

Synthesis and Optical Characterization of Zinc Borotellurite Glass Doped with Lanthanum Nanoparticles

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Abstract: A glass series with chemical composition of $\{[(\text{TeO}_2)_{0.7}(\text{B}_2\text{O}_3)_{0.3}]_{0.7}(\text{ZnO})_{0.3}\}_{1-x}(\text{La NPs})_x$ where $x = 0.01, 0.02, 0.03, 0.04$ and 0.05 molar fraction was synthesized through conventional melt-quenching method. The fabricated glasses were characterized by using UV-Vis and FTIR technique in the range of 220 to 800 nm and 280 to 2000 cm^{-1} respectively. Various absorption bands that were recorded in FTIR spectra indicates the presence of TeO_4 , BO_3 and BO_4 unit. In this research, indirect energy band gap showed an increasing trend while refractive index values decreases as amount of La NPs increases due to the decrement of high polarizability nonbridging oxygen number in the glass system. Other optical parameter that also take part in governing the value of refractive index such as electronic polarizability was also determined.

Introduction

In the quantum refined region, nanoparticles exhibits large optical nonlinearities that was essential in application such as optical limiting and optical switching devices [1]. Thus, many researchers had been doping glasses with nanoparticles especially silver and gold nanoparticles in pursuance of synthesizing glasses with better linear and nonlinear optical properties. Recently, tellurite based glasses that has good compatibility with rare earth ions were doped with rare-earth nanoparticles in order to study the effect of nano-sized particles on optical behaviour of a material [2]. According to previous researches done by Azlan et al. and Hajer et al. by using erbium and samarium nanoparticles, the glasses fabricated indicate some improvement in optical properties as amount of rare-earth nanoparticles in the glass system increases [3, 4]. In this research, lanthanum nanoparticles (La NPs) was chosen to be doped into the zinc borotellurite glass system because lanthanum was one of the lanthanide ions that have an electronic structure of $[\text{Xe}] 4f^n 5s^2 5p^6$ ($n=0-14$), where 4f electrons are known to have a dominant influence on the optical properties [5]. The aim of this research was to determine the effect of lanthanum nanoparticles on structural as well as optical properties of zinc borotellurite glass system by characterizing the fabricated samples via FTIR and UV-Vis.

Experimental Procedure

Zinc borotellurite glass doped with La NPs was fabricated through conventional melt quenching technique by using reagent grade tellurium dioxide, TeO_2 (99.99%, Alfa Aesar), boron oxide, B_2O_3 (98.5%, Alfa Aesar), zinc oxide, ZnO (99.99%, Alfa Aesar) and lanthanum oxide nanoparticles, La NPs (99.99%, Nanostructured & Amorphous Materials, Inc.) as the starting materials. All the powder form chemicals were weighted by a digital weighing machine with an accuracy of $\pm 0.0001\text{g}$. The weighted chemicals was stirred in an alumina crucible by using glass rod and transferred to an electrical furnace for one hour at 400°C to undergo pre-heating process. The pre-heated chemicals was sent to melting procedure in another electrical furnace at 900°C for a period of two hours to ensure complete reactions between the chemicals. Next, the molten chemical was