A Mechanistic Direct Fiber Simulation for Concentrated Short Fiber-Reinforced Thermoplastics

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ABSTRACT

Short fiber-reinforced thermoplastics are a promising replacement for metal parts in the course of weight reduction, as they are easy to process and offer high mechanical strength. Simulative prediction of failure and lifetime of short fiber-reinforced thermoplastics can reduce development costs significantly . The anisotropic mechanical properties of the parts are determined by the flow-induced fiber orientation. Advanced macroscopic fiber orientation models have been developed and implemented in commercial software. The prediction quality depends strongly on phenomenological parameters, which are difficult to determine. To better understand the fiber orientation mechanism and predict the phenomenological parameters used in the macroscopic model, we use a mechanistic direct fiber simulation based on Pérez [1]. This approach extends the discrete element method to account for cylindrical fibers in a homogeneous flow. With highly filled polymers, the interaction between the fibers has a significant influence on the orientation development. The lubrication of the interaction mechanism and the mechanical contact are investigated and compared to a fully coupled fiber flow simulation in COMSOL® using the fluid-structure interaction module. The analytical lubrication formulation based on Lindström et al. [2] is adapted to the forces of the coupled simulation. Furthermore, the influences of mean fiber length, fiber length distribution and fiber volume fraction are investigated.

REFERENCES

[1] Camilo Pérez. *The use of a direct particle simulation to predict fiber motion in polymer processing*. PhD dissertation, University of Wisconsin-Madison, 2016.

[2] Stefan B. Lindström and Tetsu Uesaka. Simulation of the motion of flexible fibers in viscous fluid flow. *Physics of Fluids*, 19(11):113307, 2007.