



Influence of erbium oxide on structural, physical, elastic and luminescence properties of rice husk biosilicate zinc borotellurite glasses for laser application

M.K. Halimah^{*}, A.S. Asyikin, S.N. Nazrin, M.F. Faznny

Glass and Dielectric Lab, Department of Physics, Faculty of Science, Universiti Putra Malaysia, 43400, Serdang, Selangor, Malaysia

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ABSTRACT

Nowadays, active search for more efficient and improved glass material to be employed as laser host has been take place in order to have laser with enhanced performance. In this research, erbium oxide doped rice husk biosilicate zinc borotellurite glasses have been fabricated successfully via conventional melt quenching technique. XRD pattern reveals that the prepared glasses are amorphous in nature while FTIR spectra records the presence of Si-O-Si, TeO₃, BO₄ as well as BO₃ vibrational groups in the fabricated glasses. Increasing density from 3.3505 g/cm³ to 4.1852 g/cm³ along with the rigidity of the glass as hinted in the values for elastic moduli from 55.0 GPa to 250.0 GPa is caused by the incorporation of erbium oxide that reduce the amount of non-bridging oxygen in the glass matrix. Three bands that are recorded in PL spectra correspond to the violet, blue and green emission.

1. Introduction

Glass is an inorganic substance that can be formed by melting few minerals at high temperature and rapidly cooling the molten to its solid state to prevent crystallization process. The compositions of a glass material is very crucial whereby the ratio of the oxides will influence the ability a chemical mixture to form glass. Generally, chemical elements which are incorporated in the glass mixture will assist in refining the glass and decrease the overall melting point of the glass. Besides that, the combination of the glass samples also bring about colour to the glass material and eliminate air bubbles that usually created during chemical mixture melting process [1].

According to Wells in 1975 [2], tellurium oxide, TeO₂ can exist in two crystalline form which are yellow orthorhombic form (the mineral tellurite) and colourless tetragonal form (paratellurite). There is four coordination of Te in both form with the closest neighbours arranged at four of the vertices of trigonal bipyramid which lead to the considerable covalent character of the Te-O bonds. Tellurite has a layered structure which allows TeO₄ groups to induce edge sharing pairs that will eventually produce a layer by sharing their remaining vertices. The distance between two Te atoms is very short with a value of 3.7 Å. In paratellurite, the TeO₄ groups share all vertices to generate a 3D structure in

which the O-bond angle is 140°, distance between two axial bonds are 2.08 Å and the distance between equatorial bonds are 1.9 Å. Halimah et al., (2005) explained that tellurite based glass is well known for its advantage which include high refractive index, low melting temperature, good infrared transmission and high dielectric constant. Tellurium oxide is a conditional glass former, therefore it requires combination with other glass former or modifier in order to produce a good glass [3].

Borate is one of the glass former that possess peculiar characteristics such as low melting point, high transparency and good solubility of rare earth ion which makes it suitable as optical material. In addition, borate glass show structural modification with the incorporation of rare earth ion as a modifier in the glass system [4]. Boron oxide is a glass former that is trivalent positive. The introduction of oxygen in modifier oxide into borate oxide glass system will lead to two possibilities:

- i The creation of bridging oxygen whereby the oxygen coordinated around boron elements remain as three
- ii The conversion of boron from a three coordination state to four coordination state

In BO₃ group, the oxygen are completely in bridging state with one negative charge from every oxygen rectify the three positive charges of

^{*} Corresponding author.

E-mail address: halimahmk@upm.edu.my (M.K. Halimah).