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Abstract

Micro injection moulding (µIM) process simulations can be used as powerful tool for the optimization of the design of mould, parts and process. However, numerous combined 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 sensors application is 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).

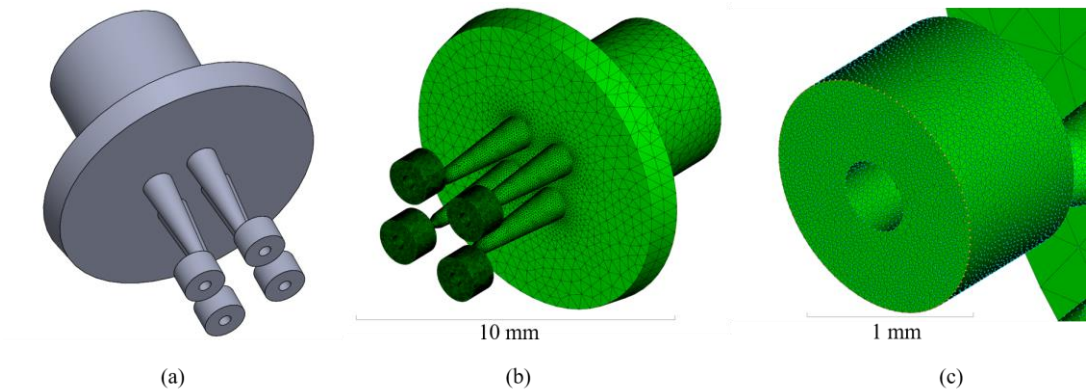

Figure 1. (a) CAD model of the parts with feed system as imported in ASMI; (b) Meshed model; and (c) detail of the meshed micro ring

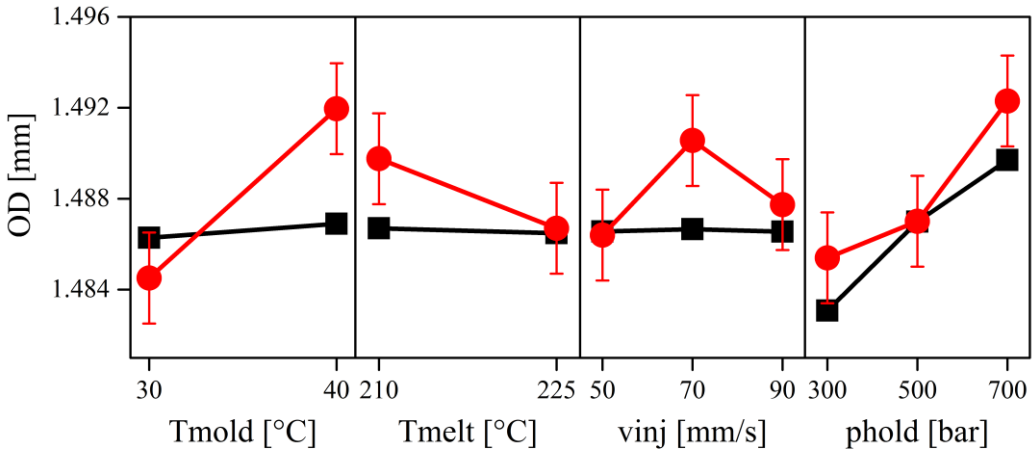

Figure 1. Main effects plots for OD. In black, the simulation results. In red, the measurements results of real parts. The error bars indicate the expanded uncertainty *U*

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