Precision Injection Moulding With Inserts Made Of Mortar Material

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Abstract

Over the last years, Additive Manufacturing (AM) technologies have developped rapidly, making it now possible to manufacture duromer-based soft moulds for polymer precision injection moulding. The tool inserts fabrication process is fast and cost-effectivewhich reduces time-to-market as well as mould fix costs for the polymer component to be produced. Yet, a major drawback is the inserts' limited lifetime (100 to a few 1 000 injection moulded parts) which cannot compete with the lifetime of high-end steel moulds.

We present a new AM concept based on mortar material for rapid fabrication of inserts used in precision injection moulding of micro-structured polymer parts. The tooling process chains starts with the 3D CAD design of the master form containing the desired micro features. This master form is then fabricated by either Fused Deposition Modeling (FDM), Stereolithography Aparatus (SLA) or by Soft Lithography (SL). The master form is filled with a freshly-mixed cementious paste that hardens within some days, generating a mortar copy of the master form. Even a very smooth, almost mirror-like surface finish can be achieved, depending on the composition of the mortar paste and the surface characteristics of the master form. This AM-made mortar insert is supposed to have a long lifetime making it suitable for low to medium scale production and was validated in the present study.

Furthermore, we employed the Autodesk Moldflow injection moulding simulation software in order to determine the optimum thermal conductivity of the mortar insert. The thermal conductivity of the mould material needs to be tailored individually in order to balance polymer melt quenching (poor micro replication fidelity) and extended cooling time (low productivity and high variable costs). The mixture of the mortar material can be adjusted accordingly.

The presented process chain exploits the advantages of AM / rapid tooling yet avoids the disadvantages of soft moulds. Therefore, it has the potential to become a game changer in polymer precision manufacturing.