Synthesis, Characterization, Dielectric, and Optical Properties of the Chitosan/Poly(ethylene glycol)/Magnesia Biopolymer Nanocomposites

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Abstract

Nanosized magnesia (MgO) was synthesized and mixed with the biopolymer chitosan/poly(ethylene glycol) (CsPEG) blend. The nanocomposite films were characterized using different techniques: X-ray diffraction (XRD), scanning electron microscopy (SEM), and Fourier transform infrared (FTIR). The dielectric and optical properties were studied. SEM showed a homogeneous dispersion for MgO on the surface of the porous CsPEG films, where the pores' sizes depended on the filler content. XRD and FTIR spectra displayed a significant change in the crystallinity and intensity of the characteristic peaks of the functional groups in the composite films with increasing amount of magnesia. The dielectric permittivity, tan $\boldsymbol{\delta}$, and ac conductivity, σ_{ac}, of the films were studied in the range 306–411 K and 0.1 kHz – 5 MHz. Two relaxation peaks were observed for pure and 5 wt% magnesia-doped CsPEG. The behavior of $\sigma_{ac}(f)$ for the composite films indicated that the conduction mechanism was correlated barrier hopping (CBH) while $\sigma_{ac}(T)$ is thermally activated depending on magnesia content. The transmittance and refractive index (n) of nanocomposites were studied in the UV–vis range. Various electric and optical parameters were evaluated. The 5 and 10 wt% MgO loaded films are candidate for some biomedical applications and 10–15 wt% MgO/CsPEG film may be used for the antireflection coating applications.

Keywords: Biopolymer blend; Nanosized magnesia; Chitosan/poly(ethylene glycol) (CsPEG); Dielectric relaxation; Optical constants; Refractive index.