Non-Stoichiometric Curing Effects on Mechanical Behaviors of Nano-Silica Particulate-Reinforced Epoxy Composites

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ABSTRACT

The non-stoichiometric curing effects on mechanical properties of nano-silica particulate-reinforced epoxy composites were clarified experimentally to consider the interaction effects between nano-particles and network structures in matrix resin. The matrixes were prepared by curing with an excessive mixture of diglycidyl ether of bisphenol A type epoxy resin as the curing agent for the stoichiometric condition. The volume fraction of the silica particles with a median diameter of 240 nm was constantly 0.2 for every composite. The crosslinking densities and glass transition temperatures of the neat epoxy resins were identified from thermo-viscoelastic properties measured by dynamic mechanical analysis. The glass transition temperatures, the bending strengths, and the fracture toughnesses were found to sensitive to the crosslinking densities but the compressive yield stresses approximately did not affect to the crosslinking densities. The interactions between the nano-particles and the network structures reduce the glass transition temperatures and improve the compressive yield stresses, the bending strengths and the fracture toughnesses in high crosslinking densities. The bending strengths, the compressive yield stresses and the fracture toughnesses were higher for composites than those of the neat epoxy resins, because existence of the nano-silica particles encumbered the entanglements of the molecular chains and the deformations in the matrix resins having fine network structures with high crosslinking densities.

Keywords

Mechanical properties, Nanocomposite, Epoxy resin, Crosslinking density, Bending strength, Glass transition temperature, Thermo-viscoelastic properties, Fracture toughness, Compressive yield stress.