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
Peer-reviewed: Yes

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): Impact factor 2.582
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.77 SJR 1.072 SNIP 2.178
Web of Science (2016): Impact factor 2.237
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.42 SJR 1.039 SNIP 2.063
Web of Science (2015): Impact factor 1.914
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.39 SJR 1.227 SNIP 2.409
Web of Science (2014): Impact factor 1.517
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.54 SJR 1.398 SNIP 2.885
Web of Science (2013): Impact factor 1.403
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.2 SJR 1.331 SNIP 3.193
Web of Science (2012): Impact factor 1.393
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.03 SJR 1.295 SNIP 2.699
Web of Science (2011): Impact factor 1.167
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.528 SNIP 2.949
Web of Science (2010): Impact factor 1.819
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.103 SNIP 2.712
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.909 SNIP 1.745
Scopus rating (2007): SJR 0.964 SNIP 1.573
Scopus rating (2006): SJR 0.829 SNIP 1.677
Scopus rating (2005): SJR 0.915 SNIP 1.995
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.539 SNIP 2.482
Scopus rating (2003): SJR 0.813 SNIP 1.921
Scopus rating (2002): SJR 0.714 SNIP 1.955
Scopus rating (2001): SJR 0.515 SNIP 1.984
Scopus rating (2000): SJR 0.498 SNIP 1.529
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.472 SNIP 1.548
Original language: English
Keywords: Production environment, Temperature compensation, Thermomechanical modelling, Polymer parts, Multisensory fixture, Online compensation
DOIs: 10.1016/j.precisioneng.2018.02.013
Source: RIS
Source-ID: urn:C018F74DD82560B1115BC1CF2AD6643C
Research output: Research - peer-review : Journal article – Annual report year: 2018