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Effect of Dysprosium Nanoparticles on the Optical Properties of Zinc Borotellurite Glass Systems

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Abstract. The glass samples of zinc borotellurite glass doped with dysprosium nanoparticles with chemical formula $\{[(TeO_2)_{0.7}(B_2O_3)_{0.3}]_{0.7}(ZnO)_{0.3}\}_{1-x}(Dy_2O_3)_x$ (where x= 0.01, 0.02, 0.03, 0.04 and 0.05 molar fraction) have been fabricated by using melt quenching technique. In this study, the structural and optical properties of the zinc borotellurite glass doped with dysprosium nanoparticles were characterized by using X-ray diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR) and UV-Vis spectroscopy. From the XRD, the amorphous nature of the glass samples has been confirmed. The infrared spectra revealed four obvious bands which are assigned for BO_3, BO_4 and TeO_4 vibrational groups. The direct and indirect optical band gap, as well as Urbach energy, was calculated through absorption spectra obtained from UV-Vis spectroscopy. From the spectra, it is observed that both direct and indirect optical band gap decreases as the concentration of dysprosium nanoparticles increase. Other than that, the Urbach energy is observed to have an inverse trend with the optical band gap. The Urbach energy is increases as the concentration of dysprosium nanoparticles increases.

Introduction

The tellurite based glass is well known as an excellent linear and non-linear optical material due to its speciality such as having a low melting point, high dielectric constant, high refractive index, large third order nonlinear susceptibility and good infrared transmission [1]. The rare earth ions are usually incorporated into the tellurite based glass systems in order to produce glasses that suitable for optical applications. The rare earth ions help to enhance the optical properties of the materials due to the structural state and surrounding ligand field of *f*-outer shell electrons [2]. The usage of the nanomaterials has been growing explosively worldwide in the past few years. The nanomaterials exposed unique and interesting properties which usually contributed by two major factors which are finite grain size effects and interface effects. The two factors become more profound as the size of the particles become smaller [3].

The research on the effect of the dysprosium nanoparticles on the glass systems is not yet discovered. Hence, the main purpose of this research is to provide some information regarding the effect of dysprosium nanoparticles on the optical properties of the zinc borotellurite glass systems at different concentration of dysprosium nanoparticles.

Experimental Method

The ZnO-B_2O_3-TeO_2 based glass was prepared by the melt quenching technique. A series of glass systems containing five different concentrations of dysprosium nanoparticle ions (Dy^{3+} NP) were fabricated with chemical formula $\{[(TeO_2)_{0.7}(B_2O_3)_{0.3}]_{0.7}(ZnO)_{0.3}\}_{1-x}(Dy_2O_3)_x$ where x=0.01, 0.02, 0.03, 0.04 and 0.05 molar fraction. All the chemicals were mixed in the alumina crucible and stirred thoroughly to obtain the homogenous mixture. The well-mixed mixture was then being placed in the first furnace at 400 ˚C for 1 hour for the preheated process. The preheated

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