ABSTRACT

Polymer nanocomposites based on organically modified montmorillonite (OMMT), vapor-grown carbon nanofiber (VGCNF), and multi-walled carbon nanotube (MWNT) filled thermoplastic polyurethane (TPU) were prepared by melt blending technique. The nanofillers were added to the TPU matrix in order to study the effect of nanofillers on nanophase morphology and structure–property relationships. The interfacial interactions between TPU matrix and nanofillers were studied by Fourier transform infrared spectroscopy (FTIR). The morphological characterizations of the nanocomposites were carried out by wide angle X-ray diffraction (WAXD), transmission electron microscope (TEM), scanning electron microscope (SEM), atomic force microscope (AFM), and polarizing optical microscope (POM) techniques. The results showed that the melt mixing is an effective process for homogeneous dispersion of the nanofillers throughout the TPU matrix. The thermogravimetric analysis (TGA) revealed that the thermal stability of the TPU nanocomposites was significantly improved by the incorporation of nanofillers. The activation energy (E_a) of the thermal decomposition was calculated by using Kissinger, Flynn–Wall–Ozawa, and modified Coats–Redfern non-isothermal kinetic methods. The differential scanning calorimetry (DSC) result revealed that the melting temperature (T_m), glass transition temperature (T_g), and enthalpy of melting (ΔH_m) of both soft and hard segments of TPU matrix were not well affected by the addition of nanofillers. The effects of applied strain amplitude, frequency, and temperature on dynamic mechanical properties of the TPU nanocomposites were analyzed using a dynamic mechanical thermal analysis (DMTA) technique from which it was concluded that the addition of nanofiller noticeably improved the storage modulus (E') and T_g of the TPU matrix. The effects of clay content and degree of clay dispersion on the dynamic rheological properties of TPU nanocomposites were studied using a rubber process analyzer (RPA) as a function of applied shear strain, angular frequency, and temperature. The complex viscosity (η^*) and storage modulus (G') of TPU nanocomposites increased significantly with insertion of nanofillers. The Han, Cole–Cole, and van Gurp–Palmen plots were employed to investigate the structural differences of heterogeneous TPU nanocomposites. The electrical properties of the nanocomposites were increased with increase in wt% of CNT loading. The mechanical properties of nanocomposites were substantially improved by the incorporation of nanofillers.

Keywords: *Carbon nanofibers; Carbon nanotubes; Material properties; Morphology; Nanocomposites; Organoclays; Thermoplastic polyurethane*