

Determining the synergistic effect of organoclay and carbon black on the morphology, structure, and mechanical properties of Epoxy-polymer using X-ray and AFM

Pranav Nawani, Leila Seyed Faraji and Raman P. Singh

Polymer nanocomposites are hybrid materials containing organic and inorganic components blended together, occurring naturally or synthetically processed. In such materials the transition of length scale from micrometer to nanometer yields dramatic changes in physical properties as nanoscale particles have a large surface area for a given volume of filler. The key to effective property enhancement is dispersion of the nanofillers as the improvements will depend not only on the properties of individual components but also on their morphology and interfacial interaction. Organoclays are organically modified layered silicates, which are widely used as nanofillers. They have sheet like morphology and sheets are stacked, which can be either intercalated or exfoliated by the polymer chains. The process of clay dispersion often results in the disintegration of large silicate stacks and formation of primary tactoids, which can be further disintegrated into single platelets, thus increasing the effective specific surface area. The property enhancement of polymer nanocomposites is, for the most part, governed by the morphological state of the nanofillers. The polymer nanocomposite thus formed shows a notable enhancement in the mechanical properties, the gas permeability, and flame retardation. Another filler carbon black, which when dispersed in the polymer matrix, can form a strong percolating network of nanostructures, resulting in an enhancement of various polymer properties. In this study we present synergistic effects of organoclay and carbon black, dispersed together in a Epoxy polymer matrix, on the structure and mechanical properties of polymer. We present the characterization of the morphology, structure, mechanical and the micromechanical properties in a series of Epoxy nanocomposites, containing organoclay as filler with and without carbon black. Two characterization techniques for the determination of nanoclay morphology (i.e., exfoliation vs. intercalation, stacking sequence statistics) atomic force microscopy (AFM) and X-ray have been used to evaluate structure of nanocomposites. We have used conventional methods to evaluate mechanical properties and AFM for micromechanical properties.