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Evaluation of physical, structural properties and shielding parameters for K_2O–WO_3–TeO_2 glasses for gamma ray shielding applications

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Abstract

In the present work, a series of ternary glasses in the K_2O–WO_3–TeO_2 system have been synthesized by conventional melt quenching technique. Glass formation range of the selected glass system was determined and physical, structural and radiation shielding properties of the glasses were investigated. Density (ρ), molar volume (V_M), oxygen molar volume (V_O), oxygen packing density (OPD), average cross-link density ($\overline{n_c}$), the number of bonds per unit volume (n_b) and Poisson's ratio (μ_{cal}) values were evaluated for the interpretation of physical and structural properties. Fourier transform infrared (FTIR) spectra of the glasses were analyzed in order to obtain the information on the structural transformations in the glass network following the equimolar substitution of TeO_2 by K_2O+WO_3 and changing K_2O or WO_3 at constant TeO_2. Increasing K_2O at constant TeO_2 decreases the network connectivity due to the formation of non-bridging oxygen sites and the glass network became less tightly packed. On the other hand, equimolar substitution of TeO_2 with WO_3+K_2O in these glasses resulted in a more compact glass network. The mass attenuation coefficients have been computed using WinXCom program and the obtained values were used to calculate the half value layer, the effective atomic number and the electron density. In addition, the macroscopic effective removal cross-section for fast neutron values are also evaluated. The variation of shielding parameters was discussed for WO_3