Public Abstract
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Graduation Term:SP 2013
Department:Mechanical & Aerospace Engineering
Degree:PhD
Title:FLOW-INDUCED MICRO- AND NANO-FIBER SUSPENSIONS IN SHORT-FIBER REINFORCED COMPOSITE MATERIALS PROCESSING

Short-fiber reinforced polymer composites enjoy widespread industrial applications due to their high strength-to-weight ratios and versatile manufacturing processes. The mechanical, electrical and thermal properties of short-fiber reinforced composite systems are tremendously dependent on fiber orientations within the polymer matrix during the manufacturing process. However, the commonly used melt flow simulation tools employ simplified empirically-derived models that have recently been shown to over-predict the rate of fiber alignment. Therefore, a physical understanding of fiber suspensions during the injection molding process is critical.

The main objective of this research project is to develop a systematic methodology to predict fiber orientations during the manufacture of polymer composites through the numerical simulation. The focus is to address such issues as the effect of fiber shape, fiber-fiber interactions, Brownian motions of nano-fibers and fiber suspensions in various solvents, such as inhomogeneous flows. We develop a stand-alone Finite Element Method (FEM) for calculating hydrodynamic forces and torques exerted on fibers. For nano-fibers, the Brownian forces and torques are modeled using a Gaussian distribution function. Our approach seeks fibers' velocities that zero the net torques and forces acting on the fibers by the surrounding bulk fluid. Fiber motions are then computed using a forth-order Runge-Kutta method to update fiber positions and orientations as functions of time.