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ORIGINAL RESEARCH ARTICLE

Synthesis, Thermal, Optical, and Radiation-Absorbing Properties of Bi_2O_3-Li_2O-As_2O_3-B_2O_3 Glasses

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Abstract

Borate glasses can be excellent optical and radiation-shielding glasses when they play host to Bi_2O_3 and Li_2O. The extent of the physical, structural, optical, and radiation-absorbing property modifications of xBi_2O_3-(30-x)Li_2O-10As_2O_3-60B_2O_3 glasses when the concentrations of Bi_2O_3 and Li_2O are altered is presented in this report. Glasses xBi_2O_3-(30-x)Li_2O-10As_2O_3-60B_2O_3 with $x = 5$ mol%, 10 mol%, 15 mol%, 20 mol%, and 25 mol% were fabricated by the melt-quench synthesis method using ultra-pure (GR grade) reagents. The amorphous structure of the prepared glasses was confirmed by XRD (x-ray diffraction) analysis, while the glass transition temperature (T_g), density, and optical transmission data were obtained following standard laboratory techniques. The glasses were characterized for gamma and fast neutron shielding competence by estimating their mass attenuation coefficient and fast neutron removal cross-section. The density and molar volume of the fabricated glasses increases with the Bi_2O_3 content, while on the other hand the oxygen packing density decreases. The current glass system has a T_g in the range 403–434°C. Evaluated optical parameters showed fluctuations dictated by the chemical compositions of the BLABx glasses. The absorption edge in the glasses shifts from 412 nm to 429 nm as the amount of Bi_2O_3 changes from 5 mol% to 25 mol%. Analysis of the gamma rays and fast neutron absorption quantities showed that the addition of Bi_2O_3 up to 25 mol% had opposing effects on the ability of the glasses to shield the two types of radiation. Also, the present glasses showed an overwhelming advantage in terms of radiation-shielding applications in comparison to many existing γ-radiation shields. They are thus recommended as environmentally attractive materials in the design and implementation of radiation protection structures.

Keywords Borate glasses · optical properties · radiation · thermal properties

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Introduction

Large numbers of glass-based engineering materials have been fabricated in recent times due to their much sought-after attributes in modern engineering materials and methods. Glass is an amorphous material which comes in a variety of chemical structures and, hence, bulk attributes. Glass therefore plays a pivoting role in modern scientific research, technology, and industrial processes. The technology of glass synthesis and applications will continue to flourish in view of the many possible glass systems that can be fabricated, their attractive properties, and potential functionalities. The modification of the general properties of traditional glass formers, such as tellurite, silicates, phosphates, and borates, through the introduction of oxides of metals, is an active area of research and material engineering. Such introductions produce glasses with

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