Synthesis, Structural, Thermal, Optical and Dielectric Properties of Chitosan Biopolymer; Influence of PVP and α-Fe_2O_3 Nanorods

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Adel M. El Sayed[1,2] Ahmad Desoky M. Mohamed[3,4]

[1]Department of Physics, Faculty of Science, Fayoum University, Fayoum 63514, Egypt.
[2]Department of Physics, Faculty of Science, Northern Border University, Arar 91431, KSA.
[3]Department of Chemistry, Faculty of Science, Sohag University, Sohag 82524, Egypt.
[4]Department of Chemistry, Faculty of Science, Northern Border University, Arar 91431, KSA.

Abstract

The present work reports the influence of Polyvinylpyrrolidone (PVP) and hematite (α-Fe_2O_3) nanorods (NRs) on the physicochemical properties of chitosan (Cs), as an approach to broaden its medical and technological applications. Hematite NRs of 11.4 nm diameter and 87.9 nm crystallite size were prepared by a free-template chemical method. Cs, PVP/Cs and blend loaded with hematite NRs were prepared by solution casting. Significant changes in the films' surface were clarified using the scanning electron microscope (SEM). Fourier transformation infrared spectroscopy (FT-IR) confirmed the interaction between the NRs and the NH_2 and OH functional groups of Cs. DSC measurements showed one endothermic peak assigned to the water elimination, and an exothermic one, in the range 268 – 287 ^oC, attributed to the decomposition of saccharine structure in Cs. The swelling properties of the films were sensitive to the pH of the solution. PVP/Cs film showed ~ 85 % transmittance in the visible region and its optical band gap narrowed from 5.4 eV to 4.05 eV after loading with 2.0 *wt.%* hematite. The influence of NRs content on the optical constants of the films is discussed. The dielectric properties depend on the film' structure. The large Polaron tunneling (LPT) model is the best suitable mechanism for the electric conduction. Due to their high thermal stability and decomposition temperature, transmittance and high conductivity, the prepared films are a candidate for the packaging industry, for use in some medical applications such as treating some chronic wounds, and optical windows and fibers.

Keywords: PVP/Chitosan blend; Biopolymer; Nanocomposite; DSC; Swelling; Optical constants; Conductivity; Conduction mechanism