Spectroscopic, Thermal and Electrical Properties of MgO/PVP/PVA Nanocomposites

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Abstract

This work aims to control the optical and electrical properties of polyvinyl alcohol (PVA) in order to broaden its industrial and technological applications. This is achieved via blending PVA with Polyvinyl pyrrolidone (PVP) and adding the sol-gel prepared MgO nanopowder. The blend film and nanocomposite films were prepared by the solution casting technique. X-ray diffraction (XRD) results showed that the crystallite size of MgO is ~18.4 nm and the highest degree of crystallinity (X_C) of the films is about 24.34% at 1.0 *wt.%* MgO. High resolution transmission electron microscope (HR-TEM) exhibit the nanoribbons morphology of MgO. Scanning electron microscope (SEM) showed the uniform distribution of MgO nanoribbons inside the surface of PVA/PVP films. Also, SEM and Fourier transformation infrared spectroscopy (FTIR) confirmed the interaction between the blend and MgO fillers. The influence of the additives on the glass transition (T_g) and melting (T_m) temperatures evaluated by the differential thermal analysis (DTA) and differential scanning calorimetry (DSC). The appearance of one melting point confirms the miscibility of the two polymers. According to UV-VIS-NIR spectroscopy measurements, the optical properties and optical constants of PVA are adjustable by PVP and MgO addition, where the optical band gap (E_g) of PVA increased with PVP, then decreased to 4.8 eV with increasing MgO content. The DC conductivity (σ_{dc}) of the films increases while the activation energy (E_a) decreases with MgO addition. This may be due to the nanoribbons shape that fixes the preferred conducting pathways. Also, MgO can break the H-bond of blend -OH groups that causes some freedom of molecular chains motion.

Keywords: PVP/PVA Nanocomposites; MgO nanoribbons; FTIR spectra; Band gap tuning; Optical constants; DC Conductivity