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ABSTRACT:

Polymerization-Induced Phase Separations in Epoxies Modified with Amphiphilic Block-Copolymers – A Phenomenological Approach

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The incorporation of amphiphilic block copolymers (BCP) into anhydride-cured epoxy systems leads to polymerization-induced phase separation, resulting in interesting nanoscale and micro-scale structures with technological relevance. The BCP-modified reactive system is optically transparent and therefore presumably ideally miscible. This initial optical transparency is reflected in the ideal shape of the Fresnel curves. As network formation progresses, the miscibility of the epoxy/BCP mixture is lost due to phase separation. This polymerization-induced phase separation is characterized using temperature-modulated optical refractometry (TMOR). When the resulting domains reach diameters comparable to the wavelengths of visible light, significant distortions of the Fresnel curves occur. The polymerized end product is characterized by scanning electron microscopy (SEM), atomic force microscopy (AFM), and dynamic mechanical thermal analysis (DMTA). The evolution of the shape of the Fresnel curves suggests that structural development during phase separation is a continuous, monotonic process. Examination of the resulting morphologies indicates that structural formation during phase separation involves a process resembling nucleation, followed by diffusion-controlled nucleus growth. The final morphology is determined by the competition between polymerization and phase separation. Based on the local volume ratios, it can be inferred that the phase-separated domains consist of interpenetrating epoxy/BCP network structures.