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RESEARCH

Ionizing radiation shielding efficiency and elastic properties of zirconium/cobalt/nickel/vanadium lithium borotellurite glasses

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Abstract
The mechanical and radiation interaction parameters are vital for characterizing a material as potential shields in nuclear radiation protection applications. This study presents a glass system with the following formula: $56B_2O_3$-$25Li_2O_3$-$10Na_2O$-5CaO-$2Al_2O_3$-2SrO-$0.5TeO_2$-1X wt%: $X = ZrO_2$ (G1-Zr), CoO (G2-Co), NiO (G3-Ni), and V_2O_5 (G4-V). The photon attenuation parameters were evaluated through the use of XCOM software for typical photon energy sources used in medical and research applications of photons (22–1330 keV). In addition, the mechanical properties of glasses were examined. The maximum value of the mass attenuation coefficient (μ_m) of 2.356, 2.049, 2.073, and 1.958 cm^2/g for G1-Zr, G2-Co, G3-Ni, and G4-V, respectively, was obtained at the least energy of 22 keV. The minimum value of μ_m was obtained at 1.33 MeV with corresponding value of 0.054 cm^2/g for the four glasses. The range of effective atomic number (Z_{eff}) of the glasses was 7.189–17.88, 7.182–16.242, 7.185–16.353, and 7.171–15.869 for G1-Zr, G2-Co, G3-Ni, and G4-V, respectively, for the considered energy spectrum. Based on the half value layer (HVL) value at 662 keV, it is clear that the present glasses are better photon absorbers than OC and RS-253-G18 glass shield. The value of Σ_R for the glasses revealed that G4-V is a better fast neutron absorber among the investigated glasses. The G1-Zr glass sample has a minimum elastic moduli values, but G3-Ni sample has the maximum values. Generally, the investigated glasses can be used as appropriate materials for gamma-ray shielding applications.

Keywords Lithium borotellurite glasses · Photon · HVL · Elastic moduli

Introduction

In our present technologically advanced world, glasses are exhaustively being used in a wide variety of applications ranging from household appliances, optical, telecommunication and electronic devices, and so on [1–4]. Over the years, the scope of glass application continues to develop due to many interesting general properties of glass materials. One major factor that has sustained such development is the chemical compositional flexibility enjoyed by glass materials. The implication of this is that the chemical content of a glass can be varied easily to obtain a different glass composition. Since the general (mechanical, physical, structural, optical, etc.) properties of a glass material rest majorly on its chemical content, it is hence possible for new glass material having novel properties to emerge from existing ones [1–6]. This has led to the synthesis and characterization of different glass species for different applications. It has also produced new glasses with potential applications

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