Physical Modelling of Amorphous Thermoplastic Polymer and Numerical Simulation of Micro Hot Embossing Process

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ABSTRACT

Micro hot embossing process is considered as one of the most promising micro replication processes for manufacturing of polymeric components, especially for the high aspect ratio components and large surface structural components [1]. A large number of hot embossing experimental results have been published, the material modelling and processes simulation to improve the quality of micro replication by hot embossing process are still lacking [2]. This paper consists to 3D modelling of micro hot embossing process with amorphous thermoplastic polymers, including the mechanical characterisation of polymers properties, identification of the viscoelastic behaviour law of the polymers, numerical simulation and experimental investigation of micro hot embossing process [3]. Static compression creep tests have been carried out to investigate the selected polymers' viscoelastic properties. The Generalized Maxwell model has been proposed to describe the relaxation modulus of the polymers and good agreement has been observed. The numerical simulation of the hot embossing process in 3D has been achieved by taking into account the viscoelastic behaviour of the polymers. The microfluidic devices with the thickness of 2 mm have been elaborated by hot embossing process. The hot embossing process has been carried out using horizontal injection/compression moulding equipment, especially developed for this study. A complete compression mould tool, equipped with the heating system, the cooling system, the ejection system and the vacuum system, has been designed and elaborated in our research. Polymer-based microfluidic devices have been successfully replicated by the hot embossing process using the compression system developed. Proper agreement between the numerical simulation and the experimental elaboration has been observed. It shows strong possibility for the development of the 3D numerical model to optimize the micro hot embossing process in the future.

REFERENCES

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