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Responsibility of Bi_2O_3 Content in Photon, Alpha, Proton, Fast and Thermal Neutron Shielding Capacity and Elastic Moduli of $ZnO/B_2O_3/Bi_2O_3$ Glasses

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Abstract
The effect of Bi_2O_3 content on photon, alpha particle, proton, fast and thermal neutron shielding capacity, and elastic moduli of $10ZnO\text{-}(90\text{-}x)B_2O_3\text{-}xBi_2O_3$ (ZBB-glasses): $x = 25–50$ mol% has been investigated. The mass density and Bi-content of the ZBB-glasses had the greatest impact on the values of mass and linear attenuation coefficients. The mass and linear attenuation coefficients values were followed the trend $(ZBB25)_{MAC,LAC} < (ZBB30)_{MAC,LAC} < (ZBB35)_{MAC,LAC} < (ZBB40)_{MAC,LAC} < (ZBB45)_{MAC,LAC} < (ZBB50)_{MAC,LAC}$. The mean free path (MFP) and half value layer (HVL) were having the same trend and opposite to which obtained in mass and linear attenuation coefficients. All the ZBB-glasses showed almost similar charged particle shielding capacity. However, ZBB50 had a comparable charged particle absorption efficiency. There was a 57% growth in fast neutron removal cross section as Bi_2O_3 molar concentration increased to 50% in the ZBB-glass matrix. ZBB50 possesses the highest fast neutron removal cross section among the ZBB-glasses. In terms of thermal neutron absorbing capacity, the presence of B in the glass matrix ensures that the ZBB-glasses are good thermal neutron absorption. ZBB25 has the highest thermal neutron absorption capacity among the investigated glasses. Generally, ZBB-glasses can be adopted for photon, thermal neutron, proton, and alpha particle shielding purposes. In addition, elastic (shear, longitudinal, and Young's) moduli and Poisson's ratio are changed significantly with the increase of Bi_2O_3 content mol% in ZBB-glasses.

Keywords Glass · Photon · Elastic moduli · Shielding capacity · Thermal neutron

1 Introduction

The use of ionizing radiation in various fields has continued [11]. Some radiation—induced effects in human tissues are deterministic while others are stochastic all of which may constitute health hazards [11]. Radiation protection has thus