

Mean-field model analysis of deformation and damage in friction stir processed Mg-C composites

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Abstract

Friction Stir Processing (FSP) is an attractive manufacturing technique to produce Mg matrix composites since it avoids the problem of excessive reactivity between reinforcement and matrix encountered in liquid-phase processing routes. However, the strength of the interface in C-reinforced Mg matrix composites produced by FSP remains to be assessed. A short fibre composite has been fabricated by FSP a stack of a C-fabric between two Mg-AZ91D alloy sheets. In order to elucidate the interplay between matrix hardness and interface bonding strength, the work investigates the influence of heat treatment on the mechanical properties of the composites. An incremental Mori-Tanaka model is developed to analyse the relative roles of heat treatment and C-fibre reinforcement on the flow strength and ductility of the composites in tension and compression. The mean-field model provides an estimate of the stress at the matrix/fibre interface, from which a simple debonding criterion can be derived. Comparison between model predictions and experimental data indicates that damage in the FSP composites is triggered by early interfacial debonding. Based on Finite Element simulations of a tensile test carried out in-situ in a scanning electron microscope, the critical interfacial stress for debonding was identified to be 435 MPa in simple traction but only 250 MPa when damage is governed by shear. This explains the limited strengthening by C fibres observed in heat treated composites.