598a Quaternary Ammonium Surfactant Effects on Polymerization Rates in Clay-Polymer Nanocomposite Systems

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Clay particles are typically modified with quaternary ammonium surfactants (comprising a polar head and non-polar alkyl tail) to render them organophilic and more miscible for polymer nanocomposite applications. Commonly used surfactants are non-polymerizable, and do not contribute to the mechanical properties of the composite. Moreover, the high surface area to volume ratio in nanocomposites may provide opportunities to study surface effects in reaction behavior, specifically for photopolymerization, which, to date, has received little attention in nanocomposite material processing. In this contribution, effects of surfactant type and clay particles on the rate of photopolymerization will be examined. Photopolymerization kinetics of polymerizable quaternary ammonium surfactants and their non-polymerizable analogs were monitored in a modified Photo-Differential Scanning Calorimeter (photo-DSC) and using Real Time Infrared spectroscopy (RTIR).

Polymerization of a neat monomer and photoinitiator shows a significant decrease in the rate of photopolymerization when clay nanoparticles are added. On the other hand, the rate of photopolymerization increases with increasing surfactant concentration when polymerizable surfactant is present in the clay/monomer mixture. A relatively constant rate of photopolymerization is observed when non-polymerizable surfactants are incorporated. Though small in magnitude, similar enhanced rates were observed in the absence of bentonite clay, indicating that a number of factors affect the rate. A comparable study with lauryl methacrylate (LMA) and 2-hydroxyethyl methacrylate (HEMA) shows a logarithmic decay in photopolymerization rate with increasing loading, with the LMA system showing a less substantial decrease in comparison to the HEMA system. These results indicate possible synergistic effects due to the addition of bentonite and the polymerizable surfactants. In light of lowered polymerization rates for typical and nanocomposite methacrylate/acrylate copolymerizations, these results show a unique and promising avenue for synthesizing clay-polymer nanocomposite materials.