Influence of the Sol–Gel-Derived Nano-Sized TiO_2 and Y_2O_3 in Improving the Optical and Electric Properties of P(VAc/MMA)

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Abstract : Metal oxides (MO)/polymer nanocomposites are attracting more attention due to their low cost and multifunctionality in diverse fields. In this report, two nano-sized MO (TiO_2 and Y_2O_3) were prepared by the sol-gel method and dispersed into a biodegradable poly(vinyl acetate)/ poly(methyl methacrylate), P(VAc/MMA) blend via the solution casting. The structure, chemical composition, morphology, UV-vis spectra, dielectric and electrical properties of the prepared samples were studied. XRD and FE-SEM showed the high purity of the prepared cubic TiO_2 nanoparticles (TNp) and Y_2O_3 nanosheets (YNs). The added MO fillers are well-dispersed inside the polymer blend and influenced its amorphous nature and surface morphology. FTIR spectra indicated a high activity of the nano-fillers towards the surrounding atmosphere, and confirmed the complexation and interaction between fillers and blend functional groups. TNp-doped films exhibited lower transmittance and narrowed the optical band gap (E_g) of the blend from 4.03 to 3.63 eV. The effect of TNp and YNs on the dielectric modulus, ac conductivity (σ_{ac}) and the blend activation energy (E_a) were also discussed. TNp improved the σ_{ac} more effectively from 1.99 x 10^{-7} to 6.292 x 10^{-5} S/cm. Moreover, increasing YNs content expanded the time required for relaxation process. The obtained TNp and as well as their nanocomposite films are suitable for the semiconductor industry and devices.

Keywords: Y_2O_3 nanosheets; MO/polymer nanocomposites; Anatase nanoparticles; band gap; Activation energy; AC conductivity.