Spectroscopic, Optical and Dielectric Investigation of (Mg, Cu, Ni, or Cd Acetates' influence on Carboxymethyl Cellulose Sodium Salt/Polyvinylpyrrolidone Polymer Electrolyte Films

Journal of Electronic Materials 49 (2020) 2381–2392. https://doi.org/10.1007/s11664-020-07953-x

Adel M. El Sayed, Gomaa Khabiri

Physics Department, Faculty of Science, Fayoum University, Fayoum 63514, Egypt

Abstract

Solid polymer electrolytes (PEs), which have a low bandgap and high a dielectric constant, are an interesting technology for optoelectronic applications and supercapacitors. This work studies the influence of Mg, Cu, Ni or Cd acetates on the structural and optical properties and the dielectric relaxation phenomena in carboxymethyl cellulose sodium salt (CMC)/ polyvinylpyrrolidone (PVP) blends. The dielectric behavior, ac conductivity and electrical modulus formalism were investigated in a frequency range of up to 1 MHz at room temperature. X-ray diffraction energy dispersive X-ray, Fourier transform infrared spectroscopy and scanning electron microscopy, revealed modifications films' structural and chemical compositions and their morphology. UV-vis and dielectric properties measurements revealed that the Cu and Mg salts had more distinctive influences on the optical properties, ac conductivity (σ_{ac}) and relaxation behavior. Cu and Mg reduced the optical bandgap E_g of the CMC/PVP blends from 5.1 eV to 4.7 and 3.6 eV, respectively, but increased σ_{ac} from 8.61 x 10^{-5} S/cm to 1.34 x 10^{-4} and 1.81 x10^{-4} S/cm, respectively. The dielectric measurements revealed an increase in the dielectric constant and dielectric losses for the composite films, which reflect the enhancement of the dielectric polarization of the films. The electric modulus spectra, calculated relaxation time and Argand plots confirmed an improvement in the ionic conductivity of the composite films. These results indicate that the incorporation of the acetate salts is a simple approach to widening the technological importance of CMC/PVP blend films for some optoelectronic devices and Cu and Mg battery applications.

Keywords: Polymer electrolyte; Polymer/salts complexation; Band gap; Refractive index; Dielectric relaxation; ac conductivity