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Developing solid polymer electrolytes-based Nd^{3+}/V_2O_5/ethyl cellulose for optoelectronic devices

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ABSTRACT

Solid electrolytes based on biopolymer nanocomposites have gained increased interest in modern applications in environment-friendly optoelectronics, energy storage, and food and pharmaceutical industries. In this study, films of V_2O_5-doped ethyl cellulose (EC) modified with $NdCl_3$ were prepared by facile solution casting and investigated for their structural, thermal, IV characteristics, and optical properties. X-ray diffraction revealed the semicrystalline nature of EC and confirmed the incorporation of V_2O_5 nanoparticles (NP) inside the polymer matrix. Fourier transform infrared spectra indicated the interaction/complexation between the fillers and the EC reactive groups. Scanning electron microscopy showed the uniform distribution of NP and investigated the morphology of the films' surface and cross-section. The thermal analyses were used to study the impact of V_2O_5 NP and $NdCl_3$ on the films' stability and transition temperatures. Non-linear IV characteristic curves were recorded, and the films displayed non-ohmic behavior. The optical analyses (UV-Vis-NIR) showed that EC is highly transparent (~ 92%), which decreased with doping. The bandgap of the films shrank from ~ 5.2 eV to 4.8 eV upon 1.0 wt % V_2O_5 NP doping and then reduced to 3.5 eV when modified with $NdCl_3$. The effect of fillers on the optical parameters (the extinction coefficient, refractive index, optical conductivity, and optical dielectric loss) are reported. The results indicate that the prepared materials are the best candidates for optoelectronic applications, and devices work at room temperature and elevated temperatures.

1 Introduction

The development of thermally stable and flexible nanocomposites and solid polymer electrolytes utilizing eco-friendly materials (polymers) receives increased attention for their importance in the fields of optoelectronic equipment, energy storage, food packaging, and medical/pharmaceutical uses [1, 2]. These composite materials combine the good features of the polymer and nano-sized fillers with those of the salt [3, 4]. The produced electrolytes exhibit the advantages of the facile preparation, the wide operating temperature range, low flammability, no leakage, higher energy density,

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