Experimental investigation and thermo-mechanical modelling for tool life evaluation of photopolymer additively manufactured mould inserts in different injection moulding conditions - DTU Orbit (10/02/2019)

Experimental investigation and thermo-mechanical modelling for tool life evaluation of photopolymer additively manufactured mould inserts in different injection moulding conditions

There is a growing interest for integrating additive manufacturing (AM) technology in different manufacturing processes such as injection moulding (IM) due to the possibility of achieving shorter manufacturing times and increased cost effectiveness. This paper evaluates IM inserts fabricated by the AM vat photopolymerisation method. The inserts are directly manufactured with a photopolymer material, integrated on an injection moulding tool and subsequently used for IM. Therefore, particular attention has to be paid in order to develop the soft tooling process chain and the IM experimental procedure as detailed in this study. Different combinations of IM parameters are investigated in this work in order to determine the influence of the various process settings on the inserts' performance (lifetime, crack propagation, consistency of the mould surface features). The mould inserts were analysed by three-dimensional optical metrology and evaluated with regard to the different surface features that were affected by the IM process. A three-dimensional thermo-mechanical with phase change model for the analysis of the effects of the IM process on the additive manufactured tools was accomplished in the FE software COMSOL Multiphysics. The potential causes for the insert failure are identified both by means of the IM experiments and the numerical model. The developed model could also predict the thermally induced deformations produced in the mould and identify where this phenomenon would eventually lead to defects in the shape of the parts. The influence of three different temperatures of the insert at 25 °C, 50 °C and 100 °C on the failure of the insert was investigated. Also a detailed discussion about the solidification and temperature changes is given.

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