Prediction of the mechanical properties of weld Lines in injection-molded short fiber-reinforced thermoplastics

Mohamed Besher Baradi[1], Camilo Cruz[2], and Gilles Régnier*†[3]

[1]Procédés et Ingénierie en Mécanique et Matériaux [Paris] (PIMM) – Arts et Métiers ParisTech, Conservatoire National des Arts et Métiers [CNAM], Centre National de la Recherche Scientifique : UMR8006 – France

[2]Robert Bosch GmbH – Allemagne

[3]Procedes et Ingenierie en Mécanique et Matériaux [Paris] (PIMM) – Arts et Métiers ParisTech, Conservatoire National des Arts et Métiers (CNAM), CNRS : UMR8006 – France

Résumé

Weld Lines (WLs) frequently appear by injection molding when separate polymer melt fronts meet. They induce a significant reduction in the failure strength and strain, especially for composites. Thus, a reliable prediction of the WL properties during the product design phase is essential; however, current simulation tools are not capable of this task. Literature points to two main reasons of WL weakness: an incomplete polymer matrix healing and a change of fiber orientation (FO). The aim of this work is to characterize and quantify the contribution of these factors and enhance the prediction of WLs' properties. Frontal and flowing WLs of 30 % wt. glass fiber-reinforced PBT were molded. The mechanical strength properties were studied by tensile tests assisted with digital image correlation. The microstructure was quantified using X-ray computed tomography scans. WLs induce a reduction that reaches 55 % on strength. Flowing WLs act like a cavity wall and frontal WLs' microstructure is dependent on the thickness and packing pressure. To predict the quality of the matrix healing, a physical model based on the reptation theory is implemented. By using the measured FO and a homogenization scheme, the WL strength was computed using FE simulations. A good agreement was found and showed that the FO is the main factor influencing the WL strength.

Mots-Clés: weld lines

*Intervenant

†Auteur correspondant: gilles.regnier@ensam.eu