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ORIGINAL CONTRIBUTION

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Towards microphase separation in epoxy systems containing PEO/PPO/PEO block copolymers by controlling cure conditions and molar ratios between blocks. Part 2. Structural characterization

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Abstract The influence of addition of poly(ethylene oxide)-block-poly (propylene oxide)-block-poly(ethylene oxide) (PEO–PPO–PEO) copolymers on final morphologies of modified epoxy matrices has been investigated as a function of PEO:PPO molar ratio and cure conditions by comparison with the cured epoxy blends only containing poly(ethylene oxide) (PEO) or poly(propylene oxide) (PPO) homopolymers. Atomic force microscopy (AFM) has been used to characterize structural features of blends. Whilst diglycidyl ether of bisphenol-A (DGEBA)/4,4'-diaminodiphenylmethane (DDM)/PPO system macrophase separates, the interactions between PEO and cured epoxy are responsible for miscibility of DGEBA/DDM/PEO system. Depending on PEO:PPO molar ratio, micro- or macrophase separated morphologies have been obtained for block copolymer modified epoxy matrices. Moreover, the influence of both copolymer content and cure temperature on final morphologies has also been investigated by both experimental and theoretical analysis.

Keywords Epoxy · Triblock copolymers · Homopolymers · Microphase separation · Thermodynamics

Introduction

The modification of epoxy resins with block copolymers has been investigated by several authors in recent years [1–10; Larrañaga et al., submitted for publication; 11–13]. Block copolymers are the focus of a great deal of research activity because their intrinsic ability to self-assemble into different structures ordered at nanoscale. One feasible pathway for generating microphase separated thermosetting matrices is the use of amphiphilic block copolymers with one of the blocks miscible with the epoxy resin. Understanding the principles that underlie the development of such morphologies can allow the design of novel nanomaterials in a controlled way.

Recent studies carried out by Ritzenthaler et al. [2, 3] for ABC triblock copolymer/epoxy-diamine blends show that the way to avoid macrophase separation and to obtain microstructured thermoset matrices is to use block copolymers containing a block miscible with the growing matrix during the whole cure reaction process. As reported before [4], though cure conditions are important to obtain micro- or macrophase separated systems, the generation of microphase separated structures is not only a function of block constituents, but also of block ratio.

In the first part of this work (Larrañaga et al., submitted for publication), the influence of PEO:PPO block ratio on cure kinetics of PEO–PPO–PEO modified epoxy systems has been investigated. Different delay on cure kinetics was