STRUCTURAL AND OPTICAL PROPERTIES OF Ni NANOPARTICLES – POLYVINYL ALCOHOL NANOCOMPOSITE FILMS

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Polymer–metal nanocomposites are used in large area of electronic applications like the communication field, magnetic storage media, electromagnetic interferences shielding, solar cells and electronic components. Nowadays, magnetic recording devices, waveguide sensors, memory storage devices and optical components consist of metallic magnetic particles dispersed in polymer matrix. The optical material applications are currently at a development stage, so it is necessary to produce new effective material with improved properties. The enhancement of linear and nonlinear optical parameters (optical band gap, linear and nonlinear refractive index, third-order nonlinear susceptibility) of these materials is the main goal for assessing the optoelectronic materials. Recently, the effect of Fe magnetic nanoparticles on the structure and optical properties of polyvinyl alcohol (PVA) nanocomposite films have been studied [1]. Herein, Ni nanoparticles are used as a filler in the PVA matrix. Such system was not investigated till now. The aim of this work is to study the effect of Ni nanoparticles on the structure and optical properties of PVA nanocomposite films. The PVA – Ni nanocomposite films were prepared via solution cast technique. The polymer films were characterized via X-ray diffraction (XRD) using a Bruker D8 Advance diffractometer with Cu Kα radiation (λ= 1.5418 Å). The morphology and the dispersion of the Ni nanoparticle in the polymer matrix were studied by a scanning electron microscope (Carl-Zeiss, LEO982). The optical properties of the polymer films were analyzed using Cary 5000 UV-Vis -NIR double beam spectrophotometer, Agilent Technologies, USA. XRD analysis confirmed the semi-crystalline nature of PVA films. The degree of crystallinity decreases with the increase in Ni nanoparticle concentration. The surface morphology of polymer films is changed from smooth into rough with the increase in Ni nanoparticle concentration in the polymer matrix. The increase of Ni nanoparticle concentration in the polymer matrix leads to: a decrease in optical band gaps (direct and indirect) and increase in Urbach tail energy, refractive index and extinction coefficient of polymer films. The optical dielectric properties and optical conductivity increase as well, with an increase in Ni nanoparticle concentration. The nonlinear optical susceptibility $\chi^{(3)}$ and nonlinear refractive index n_2 are calculated using the Wemple–Di Domenico single oscillator model. The $\chi^{(3)}$ and n_2 values are enhanced with the increase of Ni nanoparticles concentration in polymer films. It can be concluded that the prepared PVA–Ni nanocomposites can be used in optoelectronic and nonlinear optical devices applications.

1. Soliman T.S., Vshivkov S.A. // J. Non. Cryst. Solids. 2019. V. 519. No. 119452.