Structural, Morphological, Optical and Dielectric Properties of M^{3+}/PVA/PEG SPE Films (M =La, Y, Fe or Ir)

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Abstract

Low band gap polymer complexes are promising due to its flexibility, low cost and exhibiting electronic and optical properties of inorganic semiconductors. The effect of polyethylene glycol (PEG) content on the physical properties of polyvinyl alcohol (PVA) was evaluated. Then, the blend (PVA: PEG = 50:50) doped with rare earth (La or Y) and transition metal (Fe or Ir) chlorides to obtain solid polymer electrolyte (SPE) films. X-ray diffraction shows that adding PEG to PVA results in a new peak at $2\theta = 23^{o}$ with increased intensity as PEG ratio increases. However, doping with La^{3+}, Fe^{3+} or Ir^{3+} eliminate this peak and decrease the crystallinity degree of the blend. Scanning electron microscopy (SEM) exhibits significant changes in the morphology of the films. FTIR spectroscopy confirms the miscibility between PVA and PEG and the complexation of the salts with the blend. The optical band gap (E_g) of PVA ~ 5.37 eV, decreased slightly by blending with PEG. While it decreased significantly to 2.64 eV and 2.78 eV after doping with Fe^{3+} or Ir^{3+}. There are a consistency between the E_g values obtained by using Tauc's model and that obtained from the optical dielectric loss. The dielectric constant and dielectric loss, in the temperature range 303 - 405 K and frequency range 1.0 kHz - 5.0 MHz, indicate one or two relaxation peak(s) depending on the film composition. Accordingly, the conduction mechanism varied between correlated barrier hopping and large polaron tunneling. The DC conductivity was strongly depend on the dielectric loss. The transition metal salts appear to be more effective than the rare earth ones in increasing the σ_{ac} of investigated SPE films to higher values that candidates them in semiconductors industry.

Keywords: PVA/PEG blend; Solid polymer electrolyte; low band gap polymers; Conduction mechanism; Activation energy; rare earth metal complexation.