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RESEARCH

Effects of TeO_2 and B_2O_3 on photon, neutron, and charged particle transmission properties of Bi_2O_3-BaO-LiF glass system

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Abstract

This work investigates the effects of TeO_2 and B_2O_3 on photon, neutron, and charged particle transmission properties of Bi_2O_3-BaO-LiF glass system. Photon transmission parameters were obtained via narrow beam setup simulation via FLUKA and those obtained from experimentally proved XCOM calculations. The attenuation factors of $\left(\mu/\rho\right)_{IS}$ and $\left(\mu/\rho\right)_{PP}$ control the value of μ/ρ at energies greater than 1.5 MeV; however, the region of influence differs for both absorption processes. While $\left(\mu/\rho\right)_{IS}$ peaks occur at 3 MeV, the influence of $\left(\mu/\rho\right)_{PP}$ becomes appreciable at E > 5 MeV. The values of linear attenuation factor (μ) ranged from 0.2119–0.5283, 0.2085–0.5248, 0.1837–0.4676, 0.1639–0.4223, 0.1519–0.3971, 0.1370–0.3638, and 0.1222–0.3315 cm^{-1} as B_2O_3 increased from 0 to 60 mol % with step of 10, respectively. The spectra of projected range (R) of the ions and CSDA range of electrons show that the TSP of electrons in the glasses increases as B_2O_3 increased from 0 to 60 mol % for energy lower than 5 MeV; however, it reverses at 10 MeV. The ability of the present glass system for stopping the transmission of various radiation beams reveals its potential use for shielding applications in medical and nuclear facilities.

Keywords Glass system · Synthesis · FTIR · Neutron transmission · Charged particle

Introduction

The increase in the radiation benefit to risk ratio in all modern and traditional use of ionizing radiation is sustained by the provision of adequate radiation protection measures. These measures have become an integral part of technological processes involving ionizing radiations. Radiation protection procedures has evolved over the years in terms of shielding materials from simple concrete and lead shields to more sophisticated shields produced from different novel materials. In this modern era, radiation shields do not only provide basic radiation absorption competence but also their mechanical, optical, structural, electrical and other properties are very crucial in determining their suitability for radiation shielding applications. For example, a structurally and thermally unstable material may not be ideal as radiation shield in high temperature radiation environment on the other hand a good radiation absorber with poor mechanical characteristics cannot be adopted in its pure form as structural shield but would have to be hosted by a material with high mechanical strength to serve this purpose. Furthermore, radiation shielding ability of any material is a function of its chemical composition and the radiation in question. This is so as absorption capacities of different chemical species are different for different radiation types. Consequently, modern day shielding analysis involves the identification of radiation type of concern, available space for shielding construction, nature and quantity of shielding material required to provide the required level of radiation dose outside the absorbing barrier. All these factors are

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