Enhancing the Performance of PVC/PMMA Polymer Blend Through Hybrid Nanofiller of TiO2 NPs/GNPs for Capacitive Energy Storage Applications

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Abstract:

Polyvinyl chloride (PVC) and polymethyl methacrylate (PMMA) have been used as polymeric matrices for the synthesis of polymeric nanocomposite films that incorporate titanium oxide nanoparticles (TiO_2 NPs) and graphite nanoplatelets (GNPs) as nanofillers. Based on TEM studies, TiO_2 nanoparticles have a tetragonal anatase phase, ranging in size from 15 to 60 nm, whereas GNPs have a nanoplatelet-like shape, varying in thickness from 10 to 20 nm. XRD analysis shows that PVC/PMMA polymer nanocomposite samples have less crystallinity when added with TiO_2 NPs and GNPs. Infrared Fourier analysis (FT-IR) indicated a complex interaction between the PVC/PMMA blend and both GNPs and TiO_2 NPs. The UV/visible spectrum of the PVC/PMMA blend showed two absorbance peaks at 279 and 223 nm which may result from the $n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ transitions. Moreover, optical bandgaps were reduced for both indirect and direct transitions when TiO_2 NPs and GNPs were added. AC electrical conductivity and dielectric properties of the samples were measured at room temperature. Results indicated a significant increase in conductivity after filling from 2.6 x 10^{-14} S/cm for pure PVC/PMMA to 7.3 x 10^{-6} S/cm for PVC/PMMA-TiO_2/GNPs nanocomposite. In addition, high nanoparticle concentrations lead to higher composite dielectric loss and dielectric constants. These findings suggest the possibility of using the prepared nanocomposites in capacitive energy storage and optoelectronic devices.

Keywords:

PMMA, PVC, TiO2 NPs, GNPs, Dielectric functions, AC conductivity.