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Modeling the effects of elastic modulus and thermal expansion coefficient on the shrinkage of glass fiber reinforced composites[☆]

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Abstract

In a micromechanics modeling of fiber reinforced composites, the thermal expansion coefficients and the elastic moduli of the composites are important physical parameters to predict the shrinkage and structure of the composites. We suggest a shrinkage inhibition concept for the composites before and after an annealing process and model the effects of the thermal expansion coefficient and the elastic modulus on the shrinkage of the composites by using the Mori-Tanaka models. The relaxation moduli of the composites are examined to evaluate the viscoelastic deformations of the materials by applying the time-temperature superposition principle. We verify that the the prediction of the effective elastic moduli is more accurate than the effective thermal expansion coefficients of the composites, which results from the imperfection of interfacial bonding between the matrix and the fillers. The shrinkage of the composites is inhibited by embedding fillers into the matrix in both cases before and after the annealing process owing to the inhibition of stretched polymer chains into random coil deformation.

Keywords: Effective thermal expansion coefficient, effective elastic modulus, Mori-Tanaka model, Shrinkage, Glass fiber reinforced composites

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