Si wafer by e-beam lithography. Subsequent nickel electroplating was employed to replicate the obtained geometries on the tool, which was used to mold on transparent polymer substrates the functional structures. To assess the critical factors affecting the replication quality throughout the different steps of the proposed process chain, test geometries were designed and produced on the side of the functional features. The so called "Finger Print" of the lithography and molding processes was qualitatively and quantitatively evaluated through scanning electron microscopy and atomic force microscopy respectively. The entire process chain is therefore characterized and the degree of replication among the different replication steps quantified with precise measurements using a high accuracy relocation technique on the produced key test geometries.
Prototypes realization with high-risk process: Draft. COTECH deliverable D7.2.3 (CP-IP 214491-2)

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Islam, A. (Intern), Garcia, I. (Ekstern)
PUBLICATION DATE: 2012

Publication information
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Original language: English
Series: COnverging TECHnologies for micro systems manufacturing
Main Research Area: Technical/natural sciences

Bibliographical note
SP7 - Industrial prototypes and demonstrators, WP7.2 - Process prototyping based on up-scales process chain
Source: dtu
Source-ID: u::4950
Publication: Research - peer-review › Report – Annual report year: 2012

Prototypes realization with medium-risk process: COTECH Deliverables D7.2.2 (CP-IP 214491-2)

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Islam, A. (Intern)
Number of pages: 95
Publication date: 2012

Publication information
Publisher: COTECH
Original language: English
Series: COnverging TECHnologies for micro systems manufacturing
Main Research Area: Technical/natural sciences

Bibliographical note
SP7 - Industrial prototypes and demonstrators, WP7.2 - Process prototyping based on up-scales process chain
Source: dtu
Source-ID: u::4949
Publication: Research - peer-review › Report – Annual report year: 2012

Reaming process improvement and control: An application of statistical engineering

Reaming operation had to be performed within given technological and economical constraints. Process improvement under realistic conditions was the goal of a statistical engineering project, supported by a comprehensive experimental investigation providing detailed information on single and combined effects of several parameters on key responses. Results supported selection of production parameters meeting specified quality and cost targets, as well as substantial improvements.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Politecnico di Torino
Authors: Müller, P. (Intern), Genta, G. (Ekstern), Barbato, G. (Ekstern), De Chiffre, L. (Intern), Levi, R. (Ekstern)
Pages: 196-201
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: CIRP Journal of Manufacturing Science and Technology
Replica casting technique for micro Fresnel lenses characterization

The available measuring techniques are not always suitable for the characterization of optical surfaces such as Fresnel lenses or polished specimens. A way to overcome these challenges is to reproduce the optical components surface using a polymer casting method and to measure the replicated surface. The aim of this paper is to investigate the replica technique when applied to micro structured specimens such as moulds for injection moulding of Fresnel lenses. Stability studies, replication fidelity investigations and dimensional measurements were performed in order to validate the performance of the replication method.
Report on prototypes characterization basic process: COTECH Deliverable 7.3.1 (CP-IP 214491-2)

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Islam, A. (Intern), Esmoris, J. I. (Ekstern)
Number of pages: 58
Publication date: 2012

Publication information
Publisher: COTECH
Original language: English
Series: COnverging TECHnologies for micro systems manufacturing
Main Research Area: Technical/natural sciences

Bibliographical note
SP7 - Industrial prototypes and demonstrators, WP7.3 - Demonstration based on best prototypes & final validation
Publication: Research - peer-review › Report – Annual report year: 2012

Report on prototypes characterization medium-risk process, COTECH D7.3.2: Draft. COTECH Deliverable 7.3.2 (CP-IP 214491-2)

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Islam, A. (Intern), Staemmmler, L. (Ekstern)
Number of pages: 54
Publication date: 2012

Publication information
Publisher: COTECH
Original language: English
Series: COnverging TECHnologies for micro systems manufacturing
Main Research Area: Technical/natural sciences

Bibliographical note
SP7 - Industrial prototypes and demonstrators, WP7.3 - Demonstration based on best prototypes & final validation
Publication: Research - peer-review › Report – Annual report year: 2012

Report on prototypes characterization medium-risk process, COTECH D7.3.3: Final. COTECH Deliverable 7.3.3 (CP-IP 214491-2)

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Padovani, S. (Ekstern), Islam, A. (Intern)
Number of pages: 63
Publication date: 2012

Publication information
Publisher: COTECH
Original language: English
Reproducibility of a reaming test

The reproducibility of a reaming test was analysed to document its applicability as a performance test for cutting fluids. Reaming tests were carried out on a drilling machine using HSS reamers. Workpiece material was an austenitic stainless steel, machined using 4.75 m∙min⁻¹ cutting speed and 0.3 mm∙rev⁻¹ feed. A mineral straight oil and a water-based lubricant at two different oil concentrations were compared with respect to hole quality, evaluated in terms of surface finish (conventional average roughness parameter Ra and roughness profiles), and hole geometry (hole diameter and roundness). Process reproducibility was assessed as the ability of different operators to ensure a consistent rating of individual lubricants. Absolute average values as well as experimental standard deviations of the evaluation parameters were calculated, and uncertainty budgeting was performed. Results document a built-up edge occurrence hindering a robust evaluation of cutting fluid performance, if the data evaluation is based on surface finish only. Measurements of hole geometry provide documentation to recognize systematic error distorting the performance test.

Simulative Testing of Friction and Lubrication in Cold Forging of Steel and Aluminum

A new, simulative test of friction and lubrication in cold forging is developed by the authors. The test is based on a backward can extrusion process in which the workpiece rotates relatively to the conical punch. An analytical model is presented determining the friction stress from the measured torque during testing combined with an analysis of the sliding velocity distribution along the punch nose. The latter is determined by FE analysis of the test. Results show friction stress for unalloyed low C-steel provided with different types of lubricants, i.e., phosphate coating plus soap, phosphate coating plus MoS₂ and single bath lubrication with PULS and aluminum provided with 6 different lubricant systems. The new test is so severe, that it is possible to break down the best lubrication systems for cold forging of steel and aluminum.
Single-sided sheet-to-tube spot welding investigated by 3D numerical simulations
The single-sided resistance spot welding process is analyzed by a 3D numerical study of sheet-to-tube joining. Finite element simulations are carried out in SORPAS® 3D. Two levels of electrode force and five levels of welding current are simulated. The overall effects of changing current and force are discussed and special focus is put on the sensitivity to the electrode force and the potential of melt penetration to the inside of the tube. The electrode force is critical because the level is a compromise between sufficient contact area on one side and indentation and local deformation of the tube on the other side. The potential of melt penetration through the thickness of the tube during the hold time is a result of heat conduction in the tube material and lack of an electrode on the inside of the tube, which results in poor cooling of the inner tube surface.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Dortmund FuE-A Pressfügen/Kleben, SWANTEC Software and Engineering ApS
Authors: Nielsen, C. V. (Intern), Chergui, A. (Ekstern), Zhang, W. (Ekstern)
Number of pages: 12
Publication date: 2012
Event: Abstract from 7th International Seminar on Advances in Resistance Welding, Busan, Korea, Republic of.
Main Research Area: Technical/natural sciences
Electronic versions:

Stress and neutron scattering measurements on linear polymer melts undergoing steady elongational flow
We use small-angle neutron scattering to measure the molecular stretching in polystyrene melts undergoing steady elongational flow at large stretch rates. The radius of gyration of the central segment of a partly deuterated polystyrene molecule is, in the stretching direction, increasing with the steady stretch rate to a power of about 0.25. This value is about half of the exponent observed for the increase in stress value $\sigma$, in agreement with Gaussian behavior. Thus, finite chain extensibility does not seem to play an important role in the strongly non-linear extensional stress behavior exhibited by the linear polystyrene melt.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Micro- and Nanotechnology, Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark, Forschungszentrum Jülich GmbH, University of Copenhagen
Stress relaxation and reversed flow of low-density polyethylene melts following uniaxial extension.
The extensional dynamics of two low-density polyethylene melts Lupolen 3020D and Lupolen 1840D, both showing a stress overshoot in start-up of uniaxial extension [Rasmussen, H. K., J. K. Nielsen, A. Bach, and O. Hassager, 'Viscosity overshoot in the start-up of uniaxial elongation of low density polyethylene melts,' J. Rheol. 49(2), 369-381 (2005)], have been further investigated in stress relaxation and reversed flow. After the overshoot, the stress relaxation has a remarkably faster decrease of the transient stress than when the relaxation is initiated before the overshoot. The measurements from the reversed flow also show that the melts appear less elastic after the overshoot. Multi mode versions of the pom-pom and interchain pressure model fit the data quantitatively up to the stress maximum, but neither model captures the qualitative behavior after the maximum.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Huang, Q. (Intern), Rasmussen, H. K. (Intern), Skov, A. L. (Intern), Hassager, O. (Intern)
Pages: 1535-1554
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Rheology
Volume: 56
Issue number: 6
ISSN (Print): 0148-6055
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SJR 1.326 SNIP 1.564 CiteScore 3.17
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.1 SJR 1.438 SNIP 1.523
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.43 SNIP 1.531 CiteScore 2.67
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.696 SNIP 1.565 CiteScore 3.29
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.319 SNIP 1.63 CiteScore 2.96
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.359 SNIP 1.617 CiteScore 2.72
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.96 SNIP 1.839 CiteScore 3.34
Strongly non-linear extensional stress is not dominated by finite chain extensibility in polystyrene melts undergoing large steady rate extensional flows.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Amphiphilic Polymers in Biological Sensing, Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Mechanical Engineering, Manufacturing Engineering, Technical University of Denmark, Forschungszentrum Jülich GmbH, University of Copenhagen
Authors: Almdal, K. (Intern), Hassager, O. (Intern), Mortensen, K. (Forskerdatabase), Bach, A. (Ekstern), Rasmussen, H. K. (Intern), Pyckhout-Hintzen, W. (Ekstern)
Number of pages: 1
Publication date: 2012
Event: Poster session presented at High Polymer Research Group 52nd HPRG-Meeting, Pott Shrigley, United Kingdom.
Main Research Area: Technical/natural sciences

Electronic versions:
Strongly non-linear extensional stress is not dominated by finite chain extensibility in polystyrene melts undergoing large steady rate extensional flows.

Source: dtu
Source-ID: u::4416
Surface wear of TiN coated nickel tool during the injection moulding of polymer micro Fresnel lenses

Limited tool life of nickel mould inserts represents an issue for the mass-production of polymer optics with complex micro three-dimensional geometries by injection moulding. TiN coating was applied to a nickel insert for the injection moulding of polycarbonate micro Fresnel lenses. Surface wear was monitored at different intervals during production on different tool locations. 3D micro optical dimensional microscopy, surface replica technique and SEM–EDS were employed to characterize wear of the micro features. Results showed wear decreasing at higher distance from the gate. After 24,500 moulding cycles the measured height reduction of 23μm high ribs was on the order of 400–1000nm.
Temperature compensated, humidity insensitive, high-$T_g$ TOPAS FBGs for accelerometers and microphones

In this paper we present our latest work on Fiber Bragg Gratings (FBGs) in microstructured polymer optical fibers (mPOFs) and their application as strain sensing transducers in devices, such as accelerometers and microphones. We demonstrate how the cross-sensitivity of the FBG to temperature is eliminated by using dual-FBG technology and how mPOFs fabricated from different grades of TOPAS with glass transition temperatures around 135 degrees C potentially allow high-temperature humidity insensitive operation. The results bring the mPOF FBG closer to being a viable technology for commercial applications requiring high sensitivity due to the low Young's Modulus of polymer.

General information
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Department of Mechanical Engineering, Manufacturing Engineering, Singapore Institute of Manufacturing Technology, University of Patras, Brüel & Kjær A/S, Ibsen Photonics A/S
Authors: Stefani, A. (Intern), Yuan, W. (Ekstern), Markos, C. (Ekstern), Rasmussen, H. K. (Intern), Andresen, S. (Ekstern), Guastavino, R. (Ekstern), Nielsen, F. K. (Ekstern), Rose, B. (Ekstern), Jespersen, O. (Forskerdatabase), Herholdt-Rasmussen, N. (Ekstern), Bang, O. (Intern)
Number of pages: 10
Pages: 84210Y
Publication date: 2012
Conference: 22nd International Conference on Optical Fiber Sensors (OFS 2012), Beijing, China, 15/10/2012 - 15/10/2012
Main Research Area: Technical/natural sciences

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Journal: Proceedings of SPIE, the International Society for Optical Engineering
Volume: 8421
ISSN (Print): 0277-786X
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BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.43 SJR 0.243 SNIP 0.289

Optimization of an engineering system or component makes a series of changes in the initial random solution(s) iteratively to form the final optimal shape. When multiple conflicting objectives are considered, recent studies on innovization revealed the fact that the set of Pareto-optimal solutions portray certain common design principles. In this paper, we consider a 14-variable bi-objective design optimization of a MEMS device and identify a number of such common design principles through a recently proposed automated innovization procedure. Although these design principles are found to exist among near-Pareto-optimal solutions, the main crux of this paper lies in a demonstration of temporal evolution of these principles during the course of optimization. The results reveal that certain important design principles start to evolve early on, whereas some detailed design principles get constructed later during optimization. Interestingly, there exists a simile between evolution of design principles with that of human evolution. Such information about the hierarchy of key design principles should enable designers to have a deeper understanding of their problems.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Indian Institute of Technology, Kanpur
Testing and Prediction of Limits of Lubrication in Sheet Metal Forming

Increasing focus on environmental issues in industrial production has urged a number of sheet metal forming companies to look for new tribo-systems, here meaning the combination of tool_material/workpiece_material/lubricant, in order to substitute hazardous lubricants such as chlorinated paraffin oils. Testing of new tribo-systems under production conditions is, however, very costly. For preliminary testing it is more feasible to introduce laboratory tests. In this paper a new methodology for testing new tribo-systems is presented. The methodology describes a series of investigations combining laboratory and production tests as well as numerical analyses in order to evaluate and compare performance of the new tribo-systems. A part is selected from industrial production and analyzed by this methodology in order to substitute the existing tribo-system with a new one.

The COTECH knowledge database: assessment of critical factors in micro moulding

The European Large Scale Collaboration Project “COTECH” (Converging Technologies for Micro ystem Manufacturing, 2008-2012 has as one of its main objectives to improve the understanding of the micro injection moulding (µIM) process to enable its implementation in large-scale production conditions, and to propose innovative solutions of serial production control to ensure effective high quality industrial micro manufacture. Specific research work has been undertaken during the COTECH project in order to monitor, characterize, analyse, and simulate the µIM process. Relations between the fundamental process input parameters and process quality factors and material characteristics have been established. To meet the goal of high accuracy processing and manufacturing during the whole process chain, different means of optimization technologies based on the design of experiments method have been employed. Methods to enhance the performance of the optimization methods have been demonstrated and validated. Based on the research work carried out, selected µIM critical factors including µIM pressure, surface replication, filling flow pattern analysis, and process simulation are presented in this paper. Their effects and dependencies are described, and recommendations for possible optimized process configuration discussed.
The effect of post-welding conditions in friction stir welds: From weld simulation to Ductile Failure

The post-welding stress state, strain history and material conditions of friction stir welded joints are often strongly idealized when used in subsequent modeling analyses, typically by neglecting one or more of the features above. But, it is obvious that the conditions after welding do influence the weld performance. The objective of this paper is to discuss some of the main conflicts that arise when taking both the post-welding material conditions and stress-strain state into account in a subsequent structural analysis. The discussion is here based on a preliminary numerical study of the possible effect of the post-welding conditions when subjecting a friction stir weld to loading transverse to the weld line. The numerical model of the friction stir welded joint, employs a step-wise modeling approach to combine an in-situ weld simulation with a post-welding failure analysis. Using the commercial software ANSYS, a thermo-mechanical model is employed to predict the thermally induced stresses and strains during welding, while an in-house finite element code is used to study the plastic flow localization and failure in a subsequent structural analysis. The coupling between the two models is made by mapping the postwelding stress-strain conditions predicted in ANSYS to the in-house code by using re-meshing techniques. The study indicates a noticeable influence of the post-welding stress-strain condition when subjecting the welded plate to tension. E.g. an increase of the tensile curve prior to plastic flow localization was observed, with a substantial influence on the specimen elongation at the onset of localization and thereby failure. This influence is, however, shown to be strongly affected by the applied boundary conditions. Specimens cut from the welded plate, transverse to the weld line, showed the largest influence of the post-welding conditions, even though significant relaxation of the residual stress state was predicted.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Solid Mechanics
Authors: Hattel, J. H. (Intern), Nielsen, K. L. (Intern), Tutum, C. C. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.7 SJR 1.487 SNIP 1.507
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.376 SNIP 1.491 CiteScore 2.56
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.322 SNIP 1.581 CiteScore 2.14
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.619 SNIP 2.14 CiteScore 2.6
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.306 SNIP 1.817 CiteScore 1.92
Thermal modelling of the multi-stage heating system with variable boundary conditions in the wafer based precision glass moulding process

In the precision glass moulding process, the heat transfer and the resulting transient temperature distributions of the molten glass are of great importance because they significantly affect the productivity as well as the thermally induced residual stresses in the final product. Thermal modelling of the heating system in the glass moulding process considering detailed heating mechanisms therefore plays an important part in optimizing the heating system and the subsequent pressing stage in the lens manufacturing process. The current paper deals with three-dimensional transient thermal modelling of the multi-stage heating system in a wafer based glass moulding process. In order to investigate the importance of the radiation from the interior and surface of the glass, a simple finite volume code is developed to model one dimensional radiation–conduction heat transfer in the glass wafer for an extreme case with very high temperature difference considering temperature dependant thermal conductivity and heat capacity. Afterwards, by using three-dimensional FEM modelling along with a predefined experimental test, the equivalent glass–mould interface contact resistance is determined for two different pressures. Finally, the three-dimensional modelling of the multi-stage heating system in the wafer based glass moulding process is simulated with the FEM software ABAQUS for a particular industrial application for mobile phone camera lenses to obtain the temperature distribution in the glass wafer. In the numerical modelling, the interface boundary conditions for each heating stage are changed according to the determining heat transfer mechanism(s). Numerical results are compared with experimental data to show the validity of the numerical modelling. The obtained results show that the right thermal modelling is highly dependent on the proper choice of thermal boundary conditions in different stages according to the real physical phenomena behind the process.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Kaleido Technology ApS
Authors: Sarhadi, A. (Intern), Hattel, J. H. (Intern), Hansen, H. N. (Intern), Tutum, C. C. (Intern), Lorenzen, L. (Ekstern), Skovgaard, P. M. (Ekstern)

DIs: 10.1016/j.euromechsol.2011.10.004
Source: orbit
Source-ID: 316761
Publication: Research - peer-review › Journal article – Annual report year: 2012
Thermo-chemical simulation of a composite offshore vertical axis wind turbine blade

In the present study three dimensional steady state thermo-chemical simulation of a pultrusion process is investigated by using the finite element/nodal control volume (FE/NCV) technique. Pultrusion simulation of a composite having a C-shaped cross section is performed as a validation case. The obtained cure degree profiles for specific points match well with those in the literature. Following the validation case, the proposed numerical technique is applied to the modelling of the pultrusion of a composite blade which has a NACA0018 airfoil cross section. The effects of pulling speed and various set temperature schemes of heating platens on the quality of the composite NACA0018 blade are explored.

Tooling solutions for sheet metal forming and punching of lean duplex stainless steel.

For producers of advanced stainless components the choice of stainless material influences not only the product properties, but also the tooling solution for sheet metal stamping. This work describes how forming and punching tools will be affected when introducing the stainless alloys ferritic EN1.4509 and lean duplex EN1.4162 in a production designed for austenitic stainless steels, such as EN1.4301 and 1.4401. The result is a guideline that summarizes how stainless material properties may affect tool degradation, and suggests tool solutions for reduced production disturbances and tool maintenance cost.
Transient Overshoot Extensional Rheology: Experimental and Numerical Comparisons

The true steady state value for the extensional stress growth is still an open topic in the field of polymer melts. Shear and extensional flows are often used to fit the various parameters in constitutive models. Extensional flow is much more effective than shear flow at orientating and stretching polymer chains, and not having steady state values for the extensional viscosity makes understanding and modelling molecular rheology in extensional flow challenging. Here we present a comparison between tree extensional rheometers: the Sentmanat extensional rheometer (SER), the filament stretching rheometer (FSR) and the cross-slot extensional rheometer (CSER). The first two are uni-axial stretching rheometers and the third is a planar extensional rheometer. The FSR and CSER are capable of achieving steady state flows, although in different strain-rate regimes.

The SER has been a widely adopted tool as it conveniently adapts to a standard shear rheometer. However, the SER is only capable of reaching Hencky strains up to 4. We compare this to the transient measurements of the FSR which uses an active feedback system to control sample necking and is capable of Hencky strains of around 7.

We then compare the steady state measurements from the FSR to the predictions of the CSER, which measures the viscosity using optical flow induced birefringence techniques. The FSR is capable of measuring a steady state for strain rates less than 0.5/s and the CSER for strain rates typically in the range of 0.1/s to 10/s. Although we are comparing uni-axial to planar flow, these flows produce the same polymer deformation and hence stress in the strain hardening regime. The techniques show a good quantitative agreement where the two experimental windows overlap.

In comparing the FSR to the CSER we are able to explain an observed feature of the optical birefringence stress patterns, known as W-cusping. It has been shown that the Pompom model, a constitutive model for branched polymers, does not capture this feature. Here we show the cause of the observed W-cusps is due to the presence of a transient overshoot in the extensional viscosity. We present a modified Pompom model capable of capturing these overshoots and show finite element simulations of the cross-slot flow using this model. In doing this we show how the overshoot causes the W-cusp and how the shape of the cusps is dependent upon the difference between the maximum extensional viscosity and the steady state value.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Mechanical Engineering, Manufacturing Engineering, Durham University, University of Leeds, Universite Catholique de Louvain
Authors: Hoyle, D. (Ekstern), Huang, Q. (Intern), Auhl, D. (Ekstern), Rasmussen, H. K. (Intern), Skov, A. L. (Intern), Harlen, O. (Ekstern), Hassager, O. (Intern), McLeish, T. (Ekstern)
Publication date: 2012
Event: Abstract from 16th International Congress on Rheology, Lisbon, Portugal.
Main Research Area: Technical/natural sciences

Bibliographical note
Oral Presentation.
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Publication: Research › Conference abstract for conference – Annual report year: 2012

Tribological study in roll forming of lean duplex stainless steel sheets

In roll forming a sheet metal strip undergoes deformation in several successive forming steps until the desired shape is reached. It is a very cost effective process to produce series of continuous profiles. Though roll forming is not considered a tribologically critical process, as process loads are relatively low and surface expansion is more or less non-existent, long roll forming production runs imply large sliding/contact lengths due to relative movement between steel strip and rolls. This requires an efficient tribological system to prevent pick-up formation on the forming tools. The present work focus on tribological issues are galling and pick-up formation as well as tool life in roll forming of stainless duplex steel sheets. The roll forming process is exemplified by production of an s-shaped profile used in interlock carcass production for flexible pipes used in off-shore oil extraction.

Production tests show that galling can be a problem but pick-up formation on the tools seems to reach a consistent level. Improvements to tool surfaces and lubricant quality are proposed with a view to optimizing the tribo-system in order to increase the produced length before galling initiates and tool refurbishing is required. The production also shows damage to critical tool surfaces after extensive production time. Investigations focus on adhesive wear due to lubricant film breakdown and tool fatigue. Finite Element Analysis (FEA) is utilized to analyse contact interface pressures for estimation of stresses on the tools and tribological system.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, National Oilwell Varco Denmark I/S
Two-component micro injection moulding for hearing aid applications

Two-component (2k) injection moulding is an important process technique at the present state of technology, and it is growing rapidly in the field of precision micro moulding. Besides combining different material properties in the same product, two-component moulding can eliminate many assembly steps in the manufacturing process chain. One of the biggest technical challenges associated with 2k moulding is the unavailability of suitable material combinations which can meet the diverse requirement from both product and process point of views. When it comes to the point of micro application, the precise dimensional requirement and tolerance make the 2k moulding a technically challenging process.

This paper presents an industrial case study of 2k micro moulding covering all the important issues like product design, material selection, moulding and functionality testing of the micro moulded 2k parts. An intensive search for suitable 2k materials is made and few combinations of plastic materials are presented in the paper which can be used for highly demanding application areas like hearing aids. By using these material combinations, a demonstrator 2k micro part has been fabricated. The moulding machine was a state-of-the-art 2k micro machine from DESMA. The fabricated micro part was a socket house integrated with a sealing ring for the receiver-in-canal hearing instrument. The test performed on the demonstrator showed the potential of the 2k moulding technology to be able to solve some of the existing problems associated with hearing instruments.
Using sol-gel component as additive to foundry coatings to improve casting quality

The improvement of foundry coatings to enhance performance is important. This paper investigates the effect of using sol-gel component as an additive to foundry coatings applied on chemically bonded sand cores. Three parameters at three levels each were investigated using Taguchi experimental parameter design. The effects of the sol-gel component on viscosity, density, °Baumé, core coverage and permeability are shown. Numerical simulations were used to predict defect areas. The thermal profiles of the core materials during casting were determined, and the surface quality of the castings was evaluated. The results show that the surface quality of castings obtained by adding the sol-gel component to the coatings for cold box cores has no significant difference from castings produced with coatings without sol-gel component. On the other hand, the addition of the sol-gel component in coatings for furan cores showed significant improvement on the surface quality of the castings compared to that obtained without sol-gel component.
The aim of this work is to define methodologies for the tolerance verification of injection moulded components with downscaled dimensions. In micro and nano metrology different challenges can be found: lack of calibration artefacts and available ISO standards, problematic uncertainty budget and tolerance verifications due to no proper measuring instruments.

In connection to the last issue, the characterization of optical components is often difficult to obtain using contact instruments which could damage the surface of the specimen, whereas optical measurements might be inaccurate due to...
scattered light. In this thesis a replica casting technique is proposed to overcome the problem: the workpiece is replicated and the replica is characterized instead of the part. Different investigations are carried out on roughness specimens and deterministic structures (e.g. grooves) in order to define the replication degree and the replica stability. Moreover a new traceability methodology is studied and proposed when dealing with this methodology. The measuring instrument has to be calibrated on the same replica surface to ensure the traceability. Therefore the aim of the procedure is to perform a replica on a calibrated standard artefact and to measure both in order to assure an unbroken chain of comparisons. The replica technique reveals to be a fast, cost-effective and reliable method.

Regarding the tolerance verification of micro parts and nano-structured surfaces, a systematic approach is discussed based on dimensional and geometrical metrology. If the measurements uncertainty is large compared to the tolerance interval, a small conformance zone is left for process variation. Therefore particular attention has to be paid to the instrument capabilities in order to reduce the measurement uncertainty. Different methods, such as the quality control approach and the measuring indices approach, are investigated in order to optimize and maximize the repeatability of the results. Moreover a useful guideline is proposed to provide a viable method for the uncertainty calculation of measurements in the micro range (0.1 – 200 μm).

Finally, an optical component is investigated with the purpose of suggesting a quality control approach for micro-manufacturing processes through a control of the product. It is a useful method to adopt when the aim is to detect and quantify inconsistency or incompatibilities during a process chain. In this way the process parameters can be adjusted in order to fulfill the requirements of the final micro-product.

### General information
- **State:** Published
- **Organisations:** Department of Mechanical Engineering, Manufacturing Engineering
- **Authors:** Gasparin, S. (Intern), Hansen, H. N. (Intern), De Chiffre, L. (Intern), Tosello, G. (Intern)
- **Number of pages:** 290
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- **Electronic versions:**
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### Bibliographical note
- **Author:** Stefania Gasparin, PhD thesis, Technical University of Denmark, April 2012, pp. 1-290, ISBN: 978-87-90416-76-8
- **Source-ID:** u:4019
- **Publication:** Research › Ph.D. thesis – Annual report year: 2012

### Integrated Modeling of Process, Structures and Performance in Cast Parts
This thesis deals with numerical simulations of gravity sand casting processes for the production of large steel parts. The entire manufacturing process is numerically modeled and evaluated, taking into consideration mould filling, solidification, solid state cooling and the subsequent stress build up. The thermal analysis is then combined with evolutionary multi-objective optimization techniques in a search for the optimal thermal aspects and conditions for producing sound and competitive castings. The goals of the optimization procedure are related to the casting and rigging design and to defects occurrence. In other words, it is desired to eliminate all of the potential casting defects and at the same time to maximize the casting yield. The numerical optimization algorithm then takes these objectives and searches for a set of the investigated process, design or material parameters e.g. chill design, riser design, gating system design, etc., which would satisfy these objectives the most. The first step in the numerical casting process simulation is to analyze mould filling where the emphasis is put on the gating system design. There are still a lot of foundry specialists who ignore the importance of a good gating system design. Hence, it is common to see, especially in gravity sand casting, "traditional gating systems" which are known for a straight tapered down runner a well base and 90º bends in the runner system. There are theories supported by experimental results claiming that flow patterns induced by non-optimal gating systems can cause a variety of defects which are generally not considered to be filling related, such as hot tears and channel segregates. By improving the gating technology in traditional gating systems it is possible to achieve much higher casting integrity with less defects and also to reduce the amount of metal to be re-melted, hence reducing the energy consumption for melting in foundries. Guidelines on how to approach gating system design are given together with examples on how the separate elements constituting gating systems which affect filling patterns and subsequent defects occurrence. Investigation and optimization of thermal behavior of steel castings is the main focus area of this thesis. The intention is to show and discuss a relation among three well-known casting defects, namely centerline porosity, hot tears and macrosegregation. It occurs that all of these defects depend on thermal gradients, cooling rate, pressure drop over the mushy zone and solidification pattern. It is not a standard procedure in daily foundry practice to run convection, macrosegregation and stressstrain calculations on all projects to identify macrosegregation and hot tearing, because of insufficient computational power in many foundries. As a result, many castings are being produced without any knowledge of these two defects. The consequences are known to everybody. The methodology or approach, adopted during the study, lies in utilizing the prediction of centerline porosity for the subsequent assessment of hot tears and macrosegregation. The Niyama criterion is used for this purpose. If there are any narrow areas or channels with high
Niyama values, they indicate a presence of high thermal gradients over a narrow region and hence high thermal straining which may lead to hot tearing. If Niyama values are very low, flat thermal gradients are present in this area, which means that there is not a directional and progressive solidification pattern and there will be issues with centerline porosity. Moreover, flat thermal gradients imply large extent of the mushy zone which may promote macrosegregation and especially channel segregates. One can now see that indeed macrosegregation and hot tearing can be addressed by standard thermal calculations, just by using the Niyama criterion. This should not be understood as stress-strain analysis or convection calculations can be entirely omitted, not at all. But they can be reasonably substituted in the initial (informative) calculation or when there is not time to run proper stress-strain or convection calculations. The methodology applied in the thermal analysis is then exploited in numerical optimization. It is shown and verified that it is possible to eliminate hot tears and macrosegregation issues by minimizing centerline porosity and by establishing the directional and progressive solidification pattern towards the heaviest area of the casting. Multi-Objective Genetic Algorithms are applied to handle this task. Three industrial case studies are presented in which minimization of riser volumes and minimization of the three aforementioned defects are pursued by modifying the riser and chill designs and their placement.

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Authors: Kotas, P. (Intern), Hattel, J. H. (Intern)
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Source: orbit
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Publication: Research › Ph.D. thesis – Annual report year: 2011

Polymer fiber waveguides for terahertz radiation
Terahertz radiation offers many exciting applications noticeably in spectroscopy and it is showing promising results in imaging, mainly for security applications. In this project the study of using structured polymer fibers for THz waveguiding is presented. The inspiration for the THz fiber is taken from microstructured polymer optical fibers (mPOFs) used at optical wavelengths for sensing and communication. The fibers investigated can be divided into two groups, the solid core fibers and the hollow core fibers. The solid core fibers offer the broadest bandwidth with the best dispersion profile, while the hollow core fibers hold the promise for lowest loss but at the cost of lower bandwidth. In both cases the fabrication and characterization of the fibers is presented. The fibers are also investigated numerically and the numerical results are held up against the experimental results. The polymer material with lowest loss is Topas and all the solid core fibers are manufactured using this material. The polymer PMMA however has higher refractive index along with higher loss, and this higher refractive index is utilized to achieve a large bandwidth hollow core fiber with a low air-fill fraction. Finally, an example of an application is presented in the form of a broadband 3-dB directional fiber coupler. The device is numerically investigated and designed in such a way that it is manufacturable.

General information
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Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Manufacturing Engineering, Department of Mechanical Engineering, Terahertz Technologies and Biophotonics
Authors: Nielsen, K. (Intern), Bang, O. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern)
Publication date: Apr 2011

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Publication: Research › Ph.D. thesis – Annual report year: 2011
870nm Bragg grating in single mode TOPAS microstructured polymer optical fibre

We report the fabrication and characterization of a fiber Bragg grating (FBG) with 870 nm resonance wavelength in a single-mode TOPAS microstructured polymer optical fiber (mPOF). The grating has been UV-written with the phase-mask technique using a 325 nm HeCd laser. The static tensile strain sensitivity has been measured as 0.64 pm/μstrain, and the temperature sensitivity was -60 pm/°C. This is the first 870nm FBG and the first demonstration of a negative temperature response for the TOPAS FBG, for which earlier results have indicated a positive temperature response. The relatively low material loss of the fiber at this wavelength compared to that at longer wavelengths will considerably enhance the potential utility of the TOPAS FBG.
A 1d Coupled Curing and Visco-Mechanical Void Growth Model of Thick Thermosetting Composite Laminates

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Composites and Materials Mechanics, Materials Research Division, Risø National Laboratory for Sustainable Energy, Wind Turbines, Wind Energy Division
Authors: Nielsen, M. W. (Intern), Hattel, J. H. (Intern), Løgstrup Andersen, T. (Intern), Branner, K. (Intern), Nielsen, P. H. (Intern)
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Voids, Numerical modelling, Curing, Laminate

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Links:
http://www.iccm18.org/

Bibliographical note
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Advanced free-form micro tooling: Final. COTECH EU FP7 Integrated Project (Grant Agreement no.: CP-IP 214491-2)
The present deliverable contains the report of the work and results achieved within the framework of WP 2.2 in Tasks 2.2.4 “Advanced free-form micro tooling” in experimental research done regarding practical applications of methods of applying nano structures to tooling solutions. As part of Task 2.2.4, tests based on three different chemical-based-batch techniques to establish surface nano (i.e. sub-μm) structures on large tools area were performed. The three approaches regarded: o Scheme 1 The use of Ø500nm nanobeads deposition for direct patterning of a Ø4inch. silicon wafer and subsequent nickel electroplating; o Scheme 2 The use of Ø500nm nanobeads deposition as mask for Ø4inch. silicon wafer etching and subsequent nickel electroplating; o Scheme 3 The use of anodization to produce Ø500nm structures on an 30x80mm2 aluminium substrate and subsequent nickel electroplating. Preparations of periodic nanometre features can affect physical and optical properties of the surface [Liu03][Por99]. Since sub-μm feature details with ultra-low tolerances have to be manufactured, these structures are usually fabricated using clean room technologies or direct ultra precision machining procedures. Methods such as e-beam lithography and nano imprinting lithography [Che05][Che09] have high manufacturing cost and a low throughput. The aim was obtain large tool area with nano structures patterning without using energy intensive nano machining (e.g. focus ion beam, X-ray lithography, etc) but, instead, by exploiting the advantage of using chemical batch processes. The capability of different surface treatment methods of creating micro and nano structured adaptable mould inserts for subsequent polymer replication by injection moulding is investigated.

General information
A friction model for cold forging of aluminum, steel and stainless steel provided with conversion coating and solid film lubricant

Adopting a simulative tribology test system for cold forging the friction stress for aluminum, steel and stainless steel provided with typical lubricants for cold forging has been determined for varying normal pressure, surface expansion, sliding length and tool/work piece interface temperature. The results show, that friction is strongly influenced by normal pressure and tool/work piece interface temperature, whereas the other process parameters investigated show minor influence on friction. Based on the experimental results a mathematical model has been established for friction as a function of normal pressure and tool/work piece interface temperature. The model is verified by process testing measuring friction at varying reduction in cold forward rod extrusion.
Air Flow and Gassing Potential in Micro-injection Moulding

Process monitoring of micro injection moulding (μ-IM) is of crucial importance in understanding the effects of different parameter settings on the process, especially on its performance and consistency in regards to parts' quality. Quality factors related to mould cavity air evacuation can provide valuable information about the process dynamics and also about the filling of a cavity by a polymer melt. In this paper, a novel experimental set-up is proposed to monitor maximum air flow and air flow work as an integral of the air flow over time by employing a MEMS gas sensor mounted inside the mould. The influence of four μIM parameters, melt temperature, mould temperature, injection speed, and resistance to air evacuation, on two air flow-related output parameters is investigated by carrying out a design of experiment study. The results provide empirical evidence about the effects of process parameters on cavity air evacuation.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Cardiff University
Authors: Griffiths, C. (Ekstern), Dimova, S. (Ekstern), Scholz, S. (Ekstern), Tosello, G. (Intern)
Pages: 310-314
A new pair of hard-soft plastic combination for precision manufacturing of two component plastic parts.

Two component (2k) injection moulding is growing rapidly even in the field of precision micro moulding. Besides combining different material properties in the same product, two component moulding can eliminate many assembly steps in manufacturing process chain. One of the biggest technical challenges associated with 2k moulding is the unavailability of suitable two component material combinations which can meet the diverse requirement from product and process point of view. This paper presents a new pair of commercial polymer materials (BASF Ultramid A3EG10 and Kraiburg TPE Thermolast K TC5PCZ) that fulfils the criteria for two component moulding both from product and process consideration for a wide range of precision micro 2k applications. Ultramid A3EG10 is PA6.6 thermoplastic with 50 % glass fibre reinforcement. Thermolast K TC5PCZ is a thermoplastic elastomer based on hydrated styrene block copolymers (TPE-S). By using this pair of materials, a demonstrator 2k micro part (Socket house for hearing aid) has been fabricated. This kind of socket is used in Receiver-in-the-canal hearing aid system to connect the receiver with hearing aid processors. The problem with the previous design was lack of sealing between the Plug-Socket combination so, corrosive agents like human sweat, oil and dirt could corrode the contact pins inside the Socket house. The new design of the Socket is an improvement of the old design which contains a micro sealing ring. This 2k micro part was moulded by the use of State-of-the-art two component micro moulding machine named Formica Plast from Desma Tec. The tests performed on the demonstrator showed potential for the material pair to be used in high precision two component moulding applications. The adhesion between the two materials, replication quality of the 2k part, sealing and functional properties of the materials proved to be suitable for precision hearing aid applications. Replication quality of the 2k parts was investigated by visual and microscopic investigation. The adhesion of the two plastic materials was characterized by moulding 2k tensile bar test specimens by both sequential and simultaneous injection of two materials and afterwards by using a precision tensile testing machine. To characterize the sealing properties of the sealing ring material, a sealing test device was developed. It could provide hydraulic pressure inside the socket house and precisely detect the pressure developed inside the socket house and finally detect the leak of the fluid due to the sealing ring leakage. All the test procedures and results presented in this paper can be a valuable source of information for researchers and scientists who work with two component micro injection moulding.

Application of hard coatings for blanking and piercing tools

The aim of the present investigation was to examine the possibility of reducing lubrication and replacing expensive tungsten carbide material in blanking/piercing through introduction of hard tool coatings. Results show that hard PVD coatings can be successfully used in blanking/piercing applications, even on softer tool steels, thus leading to reduced
friction and wear as well as to lower costs of the tool. However, preparation of the substrate material and good coating to substrate adhesion are crucial. On the other hand, even with the use of low friction coating (DLC) stamping force exceeds critical value under dry friction conditions and leads to tool failure. Therefore, at present oxidation and temperature resistant hard coatings can give improved wear resistance of stamping tools, but elimination of lubricants in blanking and piercing processes is still not feasible.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, University of Ljubljana, HIDRIA Rotomatika
Authors: Podgornik, B. (Ekstern), Zajec, B. (Ekstern), Bay, N. (Intern), Vižintin, J. (Ekstern)
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3 SJR 1.588 SNIP 2.105
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.512 SNIP 1.997 CiteScore 2.73
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.711 SNIP 2.328 CiteScore 2.46
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.317 SNIP 2.382 CiteScore 2.37
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Web of Science (2013): Indexed yes
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Scopus rating (2011): SJR 1.526 SNIP 2.83 CiteScore 2.43
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.475 SNIP 2.146
Web of Science (2010): Indexed yes
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Scopus rating (2009): SJR 1.649 SNIP 2.06
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.585 SNIP 1.854
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.269 SNIP 1.866
Asperity deformation during running-in

Asperities loaded in pure rolling against a hard, smooth surface will often be deformed at the first contact event and will thereby experience high normal stress, presumably of a magnitude near the Vickers hardness of the softer material. Continued running-in can be imagined to develop into lower stress levels and an increase of contact area. An asperity model simulating a running-in process of rough surfaces with lengthy protractions in the rolling direction was investigated. After a limited range of only about 10^4 contact events a state of very low deformation rate was found.

General information

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Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Jakobsen, J. (Ekstern), Sivebæk, I. M. (Intern)
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Scopus rating (2014): SJR 0.3 SNIP 0.126
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ISI indexed (2013): ISI indexed no
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ISI indexed (2012): ISI indexed no
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ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.125 SNIP 0.055
Scopus rating (2009): SJR 0.441 SNIP 0.369
Scopus rating (2008): SJR 0.155 SNIP 0.284
Scopus rating (2007): SJR 0.126 SNIP 0.311
Scopus rating (2006): SJR 0.156 SNIP 0.438
Automatic synthesis of MEMS devices using self-adaptive hybrid metaheuristics
This paper introduces a multi-objective optimization approach for layout synthesis of MEMS components. A case study of layout synthesis of a comb-driven micro-resonator shows that the approach proposed in this paper can lead to design results accommodating two design objectives, i.e. simultaneous minimization of size and power input of a MEMS device, while investigating optimum geometrical configuration as the main concern. The major contribution of this paper is the application of self-adaptive memetic computing in MEMS design. An evolutionary multi-objective optimization (EMO) technique, in particular non-dominated sorting genetic algorithm (NSGA-II), has been applied together with a pattern recognition statistical tool, i.e. Principal Component Analysis (PCA), to find multiple trade-off solutions in an efficient manner. Following this, a gradient-based local search, i.e. sequential quadratic programming (SQP), is applied to improve and speed up the convergence of the obtained Pareto-optimal front. In order to reduce the number of function evaluations in the local search procedure, the obtained non-dominated solutions are clustered in the objective space and consequently, a post-optimality study is manually performed to find out some common design principles among those solutions. Finally, two reasonable design choices have been offered based on manufacturability issues.

Autonomous Optimization of a Solidification Pattern and Its Effect on Porosity and Segregation in Steel Castings
The present paper considers optimization of a solidification pattern of a gravity sand-cast steel part. That is, the choice of proper riser and chill designs has been investigated using genetic algorithms while simultaneously considering their impact on centerline porosity and macrosegregation distribution. This was accomplished by coupling a casting simulation software package with an optimization module. The casting process of the original casting design was simulated using a transient 3D thermal model incorporated in a commercial simulation software package to determine potential flaws and inadequacies. After this initial assessment, a new geometrical model was suggested with the redesigned gating system and rearranged chills to obtain better filling and solidification patterns. Based on the improved model, relevant optimization targets and constraints were defined. One multi-objective optimization case with two conflicting objectives was considered in which minimization of the riser volume together with minimization of centerline porosity and elimination of macrosegregation issues were performed. Note: Copyrights belong to the AFS, therefore it is not allowed to be shared on the web.
Backward can extrusion with conical, rotating punch as a cold forging tribology test
A new, simulative test of friction and lubrication in cold forging is developed by the authors. The test is based on a backward can extrusion process in which the workpiece rotates. An analytical model is presented determining the friction stress from the measured torque during testing combined with an analysis of the sliding velocity distribution along the punch nose. The latter is determined by FE analysis of the test. Results show friction stress for unalloyed low C-steel provided with different types of lubricants, e.g. phosphate coating plus soap, phosphate coating plus MoS2 and single bath lubrication with PULS. The new test is so severe, that it is possible to break down the best lubrication systems for cold forging, such as phosphate coating plus soap and MoS2.

Cavity air flow behavior during filling in microinjection molding
Process monitoring of microinjection molding (μ-IM) is of crucial importance in understanding the effects of different parameter settings on the process, especially on its performance and consistency with regard to parts' quality. Quality factors related to mold cavity air evacuation can provide valuable information about the process dynamics and also about the filling of a cavity by a polymer melt. In this paper, a novel experimental setup is proposed to monitor maximum air flow and air flow work as an integral of the air flow over time by employing a microelectromechanical system gas sensor mounted inside the mold. The influence of four μ-IM parameters, melt temperature, mold temperature, injection speed, and resistance to air evacuation, on two air flow-related output parameters is investigated by carrying out a design of experiment study. The results provide empirical evidences about the effects of process parameters on cavity air evacuation, and the influence of air evacuation on the part flow length. © 2011 American Society of Mechanical Engineers.
Microinjection molding, Process monitoring

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Characterisation of multifunctional surfaces with robust filters

Research has shown that engineered surfaces containing lubrication pockets and directional surface texture can decrease wear and friction in sliding or rolling contacts. A new generation of multifunctional (MUFU) surfaces is achieved by hard machining followed by robot assisted polishing (RAP). The novel production method allows for a large degree of freedom in specifying surface characteristics such as frequency, depth and volume of the lubricant retention valleys, as well as the amount of load bearing area and the surface roughness. The surfaces cannot readily be characterized by means of conventional roughness parameters due to the multi-process production method involved. A series of MUFU surfaces were characterized by using the ISO 13565 standard for stratified surfaces and it is shown that the standard in some cases is inadequate for characterisation of a MUFU surface. To improve the filtering of MUFU surfaces the robust Gaussian regression filtering technique described in ISO 16610-31 is analysed and discussed. It is shown how the robust Gaussian regression filter can be used to remove the form and find a suitable reference surface for further characterisation of the MUFU surfaces.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Friis, K. S. (Intern), Godi, A. (Intern), De Chiffre, L. (Intern)
Pages: 525-532
Publication date: 2011

Characterization and robust filtering of multifunctional surfaces using ISO standards

Engineered surfaces containing lubrication pockets and directional surface texture can decrease wear and friction in sliding or rolling contacts. A new generation of multifunctional (MUFU) surfaces has been created by hard machining followed by robot-assisted polishing. The production method allows for a large degree of freedom in specifying surface topography defined by frequency, depth and volume of the lubricant retention valleys, as well as the amount of load bearing area and the surface roughness. The surfaces cannot readily be characterized by means of conventional roughness parameters due to the multi-process production method involved. A series of MUFU surfaces were characterized by using the ISO 13565 standard for stratified surfaces and it is shown that the standard in some cases is inadequate for the characterization of a MUFU surface. To improve the filtering of MUFU surfaces, the robust Gaussian regression filtering technique described in ISO 16610-31 is analyzed and discussed. By slight modifications it is shown how the robust Gaussian regression filter can be applied to remove the form and find a suitable reference surface for further characterization of the MUFU surfaces—even for surfaces with a moderate to small plateau region.

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Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Friis, K. S. (Intern), Godi, A. (Intern), De Chiffre, L. (Intern)
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BFI (2018): BFI-level 2
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**Characterization of multifunctional surfaces during fabrication**

The multifunctional surfaces herein studied are intended for carrying high loads as well as providing lubrication. They are produced by hard turning, creating a periodic pattern that will constitute the lubricant channels, followed by accurate Robot Assisted Polishing to smooth the tops of the cusps to obtain a well defined bearing area. It is studied how the surface topography varies with the number of polishing passes. Hard-turned specimens with different feed rates are polished changing stone, spindle speed and pulse frequency. The profiles are filtered with the robust Gaussian regression filters according to ISO 16610-31 and analyzed according to ISO 13565. It is depicted how existing standards are not sufficient to fully characterize this kind of surfaces.

**General information**
- **State:** Published
- **Organisations:** Manufacturing Engineering, Department of Mechanical Engineering
- **Authors:** Godi, A. (Intern), Friis, K. S. (Intern), De Chiffre, L. (Intern)
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- **Electronic versions:** P2.02_Godi_corr.pdf
- **Source:** orbit
- **Source-ID:** 278181
- **Publication:** Research › Article in proceedings – Annual report year: 2011

**Characterization of ultra-fine surfaces produced by robot assisted polishing**

Polishing is the final processing steps in many high precision applications as for example bearings, moulds and dies. The paper describes a new robot assisted polishing (RAP) machine and the characterization techniques employed to measure the polished surfaces. Focus is given to the comparison of different measuring principles applied to polished surfaces. Finally the progression of the surface topography during RAP polishing is investigated and documented.

**General information**
- **State:** Published
- **Organisations:** Manufacturing Engineering, Department of Mechanical Engineering, Strecon A/S, University of Southern Denmark
- **Authors:** Hansen, H. N. (Intern), Gasparin, S. (Intern), Sobiecki, R. (Intern), Grønbæk, J. (Ekstern), Lazarev, R. (Ekstern)
- **Pages:** 244-248
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**Cold Welding**

**General information**
- **State:** Published
- **Organisations:** Manufacturing Engineering, Department of Mechanical Engineering
- **Authors:** Bay, N. (Intern)
- **Number of pages:** 897
- **Pages:** 711-716
- **Publication date:** 2011
Computed tomography for dimensional metrology
The paper gives a survey of the upcoming use of X-ray computed tomography (CT) for dimensional quality control purposes: i.e. for traceable measurement of dimensions of technical (mechanical) components and for tolerance verification of such components. It describes the basic principles of CT metrology, putting emphasis on issues as accuracy, traceability to the unit of length (the meter) and measurement uncertainty. It provides a state of the art (anno 2011) and application examples, showing the aptitude of CT metrology to: (i) check internal dimensions that cannot be measured using traditional coordinate measuring machines and (ii) combine dimensional quality control with material quality control in one single quality inspection run.
Deepwind - an innovative wind turbine concept for offshore

General information
State: Published
Organisations: Test and Measurements, Wind Energy Division, Rise National Laboratory for Sustainable Energy, Aerodynamic Design, Wind Turbines, Manufacturing Engineering, Department of Mechanical Engineering, Nenuphar, Vestas, Marine Technology Centre, DHI Denmark, MARIN, Delft University of Technology, University of Trento
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Conference: EWEA Annual Event 2011, Brussels, Belgium, 14/03/2011 - 14/03/2011
Offshore wind energy
Electronic versions:
Paulsen_paper_EWEA2011presentation.pdf
Demonstrator design for high risk process: COTECH Deliverable 7.1.3 (CP-IP 214491-2)

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Islam, A. (Intern)
Number of pages: 49
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Main Research Area: Technical/natural sciences

Dimensional metrology for process and part quality control in micro manufacturing
Micro manufacturing has gained interest over the last decade as the demand for micro mechanical components has increased. The need for dimensional metrology at micro scale is evident both in terms of quality assurance of components and products and in terms of process control. As critical dimensions are scaled down and geometrical complexity of objects is increased, the available measurement technologies appear not sufficient. New solutions for measuring principles and instrumentation, tolerancing rules and procedures as well as traceability and calibration are necessary if micro manufacturing is to develop into industrial manufacturing solutions. In this paper the application of dimensional precision metrology to both component and process quality control will be demonstrated. The parts investigated are micro injection moulded polymer parts, typical for the field of micro manufacturing.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Hansen, H. N. (Intern), Tosello, G. (Intern), Gasparin, S. (Intern), De Chiffre, L. (Intern)
Pages: 118-135
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Micro manufacturing, Precision moulding, Dimensional metrology
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Direct probing of evanescent field for characterization of porous terahertz fibers
We develop a technique based on a micromachined photoconductive probe-tip to characterize a terahertz (THz) porous fiber. Losses less than 0.08 cm⁻¹ are measured in the frequency range from 0.2 to 0.35 THz, with the minimum of 0.003 cm⁻¹ at 0.24 THz. Normalized group velocity greater than 0.8, which corresponds to dispersion values in between −1.3
and −0.5 ps/m/μm for 0.2

**General information**

**State:** Published

**Organisations:** Manufacturing Engineering, Department of Mechanical Engineering, Fiber Sensors and Supercontinuum Generation, Department of Photonics Engineering, University of Adelaide, RWTH Aachen University

**Authors:** Atakaramians, S. (Ekstern), Afshar V., S. (Ekstern), Nagel, M. (Ekstern), Rasmussen, H. K. (Intern), Bang, O. (Intern), Monro, T. M. (Ekstern), Abbott, D. (Ekstern)

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**Main Research Area:** Technical/natural sciences

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- Web of Science (2018): Indexed yes
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- Scopus rating (2017): CiteScore 3.25 SJR 1.382 SNIP 1.167
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 2.67 SJR 1.673 SNIP 1.249
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): SJR 1.499 SNIP 1.226 CiteScore 2.47
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 1.861 SNIP 1.492 CiteScore 3.25
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): SJR 2.146 SNIP 1.633 CiteScore 3.77
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): SJR 2.57 SNIP 1.739 CiteScore 3.76
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): SJR 2.814 SNIP 1.917 CiteScore 4.04
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
- Scopus rating (2010): SJR 2.92 SNIP 1.775
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 2
- Scopus rating (2009): SJR 2.826 SNIP 1.834
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 2
- Scopus rating (2008): SJR 2.894 SNIP 1.82
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 3.012 SNIP 1.916
- Web of Science (2007): Indexed yes
- Web of Science (2006): Indexed yes
Effects of glass fibers on the properties of micro molded plastic parts

Glass fibers are used to reinforce plastics and to improve their mechanical properties. But plastic filled with glass fibers is a concern for molding of micro scale plastic parts. The aim of this paper is to investigate the effects of glass fiber on the replication quality and mechanical properties of polymeric thin ribs. It investigates the effect of feature size and gate location on distribution of glass fibers inside the molded parts. The results from this work indicate that glass filled plastic materials have poor replication quality and nonhomogeneous mechanical properties due to the nonuniform distribution and orientation of glass fibers.
Establishment of sub-µm structured polymer surfaces texture using a non-conventional approach

Biotechnology and related medical diagnostic applications have recently shown a high growth potential. Replication of micro and nano structures is the key technology in the bio-medical field. This paper describes a process chain based on the creation of sub-µm structures via anodizing of aluminium, electroforming of a tool insert based on the obtained porous structure and finally polymer replication. Optimisations of the injection moulding process parameters allowed reproducing the features of the nickel master on a polymer substrate. Experimental results indicate the possibility of manufacturing sub-µm geometries by injection moulding of cyclic olefin co-polymer (COC) and polycarbonate (PC).

Experimental evaluation of the pseudotime principle for nonisothermal polymer flows

We have applied a series of start-up of uniaxial extensions to very high strain followed by stress relaxation. A potential temperature change was applied during the stress relaxation. We used two thermorheological simple polymers; a linear polystyrene and a branched low density polyethylene. Experiments performed with temperature changes during the stress relaxation were shown to be identical with isothermal ones in the "pseudotime", within the accuracy of the experiments. This verifies that the pseudotime approach seems to be the general basis for nonisothermal microstructural modeling for flow of polymers. The pseudotime is given as \( \xi(t) = \int_0^t aT(t(T))dT \), where \( aT \) are the well established time-temperature superposition shift factors, calculated from the past temperatures (at time \( t_0 \)) in a particle path.
Experimental investigation on 3D-SEM reconstructions of a wire gauge using stereo-pair technique
In this work an experimental investigation is addressed concerning 3D-SEM reconstructions obtained from the so-called stereo-pair technique. Three-dimensional topography of an object can be derived from two SEM images acquired from two different angles, through item rotation by means of the SEM stage. A wire gauge with a 250 μm reference diameter was adopted as calibrated artefact to perform an uncertainty evaluation of the diameter estimate, in terms of input parameters required by commercial software performing stereophotogrammetry. Systematic exploration of sample space was performed resorting to factorial experimentation and statistical analysis of results.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Politecnico di Torino
Authors: Carli, L. (Intern), Genta, G. (Ekstern), Cantatore, A. (Intern), Barbato, G. (Ekstern), De Chiffre, L. (Intern), Levi, R. (Ekstern)
Publication date: 2011

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Publisher: euspen
Main Research Area: Technical/natural sciences
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Failure mechanisms in single-point incremental forming of metals
The last years saw the development of two different views on how failure develops in single-point incremental forming (SPIF). Today, researchers are split between those claiming that fracture is always preceded by necking and those considering that fracture occurs with suppression of necking. Each of these views is supported by convincing experimental and theoretical arguments that are available in the literature. This paper revisits failure in SPIF and presents a new level of understanding on the influence of process variables such as the tool radius that assists the authors to propose a new unified view on formability limits and development of fracture. The unified view conciliates the aforementioned different explanations on the role of necking in fracture and is consistent with the experimental observations that have been reported in the past years. The work is performed on aluminium AA1050-H111 sheets and involves independent determination of formability limits by necking and fracture using tensile and hydraulic bulge tests in conjunction with SPIF of benchmark shapes under laboratory conditions.
Feasibility of wear compensation in micro EDM milling based on discharge counting and discharge population characterization

This paper investigates the applicability of real time wear compensation in micro EDM milling based on discharge counting and discharge population characterization. Experiments were performed involving discharge counting and tool electrode wear measurement in a wide range of process parameters settings involving different current pulse shapes. A strong correlation is found between average discharge energy of the populations and wear and material removal per discharge. A validation was carried out showing the feasibility of the proposed approach.
Filament Stretching Rheometry

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Department of Mechanical Engineering, Manufacturing Engineering
Authors: Hassager, O. (Intern), Huang, Q. (Intern), Yu, K. (Intern), Román Marín, J. M. (Intern), Skov, A. L. (Intern), Rasmussen, H. K. (Intern)
Publication date: 2011
Event: Abstract from Annual Meeting of the German Rheological Society, Berlin, Germany,
Main Research Area: Technical/natural sciences
Electronic versions:
Berlin2011.pdf
Links:

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Invited lecture.
Source: orbit
Source-ID: 279767
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2011
Foundry Coating Technology: A Review

The importance of foundry coating in improving the surface quality of castings cannot be over emphasized. The application of mould and core washes creates a high thermal integrity barrier between the metal and the mould resulting in the reduction of the thermal shock experienced by the sand system. These thermal shock leads to series of surface defects such as veining/finning, metal penetration, burn-on/in, scab, rat tail, erosion etc. The use of coatings reduces the tendency of occurrence of these defects. However, the understanding of the coating, its components, characteristics and mechanism of action is important. In this review, a detailed description of these topics and examples are provided where necessary. A potential area of research in foundry coating development, using sol-gel process is suggested. The application of sol-gel technology in the development of foundry coatings is a novel approach.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Nwaogu, U. C. (Intern), Tiedje, N. S. (Intern)
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MSA20110800028_74577735[1].pdf
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10.4236/msa.2011.28155
Links:
http://www.SciRP.org/journal/msa
Source: orbit
Source-ID: 276468
Publication: Research - peer-review › Journal article – Annual report year: 2011

Geometrical metrology on silicone rubber by computed tomography

Computed tomography (CT) represents a suitable measuring technique for investigation of deformable materials, since no forces are developed on the part during scanning. As for any other measuring instruments, the traceability of the CT scanners needs to be assured. An investigation on geometrical measurements on silicone rubber using CT was carried out. Measurements performed on a CT scanner were compared to measurements on a coordinate measuring machine (CMM), being used as reference.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Technical University of Cluj-Napoca
Authors: Müller, P. (Intern), Pacurar, R. A. (Ekstern), De Chiffre, L. (Intern), Cantatore, A. (Intern), Berce, P. (Ekstern)
Publication date: 2011

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Title of host publication: Proceedings of 11th International Conference of the European Society for Precision Engineering & Nano Technology
Geometrical metrology on vacuum cast silicone rubber form using computed tomography

An investigation on geometrical measurements of silicone rubber cake form and polyamide molds using three measuring techniques - CMM, optical scanner and CT scanner - was carried out. The only measurand was diameter of a cone measured at specified levels. An uncertainty budget for all three techniques was assessed and expanded combined uncertainties calculated. The measurements on CMM were considered as reference measurements. When measuring silicone rubber form, this was supported by the molds due to its the high flexibility. Investigation on deformation effect of the silicone rubber cake form and the molds was carried out. It was found that the higher probing force was used, the smaller coefficient of variation was obtained. This means that higher reproducibility was achieved when higher probing force was applied. Two measuring strategies on CMM were realized: Single point probing (SPP) and probing in scanning mode (SMP). It was found that SMP results in smaller data variability. However, the difference compared to SPP was not big and since SPP measuring strategy is generally used for measuring a big variety of parts, this was used for further comparisons between CMM and the other two measuring techniques. It was found that when the silicon rubber form was measured on the supported bottom mold or the bottom mold was measured itself, the diameter measurements performed on optical scanner and CT scanner were bigger compared to CMM measurements. On the other hand, the diameter resulted in smaller values when the silicon rubber form was measured on the supported top mold or the top mold was measured itself. A procedure for measurement of highly deformable part, such as silicone rubber form, was developed. Uncertainties from measurement on the optical scanner were big. This was mainly connected with low reproducibility of scanning individual positions of the cone. Measuring uncertainties for CT measurements were calculated in a range which is reasonable when considering such deformable sample. Therefore, CT scanning is highly recommended measuring technique, resulting in short measuring times and measuring of complicated features. In connection with the silicone rubber form, CT scanning could be also used for example for failure analysis, 3D volume analysis and other non-destructive and metrological analysis.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Universitatea Tehnica din Cluj-Napoca
Authors: Pacurar, R. (Ekstern), Müller, P. (Intern), De Chiffre, L. (Intern)
Number of pages: 68
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Original language: English
Main Research Area: Technical/natural sciences
Electronic versions: prod21322843181587.CT_cake_study[1].pdf
Source: orbit
Source-ID: 314415
Publication: Research - peer-review › Report – Annual report year: 2011

Graduate and Ph.D. Course on Design and Manufacture of Micro Mechanical Systems

Micro mechanical components play an increasing role in micro systems with product dimensions ranging from micrometers to millimetres. The use of metals, polymers and ceramics for miniature components requires product development methods as well as specific manufacturing technologies. Indeed it is now well known that micro/nanotechnology is not only a matter of downscaling applications and methods from the macro scale, and therefore an in-depth understanding and knowledge of product and process characteristics at this scale is necessary. Based on this challenge, a new course was developed at the Department of Mechanical Engineering at the Technical University of Denmark. This paper describes the framework of the course that has been applied both at graduate and Ph.D. level. The current structure of the course as well as the pedagogical approach and some examples of final projects will be presented. Moreover, the transformation of the traditional semester structure (13 weeks and 3 weeks project) into a 2 weeks PhD summer school is discussed.

General information
High Accuracy Three-dimensional Simulation of Micro Injection Moulded Parts

Micro injection moulding (μIM) is the key replication technology for high precision manufacturing of polymer micro products. Data analysis and simulations on micro-moulding experiments have been conducted during the present validation study. Detailed information about the μIM process was gathered and used to establish a reliable simulation methodology suitable for μIM parts. Various Simulation set-up parameters that have been considered in order to improve the simulation accuracy: injection speed profile, melt and mould temperatures, 3D mesh, material rheology, inertia effect and shrinkage prediction. Quality factors investigated for the quantitative comparisons were: short shots length, injection pressure profile, moulding mass and flow pattern.

Higher-level Innovization: A Case Study from Friction Stir Welding Process Optimization

The task of finding crucial design interdependencies in the form of mathematical relationships (empirical or otherwise) in an engineering design problem using the Paretooptimal front is referred to as innovization. Past studies on the subject have limited themselves to a single front. In this paper we introduce the higher-level innovization task through an application of a manufacturing process simulation for the Friction Stir Welding (FSW) process where commonalities among two different Pareto-optimal fronts are analyzed. Multiple design rules are simultaneously deciphered from each front separately and compared. Important design aspects of the FSW problem are revealed in the process. The overall study aims at showing how some design principles can considerably ease the task of optimizing future enhancements to the design.
High-temperature lead-free solder alternatives

For lead-free solders in the high-temperature regime, unfortunately, a limited number of alloying systems are available. These are Bi based alloys, gold involving alloys and Zn–Al based alloys. Based on these systems, possible candidate alloys were designed to have a melting range between 270°C and 350°C. Each has its own superior characteristics as well as some drawbacks however none of them can fulfill all the requirements to replace the current high-lead content solders. Even the alternative technologies that are currently being developed cannot address several critical issues of high-temperature soldering. Therefore, further research and development of high-temperature lead-free soldering is obviously needed.
Hole quality and burr reduction in drilling aluminium sheets

Optimization of the metal drilling process requires creation of minimum amount of burrs and uniform appearance of the drilled holes. In this paper, an experimental investigation was performed on 2 mm sheets of wrought aluminium alloy Al99.7Mg0.5Cu-H24, using 1.6 and 2 mm diameter drills. Cutting data, clamping conditions, and drill geometry were varied in order to optimize the process and reach the desired quality. The results revealed possible reduction of burr occurrence on both the entry and exit side of the sheet, requiring no additional deburring. The demand on the uniform appearance of drilled holes was fulfilled as well as high productivity achieved. Such optimized process results in a noticeable production cost reduction.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Brno University of Technology, Bang & Olufsen A/S
Authors: Pilny, L. (Intern), De Chiffre, L. (Intern), Piska, M. (Ekstern), Villumsen, M. F. (Ekstern)
Number of pages: 6
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Humidity insensitive TOPAS polymer fiber Bragg grating sensor
We report the first experimental demonstration of a humidity insensitive polymer optical fiber Bragg grating (FBG), as well as the first FBG recorded in a TOPAS polymer optical fiber in the important low loss 850nm spectral region. For the demonstration we have fabricated FBGs with resonance wavelength around 850 nm and 1550 nm in single-mode microstructured polymer optical fibers made of TOPAS and the conventional poly (methyl methacrylate) (PMMA). Characterization of the FBGs shows that the TOPAS FBG is more than 50 times less sensitive to humidity than the conventional PMMA FBG in both wavelength regimes. This makes the TOPAS FBG very appealing for sensing applications as it appears to solve the humidity sensitivity problem suffered by the PMMA FBG.
Hybrid Search for Faster Production and Safer Process Conditions in Friction Stir Welding

The objective of this paper is to investigate optimum process parameters and tool geometries in Friction Stir Welding (FSW) to minimize temperature difference between the leading edge of the tool probe and the work piece material in front of the tool shoulder, and simultaneously maximize traverse welding speed, which conflicts with the former objective. An evolutionary multi-objective optimization algorithm (i.e. NSGA-II), is applied to find multiple trade-off solutions followed by a gradient-based local search (i.e. SQP) to improve the convergence of the obtained Pareto-optimal front. In order to reduce the number of function evaluations in the local search procedure, the obtained non-dominated solutions are clustered in the objective space and consequently, a postoptimality study is manually performed to find out some common design principles among those solutions. Finally, two reasonable design choices have been offered based on several process specific performance and cost related criteria.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Indian Institute of Technology, Kanpur
Authors: Tutum, C. C. (Intern), Deb, K. (Ekstern), Hattel, J. H. (Intern)
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Publication date: 2011
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Friction stir welding, Material flow, Evolutionary multi-objective optimization, ε-constraint method, Thermal simulation, Hybrid search, Gradient-based local search technique

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Publication: Research - peer-review › Conference article – Annual report year: 2011
Introduction to computed tomography

Investigation of measuring strategies in computed tomography

Computed tomography has entered the industrial world in 1980’s as a technique for non-destructive testing and has nowadays become a revolutionary tool for dimensional metrology, suitable for actual/nominal comparison and verification of geometrical and dimensional tolerances. This paper evaluates measuring results using different measuring strategies applied in different inspection software. The strategy influence is determined by calculating the measuring uncertainty. This investigation includes measurements of two industrial items, an aluminum pipe connector and a plastic toggle, a hearing aid component. These are measured using a CT scanner and compared with reference measurements on tactile coordinate measuring machine (TCMM) and optical CMM (OCMM), to obtain traceability of measurement. Results have shown that diameter measurements of cylindrical features for both parts resulted in small bias (difference between measurements using CT scanner and reference instruments) compared to distance and height measurements. It was found that bias values as well and uncertainties of all measurands calculated in ATOS for the pipe connector were generally bigger compared to measurements in Calypso CT and VGStudio MAX. Bias values of all measurands for the toggle were in the same range for all the three software and uncertainties were in the range of calibration uncertainties. Uncertainties connected with measurement of the distance between two surfaces on the inner flange of the pipe connector from CT scanner were found bigger compared to uncertainties obtained from reference measurements performed on tactile CMM. Uncertainties for measurements of the pillar height on the toggle from CT scanner were found to be in the same range as uncertainties obtained from reference measurements performed on optical CMM.

Investigation of the stability of melt flow in gating systems

Melt flow in four different gating systems designed for production of brake discs was analysed experimentally and by numerical modelling. In the experiments moulds were fitted with glass fronts and melt flow was recorded on video. The video recordings were compared with modelling of melt flow in the gating systems. Particular emphasis was on analysing local pressure and formation of pressure waves in the gating system. It was possible to compare melt flow patterns in experiments directly to modelled flow patterns. Generally there was good agreement between flow patterns and filling
times. However, description of free liquid surfaces proved to be incorrect in the numerical model. Modelled pressure fields served to explain how specific parts of the gating systems cause instability and are a good tool to describe the quality of a gating system. The results show clearly that sharp changes in the geometry of the gating system causes pressure waves to form that eventually lead to defective castings. It is clear that sharp corners and dead ends in gating systems should be avoided, and that more streamlined, organic designs based on fluid dynamic principles will be necessary to design gating systems for production of high quality castings.

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Organisations: Manufacturing Engineering, Department of Mechanical Engineering, DISA Industries A/S
Authors: Tiedje, N. S. (Intern), Larsen, P. (Ekstern)
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.803 SNIP 1.584 CiteScore 1.74
BFI (2015): BFI-level 1
Scopus rating (2015): SNIP 1.648 SJR 0.681 CiteScore 1.54
BFI (2014): BFI-level 1
Scopus rating (2014): SNIP 2.045 SJR 0.796 CiteScore 2.41
BFI (2013): BFI-level 1
Scopus rating (2013): SNIP 1.829 SJR 0.783 CiteScore 1.81
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SNIP 2.039 SJR 0.744 CiteScore 1.14
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SNIP 1.657 SJR 0.513 CiteScore 0.78
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SNIP 1.72 SJR 0.566
BFI (2009): BFI-level 1
Scopus rating (2009): SNIP 1.285 SJR 0.39
BFI (2008): BFI-level 2
Scopus rating (2008): SNIP 1.339 SJR 0.496
Scopus rating (2007): SNIP 1.435 SJR 0.842
Scopus rating (2006): SNIP 1.547 SJR 1.084
Scopus rating (2005): SNIP 1.484 SJR 0.958
Scopus rating (2004): SNIP 1.458 SJR 0.887
Scopus rating (2003): SNIP 1.486 SJR 1.429
Scopus rating (2002): SNIP 1.198 SJR 0.741
Scopus rating (2001): SNIP 1.323 SJR 0.882
Scopus rating (2000): SNIP 1.801 SJR 0.799
Measurement of micro moulded parts by Computed Tomography and comparison to optical and tactile techniques

This paper focuses on dimensional verification of two micro-injection moulded components, selected from actual industrial productions, using CT metrological tools. In addition to CT scanning, also a tactile Coordinate Measuring Machine (CMM) with sub-micrometer uncertainty and an Optical Coordinate Measuring Machine (OCMM) allowing fast measurements suitable for in-line quality control were employed as validation instruments. The experimental work carried out and the analysis of the results provide valuable conclusions about the advantages and drawbacks of using CT metrology in comparison with CMM and OCMM when these techniques are employed for quality control of micro moulded parts.

Mechanical Contact Experiments and Simulations

Mechanical contact is studied under dynamic development by means of a combined numerical and experimental investigation. The experiments are designed to allow dynamical development of non-planar contact areas with significant expansion in all three directions as the load is increased. Different geometries and different materials are analyzed including contact between dissimilar materials. The numerical implementation is performed with a finite element computer program based on the irreducible flow formulation, and contact between deformable objects is modelled by applying the penalty method. The overall investigation serves for testing and validating the numerical implementation of the mechanical contact, which is one of the main contributions to a system intended for 3D simulation of resistance welding. Correct modelling of contact between parts to be welded, as well as contact with electrodes, is crucial for satisfactory modelling of the resistance welding process. The resistance heating at the contact interfaces depends on both contact area and pressure, and as the contact areas develop dynamically, the presented tests are relevant for assessing the validity and accuracy of the mechanical contact modelling. Experimental results and numerical predictions show good agreement as regards geometry and force-displacement curves.
Data analysis and simulations of micro-moulding experiments have been conducted. Micro moulding simulations have been executed by implementing in the software the actual processing conditions. Various aspects of the simulation set-up have been considered in order to improve the simulation accuracy (i.e. decrease deviations from experimental values): injection speed profile, cavity injection pressure, melt and mould temperatures, three-dimensional mesh parameters, and material rheological characterization. Quality factors investigated for the quantitative comparisons were: short shot length, injection pressure profile, moulding mass and flow pattern. The importance of calibrated micro moulding process monitoring for an accurate implementation strategy of the simulation and its validation has been demonstrated. In fact, inconsistencies and uncertainties in the experimental data must be minimized to avoid introducing uncertainties in the
Simulation calculations. Simulations of bulky sub-100 milligrams micro moulded parts have been validated and a methodology for accurate micro moulding simulations was established.

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Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Autodesk Inc
Authors: Tosello, G. (Intern), Costa, F. (Ekstern), Hansen, H. N. (Intern)
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Source: orbit
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

**Modeling of flow of particles in a non-Newtonian fluid using lattice Boltzmann method**
To predict correctly the castings process of self compacting concrete a numerical model capable of simulating flow patterns at the structural scale and at the same time the impact of the varying volume fraction of aggregates and other phenomena at the scale of aggregates on the flow evolution is necessary. In this contribution, the model at the scale of aggregates is introduced. The conventional lattice Boltzmann method for fluid flow is enriched with the immersed boundary method with direct forcing to simulate the flow of rigid particles in a non-Newtonian liquid. Basic ingredients of the model are presented and discussed with the emphasis on a newly developed algorithm for the dynamics of particles whose interactions strongly depend on velocities of particles. The application of the model is demonstrated by a parametric study with varying volume fractions of aggregates and speed of shearing used for computation of effective viscosities. It is shown that the presented model based on well established methods and without any artificial parameters, numerical tricks or modifications provides an efficient tool that can be applied to a range of engineering problems on different length-scales yielding results matching favorably theoretical or experimental findings.

**General information**
State: Published
Organisations: Section for Construction Materials, Department of Civil Engineering, Section for Structural Engineering, Manufacturing Engineering, Department of Mechanical Engineering, Universite Paris-Est
Authors: Skocek, J. (Intern), Svec, O. (Intern), Spangenberg, J. (Intern), Stang, H. (Intern), Geiker, M. R. (Intern), Roussel, N. (Ekstern), Hattel, J. H. (Intern)
Publication date: 2011

**Host publication information**
Title of host publication: Proceedings of the 8th International Congress on the Chemistry of Cement
Main Research Area: Technical/natural sciences
Conference: 8th International Congress on the Chemistry of Cement, Madrid, Spain, 03/07/2011 - 03/07/2011
Suspension, Flow modeling, Non-Newtonian fluid, Self compacting Concrete, Lattice Boltzmann Method (LBM)
Links:
http://www.icccmadrid2011.org/
Source: orbit
Source-ID: 317167
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

**Mode profiling of THz fibers with dynamic aperture near-field imaging**
We present terahertz near-field mode profiling of different polymer THz fibers. Images with a resolution below the THz wavelength show the fundamental mode profile and higher order modes appearing at higher frequencies.

**General information**
State: Published
Organisations: Department of Photonics Engineering, Fiber Sensors and Supercontinuum Generation, Manufacturing Engineering, Department of Mechanical Engineering, Terahertz Technologies and Biophotonics, Philipps-Universität Marburg, Macquarie University
Authors: Stecher, M. (Ekstern), Dürrschmidt, S. F. (Ekstern), Nielsen, K. (Intern), Stefani, A. (Intern), Rasmussen, H. K. (Intern), Jepsen, P. U. (Intern), Bang, O. (Intern), Town, G. E. (Ekstern), Koch, M. (Ekstern)
Publication date: 2011

**Host publication information**
Title of host publication: 2011 36th International Conference on Infrared, Millimeter and Terahertz Waves (IRMMW-THz)
Publisher: IEEE
Multi-Criteria Layout Synthesis of MEMS Devices Using Memetic Computing

This paper introduces a multi-objective optimization approach for layout synthesis of MEMS components. A case study of layout synthesis of a comb-driven micro-resonator shows that the approach proposed in this paper can lead to design results accommodating two design objectives, i.e. simultaneous minimization of size and power input of a MEMS device, while investigating optimum geometrical configuration as the main concern. The major contribution of this paper is the application of memetic computing in MEMS design. An evolutionary multiobjective optimization (EMO) technique, in particular nondominated sorting genetic algorithm (NSGA-II), has been applied to find multiple trade-off solutions followed by a gradient-based local search, i.e. sequential quadratic programming (SQP), to improve the convergence of the obtained Pareto-optimal front. In order to reduce the number of function evaluations in the local search procedure, the obtained non-dominated solutions are clustered in the objective space and consequently, a postoptimality study is manually performed to find out some common design principles among those solutions. Finally, two reasonable design choices have been offered based on manufacturability issues.

Multiple height calibration artefact for 3D microscopy

A novel artefact for calibration of the height in 3D microscopy is presented. The artefact comprises three steps having a common vertical axis, which allows z-coordinate calibration at different magnifications without requiring repositioning. The
The artefact is suitable for transferring traceability to 3D techniques at the micrometer and nanometer scale, e.g. 3D SEM, confocal microscopes etc. Two different series of samples were fabricated using EDM with three steps of 2–5–7μm, and 20–50–70μm, respectively, from a 3mm diameter carbide wire. The artefact steps were calibrated on a stylus instrument according to ISO 5436 and measured on 3D microscopes.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Institute for Product Development
Authors: De Chiffre, L. (Intern), Carli, L. (Intern), Eriksen, R. S. (Intern)
Pages: 535-538
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: C I R P Annals
Volume: 60
Issue number: 1
ISSN (Print): 0007-8506
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 2.055 SNIP 3.158
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 3.294 CiteScore 3.83
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.123 SNIP 3.992 CiteScore 4.39
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.598 SNIP 3.818 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.088 SNIP 4.156 CiteScore 3.04
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.117 SNIP 3.46 CiteScore 2.81
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.12 SNIP 3.449
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.652 SNIP 2.219
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.056 SNIP 1.645
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.119 SNIP 1.55
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.892 SNIP 1.96
Multistage single point incremental forming.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Universidade Técnica de Lisboa
Authors: Silva, M. B. (Ekstern), Skjødt, M. (Intern), Bay, N. (Intern), Martins, P. A. (Ekstern)
Publication date: 2011

Host publication information
Title of host publication: Proceedings of the Congress on Numerical Methods in Engineering
Volume: Paper ID57
Main Research Area: Technical/natural sciences
Conference: CMNE 2011, Coimbra, Portugal, 01/01/2011
Experimentation, Single point incremental forming, Finite element method
Electronic versions:
cmne.pdf
Links:
Source: orbit
Source-ID: 316034
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

New lubricant systems for cold and warm forging – advantages and limitations
The increasing focus on environmental issues and the requirements to establish solutions diminishing the impact on working environment as well as external environment has strongly motivated the efforts to develop new, environmentally friendly tribological systems for metal forming production. The present paper gives an overview of these efforts substituting environmentally hazardous lubricants in cold, warm and hot forging by new, more harmless lubricants. Introduction of these new lubricants, however, has some drawbacks due to lower limits of lubrication leading to risk of pick-up, poor product quality and tool wear.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Bay, N. (Intern)
Publication date: 2011

Host publication information
Title of host publication: Proceedings of the 12th International Cold Forging Congress
ISBN (Print): 978-3-88355-385-6
New Sol-Gel Coatings to Improve Casting Quality

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Nwaogu, U. C. (Intern), Tiedje, N. S. (Intern)
Number of pages: 343
Publication date: 2011

New sol–gel refractory coatings on chemically-bonded sand cores for foundry applications to improve casting surface quality

Foundry refractory coatings protect bonded sand cores and moulds from producing defective castings during the casting process by providing a barrier between the core and the liquid metal. In this study, new sol–gel refractory coating on phenolic urethane cold box (PUCB) core was examined. The coating density, viscosity, moisture content and wet and dry weight of the coating were evaluated on cores that had been coated at three different dip-coating times. The coating coverage, surface appearance and depth of penetration into the cores were examined with a Stereomicroscope. Gray iron castings were produced with sol-gel coated and uncoated cores and the results were related to the coating properties. The casting results were also compared with castings made with cores coated with commercial alcohol-based and water-based foundry coatings. The analyses show that castings produced with sol–gel coated cores have better surface quality than those from uncoated cores and comparable surface quality with the commercial coatings. Therefore, the new sol–gel coating has a potential application in the foundry industry for improving the surface finish of castings thereby reducing the cost of fettling in the foundry industry since the raw materials and technology are easily affordable.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Danish Technological Institute
Authors: Nwaogu, U. C. (Intern), Poulsen, T. (Ekstern), Stage, R. (Ekstern), Bischoff, C. (Ekstern), Tiedje, N. S. (Intern)
Pages: 4035-4044
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Surface and Coatings Technology
Volume: 205
Issue number: 16
ISSN (Print): 0257-8972
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.08 SJR 0.928 SNIP 1.545
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.56 SJR 0.882 SNIP 1.379
Web of Science (2016): Indexed yes
Numerical Modeling of Fluid Flow in the Tape Casting Process

The flow behavior of the fluid in the tape casting process is analyzed. A simple geometry is assumed for running the numerical calculations in ANSYS Fluent and the main parameters are expressed in non-dimensional form. The effect of different values for substrate velocity and pressure force on the flow pattern as well as resultant tape thickness is evaluated. The analysis deals with the case of parallel blades and focuses on the ratio between the present hydrostatic pressure and the magnitude of the viscous force. A new non-dimensional height for the tape thickness is proposed and the effect of the substrate velocity is evaluated. The results of the modeling show that a relatively uniform tape thickness can
be achieved. Moreover, the results are compared with selected experimental and analytical data from literature and good agreement is found.

**General information**

State: Published  
Organisations: Department of Mechanical Engineering, Manufacturing Engineering  
Authors: Jabbari, M. (Intern), Hattel, J. H. (Intern)  
Pages: 143-146  
Publication date: 2011  
Main Research Area: Technical/natural sciences

**Publication information**

Journal: AIP Conference Proceedings - American Institute of Physics  
Volume: 1389  
Issue number: 1  
ISSN (Print): 0094-243X  
Ratings:  
BFI (2018): BFI-level 1  
BFI (2017): BFI-level 1  
Scopus rating (2017): CiteScore 0.26 SJR 0.165 SNIP 0.3  
BFI (2016): BFI-level 1  
Scopus rating (2016): CiteScore 0.21 SJR 0.165 SNIP 0.246  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 0.18 SNIP 0.218 CiteScore 0.18  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 0.171 SNIP 0.202 CiteScore 0.17  
BFI (2013): BFI-level 1  
Scopus rating (2013): SJR 0.164 SNIP 0.187 CiteScore 0.16  
ISI indexed (2013): ISI indexed no  
BFI (2012): BFI-level 1  
Scopus rating (2012): SJR 0.176 SNIP 0.193 CiteScore 0.14  
ISI indexed (2012): ISI indexed no  
BFI (2011): BFI-level 1  
Scopus rating (2011): SJR 0.161 SNIP 0.16 CiteScore 0.12  
ISI indexed (2011): ISI indexed no  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 1  
Scopus rating (2010): SJR 0.166 SNIP 0.158  
BFI (2009): BFI-level 1  
Scopus rating (2009): SJR 0.163 SNIP 0.156  
BFI (2008): BFI-level 1  
Scopus rating (2008): SJR 0.17 SNIP 0.132  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 0.171 SNIP 0.176  
Scopus rating (2006): SJR 0.184 SNIP 0.187  
Scopus rating (2005): SJR 0.217 SNIP 0.416  
Scopus rating (2004): SJR 0.198 SNIP 0.249  
Web of Science (2004): Indexed yes  
Scopus rating (2003): SJR 0.153 SNIP 0.063  
Scopus rating (2002): SJR 0.288 SNIP 0.084  
Scopus rating (2001): SNIP 0.078 SJR 0.103  
Web of Science (2001): Indexed yes  
Original language: English  
Tape casting, Tape thickness, Non-dimensional parameters, Substrate velocity  
Electronic versions:  
APC000143.pdf
Numerical optimisation of friction stir welding: review of future challenges

During the last decade, the combination of increasingly more advanced numerical simulation software with high computational power has resulted in models for friction stir welding (FSW), which have improved the understanding of the determining physical phenomena behind the process substantially. This has made optimisation of certain process parameters possible and has in turn led to better performing friction stir welded products, thus contributing to a general increase in the popularity of the process and its applications. However, most of these optimisation studies do not go well beyond manual iterations or limited automation. The present paper thus attempts to give a brief overview of some of the successful autonomous optimisation applications of FSW in combination with what determines the state of the art in the field. Finally, this is followed by a discussion of some of the trends and future challenges that we foresee in the rapidly expanding area of autonomous optimisation of FSW.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Tutum, C. C. (Intern), Hattel, J. H. (Intern)
Pages: 318-324
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Science and Technology of Welding and Joining (Online Edition)
Volume: 16
Issue number: 4
ISSN (Print): 1743-2936
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.257 SJR 1.03 CiteScore 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.32 SJR 1.529 SNIP 1.507
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.205 SNIP 1.206 CiteScore 1.8
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.741 SNIP 1.81 CiteScore 2.09
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.503 SNIP 1.39 CiteScore 1.95
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.292 SNIP 1.458 CiteScore 1.58
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.613 SNIP 1.682 CiteScore 2.07
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.594 SNIP 1.37
Numerical simulation of lubrication mechanisms at mesoscopic scale

The mechanisms of liquid lubrication in metal forming are studied at a mesoscopic scale, adopting a 2D sequential fluid-solid weak coupling approach earlier developed in the first author's laboratory. This approach involves two computation steps. The first one is a fully coupled fluid-structure Finite Element computation, where cavities in the surface are plastically deformed leading to the pressurization of the entrapped fluid. The second step computes the fluid exchange between cavities through the plateaus, one cavity at a time. This second step consists in solution of the local Couette's equation, at the asperity level, in order to quantify the fluid leakage in the cavity/plateau network using the lubricant pressure computed previously. The numerical simulation is validated by experimental tests in plane strain strip reduction of aluminium sheet provided with model cavities in form of pyramidal indentations. The tests are performed with variable reduction and drawing speed under controlled front and back tension forces. Visual observations through a transparent die of the fluid entrapment and escape from the cavities using a CCD camera show the mechanisms of MicroPlastoHydroDynamic Lubrication (MPHDL) as well as cavity shrinkage due to lubricant compression and escape and strip deformation.

General information

State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Université Lille Nord de France
Authors: Hubert, C. (Ekstern), Bay, N. (Intern), Christiansen, P. (Intern), Deltombe, R. (Ekstern), Dubar, L. (Ekstern), Dubar, M. (Ekstern), Dubois, A. (Ekstern)
Pages: 1729-1734
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: AIP Conference Proceedings
Volume: 1353
ISSN (Print): 0094-243X
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 0.26 SJR 0.165 SNIP 0.3
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.21 SJR 0.165 SNIP 0.246
BFI (2015): BFI-level 1
Optical fibre Bragg grating recorded in TOPAS cyclic olefin copolymer

A report is presented on the inscription of a fibre Bragg grating into a microstructured polymer optical fibre fabricated from TOPAS cyclic olefin copolymer. This material offers two important advantages over poly (methyl methacrylate), which up to now has formed the basis for polymer fibre Bragg gratings: TOPAS has a much lower water affinity and has useful properties for biosensing. The grating had a Bragg wavelength of 1569 nm and a temperature sensitivity of 236.5±0.3 pm/°C.
Optimization in Friction Stir Welding - With Emphasis on Thermo-mechanical Aspects

This book deals with the challenging multidisciplinary task of combining variant thermal and thermo-mechanical simulations for the manufacturing process of friction stir welding (FSW) with numerical optimization techniques in the search for optimal process parameters. The FSW process is characterized by multiphysics involving solid material flow, heat transfer, thermal softening, recrystallization and the formation of residual stresses. Initially, the thermal models were addressed since they in essence constitute the basis of all other models of FSW. Following this, several integrated thermo-mechanical models of the process were developed to simulate temperature and stress evolution during welding and subsequent cooling, i.e. eventually leading to the residual stress state and reduced mechanical properties, as well as to predict the final weld's load carrying capacity. These models were finally combined with classical single-objective and evolutionary multi-objective optimization algorithms (i.e. SQP and NSGA-II), to find the optimum process parameters (heat input, rotational and traverse welding speeds) that would result in favorable thermo-mechanical conditions for the process.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Tutum, C. C. (Intern)
Number of pages: 232
Publication date: 2011

Optimization of Casting Process Parameters for Homogeneous Aggregate Distribution in Self-Compacting Concrete: A Feasibility Study

The use of self-compacting concrete (SCC) as a construction material has been getting more attention from the industry. Its application area varies from standard structural elements in bridges and skyscrapers to modern architecture having geometrical challenges. However, heterogeneities induced during the casting process may lead to variations of local mechanical properties and hence to a potential decrease in load carrying capacity of the structure. This paper presents a methodology for optimization of SCC casting aiming at having a homogeneous aggregate distribution; a beam has been used as geometric example. The aggregate distribution is predicted by a numerical flow model coupled with a user defined volume fraction subroutine. The process parameters in casting with SCC in general are horizontal and vertical positions, movement, as well as the size of the inlet, and the duration of the filling etc., however since this work is the initial feasibility study in this field, only three process parameters are considered. Despite the reduction in the number of process parameters, the complexity involved in the considered casting process results in a non trivial optimal design set.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Section for Construction Materials, Department of Civil Engineering, Universite Paris-Est
Authors: Spangenberg, J. (Intern), Tutum, C. C. (Intern), Hattel, J. H. (Intern), Roussel, N. (Ekstern), Geiker, M. R. (Intern)
Publication date: 2011

Host publication information
Title of host publication: CEC 2011
Publisher: IEEE
Porous-core honeycomb bandgap THz fiber

In this Letter we propose a novel (to our knowledge) porous-core honeycomb bandgap design. The holes of the porous core are the same size as the holes in the surrounding cladding, thereby giving the proposed fiber important manufacturing benefits. The fiber is shown to have a 0.35-THz-wide fundamental bandgap centered at 1.05 THz. The calculated minimum loss of the fiber is 0.25 dB/cm.
Process Factors Influence on Cavity Pressure Behavior in Microinjection Moulding

Process monitoring of microinjection moulding (mu IM) is of crucial importance when analysing the effect of different parameter settings on the process and then in assessing its quality. Quality factors related to cavity pressure can provide valuable information about the process dynamics and also about the filling behavior of different polymer melts. In this paper, a pressure sensor mounted inside a tool cavity was employed to analyse maximum cavity pressure, pressure increase rate during filling and pressure work. The influence of four mu IM parameters, melt temperature, mould temperature, injection speed, and packing pressure on these three pressure-related process parameters was investigated. A design of experiment study was conducted by moulding a test part, a microfluidic component, in three different polymer materials, PP, ABS, and PC. The results show a similar process behavior for all three polymers, in particular a higher injection speed led to a reduction of the pressure work while a lower mould temperature reduces the pressure rate. [DOI: 10.1115/1.4003953]

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Cardiff University
Authors: Griffiths, C. A. (Ekstern), Dimov, S. S. (Ekstern), Scholz, S. (Ekstern), Hirshy, H. (Ekstern), Tosello, G. (Intern)
Pages: 031007
Publication date: 2011
Main Research Area: Technical/natural sciences
Cavity injection pressure, Process monitoring, Microinjection moulding

DOIs:
10.1115/1.4003953
Reference micro-objects and procedures to establish traceability in micro metrology: Final. COTECH EU FP7 Integrated Project (Grant Agreement no.: CP-IP 214491-2)
The report presents methods and procedures to establish the traceability of measurements at both micro and sub-micro dimensional scales. Reference artefacts and new methodologies to ensure traceability of dimensional and geometrical 3D measurements (absolute dimensions below 3 mm, micro features with critical dimensions below 100 μm, roughness lower than 100 nm) have been developed to allow validation and verification of product and process tolerances as developed within the COTECH project.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Alicona Imaging GmbH
Authors: Gasparin, S. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern), Prantl, M. (Ekstern)
Number of pages: 44
Publication date: 2011

Publication information
Original language: English
Series: COngverging TECHnologies for micro systems manufacturing
Main Research Area: Technical/natural sciences

Bibliographical note
SP4 – Material Optimization, Simulation, Quality Control and Reliability, WP4.3 – Development and standardization of new quality control technology
Source: orbit
Source-ID: 314365
Publication: Research - peer-review › Report – Annual report year: 2011

Replication of micro and nano surface geometries
The paper describes the state-of-the-art in replication of surface texture and topography at micro and nano scale. The description includes replication of surfaces in polymers, metals and glass. Three different main technological areas enabled by surface replication processes are presented: manufacture of net-shape micro/nano surfaces, tooling (i.e. master making), and surface quality control (metrology, inspection). Replication processes and methods as well as the metrology of surfaces to determine the degree of replication are presented and classified. Examples from various application areas are given including replication for surface texture measurements, surface roughness standards, manufacture of micro and nano structured functional surfaces, replicated surfaces for optical applications (e.g. optical gratings), and process chains based on combinations of repeated surface replication steps.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, University of North Carolina at Charlotte
Authors: Hansen, H. N. (Intern), Hocken, R. (Ekstern), Tosello, G. (Intern)
Pages: 695-714
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: C I R P Annals
Volume: 60
Issue number: 2
ISSN (Print): 0007-8506
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Replication quality control of metal and polymer micro structured optical surfaces
Non contact measurements are preferred for the characterization of ultra-finely finished surfaces which is particularly challenging if damages of the structures should be avoided. However, it is not always possible to use these methods because low roughness in metallic materials, as optical surfaces, quite often results in mirror-like surfaces which scatter the light and invalidate the optical measurements. This paper focuses on an analysis of a micro-structured optical component and the corresponding mould. A first investigation leads to a control of the manufacturing process through a control of the product. The purpose is to evaluate three critical dimensions. Results show that the difference of the measurements on different areas of the mould and the polymer component is approximately 4%. A second analysis focuses on the investigation of the optical component and its mould using replication methods based on polymer casting. The replica method is used in order to avoid damages of the structures and make feasible the measurement of optical specimens with non-contact instruments. Results show a quality replication equal to 95 - 99%. In both investigations the uncertainty of the measurements is assessed following the substitution method.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Centro Ricerche Plast-Optica S.p.A.
Authors: Gasparin, S. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern), Vora, I. D. (Ekstern), Priante, S. (Ekstern), Sinesi, S. (Ekstern)
Pages: 533-539
Publication date: 2011

Host publication information
Title of host publication: 4. International Swedish Production Symposium
Main Research Area: Technical/natural sciences
Conference: 4th International Swedish Production Symposium, Göteborg, Sweden, 03/05/2011 - 03/05/2011
Optical surfaces, Replication quality control, Surface metrology
Electronic versions:
SPS11_submission32_final.pdf
Source: orbit
Source-ID: 278179
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Report on condition and monitoring platform for effective process control techniques: Final. COTECH EU FP7 Integrated Project (Grant Agreement no.: CP-IP 214491-2)
Tooling is one of the critical stages of the process chain for polymer micro products manufacture and in particular for the COTECH process chain. Therefore, within the scope of SP2 “Tooling”, the WP 2.2 “New tool-making solutions for µ-IM and HE” is designed to investigate, develop and standardize tool-making procedures for micro-moulds and inserts manufacture. The innovative approach promoted by COTECH is the use of novel hybrid processes for micro tooling. This approach has been demonstrated to be able to provide optimal performance and enable the manufacture of micro-tools rapidly and cost-effectively, especially for micro injection moulding. This particular deliverable has the objective to present the design rules for high performance µ-tools and inserts manufacture based on the new standard manufacturing process chains established during the WP 2.2 work. In particular, the achievable features, surfaces and accuracies that can be obtained by state-of-the-art micro machining are presented.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Tosello, G. (Intern), Griffiths, C. (Ekstern)
Number of pages: 93
Publication date: 2011

Publication information
Original language: English
Series: COnverging TECHnologies for micro systems manufacturing
Main Research Area: Technical/natural sciences

Bibliographical note
SP4 – Material optimisation, simulation, quality control and reliability, WP4.2 – Processes control
Source: orbit
Source-ID: 317057
Publication: Research - peer-review › Report – Annual report year: 2011
Report on design rules of μ-tools for hybrid tooling: Final. COTECH EU FP7 Integrated Project (Grant Agreement no.: CP-IP 214491-2)

Tooling is one of the critical stages of the process chain for polymer micro products manufacture and in particular for the COTECH process chain. Therefore, within the scope of SP2 "Tooling", the WP 2.2 "New tool-making solutions for μ-IM and HE" is designed to investigate, develop and standardize tool-making procedures for micro-moulds and inserts manufacture. The innovative approach promoted by COTECH is the use of novel hybrid processes for micro tooling. This approach has been demonstrated to be able to provide optimal performance and enable the manufacture of micro-tools rapidly and cost-effectively, especially for micro injection moulding. This particular deliverable has the objective to present the design rules for high performance μ-tools and inserts manufacture based on the new standard manufacturing process chains established during the WP 2.2 work. In particular, the achievable features, surfaces and accuracies that can be obtained by state-of-the-art micro machining are presented.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Esmoris, J. I. (Ekstern), Azcarate, S. (Ekstern), Tosello, G. (Intern), Bissacco, G. (Ekstern), Quadroni, A. (Ekstern), Griffiths, C. (Ekstern)
Number of pages: 60
Publication date: 2011

Publication information
Original language: English
Series: COnverging TECHnologies for micro systems manufacturing
Main Research Area: Technical/natural sciences

Bibliographical note
SP2 – Tooling, WP2.2 – New tool-making solutions for μ-IM and HE
Source: orbit
Source-ID: 317053
Publication: Research - peer-review › Report – Annual report year: 2011

Report on design rules of μ-tools for standard insert: Final. COTECH EU FP7 Integrated Project (Grant Agreement no.: CP-IP 214491-2)

Tooling is one of the critical stages of the process chain for polymer micro products manufacture and in particular for the COTECH process chain. Therefore, within the scope of SP2 "Tooling", the WP 2.2 "New tool-making solutions for μ-IM and HE" is designed to investigate, develop and standardize tool-making procedures for micro-moulds and inserts manufacture. The innovative approach promoted by COTECH is the use of novel hybrid processes for micro tooling. This approach has been demonstrated to be able to provide optimal performance and enable the manufacture of micro-tools rapidly and cost-effectively, especially for micro injection moulding. This particular deliverable has the objective to present the design rules for high performance μ-tools and inserts manufacture based on the new standard manufacturing process chains established during the WP 2.2 work. In particular, the achievable features, surfaces and accuracies that can be obtained by state-of-the-art micro machining are presented.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Tosello, G. (Intern), Esmoris, J. I. (Ekstern), Quadroni, A. (Ekstern)
Number of pages: 63
Publication date: 2011

Publication information
Original language: English
Series: COnverging TECHnologies for micro systems manufacturing
Main Research Area: Technical/natural sciences

Bibliographical note
SP2 – Tooling, WP2.2 – New tool-making solutions for μ-IM and HE
Source: orbit
Source-ID: 317052
Publication: Research - peer-review › Report – Annual report year: 2011
Report on experimental research and best practice for surface treatment solutions: Final. COTECH EU FP7 Integrated Project (Grant Agreement no.: CP-IP 214491-2)
The present deliverable contains the report of the work and results achieved within the framework of WP 2.3 / Task 2.3.2 on "Surface treatments and thin layers/films deposition to improve process output".

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Gavillet, J. (Ekstern), Tosello, G. (Intern), Gasparin, S. (Ekstern)
Number of pages: 27
Publication date: 2011

Publication information
Original language: English

Series: COnverging TECHnologies for micro systems manufacturing
Main Research Area: Technical/natural sciences

Bibliographical note
SP2 – Tooling, WP2.3 – Surface Treatments for enhanced replication capability and for functionalisation
Source: orbit
Source-ID: 317055
Publication: Research - peer-review › Report – Annual report year: 2011

Report on tolerancing guidelines for micro manufacturing: Final. COTECH EU FP7 Integrated Project (Grant Agreement no.: CP-IP 214491-2)
The present report underlines some problematic aspects of the micro manufacturing in order to develop tolerancing guidelines based on the industrial needs of the partners in the project. Some solutions were given through the investigation and characterization of three different micro-nano injection moulded components: a toggle for hearing aid application, CD/DVD/HD-DVD and, finally, Fresnel lenses.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Gasparin, S. (Intern), Tosello, G. (Intern), Hansen, H. N. (Intern)
Number of pages: 50
Publication date: 2011

Publication information
Original language: English

Series: COnverging TECHnologies for micro systems manufacturing
Main Research Area: Technical/natural sciences

Bibliographical note
SP4 – Material Optimization, Simulation, Quality Control and Reliability, WP4.3 – Development and standardization of new quality control technology
Source: orbit
Source-ID: 314369
Publication: Research - peer-review › Report – Annual report year: 2011

Reproducibility of surface roughness in reaming

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Müller, P. (Intern), De Chiffre, L. (Intern)
Publication date: 2011

Host publication information
Title of host publication: Proceedings of the 4. Swedish Production Symposium
Main Research Area: Technical/natural sciences
Conference: 4th International Swedish Production Symposium, Göteborg, Sweden, 03/05/2011 - 03/05/2011
Reaming test, Surface roughness, Measuring uncertainty
Electronic versions:
Reproducibility of surface roughness in reaming
An investigation on the reproducibility of surface roughness in reaming was performed to document the applicability of this approach for testing cutting fluids. Austenitic stainless steel was used as a workpiece material and HSS reamers as cutting tools. Reproducibility of the results was evaluated with respect to different operators, workpieces and measured position in the reamed hole for different combinations of lubrication condition and cutting speed. The measurands were the conventional surface roughness parameter, $R_a$ and the ability of a cutting fluid to ensure a surface which is a replication of tool geometry and path. 2D and 3D reference measurements were done to ensure traceability of the measurement. Moreover, surface profiles were examined under the 3D optical microscope. Measuring uncertainty evaluation using statistical methods was applied. Surfaces produced with a low cutting speed were generally reproducible when considering different operators, workpieces and measured position in the hole, unlike the surfaces produced with high cutting speed. These latter contain uneven, random surface profiles and vary considerably for different operators. However, it can be observed that a higher concentration of the oil in water-based cutting fluid (or when using a straight mineral oil) results in surface profiles that are more reproducible at higher cutting speed. Moreover, it can be seen that three cutting fluids (two water-based cutting fluids with different oil concentration and a straight mineral oil) used in connection with a low cutting speed result in "identical" surface profiles. Biggest uncertainty contributors were due to the process repeatability and repeatability around the hole circumference. This was however only in the case of high cutting speeds and low degree of oil concentration. High reproducibility of different operators, especially when low cutting speed was applied, was achieved. From the surface profiles, an identification of individual feed marks from the tool is possible, tool replication being most clear from the 3D reference measurements.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Müller, P. (Intern), De Chiffre, L. (Intern)
Number of pages: 270
Publication date: 2011

Publication information
Publisher: DTU Mechanical Engineering
Original language: English
Main Research Area: Technical/natural sciences
Electronic versions:
prod21321624701342.Reaming_report[1].pdf
Source: orbit
Source-ID: 313168
Publication: Research - peer-review › Report – Annual report year: 2011

Resistance microwelding of 316L stainless steel wire to block
The excellent corrosion resistance of low carbon vacuum melted 316 stainless steel coupled with its non-magnetic properties makes it ideal for biomedical applications. The typical joint geometry for microcomponents, such as medical implants, includes joining of fine wire to a larger block. However, this type of joint has received little attention in the current literature. The present study was conducted to examine the microstructure and mechanical properties of low carbon vacuum melted 316 stainless steel wire welded to a larger block. Results revealed solid state bonding occurring at low currents, while fusion bonding occurred at higher currents. This was due to the highly asymmetrical heat generation resulting in almost complete melting of the wire before the initiation of interfacial melting. This is a distinctly different bonding mechanism compared to previous studies on crossed wire joints.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, University of Waterloo
Authors: Friis, K. S. (Intern), Khan, M. (Ekstern), Bay, N. (Intern), Zhou, Y. (Ekstern)
Pages: 546-552
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Science and Technology of Welding and Joining (Online Edition)
Volume: 16
Issue number: 6
Reversed planar elongation of soft polymeric networks

The newly developed planar elongation fixture, designed as an add-on to the filament stretch rheometer, is used to measure reversible large amplitude planar elongation on soft elastomers. The concept of this new fixture is to elongate an annulus, by keeping the perimeter constant. The deformation on the cylindrical probe is measured using digital imaging, and it is found that the diameter only changes a few percent compared with the initial diameter. Additionally, it is found that a time-strain separable K-BKZ model based on a Doi–Edwards (DE) network strain (without independent alignment) captures the experimental data well. In particular, it is observed that it reproduces the deformation on the cylindrical probe, and this observation confirms our previous statement that the deformation on the cylindrical probe is highly sensitive.
towards the choice of strain tensor. The stress itself is well described by both the modified Lodge and the DE network strain. The amount of work needed during the deformation is calculated, and it is illustrated how the sample itself contributes with work upon flow reversal. As the stress is time-strain separable the energy loss originates from linear viscoelastic relaxation even in the nonlinear regime, and the loss can be determined solely from linear viscoelastic measurements.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Manufacturing Engineering, Department of Mechanical Engineering, The Danish Polymer Centre
Authors: Jensen, M. K. (Intern), Rasmussen, H. K. (Intern), Skov, A. L. (Intern), Hassager, O. (Intern)
Pages: 729-740
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Rheologica Acta
Volume: 50
Issue number: 9-10
ISSN (Print): 0035-4511
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.063 SJR 0.704 CiteScore 1.9
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 1.9 SJR 0.634 SNIP 1.026
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.876 SNIP 1.272 CiteScore 2.09
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.725 SNIP 1.181 CiteScore 1.72
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.877 SNIP 1.38 CiteScore 2.09
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.898 SNIP 1.36 CiteScore 1.8
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.292 SNIP 1.397 CiteScore 2.22
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.267 SNIP 1.302
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.005 SNIP 1.227
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.899 SNIP 1.312
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.942 SNIP 1.29
Scopus rating (2006): SJR 0.905 SNIP 1.243
Revisiting the Fundamentals and Capabilities of the Stack Compression Test

Knowledge of the flow curve in metal forming is crucial to analyse formability, to describe strain-hardening and to set-up the non-linear constitutive equations of metal plasticity. Commonly available mechanical testing of materials supplied in the form of sheets and plates, under low loading rates, is limited to small values of strain. As a result of this, there is a generalized practice, and important source of modelling errors, of extrapolating the remaining part of the flow curves that are usually determined by means of tensile and bulge tests. The aim of this paper is to provide a new level of understanding for the stack compression test and to evaluate its capability for constructing the flow curves of metal sheets under high strains across the useful range of material testing conditions. The presentation draws from the fundamentals of the stack compression test to the assessment of its overall performance by comparing the flow curves obtained from its utilisation with those determined by means of compressive testing carried out on solid cylinder specimens of the same material. Results show that mechanical testing of materials by means of the stack compression test is capable of meeting the increasing demand of accurate and reliable flow curves for sheet metals.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Universidade Técnica de Lisboa
Authors: Alves, L. (Ekstern), Nielsen, C. V. (Intern), Martin, P. (Ekstern)
Pages: 1565-1572
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Experimental Mechanics
Volume: 51
ISSN (Print): 0014-4851
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.565 SJR 0.947 CiteScore 2.29
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.22 SJR 0.84 SNIP 1.474
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.947 SNIP 1.511 CiteScore 1.76
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.985 SNIP 1.596 CiteScore 1.74
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.879 SNIP 1.223 CiteScore 1.42
Scale effects in metal-forming friction and lubrication

Downscaling of metal-forming operations from macro-to microscale implies significant changes caused by size effects. Among these, the friction increases as reported by researchers using indirect test methods such as the ring-compression test and double-cup-extrusion test. In this study, a new test equipment is developed for studies of the size effect in metal-forming friction in the range from macro-to microscale. Investigations confirm a significant friction increase when downscaling. Visual inspection of the workpieces shows this to be explained by the amount of open and closed lubricant pockets.

General information

State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Institute for Product Development
Authors: Nielsen, P. S. (Intern), Paldan, N. A. (Intern), Calaon, M. (Intern), Bay, N. (Intern)
Pages: 924-931
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information

Volume: 225
Issue number: 9
ISSN (Print): 1350-6501
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Selective metallization of polymers using laser induced surface activation (LISA)—characterization and optimization of porous surface topography

Laser induced selective activation (LISA) is a molded interconnected devices technique for selective metallization of polymers. On the working piece, only the laser-machined area can be metalized in the subsequent plating. The principle of the technology is introduced. Surface analysis was performed on the laser-machined polymer using an Alicona InfiniteFocus® microscope. Based on previous experiments, bearing area curve and its parameters are chosen to characterize the surface. In this paper, by comparison of plateable and non-plateable surfaces, and two types of plateable surface made by different lasers, it is found that the normalized bearing area curve is an effective method to characterize porous surface for the subsequent plating. The normalized parameters are available to make a quantitative analysis.
Spontaneous Breakup of Extended Monodisperse Polymer Melts

We apply continuum mechanical based, numerical modeling to study the dynamics of extended monodisperse polymer melts during the relaxation. The computations are within the ideas of the microstructural "interchain pressure" theory. The computations show a delayed necking resulting in a rupture, as a result of small initial sample imperfections. These ruptures agree with experimental observations.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Rasmussen, H. K. (Intern), Yu, K. (Intern)
Number of pages: 4
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Physical Review Letters
Volume: 107
Article number: 126001
ISSN (Print): 0031-9007
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.58 SJR 3.622 SNIP 2.464
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.33 SJR 4.196 SNIP 2.61
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 4.656 SNIP 2.538 CiteScore 5.76
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 5.232 SNIP 2.71 CiteScore 6.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 5.675 SNIP 2.781 CiteScore 7.46
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 6.292 SNIP 2.867 CiteScore 7.19
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 6.314 SNIP 2.905 CiteScore 7.02
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.45 SNIP 2.757
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.325 SNIP 2.947
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.194 SNIP 2.837
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 5.95 SNIP 2.738
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 4.781 SNIP 2.443
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 4.082 SNIP 2.101
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 3.847 SNIP 2.122
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 4.661 SNIP 2.651
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 5.884 SNIP 3.375
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 5.618 SNIP 3.135
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 5.771 SNIP 2.941
Original language: English
Electronic versions:
e126001.pdf
DOIs:
10.1103/PhysRevLett.107.126001
Links:
http://prl.aps.org/abstract/PRL/v107/i12/e126001
State-of-the-Art Multi-Objective Optimisation of Manufacturing Processes Based on Thermo-Mechanical Simulations

During the last couple of decades the possibility of modelling multi-physics phenomena has increased dramatically, thus making simulation of very complex manufacturing processes possible and in some fields even an everyday event. A consequence of this has been improved products with respect to properties, weight/stiffness ratio and cost. However this development has mostly been based on “manual iterations” carried out by the user of the relevant simulation software rather than being based on a systematic search for optimal solutions. This is, however, about to change because of the very tough competition between manufacturers of products in combination with the possibility of doing these highly complex simulations. Thus, there is a crucial need for combining advanced simulation tools for manufacturing processes with systematic optimisation algorithms which are capable of searching for single or multiple optimal solutions. Nevertheless, despite this crucial need, it is interesting to notice the very limited number of contributions in this field and consequently this makes us wonder about the underlying reasons for it. The understanding of the physical phenomena behind the processes, the current numerical simulation tools and the optimisation capabilities which all mainly are driven by the industrial or academic demands as well as computational power and availability of both the simulation and the multi-objective optimisation oriented software on the market are the main concerns to look for. These limitations eventually determine what is in fact possible today and hence define what the “state-of-the-art” is. So, seen from that perspective the very definition of the state-of-the-art itself in the field of optimisation of manufacturing processes constitutes an important discussion. Moreover, in the major research fields of manufacturing process simulation and multi-objective optimisation there are still many issues to be reserved.

Stress maximum and steady extensional flow of branched polymer melts

General information
State: Published
Organisations: The Danish Polymer Centre, Department of Chemical and Biochemical Engineering, Manufacturing Engineering, Department of Mechanical Engineering, Durham University, University of Cambridge, University of Leeds
Authors: Huang, Q. (Intern), Skov, A. L. (Intern), Rasmussen, H. K. (Intern), Hoyle, D. M. (Ekstern), McLeish, T. C. (Ekstern), Harlen, O. (Ekstern), Hassel, D. (Ekstern), Lord, T. D. (Ekstern), Mackley, M. R. (Ekstern), Hassager, O. (Intern)
Publication date: 2011
Event: Abstract from 83rd Annual Meeting of The Society of Rheology, Cleveland, OH, United States.
Main Research Area: Technical/natural sciences
Source: orbit
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2011

Surface Nano Structures Manufacture Using Batch Chemical Processing Methods for Tooling Applications

The patterning of large surface areas with nano structures by using chemical batch processes to avoid using high-energy intensive nano machining processes was investigated. The capability of different surface treatment methods of creating micro and nano structured adaptable mould inserts for subsequent polymer replication by injection moulding was
analyzed. New tooling solutions to produce nano structured mould surfaces were investigated. Experiments based on three different chemical-based-batch techniques to establish surface nano (i.e. sub-μm) structures on large areas were performed. Three approaches were selected: (1) using Ø500 nm nano beads deposition for direct patterning of a 4" silicon wafer; (2) using Ø500 nm nano beads deposition as mask for 4" silicon wafer etching and subsequent nickel electroplating; (3) using the anodizing process to produce Ø500 nm structures on a 30x80 mm2 aluminium substrate, subsequent nickel electroplating and finally injection moulding.

**General information**

State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Institute for Product Development, French Atomic Energy Commission
Pages: 297-301
Publication date: 2011

**Host publication information**

Title of host publication: Proceedings of the 8th International Conference on Multi-Material Micro Manufacture
Publisher: Research Publishing Services
ISBN (Print): 978-981-07-0319-6
Main Research Area: Technical/natural sciences

**Surface topography analysis for dimensional quality control of replication at the micrometre scale**

Replication of geometrical features and surfaces are present at different production levels, from realization of moulds to final product. Geometrical features must be reproduced within specification limits, to ensure product functionality. In order to control the replication quality, mould and replica surfaces must be quantitatively analysed and compared. In the present work, reference simulated surfaces were considered and studied in order to evaluate the effectiveness and traceability of different analysis tools for replication quality control. Topographies were analysed simulating different surface mapping techniques, such as optical profilometry, scanning probe microscopy and scanning electron microscopy. Different strategies for surface analysis and comparison are proposed and discussed taking into account the instrument, the measuring range and the functionality of the surface.

**General information**

State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, University of Padua
Authors: Balcon, M. (Ekstern), Marinello, F. (Ekstern), Tosello, G. (Intern), Carmignato, S. (Ekstern), Savio, E. (Ekstern)
Pages: 194-198
Publication date: 2011

**Host publication information**

Title of host publication: 13th International Conference on Metrology and Properties of Engineering Surfaces
Main Research Area: Technical/natural sciences

**Suspension of Water Droplets on Individual Pillars**

We report results of extensive experimental and numerical studies on the suspension of water drops deposited on cylindrical pillars having circular and square cross sections and different wettabilities. In the case of circular pillars, the drop contact line is pinned to the whole edge contour until the drop collapses due to the action of gravity. In contrast, on square pillars, the drops are suspended on the four corners and spilling along the vertical walls is observed. We have also studied the ability of the two geometries to sustain drops and found that if we compare pillars with the same characteristic size, the square is more efficient in pinning large volumes, while if we normalize the volumes to pillar areas, the opposite is true.
Testing and modelling of new tribo-systems for industrial sheet forming of stainless steels

Sheet metal forming of stainless steels is known to be tribologically demanding. To ensure satisfactory production without pick-up and galling, lubrication with environmentally hazardous chlorinated paraffin oil is normally required and in the most severe cases combined with ceramic tool coatings. The present paper presents an attempt to clarify the challenges of replacing chlorinated paraffin oils with new environmentally friendly oils in an industrial production, by investigating these oils in combination with alternative tool materials and tool coatings. A number of tribology systems have been screened in the laboratory by strip reduction testing and the best tribo-systems have been tested in a progressive production tool at the Danish company Grundfos A/S. The combination of a TiAlN coating with one of the environmentally friendly lubricants shows good performance in the simulative test as well as the production test with no sign of galling even at maximum production speed. Lowering production speed, and thereby the interface temperature, allows less efficient tribo-systems to function satisfactory, i.e. without galling. The tool/workpiece interface temperature is simulated for the strip reduction test as well as the production test in order to estimate the critical interface temperature for lubricant film breakdown. Simulation results show good agreement with experimental measurements of tool temperature close to the interface.
Testing a New Microporous Lubricant Carrier for Cold Forging

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Institute for Product Development
Authors: Ceron, E. (Intern), Bay, N. (Intern), Arentoft, M. (Intern), Tang, P. T. (Intern)
Pages: 240-244
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Steel Research International
Volume: 82
Issue number: Special issue
ISSN (Print): 1611-3683
Ratings:
BFI (2018): BFI-level 1
Test of Tribological Performance of Robot Assisted Polished Tool Surfaces

General information
State: Published
Organisations: Institute for Product Development, Manufacturing Engineering, Department of Mechanical Engineering
Authors: Eriksen, R. S. (Intern), Arentoft, M. (Intern), Grønbæk, J. (Ekstern), Bay, N. (Intern)
Pages: 1108-1111
Publication date: 2011
Main Research Area: Technical/natural sciences

Original language: English
Source: orbit
Source-ID: 285112
Publication: Research - peer-review » Conference article – Annual report year: 2011
The dynamics of cylindrical samples in dual wind-up extensional rheometers

Numerical computations of the extension of circular cylindrical shaped samples in a dual wind-up drum rheometer of Sentmanat extensional rheometer type M. L. Sentmanat, Rheol. Acta 43, 657 (2004); R. Garritano and H. Berting, US Patent No. 7,096,728 (08/29/2006) are presented. These time-dependent computations are fully three dimensional and based on theoretically ideal configurations. If necking or sample rupture does not occur, the elongation will resemble as ideal uni-axial if the initial sample diameter is decreased sufficiently. An initial diameter larger than 0.5 mm may result in large deviations from ideal uni-axial deformation.
Three-Sheet Spot Welding of Advanced High-Strength Steels

The automotive industry has introduced the three-layer weld configuration, which represents new challenges compared to normal two-sheet lap welds. The process is further complicated by introducing high-strength steels in the joint. The present article investigates the weldability of thin, low-carbon steel to two thicker, high-strength steels of high-strength low-alloy (HSLA) 340, DP600, or TRIP700. Factorial experimentation and statistical analysis are used to illustrate how the robustness of the process is affected by the electrode size and is heavily influenced by the protective zinc coating. The weld mechanisms are analyzed numerically and compared with metallographic analyses showing how the primary bonding mechanism between the thin, low-carbon steel sheet and the thicker sheet of high-strength steel is solid-state bonding, whereas the two high-strength steels are joined by melting, forming a weld nugget at their mutual interface. Despite the absence of the typical fusion nugget through the interface between the low-carbon steel and high-strength steel, the weld strengths obtained are acceptable. The failure mechanism in destructive testing is ductile fracture with plug failure.
Towards the first generation micro bulk forming system

The industrial demand for micro mechanical components has surged in the later years with the constant introduction of more integrated products. The micro bulk forming process holds a promising pledge of delivering high quality micro mechanical components at low cost and high production rates. This work describes a number of prototype system units, which collectively form a desktop sized micro forming production system. The system includes a billet preparation module, an integrated transfer system, a temperature controlled forming tool, including process simulation, and a dedicated micro forming press. The system is demonstrated on an advanced micro forming case where a dental component is formed in medical grade Titanium.

General information
State: Published
Organisations: Institute for Product Development, Manufacturing Engineering, Department of Mechanical Engineering
Authors: Arentoft, M. (Intern), Eriksen, R. S. (Intern), Hansen, H. N. (Intern), Paldan, N. A. (Intern)
Pages: 335-338
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: C I R P Annals
Volume: 60
Issue number: 1
ISSN (Print): 0007-8506
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 2.055 SNIP 3.158
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.088 SNIP 3.294 CiteScore 3.83
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 3.123 SNIP 3.992 CiteScore 4.39
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.598 SNIP 3.818 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.088 SNIP 4.156 CiteScore 3.04
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 2.117 SNIP 3.46 CiteScore 2.81
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.12 SNIP 3.449
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.652 SNIP 2.219
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.056 SNIP 1.645
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.119 SNIP 1.55
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.892 SNIP 1.96
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.988 SNIP 1.904
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.591 SNIP 2.376
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.142 SNIP 1.823
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.866 SNIP 2.26
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.575 SNIP 2.161
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.788 SNIP 2.182
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.779 SNIP 2.611
Original language: English
Cold forming, Micro tool, Manufacturing system
DOIs:
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Traceable surface characterization using replica moulding technology

Characterization of ultra-finely finished surfaces (e.g. mirrored surfaces or polished specimens) is nowadays challenging due to possible part damage if a contact instrument is used or due to scattered light if the measurements are performed with optical instruments. In order to prevent these problems, surface replication is considered as a method to make feasible the characterization of the polished specimens. This paper focuses on the investigation of surface characterization based on replication methods using soft and hard polymer casting. The study deals with the evaluation of the replication degree between the master and the replica as well, the different replication materials involved, the different instruments used and the calculation of the measurement uncertainty for both sub-micro surface topography and micro geometrical measurements.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Gasparin, S. (Intern), Hansen, H. N. (Intern), Tosello, G. (Intern)
Pages: 310-315
Publication date: 2011

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Main Research Area: Technical/natural sciences
Uncertainty, Micro manufacturing, Reference standard, Replication
Electronic versions:
Traceable_surface_characterization_using_replica_moulding_technology.pdf
Source: orbit
Source-ID: 271769
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Trends and Visions in Metal Forming Tribology

Research and development in metal forming tribology is characterized by intensified focus on new tribo-systems such as new lubricants, tool materials and tool coatings in order to substitute environmentally hazardous lubricant systems. Other means to solve these problems include the development of structured work piece and tool surfaces to facilitate micro-hydro-dynamic lubrication. Increased knowledge on skin-pass rolling to establish structured sheet surfaces and new automatic polishing equipment to manufacture tailored tool surfaces are important means to improve tribo-conditions in severe forming operations, which otherwise would require the use of environmentally hazardous lubricant systems. A methodology for prediction of limits of lubrication of new tribo-system for sheet forming production based on numerical modelling and off-line testing in dedicated simulative tribo-tests is proposed.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Bay, N. (Intern)
Pages: 15-26
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Steel Research International
Volume: 82
Issue number: Special issue
ISSN (Print): 1611-3683
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.068 SJR 0.783 CiteScore 1.5
Web of Science (2017): Indexed Yes
Uncertainty evaluation for three-dimensional scanning electron microscope reconstructions based on the stereo-pair technique

3D-SEM is a method, based on the stereophotogrammetry technique, which obtains three-dimensional topographic reconstructions starting typically from two SEM images, called the stereo-pair. In this work, a theoretical uncertainty evaluation of the stereo-pair technique, according to GUM (Guide to the Expression of Uncertainty in Measurement), was carried out, considering 3D-SEM reconstructions of a wire gauge with a reference diameter of 250 µm. Starting from the more commonly used tilting strategy, one based on the item rotation inside the SEM chamber was also adopted. The latter enables multiple-view reconstructions of the cylindrical item under consideration. Uncertainty evaluation was performed starting from a modified version of the Piazzesi equation, enabling the calculation of the z-coordinate from a given stereo-pair. The metrological characteristics of each input variable have been taken into account and a SEM stage calibration has been performed. Uncertainty tables for the cases of tilt and rotation were then produced, leading to the calculation of expanded uncertainty. For the case of rotation, the largest uncertainty contribution resulted to be the rotational angle; however, for the case of tilt it resulted to be the pixel size. A relative expanded uncertainty equal to 5% and 4% was obtained for the case of rotation and tilt, respectively.
Validation of three-dimensional micro injection molding simulation accuracy

Data analysis and simulations on micro-molding experiments have been conducted. Micro molding simulations have been executed taking into account actual processing conditions implementation in the software. Various aspects of the simulation set-up have been considered in order to improve the simulation accuracy (i.e. decrease deviations from experimental values): injection speed profile, cavity injection pressure, melt and mold temperatures, three-dimensional mesh parameters, and material rheological characterization. Quality factors investigated for the quantitative comparisons were: short shot length, injection pressure profile, molding mass and flow pattern. The importance of calibrated micro molding process monitoring for an accurate implementation strategy of the simulation and its validation has been demonstrated. In fact, inconsistencies and uncertainties in the experimental data must be minimized to avoid introducing uncertainties in the simulation calculations. Simulations of bulky sub-100 milligrams micro molded parts have been validated and a methodology for accurate micro molding simulations was established.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Autodesk Inc
Authors: Tosello, G. (Intern), Costa, F. (Ekstern), Hansen, H. N. (Intern)
Publication date: 2011

Verification of a CT scanner using a miniature step gauge

The work deals with performance verification of a CT scanner using a 42mm miniature replica step gauge developed for optical scanner verification. Errors quantification and optimization of CT system set-up in terms of resolution and measurement accuracy are fundamental for use of CT scanning in dimensional metrology. Influence of workpiece orientation, magnification, source-object-detector distances and surface extraction method on metrological performances of a CT scanner was evaluated. Results show that the position of the workpiece in the CT cabinet is fundamental to get reliable measurements, while the highest magnification (best resolution) does not assure the best accuracy.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Novo Nordisk A/S, University of Padua
Authors: Cantatore, A. (Intern), Andreasen, J. (Ekstern), Carmignato, S. (Ekstern), Müller, P. (Intern), De Chiffre, L. (Intern)
Publication date: 2011
Development of lead-free solders for high-temperature applications

This work also reviews the alternative technologies for replacing the high-temperature soldering since it was determined that even the expensive candidate alloys involving Au too could not cover the spectrum of properties required for being accepted as a standard soft solder for high-temperature applications. Unfortunately, even the substitute technologies that are currently being developed cannot address several critical issues of high-temperature soldering. Therefore, further research and development of high-temperature lead-free soldering is obviously needed. It is hoped that this thesis can serve as a valuable source of information to those interested in environmentally conscious electronic packaging.

Process optimization of friction stir welding based on thermal models

This thesis investigates how to apply optimization methods to numerical models of a friction stir welding process. The work is intended as a proof-of-concept using different methods that are applicable to models of high complexity, possibly with high computational cost, and without the possibility for efficient gradient calculation. Thus, the focus is on surrogate optimization methods with the aim of reducing the number of expensive function evaluations, by using a low-fidelity model together with the high-fidelity model to be optimized. The methods used here do not require the user to supply gradient information of the high-fidelity model. The optimization schemes are applied to stationary thermal models of differing complexity of the friction stir welding process. The optimization problems considered are based on optimizing the temperature field in the workpiece by finding optimal translational speed and rotational speed of the tool. Besides the deterministic problem a robust optimization problem is considered in which the effects of uncertain material and optimization parameters are taken into account. The objective is to obtain a desired mean response while reducing the standard deviation of the response. Also an optimization problem based on a microstructure model is solved, allowing the hardness distribution in the plate to be optimized. The use of purely thermal models represents a simplification of the real process; nonetheless, it shows the applicability of the optimization methods considered and forms the basis for optimization of more detailed models. Surrogate models of varying complexity, and similarity with the true model, are applied and the effect on the optimization results is discussed. Furthermore, the thesis contributes to the modelling of the heat transfer between the workpiece and the backingplate by solving an inverse modelling problem in which experimental data and a numerical model are used for determining the contact heat transfer coefficient. Different parametrizations of the spatial distribution of the heat transfer coefficient are studied and discussed, and the optimization problem is formulated as a minimization of the difference between measured and calculated temperatures. The magnitude and distribution of the heat transfer coefficient is determined for the available data.
Advanced Anodising Technology (Avanceret Anodiserings Teknologi)

General information
State: Published
Organisations: Department of Mechanical Engineering, Materials and Surface Engineering, Manufacturing Engineering
Authors: Tabrizian-Ghalehno, N. (Intern), Møller, P. (Intern), Hansen, H. N. (Intern), Ambat, R. (Intern)
Publication date: Jan 2010

Optimization of Thermo-mechanical Conditions in Friction Stir Welding
Several models for the FSW process have been applied. Initially, the thermal models were addressed since they in essence constitute the basis of all other models of FSW, be it microstructural, flow or residual stress models. Both analytical and numerical models were used and combined with the Sequential Quadratic Programming (SQP) gradient-based optimization algorithm in order to find the welding speed and the heat input that would yield a prescribed average temperature close to the solidus temperature under the tool, thereby expressing a condition which is favourable for the process.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Tutum, C. C. (Intern), Hattel, J. H. (Intern)
Number of pages: 193
Publication date: Jan 2010

3D modeling of dual wind-up extensional rheometers
Fully three-dimensional numerical simulations of a dual wind-up drum rheometer of the Sentmanat Extensional Rheometer (SER; Sentmanat, 2004 [1]) or the Extensional Viscosity Fixture (EVF; Garritano and Berting, 2006 [2]) type have been performed. In the SER and EVF a strip of rectangular shape is attached onto two drums, followed by a rotation of both drums in opposite direction. The numerical modeling is based on integral constitutive equations of the K-BKZ type. Generally, to ensure a proper uni-axial extensional deformation in dual wind-up drum rheometers the simulations show that a very small initial width and initial thickness of the strip is required. In the SER it requires an initial sample width of less than 2.5 mm and a thickness of less than 0.25 mm. This is typically observed for elastomer model. The overall picture is though more diverse, as the possibility to perform ideal uni-axial extension is very dependent of the constitutive equation. Especially the weighting between the convected relative strain tensors in the K-BKZ model seems to control the deviation from ideal behavior. Consequently, for melts or entangled liquids a proper uni-axial flow will be kept for a much
wider parameter range. In fact only the appearance of a ductile necking or a large initial thickness of the sample will create a significant deviation from ideal extension. These simulations were based on MSF constitutive model.

**General information**

State: Published  
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, The Danish Polymer Centre, Department of Chemical and Biochemical Engineering  
Authors: Yu, K. (Intern), Román Marín, J. M. (Intern), Rasmussen, H. K. (Intern), Hassager, O. (Intern)  
Publication date: 2010  
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Journal of Non-Newtonian Fluid Mechanics  
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BFI (2018): BFI-level 2  
Web of Science (2018): Indexed yes  
BFI (2017): BFI-level 2  
Scopus rating (2017): SNIP 1.509 SJR 1.14 CiteScore 2.44  
Web of Science (2017): Indexed Yes  
BFI (2016): BFI-level 2  
Scopus rating (2016): CiteScore 2.43 SJR 1.145 SNIP 1.604  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 2  
Scopus rating (2015): SJR 1.155 SNIP 1.505 CiteScore 2.23  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 2  
Scopus rating (2014): SJR 0.988 SNIP 1.324 CiteScore 1.96  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 2  
Scopus rating (2013): SJR 1.024 SNIP 1.606 CiteScore 2.09  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 2  
Scopus rating (2012): SJR 1.101 SNIP 1.532 CiteScore 1.93  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 2  
Scopus rating (2011): SJR 1.09 SNIP 1.408 CiteScore 1.93  
ISI indexed (2011): ISI indexed yes  
BFI (2010): BFI-level 2  
Scopus rating (2010): SJR 1.232 SNIP 1.743  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 2  
Scopus rating (2009): SJR 1.534 SNIP 1.504  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 1  
Scopus rating (2008): SJR 1.519 SNIP 1.917  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 1.342 SNIP 1.477  
Web of Science (2007): Indexed yes  
Scopus rating (2006): SJR 1.439 SNIP 1.456  
Scopus rating (2005): SJR 1.573 SNIP 1.52  
Web of Science (2005): Indexed yes
3D-SEM Metrology for Coordinate Measurements at the Nanometer Scale

The present work deals with a study concerning 3D-SEM metrology as a tool for coordinate measurements at the nanometer scale. The relevance of 3D-SEM, based on stereophotogrammetry technique, has been highlighted with respect to the other measuring instruments nowadays available and the main issues to be addressed concerning uncertainty evaluation have been discussed. Most recent developments in the field of micro and nano-metrology, in terms of measuring machines and techniques, are described pointing out advantages and limitations. The importance of multi-sensor and multi-orientation strategy for geometrical reconstructions is discussed through an experimental example, together with point cloud stitching methodology and the currently used algorithms for feature extraction. Theoretical basis of stereo-pair technique, based on two SEM images obtained by tilting the SEM stage of a desired amount, leading to 3D reconstructions, are given and the main phases involved in stereophotogrammetry technique are described underlying the most relevant error sources in the case of 2D and 3D-SEM metrology. An uncertainty evaluation has been thus carried out in accordance with ISO GUM, following a holistic approach, to quantify the influence of the different error sources on the stereo-pair reconstruction procedure. As a case study, a wire gauge with a known reference diameter has been employed. Although stereo-pairs are more commonly obtained trough a SEM stage tilting, a new methodology has been developed based on object rotations inside the SEM chamber, since the item under consideration had a cylindrical shape. This technique permits multi-orientation measurements enabling the reconstruction of the complete object geometry. The main error sources considered, when performing 3D-SEM reconstructions, are point cloud processing and feature extraction, instrument setting parameters and image quality. Moreover, a comparison of the results obtained trough a theoretical and an experimental uncertainty evaluation of stereo-pair technique has been performed. All these effects have been quantified through a series of experimental investigations often based on the Design of Experiments (DOE) approach. A final uncertainty budget table has been produced for the case of multi-orientation reconstructions obtained by applying 3D-SEM technique to three cylindrical items: two reference wire gauges and a hypodermic needle. In the last part of the work, the development and application of two novel multistep heights artefacts, intended for 3D-SEM calibration, is addressed. Experimental results of the different step-height values, measured from 3D-SEM reconstructions, are compared with the calibrated ones obtained from reference measurements performed by means of stylus profilometer and with measurements carried out using an Infinite Focus instrument.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Materials and Surface Engineering, Danish Fundamental Metrology
Authors: Carli, L. (Intern), De Chiffre, L. (Intern), Hansen, H. N. (Intern), Horsewell, A. (Intern), Dirscherl, K. (Ekstern)
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Main Research Area: Technical/natural sciences
Electronic versions:
Loca_PhDThesis_revised.pdf
Source: orbit
Source-ID: 276823
Publication: Research › Ph.D. thesis – Annual report year: 2011
3D Simulation of Nano-Imprint Lithography
A proof of concept study of the feasibility of fully three-dimensional (3D) time-dependent simulation of nano-imprint lithography of polymer melt, where the polymer is treated as a structured liquid, has been presented. Considering the flow physics of the polymer as a structured liquid, we have followed the line initiated by de Gennes, using a Molecular Stress Function model of the Doi and Edwards type. We have used a 3D Lagrangian Galerkin finite element methods implemented on a parallel computer architecture. In a Lagrangian techniques, the node point follows the particle movement, allowing for the movement of free surfaces or interfaces. We have extended the method to handle the dynamic movement of the contact line between the polymer melt and stamp during mold filling.

General information
State: Published
Organisations: The Danish Polymer Centre, Department of Chemical and Biochemical Engineering, Manufacturing Engineering, Department of Mechanical Engineering
Authors: Román Marín, J. M. (Intern), Rasmussen, H. K. (Intern), Hassager, O. (Intern)
Pages: 274-278
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: Nanoscale Research Letters
Volume: 5
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.874 SJR 0.713 CiteScore 2.67
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.613 SNIP 0.766 CiteScore 2.15
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.543 SNIP 0.666 CiteScore 1.69
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.762 SNIP 1.017 CiteScore 2.15
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.805 SNIP 0.972 CiteScore 2.23
ISI indexed (2013): ISI indexed yes
Scopus rating (2012): SJR 1.049 SNIP 1.073 CiteScore 2.58
ISI indexed (2012): ISI indexed yes
Scopus rating (2011): SJR 1.038 SNIP 1.113 CiteScore 2.88
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 1.061 SNIP 1.001
Web of Science (2010): Indexed yes
Scopus rating (2009): SJR 1.07 SNIP 1.019
Scopus rating (2008): SJR 0.828 SNIP 0.63
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Original language: English
MSF, NIL, Viscoelastic, Nano-imprint, Lagrangian, Finite element
DOIs:
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Source: orbit
Source-ID: 263171
Publication: Research - peer-review › Journal article – Annual report year: 2010

A Casting Yield Optimization Case Study: Forging Ram
This work summarizes the findings of multi-objective optimization of a gravity sand-cast steel part for which an increase of the casting yield via riser optimization was considered. This was accomplished by coupling a casting simulation software package with an optimization module. The benefits of this approach, recently adopted in foundry industry world wide and
based on fully automated computer optimization, were demonstrated. First, analyses of filling and solidification of the original casting design were conducted in the standard simulation environment to determine potential flaws and inadequacies. Based on the initial assessment, the gating system was redesigned and the chills rearranged to improve the solidification pattern. After these two cases were evaluated, the adequate optimization targets and constraints were defined. One multi-objective optimization case with conflicting objectives was considered in which minimization of the riser volume together with minimization of shrinkage porosity and limitation of centerline porosity were performed.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Vitkovice Heavy Machinery A.S., Ostrava
Authors: Kotas, P. (Intern), Tutum, C. C. (Intern), Hattel, J. H. (Intern), Snajdrova, O. (Ekstern), Thorborg, J. (Intern)
Pages: 61-76
Publication date: 2010
Main Research Area: Technical/natural sciences

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Journal: International Journal of Metalcasting
Volume: 4
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Ratings:
Web of Science (2018): Indexed yes
Scopus rating (2017): CiteScore 0.66 SJR 0.329 SNIP 0.729
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 0.47 SJR 0.304 SNIP 0.688
Scopus rating (2015): SJR 0.286 SNIP 0.58 CiteScore 0.32
Scopus rating (2014): SJR 0.285 SNIP 0.546 CiteScore 0.37
Scopus rating (2013): SJR 0.21 SNIP 0.33 CiteScore 0.18
ISI indexed (2013): ISI indexed yes
Scopus rating (2012): SJR 0.194 SNIP 0.692 CiteScore 0.31
ISI indexed (2012): ISI indexed yes
Scopus rating (2011): SJR 0.281 SNIP 0.989 CiteScore 0.41
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.256 SNIP 0.857
Web of Science (2010): Indexed yes
Scopus rating (2009): SJR 0.169 SNIP 0.041
Scopus rating (2008): SJR 0.104 SNIP 0
Original language: English
Casting yield, Riser volume optimization, Steel casting, Centerline porosity, Casting process simulation, Genetic algorithms, Macro-porosity
Source: orbit
Source-ID: 266177
Publication: Research - peer-review › Journal article – Annual report year: 2010

Accuracy optimization of high-speed AFM measurements using Design of Experiments
Atomic Force Microscopy (AFM) is being increasingly employed in industrial micro/nano manufacturing applications and integrated into production lines. In order to achieve reliable process and product control at high measuring speed, instrument optimization is needed. Quantitative AFM measurement results are influenced by a number of scan settings parameters, defining topography sampling and measurement time: resolution (number of profiles and points per profile), scan range and direction, scanning force and speed. Such parameters are influencing lateral and vertical accuracy and, eventually, the estimated dimensions of measured features. The definition of scan settings is based on a comprehensive optimization that targets maximization of information from collected data and minimization of measurement uncertainty and scan time. The Design of Experiments (DOE) technique is proposed and applied to perform the optimization of AFM measurements on calibrated one-dimensional silicon grating featuring a triangular periodical profile (slopes of 54.7 degrees, period of 3 μm).

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, University of Padua
Authors: Tosello, G. (Intern), Marinello, F. (Ekstern), Hansen, H. N. (Intern), Antico, A. (Ekstern)
Pages: 172-175
A comprehensive parameter study of an active magnetic regenerator using a 2D numerical model

A two-dimensional numerical heat transfer model is used to investigate an active magnetic regenerator (AMR) based on parallel plates of magnetocaloric material. A large range of parameter variations are performed to study the optimal AMR. The parameters varied are the plate and channel thicknesses, cycle frequency and fluid movement. These are cast into the non-dimensional units utilization, porosity and number of transfer units (NTU). The cooling capacity vs. temperature span is mapped as a function of these parameters and each configuration is evaluated through the maximum temperature span and exergy. The results show that the optimal AMR should have a utilization in the range 0.2–1 and an NTU higher than 10 and not necessarily more than 30. It is concluded that parallel plate-based regenerators face significant challenges in terms of manufacturability. However, the benefit of parallel plate regenerators is a very low pressure drop, which is needed for high performance.
A Multi-objective Optimization Application in Friction Stir Welding: Considering Thermo-mechanical Aspects

The objective of this paper is to investigate optimum process parameters in Friction Stir Welding (FSW) to minimize residual stresses in the work piece and maximize production efficiency meanwhile satisfying process specific constraints as well. More specifically, the choices of tool rotational speed and traverse welding speed have been sought in order to achieve the goals mentioned above using an evolutionary multi-objective optimization (MOO) algorithm, i.e. non-dominated sorting genetic algorithm (NSGA-II), integrated with a transient, 2-dimensional sequentially coupled thermomechanical model implemented in the FE-code, ANSYS. The thermal model is based on a heat source description which in essence is governed by the rotational speed and the temperature dependent yield stress of the work piece material. This model in turn delivers the temperature field, in order to compute thermal strain field which is the main driver for the mechanical model predicting both transient and finally residual stresses in the work piece. This thermo-mechanical model is then used in the aforementioned constrained MOO case where the two objectives are conflicting. Following this, two reasonable design solutions among those multiple trade-off solutions have been selected based on the cost and the quality preferences.
Analysis and Modelling of Electrode Wear in Resistance Spot Welding

A model describing electrode wear as a function of weld number, initial tip diameter, truncated cone angle, welding current and electrode force is proposed. Excellent agreement between the model and experimental results is achieved, showing that the model can describe the change in electrode tip diameter with increasing weld number at different weld settings. Furthermore a method for measuring the worn tip diameter in a fast and robust manner is developed. The method relies on a well-known technique for capturing the electrode tip area by the use of carbon imprints and a new developed image-processing program written in MatLab. Very fine agreement between the present experimental results and previously published wear data is achieved. Finally the pitted areas on the electrode tip are analyzed using MatLab and an optical 3D surface measurement device. Two types of pitting are characterized. One where a central cavity is formed and one where smaller pits are formed randomly across the electrode face. The influence of these two types of surface pits on the nugget size are investigated using the FE code SORPAS, revealing ring welds and undersized weld nuggets.

An analytical model for force prediction in ball nose micro milling of inclined surfaces

Ball nose micro milling is a key process for the generation of free form surfaces and inclined surfaces often present in mould inserts for micro replication. This paper presents a new cutting force model for ball end micro milling of slanted surfaces for any value of the surface inclination angle relative to the tool axis.

Application of Hard Coatings for Improved Tribological Performance of Blanking and Piercing Tools

The aim of the present investigation was to examine the possibility of reducing lubrication and replacing expensive tungsten carbide material in blanking/piercing through introduction of hard tool coatings. Results show that hard PVD coatings can be successfully used in blanking/piercing applications, even on softer tool steels, thus leading to reduced
friction and wear as well as to lower costs of the tool. However, preparation of the substrate material and good coating to substrate adhesion are crucial. On the other hand, even with the use of low friction coating (DLC) stamping force exceeds critical value under dry friction conditions and leads to tool failure. Therefore, at present oxidation and temperature resistant hard coatings can give improved wear resistance of stamping tools, but elimination of lubricants in blanking and piercing processes is still not feasible.

A quantitative lubricant test for deep drawing
A tribological test for deep drawing has been developed by which the performance of lubricants may be evaluated quantitatively measuring the maximum backstroke force on the punch owing to friction between tool and workpiece surface. The forming force is found not to give useful information regarding the lubricant performance, since it is not sensitive enough to reveal changes in the frictional contact, whereas the backstroke force is very sensitive to pick-up and galling even on micro-scale. Results from testing different lubricants with different performances are found to be consistent with visual judgement of the resulting surface of the drawn cups.
Asperity deformation during running-in
Asperities loaded in pure rolling against a hard, smooth surface will often be deformed at the first contact event and will thereby experience high normal stress, presumably of a magnitude near the Vickers hardness of the softer material. Continued running-in can be imagined to develop into lower stress levels and an increase of contact area. An asperity model simulating a running-in process of rough surfaces with lengthy protractions in the rolling direction was investigated. After a limited range of only about 104 contact events a state of very low deformation rate was found.

Broadband polymer microstructured THz fiber coupler with downdoped cores
We demonstrate a broadband THz directional coupler based on a dual core photonic crystal fiber (PCF) design with mechanically down-doped core regions. For a center frequency of 1.3 THz we demonstrate a bandwidth of 0.65 THz.
Broadband terahertz fiber directional coupler
We present the design of a short broadband fiber directional coupler for terahertz (THz) radiation and demonstrate a 3 dB coupler with a bandwidth of 0.6 THz centered at 1.4 THz. The broadband coupling is achieved by mechanically downdoping the cores of a dual-core photonic crystal fiber by microstructuring the cores. This is equivalent to chemical downdoping but is easier to realize experimentally.
Cavity Pressure Behaviour in Micro Injection Moulding

Process monitoring of micro injection moulding (µIM) is of crucial importance to analyse the effect of different parameter settings on the process and to assess its quality. Quality factors related to cavity pressure can provide useful information directly connected with the dynamics of the process as well as with the filling of the cavity by the polymer melt. In this paper, two parameters derived from cavity pressure over time (i.e. pressure work). The influence of four µIM parameters (melt temperature, mould temperature, injection speed, and packing pressure) on the two pressure-related outputs has been investigated by moulding a micro fluidic component on three different polymers (PP, ABS, PC) using the design of experiment approach. Similar trends such as the effects of a higher injection speed in decreasing the pressure work and of a lower temperature in decreasing pressure rate have been found for all three materials.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Cardiff University
Authors: Griffiths, C. (Ekstern), Dimov, S. (Ekstern), Scholz, S. (Ekstern), Hirshy, H. (Ekstern), Tosello, G. (Intern), Hansen, H. N. (Intern), Williams, E. (Ekstern)
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Main Research Area: Technical/natural sciences
Characterization of Laser Machined Polymer Surface Using Bearing Area Curve Parameters for Future Plating

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Institute for Product Development
Authors: Zhang, Y. (Intern), Hansen, H. N. (Intern), De Grave, A. (Intern), Tang, P. T. (Intern), Nielsen, J. S. (Intern)
Publication date: 2010

Host publication information
Title of host publication: ICOMM/4M2010
Main Research Area: Technical/natural sciences
Conference: 5th International Conference on MicroManufacturing, Madison, WI, United States, 05/04/2010 - 05/04/2010
Source: orbit
Source-ID: 261941
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Constraints on the Adiabatic Temperature Change in Magnetocaloric Materials
The thermodynamics of the magnetocaloric effect implies constraints on the allowed variation in the adiabatic temperature change for a magnetocaloric material. An inequality for the derivative of the adiabatic temperature change with respect to temperature is derived for both first- and second-order materials. For materials with a continuous adiabatic temperature change as a function of temperature, this inequality is shown to hold for all temperatures. However, discontinuous materials may violate the inequality. We compare our results with measured results in the literature and discuss the implications of the result. Similar inequalities hold for barocaloric and electrocaloric materials.

General information
State: Published
Authors: Nielsen, K. K. (Intern), Bahl, C. R. H. (Intern), Smith, A. (Intern)
Pages: 054423
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Physical Review B Condensed Matter
Volume: 81
Issue number: 5
ISSN (Print): 0163-1829
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Indexed yes
Scopus rating (2015): SJR 2.377 SNIP 1.13 CiteScore 2.8
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 2.762 SNIP 1.316 CiteScore 3.3
Web of Science (2014): Indexed yes
Scopus rating (2013): SJR 2.813 SNIP 1.326 CiteScore 3.55
Design of lead-free candidate alloys for high-temperature soldering based on the Au–Sn system

Au–Sn based candidate alloys have been proposed as a substitute for high-lead content solders that are currently being used for high-temperature soldering. The changes in microstructure and microhardness associated with the alloying of Ag and Cu to the Au rich side as well as to the Sn rich side of the Au–Sn binary system were explored in this work. Furthermore, the effects of thermal aging on the microstructure and microhardness of these promising Au–Sn based ternary alloys were investigated. For this purpose, the candidate alloys were aged at a lower temperature, 150°C for up to 1 week and compared with aging at 200°C for respective durations. It was determined in this work that the candidate alloys on the Sn rich side were relatively more stable, i.e., only the aging temperature had a substantial impact on the microstructure and not the aging duration. The candidate alloys aged at 200°C were substantially softer on the Au rich side than the candidate alloys on the Sn rich side. However, the difference in hardness narrowed down considerably between the candidate alloys on the Au rich side and the Sn rich side when subjected to aging at 150°C.
General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Materials and Surface Engineering
Authors: Chidambaram, V. (Intern), Hattel, J. H. (Intern), Hald, J. (Intern)
Pages: 4638-4645
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Materials & Design
Volume: 31
Issue number: 10
ISSN (Print): 0264-1275
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SJR 1.82 SNIP 2.424 CiteScore 5.16
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.9 SJR 1.76 SNIP 2.547
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.844 SNIP 2.623 CiteScore 4.51
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 2.364 SNIP 3.403 CiteScore 4.36
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.024 SNIP 3.215 CiteScore 3.8
ISI indexed (2013): ISI indexed no
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.963 SNIP 3.171 CiteScore 3.31
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.387 SNIP 2.501 CiteScore 2.63
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.058 SNIP 1.845
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.931 SNIP 1.808
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.961 SNIP 1.355
Scopus rating (2007): SJR 0.83 SNIP 1.674
Scopus rating (2006): SJR 0.66 SNIP 1.416
Scopus rating (2005): SJR 0.739 SNIP 1.364
Scopus rating (2004): SJR 0.521 SNIP 1.153
Scopus rating (2003): SJR 0.596 SNIP 1.207
Scopus rating (2002): SJR 0.627 SNIP 1.196
Scopus rating (2001): SJR 0.373 SNIP 0.604
Scopus rating (2000): SJR 0.189 SNIP 0.723
Scopus rating (1999): SJR 0.189 SNIP 0.314
Original language: English
Development of Au-Ge based candidate alloys as an alternative to high-lead content solders

Au-Ge based candidate alloys have been proposed as an alternative to high-lead content solders that are currently being used for high-temperature applications. The changes in microstructure and microhardness associated with the addition of low melting point metals namely In, Sb and Sn to the Au-Ge eutectic were investigated in this work. Furthermore, the effects of thermal aging on the microstructure and its corresponding microhardness of these promising candidate alloys have been extensively reported. To investigate the effects of aging temperature, candidate alloys were aged at a lower temperature, 150°C for up to 3 weeks and compared with aging at 200°C. After being subjected to high-temperature aging, the microstructure varied a lot in morphology in the case of both Au-Ge-Sb and Au-Ge-Sn candidate alloys while the microstructure remained relatively stable even after long-term thermal aging in the case of the Au-Ge-In candidate alloy. The microhardness measurement is well correlated with the solubility and reactivity of these alloying elements, characteristics of their intermetallic compounds (IMCs) and the distribution of phases. The primary strengthening mechanism in the case of Au-Ge-In and Au-Ge-Sn combinations was determined to be the classic solid solution strengthening. The Au-Ge-Sb combination was primarily strengthened by the refined (Ge) dispersed phase. The aging temperature had a significant influence on the microhardness in the case of the Au-Ge-Sn candidate alloy. The distribution of phases played a relatively more crucial role in determining the ductility of the bulk solder alloy. The findings of this work are: the addition of Sb to the Au-Ge eutectic would not only decrease its melting point but would also improve its ductility substantially and the lattice strains induced by the In atoms were the most effective strengthening mechanism.
Direct testing of scale effects in metal forming friction and lubrication

Downscaling of metal forming operations from macro to micro scale implies significant changes caused by size effects, among these the friction increase, which has been reported by researchers using indirect test methods such as ring-compression test and double-cup-extrusion test. In the present work a new test equipment is developed for direct friction measurements in the range from macro to micro scale. Investigations confirm a significant friction increase when downscaling. Visual inspection of the work pieces show this to be explained by the amount of open and closed lubricant pockets.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Institute for Product Development
Authors: Nielsen, P. S. (Intern), Calaon, M. (Intern), Paldan, N. A. (Intern), Bay, N. (Intern)
Number of pages: 917
Pages: 497-506
Publication date: 2010

Host publication information
Title of host publication: Tribology of Manufacturing Processes
ISBN (Print): 978-2-911256-27-1
Main Research Area: Technical/natural sciences
Conference: 4th International Conference on Tribology in Manufacturing Processes, Nice, France, 13/06/2010 - 13/06/2010
Lubrication, Friction, Micro forming, Size effects
Does the interchain pressure effect exist in flow of polymer melt?
Based on the uniaxial extension of monodisperse polystyrenes presented by Bach et al. (Macromolecules, 2003) Marrucci and Ianniruberto (Macromolecules, 2004) formulated the 'interchain pressure' concept, based on ideas going back to Doi and Edwards. For a theory to be valid it needs the ability to quantitatively to predict experiments observation. Here we critically evaluate the 'interchain pressure' concept within the MSF model as suggested by Wagner et al. (J.Rheol. 2005). The experiments are startup of uni-axial elongational flow until steady flow, followed by stress relaxation or reversed bi-axial flow. The measurements are all performed on a filament stretching rheometer and narrow molar mass distribution polystyrene; controlled architecture branched as well as linear polymers.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Chemical and Biochemical Engineering, The Danish Polymer Centre
Authors: Rasmussen, H. K. (Intern), Hassager, O. (Intern)
Publication date: 2010

Host publication information
Title of host publication: AERC 2010
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 272272
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Effects of moulding and environmental conditions on the mechanical and surface properties of injection moulded Santoprene rubber

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Authors: Islam, A. (Intern), Ruby, T. M. (Ekstern), Jessen, R. L. (Ekstern)
Publication date: 2010
Event: Poster session presented at Polymers in Process and Products, Lyngby, DTU.
Main Research Area: Technical/natural sciences
Electronic versions:
Poster_3 week_Sonion_DTU.pdf
Source: orbit
Source-ID: 256973
Publication: Research › Poster – Annual report year: 2010

Effects of organic acid pickling on the corrosion resistance of magnesium alloy AZ31 sheet
Organic acids were used to clean AZ31 magnesium alloy sheet and the effect of the cleaning processes on the surface condition and corrosion performance of the alloy was investigated. Organic acid cleanings reduced the surface impurities and enhanced the corrosion resistance. Removal of at least 4 $\mu$m of the contaminated surface was required to reach corrosion rates less than 1 mm/year in salt spray condition. Among the three organic acids examined, acetic acid is the best choice. Oxalic acid can be an alternative while citric acid is not suitable for cleaning AZ31 sheet, because of insufficient removal of iron impurities.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, GKSS Forschungszentrum Geesthacht GmbH
Authors: Nwaogu, U. C. (Intern), Blawert, C. (Ekstern), Scharnagl, N. (Ekstern), Dietzel, W. (Ekstern), Kainer, K. U. (Ekstern)
Pages: 2143-2154
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Corrosion Science
Original language: English
EIS, IR spectroscopy, Weight loss, Acid solutions, Magnesium, Pitting corrosion
DOIs:
10.1016/j.corsci.2010.03.002
Source: orbit
Source-ID: 263415
**Electroless Plating on Plastic Induced by Selective Laser Activation**

**General information**
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Institute for Product Development
Authors: Zhang, Y. (Intern), Tang, P. T. (Intern), Hansen, H. N. (Intern), Nielsen, J. S. (Intern)
Pages: 43-47
Publication date: 2010
Conference: Sur Fin 2009, Louisville, Kentucky, US, 01/01/2009
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Plating and Surface Finishing
Volume: 97
Issue number: 2
ISSN (Print): 0360-3164
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.113 SNIP 0.198
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.128 SNIP 0.136
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.105 SNIP 0.115
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.124 SNIP 0.105
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.128 SNIP 0.026
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.172 SNIP 0.091
Scopus rating (2007): SJR 0.24 SNIP 0.422
Scopus rating (2006): SJR 0.221 SNIP 0.379
Scopus rating (2005): SJR 0.418 SNIP 0.461
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.514 SNIP 0.273
Scopus rating (2003): SJR 0.437 SNIP 0.461
Scopus rating (2002): SJR 0.393 SNIP 0.539
Scopus rating (2001): SJR 0.36 SNIP 0.54
Scopus rating (2000): SJR 0.613 SNIP 0.86
Scopus rating (1999): SJR 0.575 SNIP 0.709
Original language: English
Source: orbit
Source-ID: 260325

**Emission of organic compounds from mould and core binders used for casting iron, aluminium and bronze in sand moulds**

Emissions from mould and core sand binders commonly used in the foundry industry have been investigated. Degradation of three different types of binders was investigated: Furfuryl alcohol (FA), phenolic urethane (PU) and resol-CO2 (RC). In each group of binders at least two different binder compositions were tested. A test method that provides uniform test
conditions is described. The method can be used as general test method to analyse off gasses from binders. Moulds containing a standard size casting were produced and the amount and type of organic compounds resulting from thermal degradation of binders was monitored when cast iron, bronze and aluminium was poured in the moulds. Binder degradation was measured by collecting off gasses in a specially designed ventilation hood at a constant flow rate. Samples were taken from the ventilation system and analysed for hydrocarbons and CO content. It is shown how off gasses vary with time after pouring and shake out. Also the composition of off-gasses is analysed and shown. It is further shown how the composition of off-gasses varies between different types of binders and with varying composition of the binders as well as function of the thermal load on the moulding sand.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Institute for Product Development, Danish Technological Institute
Authors: Tiedje, N. S. (Intern), Crepaz, R. (Ekstern), Eggert, T. (Ekstern), Bey, N. (Intern)
Pages: 1866-1876
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Volume: 45
Issue number: 14
ISSN (Print): 1093-4529
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.625 SJR 0.508 CiteScore 1.64
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.52 SJR 0.524 SNIP 0.667
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.522 SNIP 0.695 CiteScore 1.34
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.557 SNIP 0.674 CiteScore 1.23
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.53 SNIP 0.624 CiteScore 1.2
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.636 SNIP 0.647 CiteScore 1.27
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.647 SNIP 0.58 CiteScore 1.24
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.591 SNIP 0.574
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.559 SNIP 0.609
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.473 SNIP 0.459
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.538 SNIP 0.651
Scopus rating (2006): SJR 0.469 SNIP 0.612
Scopus rating (2005): SJR 0.447 SNIP 0.564
End of life environmental assessment of micro technologies: the need for the carrot or the stick?
The paper presents the importance of understanding the environmental implications of the end of life of micro technology. A brief overview of different management approaches of micro waste is shown, such as landfill, incineration, recycling, reuse and prevention is given. However, the management of waste is subject to a number of directives and regulations (in Europe) or a “stick” forcing the industry to minimise the environmental impacts of micro waste. In contrast, there are strong drivers, the “carrot” that can stimulate the industry to design micro technology following EcoDesign principle. On one hand the industry is faced with legal sticks to minimise the impacts of waste, on the other hand the industry is offered a number of carrots that could present strong financial and environmental advantages compared to other products providing the same service.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Residual Resource Engineering, Department of Environmental Engineering
Authors: De Grave, A. (Intern), Gentil, E. (Intern), Hansen, H. N. (Intern)
Number of pages: 323
Pages: 143-146
Publication date: 2010

Environmentally Benign Lubricant Systems For Cold, Warm And Hot Forging: Keynote paper
The growing awareness of environmental issues and the requirements to establish solutions diminishing the impact on working environment as well as external environment has initiated ever increasing efforts to develop new, environmentally benign tribological systems for metal forming. The present paper gives an overview of these efforts substituting environmentally hazardous lubricants in cold, warm and hot forging. The paper is an extract of the keynote paper [3] written by the author together with eight co-authors referring to collected papers and other information from more than 30 different research laboratories and industries in the World.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Bay, N. (Intern)
Number of pages: 542
Pages: 297-313
Publication date: 2010
Environmentally Benign Lubricant Systems for Sheet Metal Stamping: Keynote paper

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Authors: Bay, N. (Intern)
Number of pages: 416
Pages: 273-295
Publication date: 2010

Host publication information
Volume: 2
Main Research Area: Technical/natural sciences
Sheet Forming, Lubricants, Tribology, Metal Forming
Source: orbit
Source-ID: 268580
Publication: Research › Article in proceedings – Annual report year: 2010

Environmentally Benign Tribo-systems for Metal Forming: Keynote paper

The growing awareness of environmental issues and the requirements to establish solutions diminishing the impact on working environment as well as external environment has initiated ever increasing efforts to develop new, environmentally benign tribological systems for metal forming. The present paper gives an overview of these efforts substituting environmentally hazardous lubricants in cold, warm and hot forging as well as sheet forming and punching/blanking by new, less harmful lubricants and furthermore describes other measures directed towards the same goal such as development of anti-seizure tool materials and coatings and application of structured workpiece and tool surfaces.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Yokohama National University, Sumico Lubricants Co., Ltd, University of Erlangen-Nuremberg, Toyota Motor Corporation, Shizuoka University, University of Notre Dame, Nihon Parkerizing Co., Technical University of Darmstadt
Pages: 760-780
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: C I R P Annals
Volume: 59
Issue number: 2
ISSN (Print): 0007-8506
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.09 SJR 2.034 SNIP 2.811
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.93 SJR 2.055 SNIP 3.158
Web of Science (2016): Indexed yes
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Original language: English

Metal forming tribology, Structured workpiece surfaces, Structured tool surfaces, Tool coatings, Tool materials, Lubricants, Environmental impact

Electronic versions:


DOIs:

10.1016/j.cirp.2010.05.007

Source: orbit

Source-ID: 268566

Publication: Research - peer-review › Journal article – Annual report year: 2010
Error sources in atomic force microscopy for dimensional measurements: Taxonomy and modeling

This paper aimed at identifying the error sources that occur in dimensional measurements performed using atomic force microscopy. In particular, a set of characterization techniques for errors quantification is presented. The discussion on error sources is organized in four main categories: scanning system, tip-surface interaction, environment, and data processing. The discussed errors include scaling effects, squareness errors, hysteresis, creep, tip convolution, and thermal drift. A mathematical model of the measurement system is eventually described, as a reference basis for errors characterization, with an applicative example on a reference silicon grating. Copyright © 2010 by ASME.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, University of Padua
Authors: Marinello, F. (Ekstern), Voltan, A. (Ekstern), Savio, E. (Ekstern), Carmignato, S. (Ekstern), De Chiffre, L. (Intern)
Pages: 0309031-0309038
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Manufacturing Science and Engineering
Volume: 132
Issue number: 3
ISSN (Print): 1087-1357
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.548 SJR 1.181 CiteScore 2.85
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): SJR 1.499 SNIP 1.696 CiteScore 2.68
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.832 SNIP 1.249 CiteScore 1.62
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 0.815 SNIP 1.25 CiteScore 0.96
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 0.827 SNIP 1.351 CiteScore 1.2
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 0.705 SNIP 1.119 CiteScore 0.8
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 0.631 SNIP 1.082 CiteScore 0.93
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 0.839 SNIP 1.14
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 0.934 SNIP 1.35
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.889 SNIP 1.48
Scopus rating (2007): SJR 1.245 SNIP 1.605
Scopus rating (2006): SJR 0.906 SNIP 1.475
Web of Science (2006): Indexed yes
Experimental evaluation of the pure configurational stress assumption in the flow dynamics of entangled polymer melts
A filament stretching rheometer was used for measuring the startup of uni-axial elongational flow followed by reversed bi-
axial flow, both with a constant elongational strain rate. A narrow molecular mass distribution linear polyisoprene with a
molecular weight of 483 kg/mole was subjected to the flow in the non-linear flow regime. This has allowed highly elastic
measurements within the limit of pure orientational stress, as the time of the flow was considerably smaller than the Rouse
time. A Doi-Edwards [J. Chem. Soc., Faraday Trans. 2 74, 1818-1832 (1978)] type of constitutive model with the
assumption of pure configurational stress was accurately able to predict the startup as well as the reversed flow behavior.
This confirms that this commonly used theoretical picture for the flow of polymeric liquids is a correct physical principle to
apply. c 2010 The Society of Rheology. [DOI: 10.1122/1.3496378]
Experimental investigation of the factors influencing the polymer-polymer bond strength during two-component injection moulding

Two-component injection moulding is a commercially important manufacturing process and a key technology for combining different material properties in a single plastic product. It is also one of most industrially adaptive process chain for manufacturing so-called moulded interconnect devices (MIDs). Many fascinating applications of two-component or multi-component polymer parts are restricted due to the weak interfacial adhesion of the polymers. A thorough understanding of the factors that influence the bond strength of polymers is necessary for multi-component polymer processing. This paper investigates the effects of the process conditions and geometrical factors on the bond strength of
two-component polymer parts and identifies the factors which can effectively control the adhesion between two polymers. The effects of environmental conditions on the bond strength are also investigated. Investigation shows that melt and mould temperatures are vital process parameters that influence the bond strength. Besides this, surface roughness of the first-shot part and environmental factors like moisture have profound influence on the bonding of the two materials. The selections of materials and environmental conditions were done based on the suitability of MID production, but the results could be useful for two-component polymer processing for a wide range of industrial applications. The results and discussion presented in this paper are only valid for the two-component plastic parts moulded by over moulding in cavity-transfer process.

**General information**
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Sonion A/S
Authors: Islam, A. (Intern), Hansen, H. N. (Intern), Bondo, M. (Ekstern)
Pages: 101-111
Publication date: 2010
Main Research Area: Technical/natural sciences

**Publication information**
Journal: International Journal of Advanced Manufacturing Technology
Volume: 50
Issue number: 1-4
ISSN (Print): 0268-3768
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.8 SJR 0.994 SNIP 1.697
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.3 SJR 1.046 SNIP 1.608
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.889 SNIP 1.325 CiteScore 1.8
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.082 SNIP 1.841 CiteScore 2.03
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.134 SNIP 2.131 CiteScore 2.26
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.971 SNIP 2.099 CiteScore 1.75
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.817 SNIP 1.673 CiteScore 1.61
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.785 SNIP 1.445
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.797 SNIP 1.384
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.52 SNIP 1.029
Web of Science (2008): Indexed yes
Experimental investigation on the influence of instrument settings on pixel size and nonlinearity in SEM image formation

The work deals with an experimental investigation on the influence of three Scanning Electron Microscope (SEM) instrument settings, accelerating voltage, spot size and magnification, on the image formation process. Pixel size and nonlinearity were chosen as output parameters related to image quality and resolution. A silicon grating calibrated artifact was employed to investigate qualitatively and quantitatively, through a designed experiment approach, the parameters relevance. SEM magnification was found to account by far for the largest contribution on both parameters under consideration. Optimal instrument settings were also identified.

General information
State: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Politecnico di Torino
Authors: Carli, L. (Intern), Genta, G. (Ekstern), Cantatore, A. (Intern), Barbato, G. (Ekstern), De Chiffre, L. (Intern), Levi, R. (Ekstern)
Pages: 192-195
Publication date: 2010

Host publication information
Title of host publication: Proceedings of the 10th euspen International Conference
Volume: 1
ISBN (Print): 978-0-9553082-8-4
Main Research Area: Technical/natural sciences
Conference: 10th International Conference of the European Society for Precision Engineering and Nanotechnology, Zürich, Switzerland, 18/05/2008 - 18/05/2008
SEM
Electronic versions:
P2.42_Carli.pdf
Source: orbit
Source-ID: 265323
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Extension of cylindrical samples in the Sentmanat Extensional Rheometer (SER)

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Technical University of Denmark
Authors: Yu, K. (Intern), Marin, J. M. R. (Ekstern), Jensen, M. K. (Intern), Rasmussen, H. K. (Intern), Hassager, O. (Intern)
Publication date: 2010
Friction in sheet metal forming: A Comparison between milled and manually polished surfaces

The evolvement of product requirements in the automotive industry, e.g. reduced weight, means that the use of advanced high strength steels (HSS, EHSS, UHSS) in automotive applications is continuously increasing. The introduction of high strength steels in production implies increased tool wear and calls for functional tool surfaces that are durable in these severe tribological conditions. In this study the influence of tool surface topography on friction has been investigated. The frictional response was studied in a Bending Under Tension test. The results did show that a low frictional response was generated by low slope of roughness profiles combined with a strong anisotropy applied perpendicularly to the sliding direction. An improved machining strategy has a high potential to significantly reduce the need for manually polished surfaces.

Green Lubricants for Metal Forming: Keynote paper

The increasing focus on legislation towards diminishing the impact on working environment as well as external environment has driven efforts to develop new, environmentally benign lubricants for metal forming. The present paper gives an overview of these efforts to substitute environmentally hazardous lubricants in cold, warm and hot forging as well as sheet forming and punching/blanking with new, less harmful lubricants.
Influence of annealing and deformation on optical properties of ultra precision diamond turned and anodized 6060 aluminium alloy

Influence of cold forging, and subsequent heat treatment and diamond turning on optical quality of anodized film on 6060 (AlMgSi) alloy was investigated and compared with microstructural changes. Heat treatment of the samples was carried out either prior to forging, post-forging, or both. The surface of the forged material was then diamond turned to a mirror like finish. The diamond turned samples were subsequently anodized in a sulphuric acid bath. The microstructure of the samples was analysed using optical microscopy (LOM), scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDX). Colour/brightness measurements were carried out using CIE Lab system. An optical method was used to measure the thickness of the oxide film and roughness of the surface was measured before and after anodizing using stylus, a mechanical instrument, and bidirectional reflection distribution function (BRDF), an optical instrument.

Results indicated that the post-forging heat treatment had a great influence on the appearance of the anodized layer, which was also a function of the deformation introduced prior to heat treatment. The effect was assumed to be attributed to the change in microstructure, especially the distribution and the amount of the intermetallic particles such as elemental Si and Mg2Si. Roughness of the oxide film was also found to be a function of the heat treatment and deformation condition.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering, Materials and Surface Engineering, Danish Fundamental Metrology
Authors: Tabrizian-Ghalehno, N. (Intern), Hansen, H. N. (Intern), Hansen, P. (Ekstern), Ambat, R. (Intern), Møller, P. (Intern)
Pages: 2632-2638
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Surface and Coatings Technology
Volume: 204
Issue number: 16-17
ISSN (Print): 0257-8972
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.08 SJR 0.928 SNIP 1.545
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.56 SJR 0.882 SNIP 1.379
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.852 SNIP 1.37 CiteScore 2.46
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.983 SNIP 1.652 CiteScore 2.44
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.048 SNIP 1.832 CiteScore 2.58
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.041 SNIP 1.641 CiteScore 2.2
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.041 SNIP 1.85 CiteScore 2.38
New Sol-Gel coated sand cores made from coldbox and furan binder systems were investigated. The idea of the coating was to improve the surface quality of castings. Grey iron was cast on the cores in a sand casting process. The effect of the high temperature of the melt on the cores was assessed by measuring the heating curves. The viscosity of the coating, moisture content and the permeability of the cores were evaluated. The surface quality of the castings was investigated using SEM and OM. The results show that the moisture content of the cores affected the permeability. In furan cores the vapour transport zone (VTZ) when in contact with the melt is larger than it is in a coldbox which means the furan cores have higher moisture content. The new sol-gel coating has the potential for improving the surface quality of castings without negative effects on the graphite distribution. The surface of castings made using the new sol-gel coated furan cores show better surface quality than those made using the coldbox.
Influence of surface texture on the galling characteristics of lean duplex and austenitic stainless steels
Two simulative test methods were used to study galling in sheet forming of two types of stainless steel sheet: austenitic (EN 1.4301) and lean duplex LDX 2101 (EN 1.4162) in different surface conditions. The pin-on-disc test was used to analyse the galling resistance of different combinations of sheet materials and lubricants. The strip reduction test, a severe sheet forming tribology test was used to simulate the conditions during ironing. This investigation shows that the risk of galling is highly dependent on the surface texture of the duplex steel. Trials were also performed in an industrial tool used for high volume production of pump components, to compare forming of LDX 2101 and austenitic stainless steel with equal thickness. The forming forces, the geometry and the strains in the sheet material were compared for the same component. It was found that LDX steels can be formed to high strain levels in tools normally applied for forming of austenitic steels, but tool adaptations are needed to comply with the higher strength and springback of the material.

General information
State: E-pub ahead of print
Organisations: Manufacturing Engineering, Department of Mechanical Engineering, Dalarna University, Avesta Research Center, Grundfos A/S, Swerea AB
Authors: Wadman, B. (Ekstern), Eriksen, J. (Ekstern), Olsson, M. (Ekstern), Schedin, E. (Ekstern), Madsen, E. (Ekstern), Bay, N. (Intern)
Pages: IV.B.7
Publication date: 2010

Host publication information
Title of host publication: Proceedings Duplex World 2010 Conference & Exhibition
Main Research Area: Technical/natural sciences
Conference: Duplex World 2010 Conference & Exhibition, Beaune, France, 01/01/2010
Source: orbit
Source-ID: 268593
Publication: Research › Article in proceedings – Annual report year: 2010

Projects:

High Precision Process Chains for the Mass Production of Functional Structured Surfaces
Department of Mechanical Engineering
Manufacturing Engineering
Period: 01/01/2018 → 31/12/2020
Number of participants: 1
Acronym: ProSurf
Project participant:
Quagliotti, Danilo (Intern)

Characterizing Porous Tool Materials for Impulse Drying Technology
Department of Applied Mathematics and Computer Science
Department of Mechanical Engineering
Manufacturing Engineering
Period: 01/06/2016 → 01/07/2017
Number of participants: 1
Project participant:
Stolfi, Alessandro (Intern)

Metrology for Additively Manufactured Medical Implants
Additive manufacturing, a technology used to manufacture parts layer-by-layer from a 3D digital model, offers an effective solution. Indeed, the key advantage of this technology, in
the medical sector, is to produce on demand (without the need of a large inventory of
different sizes or sterile storage) customised medical devices for specialities such as
orthopaedic, spinal, cranial, maxillo-facial, and dental surgery, and to provide grafts that
promote bone growth which match the patient’s anatomy. The overall objective of this
project is to provide a comprehensive basis to enable the safe and cost efficient use of
additive manufacturing (AM) products within the medical sector. Therefore, within this
project AM off-the-shelf medical devices as well as patient specific guides (PSG) and
patient specific implants (PSI) manufactured from patient X-ray Computed Tomography
(XCT) image data sets or computer aided design (CAD) will be qualified. This will guarantee
their reliability to notified bodies and facilitate acceptance of this technology, which has
proven clinical advantages in the medical sector.

Department of Mechanical Engineering
Manufacturing Engineering
Period: 01/06/2016 → 31/05/2019
Number of participants: 2
Acronym: MetAMMI
Project participant:
Stolfi, Alessandro (Intern)
Project Manager, academic:
De Chiffre, Leonardo (Intern)

Relations
Publications:
MetAMMI - Metrology for additively manufactured medical implants
Project

MICROMAN, Process Fingerprint for Zero-defect NET-shape

Department of Mechanical Engineering
Manufacturing Engineering
University of Nottingham
University of Bremen
University of Strathclyde
Technische Universität Chemnitz
Politecnico di Milano
University of Leuven
University of Bradford
Institute for Product Development
Period: 01/10/2015 → 30/09/2019
Number of participants: 8
Acronym: MICROMAN
Project ID: 76816
Number of related Ph.D. students: 3
Project participant:
Calaon, Matteo (Intern)
Bissacco, Giuliano (Intern)
Bay, Niels Oluf (Intern)
Nielsen, Chris Valentin (Intern)
Baruffi, Federico (Intern)
Enggrob, Hans G. (Intern)
Project Manager, organisational:
Carlberg, Lena Kristina (Intern)
Project Coordinator:
Tosello, Guido (Intern)

Exhaust Gas Valve for High Temperatures
Department of Mechanical Engineering
Manufacturing Engineering
Period: 01/01/2015 → 31/12/2017
Number of participants: 2
Project participant:
Hattel, Jesper Henri (Intern)
Sonne, Mads Rostgaard (Intern)

FMAT
Department of Mechanical Engineering
Manufacturing Engineering
Period: 15/09/2014 → …
Number of participants: 2
Project participant:
Mahshid, Rasoul (Intern)
Project Coordinator:
Hansen, Hans Nørgaard (Intern)

Mechanical and microstructural transients after strain path changes in metal forming
Department of Mechanical Engineering
Materials and Surface Engineering
DTU Admission Course
Manufacturing Engineering
Period: 01/03/2014 → 06/06/2017
Number of participants: 3
Project participant:
Jensen, Mikkel Ravn Boye (Intern)
Winther, Grethe (Intern)
Bay, Niels Oluf (Intern)

Relations
Parent project:
Multi-scale material models for smart metal forming

Multi-scale material models for smart metal forming
Analysis of deformation-induced intragranular orientation spread in IF-steel by a combination of 3DXRD and crystal plasticity
Department of Mechanical Engineering
Materials and Surface Engineering
Department of Physics
Neutrons and X-rays for Materials Physics
Manufacturing Engineering
DTU Admission Course
University of Illinois
Period: 01/02/2014 → 31/07/2017
Number of participants: 5
Acronym: MulMatMod
Number of related Ph.D. students: 2
Project participant:
  - Winther, Grethe (Intern)
  - Oddershede, Jette (Intern)
  - Bay, Niels Oluf (Intern)
  - Juul, Nicolai Ytterdal (Intern)
  - Jensen, Mikkel Ravn Boye (Intern)

Relations
Related projects:
  - Characterisation and modelling of crystallographic orientation changes at the grain scale during plastic deformation
  - Mechanical and microstructural transients after strain path changes in metal forming

Activities:
  - Analysis of deformation-induced intragranular orientation spread in IF-steel by a combination of 3DXRD and crystal plasticity
  - Intragranular orientation spread induced by grain interaction
  - Grain-scale investigations of deformation and surface treatment of stainless steel
  - Deformation-induced intragranular orientation spread in ferrite investigated by 3DXRD and forward modeling
  - Combining crystal plasticity and dislocation theory to model dislocation boundary characteristics
  - Intragranular orientation spread induced by grain interaction
  - Analysis of grain-scale experimental data in a crystal plasticity framework
  - Measured Resolved Shear Stresses on Slip Systems in Austenitic Steel Grains
  - Parallel evolution of deformation textures and dislocation boundaries
  - Hierarchical microstructures in metals due to dislocation-mediated plasticity

Publications:
  - Analysis of deformation-induced intragranular orientation spread in IF-steel by a combination of 3DXRD and crystal plasticity
  - Deformation-induced orientation spread in individual bulk grains of an interstitial-free steel

Quality control and tolerance verification of complex castings by means of optical methods
To remain competitive the foundries find it imperative that they can offer the most modern and precise documentation of the products they make.
For the foundries this project is essential to be able to reduce production costs and to remain competitive. Disa Industries wishes to strengthen its position as one of the world’s leading suppliers of foundry equipment. Zebicon will through the project strengthen its position as supplier of advanced optical measurement equipment to the Danish industry.
The results from the project will be used to reduce production costs at Vestas’ and Vald. Birm’s foundries by reducing the number of defective castings and by reducing the machining requirements of the finished castings.
When tolerances are improved it will allow engineers and designers to create structurally optimised, light constructions for the energy and transport sectors.

Department of Mechanical Engineering
Manufacturing Engineering
Period: 01/11/2013 → 01/11/2016
Number of participants: 1
Acronym: Q-CAST
Project Manager, organisational:
  - Mohaghegh, Kamran (Intern)

Automation and Robotics for EUropean Sustainable Manufacturing
Department of Management Engineering
Quantitative Sustainability Assessment
Department of Mechanical Engineering

Manufacturing Engineering
Period: 01/09/2013 → 31/08/2016
Number of participants: 6
Acronym: AREUS
Project ID: 81375
Number of related Ph.D. students: 1
Project participant:
Bey, Niki (Intern)
Rödger, Jan-Markus (Intern)
Dijkman, Teunis Johannes (Intern)
Hauschild, Michael Zwicky (Intern)
Molin, Christine (Intern)
Alting, Leo (Intern)

Project

BLADERUNNER - Large scale cost-effective robotic production of advanced formwork
Department of Mechanical Engineering
Manufacturing Engineering
Department of Applied Mathematics and Computer Science
Mathematics
Danish Technological Institute
Period: 01/03/2013 → 31/08/2016
Number of participants: 3
Acronym: BLADERUNNER
Project ID: 76421
Project participant:
Hattel, Jesper Henri (Intern)
Petkov, Kiril (Intern)
Gravesen, Jens (Intern)

Project

Micro punching of micro containers for oral drug delivery
Department of Mechanical Engineering
Manufacturing Engineering
Department of Micro- and Nanotechnology
Nanoprobes
Period: 21/01/2013 → 13/11/2014
Number of participants: 3
Project participant:
Petersen, Ritika Singh (Intern)
Mahshid, Rasoul (Intern)
Hansen, Hans Nørgaard (Intern)

Project

High Precision Micro Production Technologies
HiMicro is a collaborative research project funded by EU. The Hi-Micro project proposes an innovative process chain for precision μM and μPIM, using Additive Manufacturing (AM) to produce monolithic tool inserts with integrated complex internal channels for efficient thermal management and process control. At the same time, enabling precision manufacturing technologies will be developed to post-process the tool insert features. Special metrology techniques based on computer-tomography (CT) will be applied to control the quality of the integrated complex internal channels. Handling system and high-speed in-line quality control system for non-statistic quality control will be developed and integrated into an industrial production platform.
Department of Mechanical Engineering

Manufacturing Engineering
Period: 30/10/2012 → 30/11/2015
Number of participants: 4
Micro injection moulding precision manufacturing X-ray CT metrology micro-EDM micro-milling micro-ECM digital holography
Acronym: HiMicro
Project ID: 314055
Project participant:
Tosello, Guido (Intern)
Islam, Aminul (Intern)
Giannekas, Nikolaos (Intern)
Phd Student:
Marhöfer, David Maximilian (Intern)

Relations
Publications:
D1.3 Standardized micro moulding simulation procedure and tolerance guidelines
D1.1 Product/Tool/Process Simulation Report for PoT Components
High Precision Micro Production Technologies - MS12 Handling concepts for all micro part demonstrators are available
D4.3 System integration technologies for Hi-Micro production platform with in-line quality control
D5.3 Production and Validation of Hi-Micro Demonstrators
Calibration and Metrology for Micro/Nano Dimensional Quality Control. D3.5.
D 1.3 Standardized micro moulding simulation procedure and tolerance guidelines

Project

High Precision Micro Production Technologies
Department of Mechanical Engineering

Manufacturing Engineering
Period: 30/10/2012 → 30/11/2015
Number of participants: 1
Micro injection moulding precision manufacturing X-ray CT metrology micro-EDM micro-milling micro-ECM digital holography
Acronym: HiMicro
Project ID: 314055
Project participant:
Quagliotti, Danilo (Intern)

Relations
Publications:
Optical micro-metrology of structured surfaces micro-machined by jet-ECM
Shrinkage calibration method for μPIM manufactured parts
Calibration and Metrology for Micro/Nano Dimensional Quality Control. D3.5.
Optical micro-metrology of structured surfaces micro-machined by jet-ECM

Project

Dimensionally stable reflow polishing of molding tools
In spite of the technological development most of molding tool polishing is still performed by hand with uneven quality as a result. A new glazing method achieves a better and more uniform surface finish.

The concept is inspired by nanotechnological processes used in the semiconductor industry

The project will ensure a significantly shorter turnaround time for polishing as well as a much bigger polishing capacity – both will be of great value for the end users.

The manufacturing of larger product series typically also requires a large number of molding tools – many of these series of tools require months or years of total polishing time. The aim of the project is to establish a European service center, which offers polishing of all types of molding tools within 24 hours.
Department of Mechanical Engineering
Manufacturing Engineering
Period: 01/09/2012 → 31/10/2013
Number of participants: 1
Acronym: RePol
Project participant:
Mohaghegh, Kamran (Intern)

**IFaCOM– Intelligent Fault Correction and selfOptimizing Manufacturing systems**

Department of Mechanical Engineering
Manufacturing Engineering
Period: 01/05/2012 → 31/08/2012
Number of participants: 1
Acronym: IFaCOM
Project participant:
Mohaghegh, Kamran (Intern)

**Yaw Drive Unit**
Surface characterisation of brakes for wind turbines

Department of Mechanical Engineering
Manufacturing Engineering
Period: 01/02/2012 → 31/05/2012
Number of participants: 1
Acronym: YDU
Project participant:
Mohaghegh, Kamran (Intern)

**Multi-Functional Surfaces**
Characterisation of Multifunctional surfaces

Department of Mechanical Engineering
Manufacturing Engineering
Period: 01/10/2011 → 31/01/2012
Number of participants: 1
Acronym: MUFU
Project participant:
Mohaghegh, Kamran (Intern)

**REWIND - Knowledge based engineering for improved reliability of critical wind turbine components**

Department of Mechanical Engineering
Manufacturing Engineering
Solid Mechanics
Materials and Surface Engineering
Department of Wind Energy
Materials science and characterization
Wind Turbines
Aalborg University
Magma Gießereitechnologie GmbH

Michigan State University
Period: 01/01/2011 → 31/12/2016
Number of participants: 6
Acronym: REWIND
Project ID: 76142
Number of related Ph.D. students: 8
Project participant:
Tvergaard, Viggo (Intern)
Somers, Marcel A. J. (Intern)
Fæster, Søren (Intern)
Natarajan, Anand (Intern)
Klit, Peder (Intern)
Project Manager, academic:
Hattel, Jesper Henri (Intern)

Nanotribology
Manufacturing Engineering
Department of Mechanical Engineering
Department of Management Engineering
Period: 01/07/2007 → 30/11/2009
Number of participants: 4
Project participant:
Tosello, Guido (Intern)
De Grave, Arnaud (Intern)
Sivebæk, Ion Marius (Intern)
Project Manager, organisational:
Hansen, Hans Nørgaard (Intern)

Financing sources
Source: Udenfor rammen
Name of research programme: Ukendt
Amount: 750,000.00 Danish Kroner

Stressforebyggelse i videnarbejdet: - mellem begejstring og belastning
Manufacturing Engineering
Department of Mechanical Engineering
Department of Management Engineering
Period: 01/10/2006 → 31/12/2009
Number of participants: 7
Project ID: 80744
Project participant:
Buch, Anders (Intern)
Weller, Tina (Intern)
Sørensen, Ole Henning (Intern)
Bramming, Pia (Intern)
Larsen, Henrik Holt (Intern)
Jensen, Per Langaa (Intern)
Project Manager, organisational:
Andersen, Vibeke (Intern)

Financing sources
Source: Forskningsrådene - Andre
Alloy development for overlay welding in waste incineration plants

Manufacturing Engineering
Department of Mechanical Engineering
Department of Management Engineering
Period: 01/09/2006 → 31/08/2009
Number of participants: 1
Project ID: 80720
Project Manager, organisational:
Tiedje, Niels Skat (Intern)

Financing sources
Source: Forsk. Andre statslige danske i øvrigt
Amount: 2,000,000.00 Danish Kroner

Quality and values in the job

Manufacturing Engineering
Department of Mechanical Engineering
Department of Management Engineering
Roskilde University
Skovtofte College
Period: 01/01/2006 → 31/12/2008
Number of participants: 3
Meaningful work, Developmental work, Employee participation, Service quality
Project participant:
Jørgensen, Michael Søgaard (Intern)
Bilfeldt, Annette (Ekstern)
Meyer-Johansen, Hanne (Ekstern)

Financing sources
Source: Udenfor rammen
Name of research programme: Ukendt
Amount: 0.00 Danish Kroner

Center for metalliske mikroprodukter

Manufacturing Engineering
Department of Mechanical Engineering
Department of Management Engineering
Period: 01/10/2005 → 30/09/2010
Number of participants: 3
Project ID: 80589
Project participant:
Eriksen, Rasmus Solmer (Intern)
Project Manager, organisational:
Hansen, Hans Nørgaard (Intern)
Bay, Niels Oluf (Intern)

Financing sources
Source: Forskningsprojekter - Andre ministerier og styrelser
**Research in System Deliveries within Construction**

Manufacturing Engineering

Department of Mechanical Engineering

Department of Management Engineering

Byggeriets Innovation

Period: 01/09/2005 → 01/03/2006

Number of participants: 3

Project participant:

Tølle, Martin (Intern)
Thomassen, Mikkel (Ekstern)

Project Manager, organisational:

Hvam, Lars (Intern)

**Financing sources**

Source: Forsk. Private danske - Fonde

Amount: 6,078,000.00 Danish Kroner

---

**SYNOPSIS**

Department of Management Engineering

Manufacturing Engineering

Department of Mechanical Engineering

Period: 01/12/2000 → 01/06/2006

Number of participants: 4

Project participant:

Jørgensen, Ulrik (Intern)
Yoshinaka, Yutaka (Intern)

Project Manager, organisational:

Clausen, Christian (Intern)
McAloone, Tim C. (Intern)

**Financing sources**

Source: Forsk. Andre statslige danske i øvrigt

Amount: 400,000.00 Danish Kroner

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**EFFORTS - Enhanced framework for forging design using reliable three-dimensional simulation**

Brite-Euram project with 10 partners focusing on development of the finite element method to 3D problems for the application as a process and product development and quality assurance system related to metal forming production. Research work at IPT is associated with development of realistic constitutive laws describing: 1. the material behaviour in cold forming operations involving non-linear strain paths, 2. the tool/workpiece interface conditions as regards friction in cold as well as warm forging and heat transfer in warm forging. Furthermore IPT has the task to verify 3-D FEM analyses of forging simple primitives as well as complex industrial components.

Department of Management Engineering

Manufacturing Engineering

Department of Mechanical Engineering

ARMINES-CEMEF
MUP2 - Center for Structural Materials - MP2M - Materials processing, Properties and Modelling

The center has gathered the six most important Danish groups in a network within Manufacturing and Materials Science and Engineering with the aim of performing coordinated, basic research on, Materials Processing, Properties and Modelling, MP2M. The research refers to the integrated process of design - material - processing, adopting and developing the most advanced theoretical and experimental techniques for studies of materials manufacturing and processing. The coordinated research has been carried out within the following four basic areas: A. Numerical modelling and analysis of material properties B. Numerical modelling and analysis of process phenomena C. Experimental modelling and analysis of materials properties D. Experimental modelling and analysis of process phenomena. All in all 36 projects have been carried out under the center programme engaging 118 researchers, who have contributed 466 publications in total among which more than 300 are international publications.
DEMEX AB
B&W Shipyard
NKT Research & Innovation A/S
Period: 01/05/1994 → 28/02/1999
Number of participants: 25
Project participant:
Arentoft, Mogens (Intern)
Bjerregaard, Henrik (Intern)
Eriksen, Morten (Intern)
Gjørtvang, Henrik Højborg (Intern)
Ravn, Bjarne Gottlieb (Intern)
Hansen, Søren Feldager (Intern)
Frandsen, Jens Ole (Intern)
Hansen, Jan Langkjær (Intern)
Hattel, Jesper Henri (Intern)
Henningsen, Poul (Intern)
Lassen, Søren (Intern)
Lindegren, Maria (Intern)
Malberg, Michael Peter (Intern)
Nielsen, Lars Sagaard (Intern)
Post-Pedersen, Bente (Intern)
Thorborg, Jesper (Intern)
Wanheim, Tarras (Intern)
Tan, Xincai (Intern)
Wanheim, Tarras (Intern)
Hattel, Jesper Henri (Intern)
Tvergaard, Viggo (Intern)
Danckert, Joachim (Ekstern)
Hansen, Niels (Ekstern)
Project Manager, organisational:
Bay, Niels Oluf (Intern)
Bay, Niels Oluf (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 17,000,000.00 Danish Kroner
Source: Unknown
Name of research programme: Ukendt
Amount: 4,800,000.00 Danish Kroner

Activities:

Journal of Manufacturing Processes (Journal)
Period: Jun 2018
Ali Davoudinejad (Reviewer)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Peer reviewed for Journal of Manufacturing Processes

Related journal
Journal of Manufacturing Processes
1526-6125
Scopus rating (2017): CiteScore 3.35 SJR 1.166 SNIP 2.064, Web of Science (2018): Indexed yes
Central database
Activity: Research › Peer review of manuscripts

Materials (Journal)
Period: Jun 2018
Ali Davoudinejad (Peer reviewer)
Department of Mechanical Engineering
Manufacturing Engineering

Description
peer reviewed for Journal of materials

Related journal
Materials
1996-1944
Indexed in DOAJ
Central database
Activity: Research › Peer review of manuscripts

Additive manufacturing with vat polymerization method for precision polymer micro components production
Period: 12 Jun 2018
Ali Davoudinejad (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Description
15th CIRP Conference on Computer Aided Tolerancing – CIRP CAT 2018
Additive manufacturing with vat polymerization method for precision polymer micro components production
Documents:
CIRP CAT 2018 Davoudinejad

Related event
15th CIRP Conference on Computer Aided Tolerancing – CIRP CAT 2018
Milan, Italy:
11/06/2018 → 13/06/2018
Milan, Italy
Activity: Talks and presentations › Conference presentations

International Journal of Mechanical Sciences (Journal)
Period: May 2018
Ali Davoudinejad (Peer reviewer)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Peer reviewed for International Journal of Mechanical Sciences with the title of Analytical model of workpiece temperature in end milling in-situ TiB2/7050Al metal matrix composites

Related journal
International Journal of Mechanical Sciences
Reproduction of multi-hierarchical structural surfaces by vat-photopolymerization
Period: 7 Feb 2018
Macarena Mendez Ribo (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Description
This study investigates the intersection of bio-inspired surfaces and additive manufacturing (AM), with the aim of determining the feasibility and viability of leveraging 3D printing technologies to replicate surfaces that mirror those found in nature. These surfaces, like metamaterials, are constituted by arrays of microstructures arranged at multiple hierarchical levels. The ability to rapidly and inexpensively reproduce microstructures using AM at micro scale would thus serve to enable the scientific community to conduct optimization of 3D surface model designs. This would allow for improved forecasting of surface properties and behaviors before investment in other micromanufacturing methods. The investigation was carried out using a state-of-the-art vat photopolymerization AM machine-tool suitable for precision manufacturing at the micro dimensional range developed, built and validated at the Technical University of Denmark. It was shown that it was possible to reproduce multihierarchical micro features inspired by the surface of the Tokay gecko toe. Ultimately, voxel resolution of 7.6 μm was visualized. Moreover, two more intricate designs were fabricated with the same parameters, yet showing higher hydrophobicity with a water contact angle of 124°±0.10°, due to their increased density
and decreased feature size, not due to its material properties. These results indicate the possibility of using precision AM for a rapid, easy and reliable fabrication of working functional surfaces, which can also be applied to the design and fabrication of metamaterials.

Related event

Dedicated manufacturing and experimental techniques for acoustic metamaterials and acoustic treatments
06/02/2018 → 07/02/2018
Leuven, Belgium
Activity: Talks and presentations › Conference presentations

GREEN FIBER BOTTLE: TOWARDS A SUSTAINABLE PACKAGE
Period: 2017
Mattia Didone (Guest lecturer)
Department of Mechanical Engineering
Manufacturing Engineering
Documents:
GREEN FIBER BOTTLE TOWARDS A SUSTAINABLE PACKAGE_Didone

Related event

16th Fundamental Research Symposium: Advances in Pulp and Paper Research
03/09/2017 → 08/09/2017
Oxford, United Kingdom
Activity: Talks and presentations › Conference presentations

Green Fiber Bottle: Towards a Sustainable Package and a Manufacturing Process
Period: 2017
Mattia Didone (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering
Documents:
Green Fiber Bottle Towards a Sustainable Package and a Manufacturing Process_Didone

Related event

28th IAPRI World Symposium on Packaging
09/05/2017 → 12/05/2017
Lausanne, Switzerland
Activity: Talks and presentations › Conference presentations

Robotics and Computer-Integrated Manufacturing (Journal)
Period: 2017
Alessandro Stolfi (Reviewer)
Department of Applied Mathematics and Computer Science
Department of Mechanical Engineering
Manufacturing Engineering

Related journal

Robotics and Computer-Integrated Manufacturing
0736-5845
Central database
Activity: Research › Peer review of manuscripts
Characterization of additive manufacturing processes for polymer micro parts productions using direct light processing (DLP) method

Period: 12 Dec 2017
Ali Davoudinejad (Speaker)

Department of Mechanical Engineering
Manufacturing Engineering

Description
The process capability of additive manufacturing (AM) for direct production of miniaturized polymer components with micro features is analyzed in this work. The consideration of the minimum printable feature size and obtainable tolerances of AM process is a critical step to establish a process chains for the production of parts with micro scale features. A specifically designed direct light processing (DLP) AM machine suitable for precision printing has been used. A test part is designed having features with different sizes and aspect ratios in order to evaluate the DLP AM machine capability to fabricate polymer micro scale features geometries. Four different factors are evaluated for the AM process analysis: printing layer thickness, exposure time, film thickness and geometry. The process optimization of the workpiece quality features is carried out to highlight potential and challenges of the micro AM process.

Degree of recognition: International

Related event
33rd Annual Meeting of the Polymer Processing Society (PPS33)
10/12/2017 → 14/12/2017
Cancun, Mexico
Activity: Talks and presentations › Conference presentations

Dimensional accuracy of Acrylonitrile Butadiene Styrene injection molded parts produced in a pilot production with an additively manufactured insert

Period: 12 Dec 2017
Ali Davoudinejad (Speaker)

Department of Mechanical Engineering
Manufacturing Engineering

Description
Injection molding inserts manufactured additively by vat photopolymerization have become a serious option for significantly faster and more economical prototyping and pilot production due to technological progress and advancements in photopolymer materials in the recent years. 10 000 parts of a geometry including micro-features have been injection-molded in Acrylonitrile Butadiene Styrene (ABS) with a single 20x20x2.5 mm³ injection molding insert manufactured in a photopolymer composite material. This research investigates the dimensional accuracy of the injection molded parts as a function of inserts wearing and deformation with increasing shot number.

Degree of recognition: International

Related event
33rd Annual Meeting of the Polymer Processing Society (PPS33)
10/12/2017 → 14/12/2017
Cancun, Mexico
Activity: Talks and presentations › Conference presentations

Biological features produced by additive manufacturing processes using vat photopolymerization method

Period: 8 Nov 2017
Ali Davoudinejad (Speaker)

Department of Mechanical Engineering
Manufacturing Engineering

Description
Bio inspired surfaces have attracted great interest due to their potential applications in different industries by using a variety of structures. The fabrication of microstructures having complex shapes have been developed within the recent decades. This work realizes the direct fabrication of micro biological features by Additive Manufacturing (AM) processes. The study characterizes the additive manufacturing processes for polymeric micro part productions using the vat photopolymerization method. A specifically designed vat photopolymerization AM machine suitable for precision printing at the micro dimensional scale has been developed, built and validated. In order to evaluate the AM machine capability a Tokay gecko test part that contains microscale pillars with widened tips was used as benchmark sample. Two main printing parameters were selected for the study: exposure time and layer thickness. In order to select the optimal range of printing parameters, a sensitivity analysis was carried out prior to the final experiment. The print quality was assessed in terms of features heights, tip heights and tip diameters.

Degree of recognition: International

Related event

euspen Special Interest Group Meeting: Micro/Nano Manufacturing
08/11/2017 → 09/11/2017
Glasgow, United Kingdom
Activity: Talks and presentations › Conference presentations

University of North Carolina at Charlotte
Period: 1 Oct 2017 → 30 Nov 2017
Danilo Quagliotti (Visiting researcher)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Statistical modelling, surfaces generation and traceability for 3D Micro/Nano Optical Metrology at the Center for Precision Metrology
Activity: Visiting an external institution › Visiting another research institution

Micro 3D Additive Manufacturing and metrological methods
Period: Sep 2017 → Dec 2017
Ali Davoudinejad (Supervisor)
Department of Mechanical Engineering
Manufacturing Engineering

Description
visiting PhD student researcher at the Technical University of Denmark (DTU)
Degree of recognition: International
Activity: Examinations and supervision › Supervisor activities

Influence of tool texture on friction and lubrication in strip reduction
Period: 17 Sep 2017 → 22 Sep 2017
Mohd Hafis Bin Sulaiman (Guest lecturer)
Peter Christiansen (Guest lecturer)
Niels Oluf Bay (Guest lecturer)
Department of Mechanical Engineering
Manufacturing Engineering

Description
International Conference on the Technology of Plasticity, ICTP 2017, 17-22 September 2017, Cambridge, United Kingdom
Abstract:
Tool texturing is studied as a method to enhance lubrication and prevent the occurrence of galling. Strip reduction test tools manufactured with longitudinal, shallow pocket geometries oriented perpendicular to the sliding direction are tested. The pockets have small angles to the workpiece surface and varying distance. The experiments show an optimum distance between the pockets to exist that creates table mountain topography with flat plateaus and narrow pockets in between. If the flat plateaus are too narrow, an increase in drawing load and pick-up on the tool plateaus is observed. The same occurs for too wide plateaus. A theoretical friction model supports the experimental findings of an optimum distance
between the pockets, where the contribution to friction by mechanical interlocking of the strip in the pockets is limited and lubrication of the plateaus is enhanced by micro-plasto-hydrodynamic lubrication.

Degree of recognition: International

Related external organisation
Universiti Malaysia Perlis
Malaysia
Activity: Talks and presentations › Conference presentations

Digital Manufacturing in the Extrusion Process Chain by Additively Manufacturing Soft Tooling for Extrusion Dies
Period: 15 Aug 2017 → 30 Jan 2018
Ali Davoudinejad (Supervisor)
Department of Mechanical Engineering
Manufacturing Engineering
Degree of recognition: International
Activity: Examinations and supervision › Supervisor activities

Period: 1 Jun 2017
Ali Davoudinejad (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering
Description
This study investigates the micro end-milling process by using a 3D finite element modeling (3D FEM) approach. The FE model is developed for contouring up-milling operation to predict chip flow, burr formation and cutting forces. Different cutting conditions were simulated in order to investigate the influence of process variables that might be difficult or even impossible to follow in the physical experiments, particularly at this scale. 3D simulations of chip flow and temperature distribution are compared in various cutting conditions. The results of the burr formation and cutting forces predictions are compared against the experiments. The correlations were observed in terms of burr dimension trends and force profile shapes and magnitude.
Degree of recognition: International

Related event
17th euspen International Conference & Exhibition
29/05/2017 → 02/06/2017
Hannover, Germany
Activity: Talks and presentations › Conference presentations

3D Printing of Bio-inspired Surfaces
Period: May 2017
Ali Davoudinejad (Supervisor)
Department of Mechanical Engineering
Manufacturing Engineering
Description
In this thesis report, the intersection of bio-inspired surfaces and additive manufacturing is investigated, with the aim of determining the feasibility and viability of leveraging 3D printing technologies to rapidly prototype surfaces that mirror those found in nature. While both of these areas are heavily researched, the overlap of the two is an area filled with endless potential, ranging from the medical industry to product design and much more. The ability to rapidly and inexpensively reproduce bio-inspired surfaces using conventional 3D printing at microscale would thus serve to enable the scientific community to conduct optimisation of 3D surface model designs and printing process parameters. This would allow for improved forecasting of surface properties before investment in nano-fabrication takes place. However, as biological surfaces display divergent and numerous features, this report utilises the gecko toes, known for their dry adhesion properties, as a case study and a basis for investigation. As a point of departure, a literature geometry based on the gecko toe is used as a benchmark.

With reference to the research consulted in the duration of this project, this report identifies multi-hierarchical structures, feature geometry, feature density, and manufacturing methods used as the key determinants of how well 3D printing can
emulate the intricate features of the gecko’s toes. In this regard, Stereolithography (SLA) and Direct Light Processing (DLP) are characterised via experiments involving translating a simplification of the gecko toes features derived from the literature (literature sample) into a CAD model, and thereafter printing the model while manipulating different process parameters. In this particular case, DLP was found to outperform SLA in relation to features sizes, tolerances and other qualitative and quantitative criteria. As such, this thesis focuses on DLP as the most promising manufacturing method for the purpose of this project’s aim. Based on conducting a wettability test (water drop angle measurement), it was determined that smaller and more intricate designs showed better wettability properties compared with the simplified literature geometry. This is indicative of that the simplification of bio-inspired surfaces is likely detrimental to the emergent properties of the replicated geometry. Hence, the capabilities of 3D printing geometries to print smaller, denser an more complex surface features should enable a closer match between synthetic bio-surfaces and real ones.

Degree of recognition: International

Links:

Activity: Examinations and supervision › Supervisor activities

Feasibility study on integrated process/product quality assurance framework for precision injection moulding based on vibration monitoring
Period: 29 May 2017 → 31 May 2017
Nikolaos Giannekas (Other)
Rene Gammelby (Other)
Guido Tosello (Other)
Dmitri Tcherniak (Other)
Yang Zhang (Other)

Department of Mechanical Engineering
Manufacturing Engineering

Description
Feasibility study on integrated process/product quality assurance framework for precision injection moulding based on vibration monitoring
Degree of recognition: International

Documents:
EUSPEN2017_Poster_nikgia

Related organisation
Feasibility study on Integrated process/product quality assurance framework for precision injection moulding based on vibration monitoring
Giannekas, N. (Other), Rene Gammelby (Other), Tosello, G. (Other), Dmitri Tcherniak (Other), Zhang, Y. (Other)
29 May 2017 → 31 May 2017
Activity: Talks and presentations › Conference presentations

Replication and analysis of polymer micro structured functional surfaces for contrast generation
Period: 9 May 2017
Francesco Regi (Speaker)

Department of Mechanical Engineering
Manufacturing Engineering

Related event
Polymer Replication on Nanoscale 2017
08/05/2017 → 09/05/2017
Aachen, Germany
Activity: Talks and presentations › Conference presentations

A preliminary study on replication and quality correlation of on-part and on-runner polymer injection moulded micro features
Period: 7 May 2017 → 9 May 2017
Nikolaos Giannekas (Guest lecturer)
Guido Tosello (Other)
Yang Zhang (Other)
Department of Mechanical Engineering
Manufacturing Engineering

Description
A preliminary study on replication and quality correlation of on-part and on-runner polymer injection moulded micro features
PRN 2017- Polymer replication on Nanoscale Conference
Degree of recognition: International
Documents:
PRN2017_Poster_nikgia

Related event

Polymer Replication on Nanoscale 2017
08/05/2017 → 09/05/2017
Aachen, Germany
Activity: Talks and presentations › Conference presentations

University of North Carolina at Charlotte
Period: 1 May 2017 → 31 Jul 2017
Danilo Quagliotti (Visiting researcher)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Statistical modelling, surfaces generation and traceability for 3D Micro/Nano Optical Metrology at the Center for Precision Metrology
Activity: Visiting an external institution › Visiting another research institution

Massachusetts Institute of Technology
Period: 1 Mar 2017 → 30 Jun 2017
Thomas Hofstätter (Visiting researcher)
Department of Mechanical Engineering
Manufacturing Engineering

Description
@Mechanosynthesis Group
Degree of recognition: International
Activity: Visiting an external institution › Visiting another research institution

Metrology for additively manufactured medical implants
Period: 3 Feb 2017 → 30 Apr 2017
Alessandro Stolfi (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Activity: Other

Precision Engineering (Journal)
Period: 2016 → …
Alessandro Stolfi (Reviewer)
Department of Applied Mathematics and Computer Science
Department of Mechanical Engineering
Manufacturing Engineering
Degree of recognition: International

Related journal

**Precision Engineering**
0141-6359
BFI (2018): BFI-level 1, Scopus rating (2017): CiteScore 2.79 SJR 0.98 SNIP 1.874, ISI indexed (2013): ISI indexed yes,
Web of Science (2018): Indexed yes
Central database
Activity: Research › Peer review of manuscripts

**Sensors (Journal)**
Period: 2016 → …
Alessandro Stolfi (Reviewer)
Department of Applied Mathematics and Computer Science
Department of Mechanical Engineering
Manufacturing Engineering

Related journal

**Sensors**
1424-8220
BFI (2018): BFI-level 2, Scopus rating (2017): CiteScore 3.23 SJR 0.584 SNIP 1.55, ISI indexed (2013): ISI indexed yes,
Web of Science (2018): Indexed yes
Indexed in DOAJ
Central database
Activity: Research › Peer review of manuscripts

**Mechanics of Advanced Materials and Modern Processes (Journal)**
Period: 1 Dec 2016 → …
Govindan Puthumana (Reviewer)
Department of Mechanical Engineering
Manufacturing Engineering

Related journal

**Mechanics of Advanced Materials and Modern Processes**
2198-7874
Indexed in DOAJ
Local database
Activity: Research › Peer review of manuscripts

**ATV Sustain conference**
Period: 30 Nov 2016
Govindan Puthumana (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Description
ATV Sustain conference

Related event

**ATV Sustain conference**
30/11/2016 → 30/11/2016
Activity: Talks and presentations › Conference presentations
How to Get Published in an International Journal
Period: 29 Nov 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
How to Get Published in an International Journal

Related event
How to Get Published in an International Journal
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Oral examinations, including group examination
Period: 28 Nov 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Oral examinations, including group examination

Related event
Oral examinations, including group examination
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

How to prepare a successful proposal for Horizon 2020
Period: 24 Nov 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
How to prepare a successful proposal for Horizon 2020

Related event
How to prepare a successful proposal for Horizon 2020
24/11/2016 → 24/11/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Supervision of PhD students at DTU
Period: 14 Nov 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
LearningLab DTU

Description
Supervision of PhD students at DTU

Related event
Supervision of PhD students at DTU
14/11/2016 → 14/11/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Euspen Special Interest Group Meeting: Structured & Freeform Surfaces
Period: 9 Nov 2016 → 11 Nov 2016
Prateek Saxena (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Poster presentation
Computed Tomography characterization of the Green Fiber Bottle
Documents:
Poster_Saxena and Bissacco

Related event
Euspen Special Interest Group Meeting: Structured & Freeform Surfaces
09/11/2016 → 10/11/2016
Kgs. Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

Euspen Special Interest Group Meeting: Structured & Freeform Surfaces
Period: 9 Nov 2016
Mattia Didone (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Related event
Euspen Special Interest Group Meeting: Structured & Freeform Surfaces
09/11/2016 → 10/11/2016
Kgs. Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

Special Interest Group Meeting: Structured & Freeform Surfaces 9th – 10th November 2016 - Technical University of Denmark (DTU) Copenhagen, DK
Period: 9 Nov 2016 → 10 Nov 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Special Interest Group Meeting: Structured & Freeform Surfaces 9th – 10th November 2016 - Technical University of Denmark (DTU) Copenhagen, DK

Related event
Special Interest Group Meeting: Structured & Freeform Surfaces 9th – 10th November 2016 - Technical University of Denmark (DTU) Copenhagen, DK
09/11/2016 → 10/11/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Special Interest Group Meeting: Structured & Freeform Surfaces 9th – 10th November 2016 - Technical University of Denmark (DTU) Copenhagen, DK
Period: 9 Nov 2016
Danilo Quagliotti (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

**Description**
Objectives comparison in a confocal microscope using pseudo-random roughness artefacts

Oral session: Surfaces for nano manufacturing and their metrology
Documents:
LWD Bento B_Quagliotti DID # SFS121

**Related event**

**Special Interest Group Meeting: Structured & Freeform Surfaces 9th – 10th November 2016 - Technical University of Denmark (DTU) Copenhagen, DK**
09/11/2016 → 10/11/2016
Activity: Talks and presentations › Conference presentations

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**University of Nottingham**
Danilo Quagliotti (Visiting researcher)
Department of Mechanical Engineering
Manufacturing Engineering

**Description**
ISO 25178 part 600 metrological characteristics for a point autofocus instrument: Measurement noise of a point autofocus instrument
Activity: Visiting an external institution › Visiting another research institution

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**University of Copenhagen Innovation Day 2016**
Period: 13 Oct 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

**Description**
Innovation Day 2016 - Workshop: Innovation course design - themes, tools and methods
Innovation Day - University of Copenhagen

**Related event**

**University of Copenhagen Innovation Day 2016: Innovation course design - themes, tools and methods**
13/10/2016 → 13/10/2016
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

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**Making your research visible II**
Period: 6 Oct 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

**Description**
Making your research visible - II

**Related event**
Making your research visible II
06/10/2016 → 06/10/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Danish course 872
Period: 3 Oct 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Danish course 872

Related event
Danish course 872
03/10/2016 → ...
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Characterization of the micrometric structure of molded pulp using X-ray microtomography
Period: 21 Sep 2016 → 22 Dec 2016
Alessandro Stolfi (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Activity: Other

Meeting with SIRI and DIS
Period: 20 Sep 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Meeting with SIRI and DIS

Related event
Meeting with SIRI and DIS
20/09/2016 → 20/09/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Metrology for additive manufacturing of medical implants
Period: 13 Sep 2016 → 31 Dec 2016
Alessandro Stolfi (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Activity: Other

Demonstration - Course 41742
Period: 8 Sep 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Demonstration - Course 41742
Introduction to micro-mechanical system design and manufacture

Related event

Demonstration - Course 41742
08/09/2016 → 08/09/2016
Activity: Attending an event › Participating in or organising a conference

Technological signature in precision injection compression moulding of polymer Fresnel lenses
Period: 1 Sep 2016 → 31 Jan 2017
Danilo Quagliotti (Supervisor)
Department of Mechanical Engineering
Manufacturing Engineering
Activity: Examinations and supervision › Supervisor activities

EuroTech Postdoc workshop
Period: 31 Aug 2016 → 2 Sep 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Description
Technical University of Munich
EuroTech Postdoc workshop
Related event

EuroTech Postdoc workshop
31/08/2016 → 02/09/2016
Munich, Germany
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Rheology of High-Melt-Strength Polypropylene for Additive Manufacturing
Period: 24 Aug 2016
Thomas Hofstätter (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering
Description
Oral Contribution at EAMC
Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

DTU Mekanik Sommerseminar 2016
Period: 18 Aug 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Description
DTU Mekanik Sommerseminar 2016
DTU Mekanik Sommerseminar 2016

**Related event**

**DTU Mekanik Sommerseminar 2016**  
18/08/2016 → 18/08/2016  
*Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.*

**Danish summer school 880**  
Govindan Puthumana (Participant)  
Department of Mechanical Engineering  
Manufacturing Engineering  
**Description**

Danish summer school 880

Danish summer school 880

**Related event**

**Danish summer school 880**  
04/07/2016 → 15/07/2016  
*Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.*

**Traceability investigation in Computed Tomography using industry-inspired workpieces**  
Period: 1 Jul 2016 → 30 Sep 2017  
Alessandro Stolfi (Participant)  
Department of Mechanical Engineering  
Manufacturing Engineering  
*Activity: Other*

**Motivation and Learning**  
Period: 22 Jun 2016  
Govindan Puthumana (Participant)  
Department of Mechanical Engineering  
Manufacturing Engineering  
**Description**

Motivation and Learning

**Related event**

**Motivation and Learning**  
22/06/2016 → 22/06/2016  
*Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.*

**Accurate Manufacture-DLM**  
Period: 16 Jun 2016  
Govindan Puthumana (Participant)  
Department of Mechanical Engineering  
Manufacturing Engineering  
**Description**

Accurate Manufacture-DLM

**Related event**
**Accurate Manufacture-DLM**
16/06/2016 → 16/06/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Økonomioversigter**
Period: 13 Jun 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Description
Økonomioversigter

**Related event**
**Økonomioversigter**
13/06/2016 → 13/06/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Novo Nordisk AS**
Period: 10 Jun 2016 → 30 Aug 2016
Alessandro Stolfi (Visiting researcher)
Department of Mechanical Engineering
Manufacturing Engineering
Description
Harmonization of uncertainty budget for CT scanner at Novo Nordisk
Activity: Visiting an external institution › Visiting another research institution

**Performance Verification of the Moulding Method for Production of Paper Bottles**
Period: 3 Jun 2016 → 23 Jun 2016
Alessandro Stolfi (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Activity: Other

**Best Presentation Award**
Period: 2 Jun 2016
Thomas Hofstätter ( Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Degree of recognition: International

**Related event**
**16th euspen International Conference & Exhibition**
30/05/2016 → 03/06/2016
Nottingham, United Kingdom
Activity: Other

**Successful management of externally financed project at DTU - from Grant to project closing**
Period: 26 May 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Successful management of externally financed project at DTU - from Grant to project closing

Related event
Successful management of externally financed project at DTU - from Grant to project closing
26/05/2016 → 26/05/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Marie Skłodowska-Curie Individual Fellowships 2016
Period: 24 May 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Marie Skłodowska-Curie Individual Fellowships 2016

Related event
Marie Skłodowska-Curie Individual Fellowships 2016
24/05/2016 → 24/05/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Intern handel
Period: 18 May 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Intern handel

Related event
Intern handel
18/05/2016 → 18/05/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Learning by Failing/Learning by Succeeding
Period: 3 May 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Learning by Failing/Learning by Succeeding

Related event
Learning by Failing/Learning by Succeeding
03/05/2016 → 03/05/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.
Precision Metrology Workshop - Optical Metrology
Period: 19 Apr 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Precision Metrology Workshop - Optical Metrology

Related event
Precision Metrology Workshop - Optical Metrology
19/04/2016 → 19/04/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Principle for achieving metrological traceability with CMM's
Period: 12 Apr 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Principle for achieving metrological traceability with CMM's

Related event
Principle for achieving metrological traceability with CMM's
12/04/2016 → 12/04/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Search, cite, publish - information competences for PhD students and newly employed researchers
Period: 12 Apr 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Search, cite, publish - information competences for PhD students and newly employed researchers
Search, cite, publish - information competences for PhD students and newly employed researchers

Related event
Search, cite, publish - information competences for PhD students and newly employed researchers
12/04/2016 → 12/04/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

PhD supervision
Period: 4 Apr 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
PhD supervision

Related event
PhD supervision
04/04/2016 → 04/04/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Physikalisch-Technische Bundesanstalt,
Period: 15 Mar 2016 → 1 May 2016
Alessandro Stolfi (Visiting researcher)
Department of Mechanical Engineering
Manufacturing Engineering
Description
Creating a Multi-material Probing Error Test for the Acceptance Testing of Dimensional Computed Tomography Systems
Activity: Visiting an external institution › Visiting another research institution

Making your research visible
Period: 8 Mar 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Description
Making your research visible
Related event
Making your research visible
08/03/2016 → 08/03/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

H.C. Ørsted COFUND Postdoc Programme Network Group Meeting
Period: 26 Feb 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Description
H.C. Ørsted COFUND Postdoc Programme Network Group Meeting
Related event
H.C. Ørsted COFUND Postdoc Programme Network Group Meeting
26/02/2016 → 26/02/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Danish course 874
Period: 2 Feb 2016 → 2 Jun 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Description
Danish course 874
Danish course 874
Related event
Danish course 874
02/02/2016 → 02/06/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Design and Optimization of High Precision Positioning Fixture
Period: 1 Feb 2016 → 23 Jun 2016
Danilo Quagliotti (Supervisor)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Co-supervision of Bachelor thesis. Students: Martin Kain and Michael Gani
Activity: Examinations and supervision › Supervisor activities

H. C. Ørsted COFUND postdoc Fellow day
Period: 7 Jan 2016
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
H. C. Ørsted COFUND postdoc Fellow day

Related event
H. C. Ørsted COFUND postdoc Fellow day
07/01/2016 → 07/01/2016
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

DTU Sustain conference 2015
Period: 17 Dec 2015
Govindan Puthumana (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Description
DTU Sustain conference 2015

Related event
DTU Sustain Conference 2015
17/12/2015 → 17/12/2015
Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

DTU Seminar: Educating Engineers for the Future - Solving Engineering Dilemmas with Innovation as a Context for Teaching
Period: 8 Dec 2015
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
DTU Seminar: Educating Engineers for the Future - Solving Engineering Dilemmas with Innovation as a Context for Teaching
DTU Seminar: Educating Engineers for the Future - Solving Engineering Dilemmas with Innovation as a Context for Teaching

Related event

DTU Seminar: Educating Engineers for the Future - Solving Engineering Dilemmas with Innovation as a Context for Teaching
08/12/2015 → 08/12/2015
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

DTU Modeling day 2015
Period: 7 Dec 2015
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
DTU Modeling day 2015

DTU Modeling day 2015

Related event

DTU Modeling day 2015
07/12/2015 → 07/12/2015
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

EUSPEN Micro/Nano Manufacturing Workshop
Period: 25 Nov 2015
Danilo Quagliotti (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Metrological investigation of nanostructured polymer surfaces replication using atomic force microscopy

Oral Session: Metrology & Quality Control for Microparts II
Documents:
AdvIMReplication_ID # MN-136_v1_revised

Related event

EUSPEN Micro/Nano Manufacturing Workshop
24/11/2015 → 26/11/2015
Teddington, United Kingdom
Activity: Talks and presentations › Conference presentations

Language Learning Event
Period: 2 Nov 2015
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Language Learning Event

Related event

Language Learning Event
02/11/2015 → 02/11/2015
Introduction to research councils and foundations 20th October 2015
Period: 20 Oct 2015
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Introduction to research councils and foundations 20th October 2015

Related event
Introduction to research councils and foundations 20th October 2015
20/10/2015 → 20/10/2015
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

11621 How to write a scientific paper
Period: 17 Sep 2015 → 9 Dec 2015
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
11621 How to write a scientific paper

Related event
11621 How to write a scientific paper
17/09/2015 → 09/12/2015
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Danish course 888
Period: 15 Sep 2015 → 3 Dec 2015
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Danish course 888

Related event
Danish course 888
15/09/2015 → 03/12/2015
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Dimensional and Surface Micro/Nano Metrology for Precision Moulding Technology
Period: 7 Sep 2015 → 15 Jan 2016
Danilo Quagliotti (Supervisor)
Department of Mechanical Engineering
Manufacturing Engineering
Optical Metrology and Precision Milled Metal Surfaces for Process Validation and Product Quality Assurance

Period: 1 Sep 2015 → 1 Feb 2016

Danilo Quagliotti (Supervisor)

Department of Mechanical Engineering

Description

Master project supervisor

Optical Metrology and Precision Milled Metal Surfaces for Process Validation and Product Quality Assurance

Period: 1 Sep 2015 → 1 Feb 2016

Danilo Quagliotti (Supervisor)

Department of Mechanical Engineering

Description

Master project supervisor

Danish title: Optisk metrologi af præcision fræsede metaloverflader til procesvalidering og kvalitetssikring af produktet

English title: Optical Metrology and Precision Milled Metal Surfaces for Process Validation and Product Quality Assurance

ECTS Credits: 30

Cooperation Companies: LEGO Systems A / S

The forms of cooperation: The project conducted partly at DTU and partly in company

Project conducted in: Denmark

Supervisor (s): Guido Tosello (guto@mek.dtu.dk) - Danilo Quagliotti (danqua@mek.dtu.dk)

Supervisor (s) (external): Stefania Gasparin (stefania.gasparin@lego.com)

Students: 151883 (Federico Baruffi)

Activity: Examinations and supervision › Supervisor activities

Connect! European Moldflow User Meeting 2015

Period: 23 Jun 2015 → 24/06/2015

Frankfurt am Main, Germany

Activity: Talks and presentations › Conference presentations

Micro Mechanical Systems Design and Manufacturing Course 41790

Period: 22 Jun 2015 → 3 Jul 2015

Govindan Puthumana (Participant)

Department of Mechanical Engineering

Manufacturing Engineering
Description
Micro Mechanical Systems Design and Manufacturing Course 41790

Micro Mechanical Systems Design and Manufacturing Course 41790

Related event

**Micro Mechanical Systems Design and Manufacturing Course 41790**
22/06/2015 → 03/07/2015
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Polymer tribology: The polymer against polymer wear puzzle**
Period: 22 Jun 2015 → 26 Jun 2015
Ion Marius Sivebæk (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Description
The International Conference on Understanding and Controlling Nano and Mesoscale Friction: June 22-26 2015, Istanbul, Turkey.

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

The International Conference on Understanding and Controlling Nano and Mesoscale Friction
Period: 22 Jun 2015 → 26 Jun 2015
Ion Marius Sivebæk (Organizer)
Department of Mechanical Engineering
Manufacturing Engineering

Related event

The International Conference on Understanding and Controlling Nano and Mesoscale Friction
22/06/2015 → 26/06/2015
Istanbul, Turkey
Activity: Attending an event › Participating in or organising a conference

**ATV-SEMAPP micro-nano moulding: technologies and applications. 4th MicroNano Moulding ATV-SEMAPP Seminar.**
Period: 18 Jun 2015
David Maximilian Marhöfer (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Title: Micro product development and micro tool design by means of micro injection molding process simulations Abstract: Similar to conventional injection molding, process simulations are an effective tool in micro injection molding for the optimization and simulation-aided design of micro components as well as the mold and the molding process. Although the demand for simulations in micro injection molding rises, their application must be conducted carefully, because available software packages are actually made for macroscopic injection molding. In the presented work, the proper implementation, meshing, and modeling strategy for micro components is reported. Process simulations are applied to two microfluidic devices (micro distributor and micro mixer) fabricated in plastic and exhibiting feature sizes down to about 100 μm and aspect ratios of up to three. The goal of the simulations is the investigation of the general filling of each part and the influence of different gate configurations. The simulation results are used to evaluate the gate designs and find the most suitable one with regard to the process window, the filling behavior, and possible part quality criteria such as part flatness. An outlook on limitations and possible improvements rounds up the talk.

Related event

18/06/2015 → …
Odense, Denmark
Activity: Talks and presentations › Conference presentations

Poster Session - DTU (on 15th International Conference of the European Society for Precision Engineering)
Period: 12 Jun 2015
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Poster Session - DTU (on 15th International Conference of the European Society for Precision Engineering)
Poster Session - DTU (on 15th International Conference of the European Society for Precision Engineering)

Related event

Poster Session - DTU (on 15th International Conference of the European Society for Precision Engineering)
12/06/2015 → 12/06/2015
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Tolerance verification of a hearing aid component using Computed Tomography
Period: 1 Jun 2015 → 31 Jul 2015
Alessandro Stolfi (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Activity: Other

Transition from wet to dry friction
Period: 22 May 2015
Ion Marius Sivebæk (Invited speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Description

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Acoustical technological facilities visit - DTU Elektro
Period: 13 May 2015
Govindan Puthumana (Participant)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Acoustical technological facilities visit - DTU Elektro
Acoustical technological facilities visit - DTU Elektro

Related event
Acoustical technological facilities visit - DTU Elektro
13/05/2015 → 13/05/2015
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Analysis of Ingot Forging Damage Evolution Using Different Simulation Methods
Period: 9 Mar 2015
Peter Christiansen (Invited speaker)
Department of Mechanical Engineering
Manufacturing Engineering
Documents:
Christiansen_Bay_Martins_Hattel_Analysis_of_ingot_forging_damage_evolution_using_different_simulation_methods

Related event
7th International Seminar on Precision Forging
09/03/2015 → 12/03/2015
Nagoya, Japan
Activity: Talks and presentations › Conference presentations

Euspen Special Interest Group Meeting - Structured and Freeform Surfaces
Period: 19 Nov 2014 → 20 Nov 2014
Matteo Calaon (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering
Documents:
Structured and freeform surfaces Padova 2014-Calaon Matteo

Related event
Euspen Special Interest Group Meeting - Structured and Freeform Surfaces
19/11/2014 → 20/11/2014
Padova, Italy
Activity: Talks and presentations › Conference presentations

Karlsruhe Institute of Technology KIT
Period: Oct 2014 → Dec 2014
David Maximilian Marhöfer (Visiting researcher)
Department of Mechanical Engineering
Manufacturing Engineering
Description
Material characterization, process capability, and simulation accuracy assessment of precision powder injection molding
External stay as guest PhD
Activity: Visiting an external institution › Visiting another research institution

Comparison of measurements using Computed Tomography and CMM
Period: 1 Oct 2014 → 9 Jan 2015
Alessandro Stolfi (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Activity: Other

Material and geometry characterization of FDM parts
Period: 15 Aug 2014 → 15 Nov 2015
Alessandro Stolfi (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Activity: Other

Membership in the European Society for Precision Manufacturing and Nanotechnology (euspen) (External organisation)
Period: 2013 → …
David Maximilian Marhöfer (Participant)
Department of Mechanical Engineering
Manufacturing Engineering
Degree of recognition: International

Related external organisation
Membership in the European Society for Precision Manufacturing and Nanotechnology (euspen)
Activity: Membership › Membership of research networks or expert groups

Atv-semapp micro-nano moulding: technologies and applications
Period: 13 Nov 2013
David Maximilian Marhöfer (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Description
Title: Advancements on the simulation of the micro injection moulding process
Abstract: Process simulations are applied in micro injection moulding with the same purpose as in conventional injection moulding: optimization and support of the design of mould, inserts, parts, and process. Commercial software is however not well suited for micro injection moulding. The software is developed for macro plastic parts and it is therefore limited in the capability of modelling the polymer flow in micro cavities properly. Nonetheless, current developments of the simulation technology brought up new opportunities for improved accuracy. In this speech, new strategies and aspects for comprehensive simulation models which provide more precise results for micro injection moulding are discussed. Modelling and meshing recommendations are presented, leading to a multi-scale mesh of all relevant process and system units of micro injection moulding. The implementation and influence of process boundary conditions (e.g. venting, machine behaviour) on simulations results are described. Ultimately, the importance of cooling simulations settings is addressed.

ATV-SEMAPP micro-nano moulding: technologies and applications. 3rd MicroNano Moulding ATV-SEMAPP Seminar.

Related event
Atv-semapp micro-nano moulding: technologies and applications: 3rd MicroNano Moulding ATV-SEMAPP Seminar
13/11/2012 → 13/11/2013
Kgs. Lyngby, Denmark
Activity: Talks and presentations › Conference presentations

Journal of Intelligent Manufacturing (Journal)
Period: 1 Jan 2013 → …
Govindan Puthumana (Reviewer)
Department of Mechanical Engineering
Manufacturing Engineering

Related journal
Journal of Intelligent Manufacturing
0956-5515
Scopus rating (2017): CiteScore 2.95 SJR 1.179 SNIP 1.875, Web of Science (2018): Indexed yes
Local database
Activity: Research › Peer review of manuscripts
Influence of New Sol-gel Refractory Coating on the Casting Properties of Cold Box and Furan Cores for Grey Cast iron:
Presented at the 69. World Foundry Congress, Hangzhou 2010
Period: 1 Jan 2010 → …
Ugochukwu Chibuzoh Nwaogu (Speaker)
Department of Mechanical Engineering
Manufacturing Engineering

Related external organisation
Unknown external organisation
Activity: Talks and presentations › Conference presentations

Laser operatør kursus
Period: 2 Oct 2008
Flemming Ove Olsen (Other)
Manufacturing Engineering
Department of Mechanical Engineering
Description
Laser-ERFA-Gruppen afholder torsdag d. 2. oktober 2008, kl. 08:30-16:30 et 1-dags laseroperatør kursus. Kurset er et rent teorikursus, hvor Professor Flemming Olsen, DTU fortæller om laserskæring. Formålet er at give operatører af laserskæremaskiner en teoretisk ballast for deres arbejde. Kurset koncentrerer sig om en række teorilektioner, men der vil være rig lejlighed til at stille spørgsmål og bringe egne problemstillinger op i diskussionen. Kurset indeholder lektioner om:
• Laserskæringens udvikling
• Lasers virkemåde og gennemgang af de lasertyper, der anvendes til laserskæring
• Fokusering af laserstråler
• Indkobling af lys i emnet
• Skæreprocessens øvrige parametre
• Metoder til at vurdere kvaliteten af de laserskærte emner
• Procesoptimeringsmetodik
• Maskinjustering.
Head: Flemming Ove Olsen

Related external organisation
Laser-ERFA-Gruppen
Fredericia, Denmark
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Laser Operatør Kursus
Period: 14 Feb 2008
Flemming Ove Olsen (Other)
Manufacturing Engineering
Department of Mechanical Engineering
Description
Laserskæringens udvikling • Laseres virkemåde og gennemgang af de lasertyper, der anvendes til laserskæring • Fokusering af laserstråler • Indkobling af lys i emnet • Skæreprocessens øvrige parametre • Metoder til at vurdere kvaliteten af de laserskærne emner • Procesoptimeringsmetodik • Maskinjustering.

Head: Flemming Ove Olsen

Related external organisation

Laser-ERFA-Gruppen
Fredericia, Denmark
Activity: Talks and presentations › Guest lectures, external teaching and course activities at other universities

Selskabet for Maskinteknisk Proces- og Produktionsteknik (ATV-SEMAPP)

Period: 30 Apr 1998 → 29 Apr 2010
Flemming Ove Olsen (Chairman)
Department of Mechanical Engineering
Manufacturing Engineering

Related external organisation

Selskabet for Maskinteknisk Proces- og Produktionsteknik (ATV-SEMAPP)
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Prizes:

Civilingeniør Kristian Rasmussen og hustru Gunhild Katrine Rasmussens Fond
Danilo Quagliotti (Recipient)
Department of Mechanical Engineering, Manufacturing Engineering

Description
Awarded with a research grant to support Postdoc research "Statistical modelling, surfaces generation and traceability for 3D Micro/Nano Optical Metrology"

Details
Awarded date: Jan 2017
Prize: Prizes, scholarships, distinctions

Fabriksejer, Civilingeniør Louis Dreyer Myhrwold og hustru Janne Myhrwolds Fond
Danilo Quagliotti (Recipient)
Department of Mechanical Engineering, Manufacturing Engineering

Description
Awarded with a research grant to support PhD research project "Multi Scale Micro Nano Metrology for Advanced Moulding Technologies"

Details
Awarded date: 30 Oct 2015
Prize: Prizes, scholarships, distinctions

Idella Foundation
Danilo Quagliotti (Recipient)
Department of Mechanical Engineering, Manufacturing Engineering

Description
Awarded with a research grant to support external stay at The University of Nottingham

Details
Awarded date: 20 Jun 2016
Prize: Prizes, scholarships, distinctions
**Otto Mønsteds Fond**  
Danilo Quagliotti (Recipient)  
Department of Mechanical Engineering, Manufacturing Engineering

**Description**  
Awarded with a research grant to support PhD research project "Multi Scale Micro Nano Metrology for Advanced Moulding Technologies"

**Details**  
Awarded date: 15 Mar 2016  
Prize: Prizes, scholarships, distinctions

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**Polymer Processing Society Graduate Travel Award**  
Thomas Hofstätter (Recipient)  
Department of Mechanical Engineering, Manufacturing Engineering

**Details**  
Awarded date: 21 May 2018  
Degree of recognition: International  
Prize: Prizes, scholarships, distinctions

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**Young Scientist Award: 6th ACE-X Conference, Istanbul, Turkey 2012**  
Michael Wenani Nielsen (Recipient)  
Department of Mechanical Engineering, Manufacturing Engineering

**Description**  
For his contribution:  
Prediction of internal strains during curing, post-curing and demoulding of thick glass/epoxy composite – Analysis of different constitutive models  

**Details**  
Awarded date: 4 Jul 2012  
Prize: Prizes, scholarships, distinctions