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Bi_2O_3 reinforced $B_2O_3 + Sb_2O_3 + Li_2O$: composition, physical, linear optical characteristics, and photon attenuation capacity

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ABSTRACT

Role of Bi_2O_3 on the structure, physical, linear optical characteristics, and radiation protection capacity of antimony borate–lithium with the form $(65 - x)B_2O_3 + 10Sb_2O_3 + 25Li_2O + xBi_2O_3$ $x = 0$ (BSLB0), 4 (BSLB4), 8 (BSLB8), 12 (BSLB12), 16 (BSLB16), 20 (BSLB20) mol% glass systems was examined. The density was increased from 2.7125 to 3.9454 g cm^{-3} for BSLB0 and BSLB20 glass samples, respectively. The indirect optical bandgap decreases from 2.63 to 2.45 eV, while the direct optical bandgap decreases from 3.06 to 2.89 eV. Therefore, values of the refractive index (n) were varied from 2.50 to 2.56. Both optical ($\sigma_{optical}$) and electrical ($\sigma_{electrical}$) conductivities were enhanced with increasing Bi_2O_3 content in the investigated glasses. The observed trend of linear attenuation coefficient (LAC) values throughout the energy spectrum was followed the sequence: $(LAC)_{BSLB20} > (LAC)_{BSLB16} > (LAC)_{BSLB12-} > (LAC)_{BSLB8} > (LAC)_{BSLB4} > (LAC)_{BSLB0}$ with values in the range of 0.052–14.469, 0.062–28.291, 0.070–42.738, 0.082–61.708, 0.091–79.616, and 0.104–102.154 cm^{-1} for BSLB0–BSLB20 glasses, respectively. At each energy within the energy spectrum, the mean free path (MFP) and half value layer (HVL) of the BSLB-glasses were decreased in the order of increasing Bi_2O_3 content in the glasses. The effective atomic number (Z_{eff}) value varies from 6.53 to 15.12, 6.76–16.32, 7.02–17.37, 7.29–18.36, 7.58–19.29, and 7.89–20.16 for BSLB0–BSLB20 glasses, respectively. Therefore, BSLB-glasses possess superior photon protection capacity than ordinary (OC) and barite (BC) concretes for photons.

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