Preparation and characterization of CuO/Co_3O_4/ poly(methyl methacrylate) nanocomposites for optical and dielectric applications

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Abstract

Composites of transition metal oxides (TMOs)/polymers have many modern technological, industrial, and biological applications. Co_3O_4 and CuO nanoparticles (Nps) were synthesized by sol–gel. Then they are doped into poly(methyl methacrylate) (PMMA) via the solution casting method. The obtained Nps and nanocomposites were then investigated using several techniques. XRD and HR-TEM indicated the high purity of Co_3O_4 and CuO Nps of face-centered cubic (fcc) with 58 nm average particle size (D_{av}), and monoclinic structure with D_{av} = 35 nm, respectively. The amorphous nature of PMMA was influenced after mixing with these Nps. SEM and FTIR confirmed the interaction between Nps and the polymer chains. The pure sample showed transparency of about 90% and Nps addition narrowed the optical bandgap effectively while keeping the samples with high transmittance. CuO is more effective than Co_3O_4 on the optical parameters of the nanocomposites. The dielectric constant improved after adding the Nps, while all samples have a low dielectric loss. Additionally, the effects of Co_3O_4 and CuO on the ac conductivity, conduction mechanism, Argand plots, and the dielectric modulus are reported. Our nanocomposites are considered a promising candidate for nanotechnology-based devices such as electric stress control, film capacitors and anti-reflective coating for solar cell application.