Relation between Phase Diagrams, Morphologies and Glass Transition Temperatures in a Thermoplastic/Thermoset Polymer System

Joaquin Lopez [C, S], Maite Rico, Belen Montero, Javier Diez and Marcelino Ladra
Universidad de A Coruña, Ferrol, A Coruña, Spain

The toughness of epoxy resins may be improved by the incorporation of thermoplastic components which are initially miscible in the blend but are segregated in the course of polymerization of thermoset. To predict and understand the developed morphologies of these materials it is necessary to know the phase diagram of the blend. The aim of this work is to study the miscibility of an epoxy resin with a thermoplastic modifier by obtaining the phase diagrams, the morphologies and the glass transition temperatures; analyzing the effect of proportion modifier and cure temperature. The epoxy resin consisted of a stoichiometric mixture of diglycidyleter of bisphenol A and the aromatic diamine 4,4´-methylenebis(2,6-diethylaniline). The thermoplastic modifier was a polystyrene (PS). The phase diagrams for the system before and during polymerization at three cure temperatures were obtained from a thermodynamic analysis of phase separation. This analysis was conducted using a model based on the Flory-Huggins Theory. The phase diagrams showed an UCST behaviour for the system and led to critical compositions between 10-12 % in volume of PS in the range of temperatures studied. The glass transition temperatures (Tg) were measured by DSC. Two Tg were observed for most modified systems, indicating the existence of two separated phases which were not pure but contained amounts of the other component. The morphologies of the materials were observed by SEM. Different types of morphologies were obtained depending mainly on the initial proportion of PS. The effect of cure temperature and modifier proportion on the size and concentration of dispersed particles was analyzed and discussed for each type of morphology. The critical compositions theoretically obtained were in the possible range shown by the morphologies, indicating a good agreement between thermodynamic and morphological results.

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