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Numerical Analysis of Microstructures Thermal Formation in a Polymeric Material

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Extended Abstract

In recent days, microgeometry is being widely used in medicine, microchip technologies, mechatronic systems, or innovative sensors [1-3]. Microgeometry can be formed by various methods depending on the desired structure. Polymeric materials are distinguished by the possibility of forming structures using a hot embossing method. This method can ensure a high-quality structure and a high speed of its formation [4]. However, it is difficult to ensure the necessary parameters for different geometries in the experiments. Therefore, computerized finite elements are used for this purpose [5].

Using ANSYS software, a model was created that can be used to predict the necessary parameters for the formation of the microstructure. Since a main matrix structure was experimentally produced using reactive ion etching technology, which achieved a 4 μm periodicity and a groove depth of 1 μm of microstructure, the corresponding model of the matrix structure was created in theoretical calculations. The characteristics of the material (strain, stress, and Young's modulus) were additionally described to change the mechanical characteristics when the temperature changes. Due to the relatively large deformations, a non-linear adaptive domain was used for mesh recalculation. In addition, the model was simplified using fixed and frictionless supports. An animation of strain, elastic strain, stress, and reaction force graph were generated. After performing theoretical calculations, the obtained results allowed to see how the plastic flows into the mold. It was observed that at lower temperatures, the plastic mold was not filled. During the experiment, the reaction force was obtained, which made it possible to select the optimal pressure force at a specific temperature.

The theoretical model described in this article allows to predict the geometry of the formed structure and the necessary parameters to form the microstructure. Moreover, the model can show invisible defects such as residual stresses. In addition, for more complex casting geometry, the model can be adapted to find the optimal parameters.

References

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