Title

PREDICTION OF FIBER ORIENTATION IN SHORT GLASS FIBER POLYPROPYLENE COMPOSITES AND THE CONSEQUENCES FOR MICROMECHANICAL SIMULATIONS

Abstract text

Fiber orientation distribution (FOD) and fiber length distribution (FLD) play an important role for the mechanical behavior of short fiber reinforced polymeric materials. Both, FOD and FLD significantly depend on part design and process conditions. Moreover, for injection molded components appropriate gate design is crucial for optimized material performance. In order to predict the mechanical performance of these components, accurate prediction of fiber orientation and appropriate micromechanical modeling are important. In recent years, prediction of FOD using state of the art processing simulation software has become very popular. Transferring these data to the structural simulation allows for the calculation of the overall component behavior with detailed information about the local properties utilizing micromechanics-based material models. This approach provides the fundamental information for adequate virtual component design. However, detailed quantitative comparison of the numerical prediction with experiments is still missing along the whole simulation chain. Therefore, the objective of this research study is to evaluate (i) the prediction accuracy of fiber orientation distribution and (ii) to explore the consequences on the calculated composite behavior including damage and ultimate failure.

Microstructure characterization has been carried out using a high resolution computed tomography (CT) device. A methodology has been developed to determine FOD for polypropylene composites to a very degree of accuracy. The results were compared to the predicted fiber orientations of Autodesk Moldflow. In addition to the well-known Folgar-Tucker fiber prediction model, results will also be presented for the recently available reduced strain closure model. Optimized set of parameters will be shown minimizing the error between prediction and experiment. Different geometries were selected for this study to check the effect of part thickness, type of flow front and part complexity (2D vs. 3D).

Tensile specimens were machined from the various geometries and tested in uniaxial tension. The experimental results were compared to the structural simulation based on different fiber orientations as predicted. Results were compared in terms of stiffness, strength and ultimate failure. Therefore the overall potential error in the coupled simulation is addressed and underlines the need for model validation in each step along the simulation process.

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