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Influence of Bi_2O_3, PbO, and Y_2O_3 nanofillers on the physical features of polyvinyl chloride: Materials for optoelectronics or dielectric applications

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Abstract

This paper presents a new attempt to develop flexible polymeric materials for optoelectronic and/or dielectric applications. Nano-sized bismuth oxide (Bi_2O_3), lead oxide (PbO), and yttrium oxide (Y_2O_3) nanoparticles (NPs) were prepared by a facile chemical route. Then, these oxides were loaded into the polyvinyl chloride (PVC), resulting in PVC:Bi, PVC:Pb, and PVC:Y nanocomposites. The samples' microstructure was investigated by transmission electron microscopy (TEM), X-ray diffraction (XRD), and scanning electron microscopy (SEM). XRD results showed that the phases and sizes of Bi_2O_3, PbO, and Y_2O_3 are (monoclinic, 71 nm), (tetragonal, 59 nm), and (cubic, 22.8 nm), respectively. In addition, XRD and Fourier transform infrared (FTIR) spectroscopy confirmed the inclusion and interaction of these fillers with the PVC. FTIR and optical measurements revealed the high Cl content in PVC. The influences of fillers on the transmittance spectra and extinction coefficient are reported. The index of refraction improved from ~1.46 to ~4.03. The films displayed dual direct (5.2 and 4.26 eV) and indirect (5.0 and 4.1 eV) band gaps that narrowed to (5.0, 4.2 eV) and (4.8, 4.0 eV), respectively, after doping. The real/imaginary dielectric constant and modulus are discussed. PVC showed a maximum ac conductivity of ~ 3×10^{-6} S/m, increased to 10×10^{-6}, 14×10^{-6}, and 25×10^{-6} S/m for PVC:Y, PVC:Bi, and PVC:Pb films, respectively. The findings of this study suggest that PVC:Y is the best for optoelectronic and photonic devices, while PVC:Pb and PVC:Bi are the best for developing dielectric materials for supercapacitors and energy storage.

***Keywords*:** Y_2O_3/PVC nanocomposites; Bi_2O_3 NPs; Dual-band gap; AC conductivity; Dielectric relaxation.