255e Properties and Morphology of Organoclay/Poly(Styrene-Co-Acrylonitrile) Nanocomposites: Effect of Copolymer Composition

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Polymer/montmorillonite clay (MMT) nanocomposites have generated significant commercial interest due to the excellent balance of properties produced at very low filler loadings. For melt-processed nanocomposites in particular, compatibility between the organoclay and polymer must be optimized in order to insure proper dispersion early in the mixing process, but the issues controlling proper clay dispersion in this complex environment are poorly understood. Current studies examine the effects of polymer and organoclay structure on properties of melt-processed poly(styrene-co-acrylonitrile) (SAN)/MMT composites, where the SAN copolymer is a model system for the more complex ABS/MMT nanocomposites, with applications in computer housings. Interactions between the polymer and silicate surface were probed by varying the SAN copolymer composition in melt-processed nanocomposites formed from a single organoclay. In order to utilize a wide range of copolymer structures (acrylonitrile compositions varied from 0-58 weight % in this study), where materials were available in limited supply, the nanocomposites were processed on a DSM microcompounder. Young's modulus was determined from injection molded parts produced on a small-scale pneumatic ram benchtop molding device. Modulus data are corrected for the effects of variation in matrix modulus and reinforcement levels observed in these composites are quantitatively compared. TEM-based digital image analysis of the particle dispersion are also presented, leading to predictions for the modulus using Mori-Tanaka and Halpin-Tsai composite theories, which are then compared to experimental moduli. Wide angle x-ray scattering results are also discussed. Higher acrylonitrile content was found to produce increased reinforcement after correcting for the effect of the matrix modulus. Improvements in reinforcement were also noted for higher screw rpm, indicating that increasing dispersion with increasing acrylonitrile content is not solely due to improvements in compatibility as the copolymer polarity is increased. TEM-based specific particle densities reached ~8 particles/μm^2 compared to well-exfoliated nylon 6 composites at 100 particles/μm^2, and an explanation for the exfoliation levels in SAN/MMT nanocomposites is suggested in terms of the thermodynamic driving force.