A thorough experimental investigation was carried out to study the behaviour of thermoplastic elastomers (TPEs) when moulding a commercial micro ring component having a mass of 2.2 mg. The quantification of part defects such as weld lines and air traps allowed drawing clear recommendations on how to set up the process window. The geometrical precision and accuracy of the produced parts were investigated using optical measurements over a broad range of process variables in order to characterize the impact of process variations on the final output. A novel shrinkage factor was calculated to provide a method to extrapolate the mould from the master. On the other hand, indirect measurements of geometry revealed that the silicone shrunk linearly with overestimation of the real roughness because of the stretch of the replication media generated during its manual removal and virtual process optimization was investigated in this thesis. A commercially available injection moulding simulation software was employed to build models and run simulations for two of the case studies of the project, namely the TPE micro ring and the 3D micro component. Model calibration proved a task of primary importance in order to match experimental measurements with numerical data. In regard to the micro ring simulations, the calibrated model was capable of predicting the final dimensions of the moulded parts with a 1.6 μm accuracy. The effects of the μIM parameters on the part dimensions were also well forecasted, validating the model as a tool for virtual optimization. Process simulations were applied to the 3D micro component to predict the size of the flash that affected the part quality. The results showed that the model accurately captured the variations induced by the different process variables on the defect. The use of replica technology as a method for indirect measurements of inaccessible micro milled features, which are often present in micro moulds, was assessed. Two benchmark samples were designed and micro milled in order to quantify the degree of fidelity of a commercial two-component silicone rubber when applied to the measurement of both surface texture and geometry. The comparison between direct and indirect measurements allowed defining the applicability of the method. The surface topography measurements showed that the indirect approach led to an overestimation of the real roughness because of the stretch of the replication media generated during its manual removal from the master. On the other hand, indirect measurements of geometry revealed that the silicone shrunk linearly with respect to the original dimension. The shrinkage factor was calculated to provide a method to extrapolate the mould dimensions in the industrial situation in which only indirect data are available.

**General information**

Publication status: Published
Organisations: Manufacturing Engineering, Department of Mechanical Engineering
Contributors: Baruffi, F.
Number of pages: 205
Publication date: 2019

**Publication information**

Place of publication: Kgs. Lyngby
Publisher: Technical University of Denmark (DTU)
Original language: English
Electronic versions:
PhD_thesis_Federico_Baruffi.pdf
Research output: Book/Report – Annual report year: 2019 – Research