Improving the Optical and Thermal Properties, and Stress-Strain Behavior of a PV(Ac-C) Blend using PbO and MgO nanofillers: A comparative study

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Abstract

Introducing nano-sized fillers increases the matrix/reinforcement interface in polymer nanocomposites (PNC) and improves the performance of these materials. In this work, sol-gel prepared PbO, MgO, and $Pb_{0.5}Mg_{0.5}O$ powders were incorporated into a poly(vinyl acetate)/poly(vinyl chloride) [PV(Ac-C)], blend. FE-SEM, HR-TEM, and XRD analyses indicated that PbO was composed of nanoparticles (NP) in two phases (tetragonal and orthorhombic) and MgO had a nanoneedle-like morphology with varying lengths and cubic crystal structure. MgO was well distributed in the PV(Ac-C) matrix without affecting its structure. FTIR spectroscopy confirmed the presence of Mg–O and Pb–O vibrations, and the tendency of the materials to adsorb gases (H_2O and CO_2) from the surrounding atmosphere. The addition of MgO and PbO effectively reduces the intensity of the vibrations of all the blended functional groups, while $Pb_{0.5}Mg_{0.5}O$ improved the vibrational properties of the blend. The pure blend showed high transmittance (89% at λ =700 nm) and 1.0 wt.% of MgO, PbO, and $Pb_{0.5}Mg_{0.5}O$ decreased this value to 67.82, 38.13 and 55.73%, respectively. Moreover, the optical bandgap decreased and the ratio of charge carriers to electron effective mass (N/m^*) were influenced by the dopants. 1.0 wt.% MgO greatly improved the mechanical properties of the blend. Furthermore, thermogravimetric analysis (TGA) and differential scanning calorimetric (DSC) showed that the films exhibit thermal stability in the temperature range of 120–240 °C. The effect of the dopants on the glass transition temperature (T_g) and melting temperature (T_m) has been reported. Our results indicate the doped PV(Ac-C) blend is a suitable candidate for coatings and packaging applications.

Keywords: PV(Ac-C) blend; Optical constants; Stress-strain behavior; Toughness; Thermal stability.

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