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Research Article

Linear Optical Properties of Zinc Borotellurite Glass Doped with Lanthanum Oxide Nanoparticles for Optoelectronic and Photonic Application

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Enhancing the optical properties of glasses for the sake of optical application in various fields is an ongoing challenge in materials science and technology. Thus, the optical properties of zinc borotellurite glass doped with lanthanum oxide nanoparticles (La_2O_3 NPs) with the chemical composition of $\{[(TeO_2)_{0.7}(B_2O_3)_{0.3}]_{0.7}(ZnO)_{0.3}\}_{1-x}$ $(La_2O_3$ NPs$)_x$, where x = 0.01, 0.02, 0.03, 0.04, and 0.05 molar fraction, have been investigated. Characterization techniques such as x-ray diffraction, Fourier Transform Infrared Spectroscopy, and Ultraviolet-Visible Spectroscopy are employed to yield the structural properties and optical parameter of the glass. The amorphous nature of the fabricated glasses is confirmed with the presence of a broad hump via XRD diffraction pattern. The decreasing amount of high polarizable nonbridging oxygen as the concentration of La_2O_3 NPs increases has contributed to the increasing trend of energy band gap in the range of 2.70 to 3.52 eV and decreasing value of refractive index between 2.34 and 2.48. The fabricated glasses that have a higher refractive index than the widely used fiber material, pure silica glass, indicate that zinc borotellurite glass doped with lanthanum nanoparticles is a promising material to be applied as optical fibers.

1. Introduction

Glasses doped with rare earth element are materials with high potential to be applied in many fields including optical fibers, amplifiers, laser wave guides, and magneto-optical devices [1]. The properties of oxide glasses strongly rely on the composition and local structure of the glass structure [2]. Lately, in pursuance of synthesizing fiber optics with better linear and nonlinear optical properties, tellurite based glass doped with rare earth element has been extensively studied. Tellurite glasses become the best candidate to be used to synthesize photonics devices because of its low melting temperature, good thermal stability, low phonon energy, and high linear and nonlinear refractive index [3–5].

Meanwhile, boron oxide is an excellent glass former that owns the ability to exist in both three and four coordinated environments, has high strength of covalent B-O bond, is able to form stable glasses, and has high potential to be designed as new optical devices because of their good rare earth ions solubility [6, 7]. Zinc oxide is added in the glass matrix to increase glass forming ability and to ensure low rates of crystallization in the glass system [8].

Lanthanum oxide on the other hand has a band gap value of 4.3 eV and a hexagonal crystal structure and is used in various fields such as in optoelectronic devices and as dopant in camera glass lens to enhance sharpness and to improve clarity of the image. Other than that, lanthanum oxide is used to produce a ceramic superconductor in which the magnetic properties of the lanthanum containing ceramic superconductor could be modified by only inducing light [9].

Extraordinary properties of rare earth ions due to the optical transitions in the intra-4f shell have made rare earth ion a popular dopant in various glass systems [10]. According to Vajtai, when lanthanide nanocrystals is incorporated and