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CRYSTALLIZATION MODELLING FOR POLYMER INJECTION MOLDING IN A SPACE-TIME FRAMEWORK

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Nowadays, most industrial processes are modeled, studied, and controlled with computer assistance. This fact permits not only to optimize the process but also to improve the final product and fulfill the demanding accuracy requirements of today's industry. In the case of the widely used process of polymer injection molding, the prevention of manufacturing defects, such as warpage, component stress, air entrapment, or shrinkage, is a core factor in avoiding failure or malfunction of the final piece. Here is where high-resolution computational analysis takes part. However, the challenges of the simulation of this process are manifold, and a high resolution and efficient numerical methods for it are still being researched.

In this study, we analyze the crystallization of the polymer during the injection phase. We use the in-house finite-elements solver XNS to simulate the polymer and air flows. To distinguish between the air and the polymer phase, we use the level-set approach, which captures the interface of the two-phase flow [1]. For the polymer characterization, we use the non-Newtonian Cross-WLF rheology model and, for the solidification process, we implement a pvT model. To extend the model to semi-crystalline polymers, we use the Nakamura [2] and the Hoffman-Lauritzen models [3] to describe the crystallization process.

For higher computational efficiency, the space-time method is used [4]. This method permits the refinement of the time-stepping locally in areas of interest, such as the moving interface. The results and performance of the injection molding simulation and the advantages of using the space-time method for these simulations are analyzed.

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