MODELING ANISOTROPIC AND RATE-DEPENDENT PLASTICITY IN SHORT-FIBER REINFORCED THERMOPLASTICS

A. Amiri-Rad*, L.V. Pastukhov†, L.E. Govaert* and J.A.W. van Dommelen*

* Eindhoven University of Technology, P. O. Box 513, 5600 MB, Eindhoven, the Netherlands
† Dutch Polymer Institute (DPI), P.O. Box 902, 5600 AX, Eindhoven, the Netherlands

ABSTRACT

In this study, an anisotropic viscoelastic-viscoplastic macro-mechanical model is presented for short-fiber reinforced thermoplastics (SFRT). In injection molding of SFRT, the fiber orientation is influenced by the flow velocity profile which varies throughout the mold. The non-uniform fiber orientation distribution leads to anisotropy in the mechanical response. In addition to the mechanical anisotropy, SFRT shows time dependent behaviour because of the thermoplastic matrix.

Uniaxial tests are performed at different strain rates and material orientations with samples cut from injection molded plaques. The developed model captures the effects of both material orientation and loading rate on the yield behaviour. The experimental results (Figure 1) show that the effects of loading rate and the material orientation on the yield are decoupled. The presented model, takes advantage of this observation to simplify the material characterization. An implicit integration scheme is used for numerical implementation of the model as a UMAT in ABAQUS.

Experimental results are used for validation of the model and a good agreement is observed for the prediction of the yield behaviour. First, the model with a single relaxation time is presented and then the model is extended to multiple relaxation times to improve the predictions in the elastic regime (Figure 2). An efficient method for obtaining the model parameters for different modes is proposed.