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PREDICTING THE ORIENTATION OF CONCENTRATED LONG GLASS FIBER SUSPENSIONS IN SIMPLE SHEAR FLOW: APPLICATION TO PROCESSING FLOWS

Donald G. Baird,[1] Kevin Ortman,[1] Peter Wapperom,[2] A. Jeffrey Giacomin[3] and Adam W. Mix[3]

[1]Chemical Engineering, Virginia Tech, Blacksburg, VA 24061, [2]Mathematics, Virginia Tech, Blacksburg, VA 24061 and [3]Rheology Research Center, University of Wisconsin, Madison, WI 53706

The purpose of this research is to understand the transient fiber orientation of long glass fiber (> 1mm) reinforced polypropylene in a well-defined simple shear flow by determining unambiguous model parameters from rheological experiments, and to ultimately predict fiber orientation in complex processing flows. A sliding plate rheometer was designed to measure stress growth at the startup and cessation of steady shear flow. Two fiber orientation models were investigated to predict the transient orientation of the long glass fiber system. One model, the Folgar-Tucker model[2,3,4], has been particularly useful for predicting fiber orientation in short glass fiber[1] systems and was used in this paper to assess its performance with long glass fibers. A second fiber orientation model[5], one that accounts for the flexibility of long fibers, was also investigated. The accuracy of both the Folgar-Tucker model and the semi-flexible orientation model, when used with the Lipscomb[6] model for the stress tensor and a modified version of this tensor (one that tries to account for bending stresses), respectively, is evaluated by comparing orientation predictions against experimentally measured orientations. Samples consisting of 10 wt. % glass fiber in polypropylene with an average fiber length of 3 mm were prepared with near planar random initial orientation and were sheared at different shear rates. Results show that, when parameters are determined from rheology, the combination of the Lipscomb model and Folgar-Tucker model is unable to accurately predict the transient fiber orientation. On the other hand, the combination of the semi-flexible fiber orientation model and the modified Lipscomb model show orientation predictions that are in good agreement with experimental orientation values.

References:

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