Application of Large Amplitude Oscillatory Shear (LAOS) Method for Assessment of Morphological Changes Caused by Addition of Block Copolymers Into CNT-based Immiscible Polymer Blend Nanocomposites

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Abstract

Polypropylene (PP): Polystyrene (PS) /70:30/MWCNT 1.0 vol.% blend nanocomposites containing different loading of a diblock styrene/butadiene copolymer have been prepared using melt mixing method. Light optical microscopy (LOM) images revealed significant differences in morphology upon incorporating the block copolymers. The copolymers effectively decreased the domain size in the blend nanocomposites. This is a direct consequence of localization of the copolymer at the interface of the immiscible blend and thus morphology stabilization. The increase of MWCNT content, which is known to induce co-continuity in PP:PS blends, did not block or slow down the migration of copolymer to the interphase.

Strain sweep tests confirmed the compatibilization effect of the copolymers added to the blend systems. With increasing copolymer content, an increase of the storage modulus as well as the strain for linear to non-linear transition was observed. This was related to the resistance of the copolymer segments to be unraveled from each of the phases, thus increasing the nanocomposite resistance to flow. In addition, the two-step yielding observed in PP:PS/70:30/MWCNT 1.0 vol.% disappeared upon addition of copolymers. To investigate the effect of the copolymer on nonlinear viscoelastic behavior of the polymer blend nanocomposite samples, the nonlinear viscoelastic parameters were obtained using large amplitude oscillatory shear (LAOS) flow. Results of the nonlinear response of are mainly presented using qualitative stress-strain or stress-strain rate Lissajous-Bowditch plots, physical interpretations based on intra-cycle nonlinearity parameters and Chebyshev coefficients.