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$Ge_{20}Se_{80-x}Bi_x$ ($x \leq 12$) chalcogenide glasses for infrared and gamma sensing applications: structural, optical and gamma attenuation aspects

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ABSTRACT

This research work represents the impact of adding bismuth on structural and optical properties of $Ge_{20}Se_{80-x}Bi_x$ ($0 < x < 12$) chalcogenide glasses. The fundamental experimental measurements are used to evaluate several structural and optical parameters such as the density, molar volume, excess volume, optical bandgap, free volume percentage, the compactness, and packing factor. The results show that as the bismuth content increased from 0 to 12 at. %, the compactness, the optical bandgap, and packing density decreased, whereas the density, molar volume, excess volume and free volume percentage increased. Additionally, Monte Carlo technique is employed to estimate gamma-ray attenuation ability (GAA) of the $Ge_{20}Se_{80-x}Bi_x$ ($0 < x < 12$) chalcogenide glasses. The GAA initially decreases with energy for energies up to 6 meV and then increases throughout the remaining part of the energy spectrum. The highest half value layer was obtained at energy of 6 meV with values equal to 4.544, 4.185, 4.029, 3.886, 3.754, 3.631 cm for $x = 0$, 4, 6, 8, 10 and 12, respectively. Comparatively, the samples with $x = 10$ and $x = 12$ possess superior photon shielding properties compared to the other materials except AFZT5. This

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