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Synthesis, structural, optical, and dielectric properties of $CuWO_4$/PVP/Cs bio-nanocomposites for some industrial applications

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ABSTRACT

The nanocomposites of biopolymers and bimetallic oxides are exciting classes of materials. Besides the economic and environmental considerations, these materials became the best candidates for various applications in industry and medicine. In this study, $CuWO_4$ nanoparticles (NP) with high purity were prepared by co-precipitation and loaded into poly(vinyl pyrrolidone)/chitosan (PVP/Cs) films. XRD results showed that $CuWO_4$ has a triclinic phase with an average crystallite size of 43 nm. PVP/Cs is semi-crystalline blend and its crystallinity degraded by $CuWO_4$ incorporation. EDX analysis was used to study the chemical composition of all samples. FE-SEM showed that $CuWO_4$ has particle sizes of 50–150 nm and that the crack-free surface of PVP/Cs became rougher and more porous after loading of $CuWO_4$ NP. FTIR confirmed the presence of the reactive functional group of $CuWO_4$, PVP, and Cs and that the low doping ratio of $CuWO_4$ NP restricted the functional group's vibrations. The UV–vis–NIR investigation showed that the films have a small absorption index and high transmittance in the range of 68–90%. The direct and indirect band gaps (E_g^{dir} and E_g^{ind}) of the blend were found equal to 5.0 and 4.2 eV and can be tuned by $CuWO_4$ content. Similarly, the index of refraction and carrier concentration/electron effective mass ratio (N/m*), the dielectric constant ($\varepsilon' = 8.3–24.5$), and the dielectric loss depend on the applied frequency, temperature, and $CuWO_4$ filler content. The conductivity (σ_{ac}) ranges from 1.2×10^{-6} to 9.16×10^{-4} S/m and exhibits the Arrhenius behavior. The optical and dielectric results show that the prepared PNC may suit some energy storage device,s such as supercapacitors, and organic optoelectronic devices, such as light emitting diodes and/or photovoltaic solar cells.

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