

CONTROLLED PHASE SEPARATION AND THERMO-MECHANICAL PROPERTIES IN HYBRID RADICAL/CATIONIC SYSTEMS USING PHOTOPOLYMERIZATION

Erion Hasa and C. Allan Guymon

Chemical and Biochemical Engineering, University of Iowa, Iowa City, IA 52246 USA

Polymerization-induced phase separation has shown promise in generating materials with controllable morphology and mechanical properties. In this work, we show that light initiation intensity and formulation chemistry allow direct control of phase separation in photo-cured hybrid radical/cationic systems. Interestingly, irradiation intensity has a deterministic effect on the formation of phase-separated domains. By increasing the irradiation intensity in butyl acrylate (BA) and di-oxetane (DOX) photopolymerizations, the morphology changes from one with a continuous softer BA domain to one with co-continuous BA (soft) and DOX (hard) domains. At higher irradiation intensity, the domain size of each phase is decreased due to fast photopolymerization which limits significantly monomer/polymer diffusion (Figure 1). On the other hand, irradiation intensity has little to no effect on polymer structure and mechanical properties for systems with low concentrations of BA as no phase separation is observed. Phase separation dramatically enhances mechanical properties such as Young's modulus and elongation at break at higher irradiation intensities as well as opacity and gloss. The extent of phase separation is controlled further by incorporating multi-functional monomers that either cross-link the soft acrylate soft domain or connect the hard and soft domains using a hybrid acrylate-oxetane monomer. The domain size of the harder oxetane phase reduces with increasing crosslinker concentration because of faster gelation. Interestingly, an approximately three-fold increase in toughness is observed with higher elongation at break due to small hard and soft domains facilitated by controlled cross-linking and photo-cure intensity. These results demonstrate the ability to control the morphology and thereby significantly enhance properties of radical/cationic systems through photopolymerization-induced phase separation with increased irradiation intensity and cross-linker design.

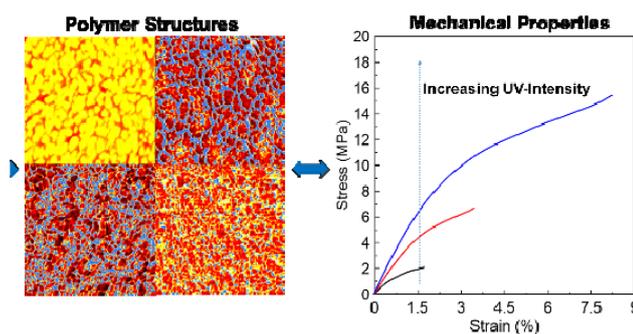


Figure 1, Polymer morphology and corresponding mechanical properties of hybrid radical/cationic systems with increasing UV curing intensity.