Structural, thermal, optical and conductivity studies of Co/ZnO nanoparticles doped CMC polymer for solid state battery applications

M.M.Abutalib[a] A.Rajeh[b]

University of Jeddah, College of Science, Department of Physics, Jeddah, Saudi Arabia
Physics Department, Faculty of Science, Saadah University, Saadah, Yemen

Abstract

In this study, a simple chemical precipitation method was used to synthesize ZnO: Co^{2+} as nanoparticles. The solution casting technique was used for the preparation of polymer films of Carboxymethyl cellulose (CMC) doped with different contents (0.5, 1.5, 3, and 5 wt%) of ZnO/Co NPs. As shown by the X-ray diffraction, the average size of ZnO/Co crystallite of the NPs is 25.6 nm. Meanwhile, the addition of ZnO/Co reduced the semi-crystallinity of CMC. The Fourier transform infrared (FTIR) confirmed the interaction between the ZnO/Co NPs and the polymer CMC. The direct and indirect band gap (Eg) was reduced from (5.32–5.01 eV and 5.20 to 4.99 eV respectively) with the increase in ZnO/Co NPs content up to 3 wt% after this content the Eg is increased as shown by the UV–Vis spectra. In addition, the results of TGA displayed the decomposition of the nanocomposite to be little compared to that of the pure CMC indicating the success of fabrication of products. The improvement of the ionic conductivity was noticed upon the addition of ZnO/Co NPs into the polymer CMC system which can be explained in terms of an increase in amorphicity as shown by the impedance spectroscopic study. It was found that the optimum ionic conductivity (3.209×10^{-6} Scm^{-1}) at ambient temperature was higher for the sample containing 1.5 wt% ZnO/Co NPs with highest of amorphicity and the lowest total loss of weight. Therefore, the improvements in optical properties, thermal stability, and AC conductivity which were observed represent a strong support for the use of the nanocomposite films in the solid state battery applications.