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Simulation of rare-earth ion effects on the radiation shielding parameters using Phy-X/PSD,XCOM, and Geant4 softwares in the X-ray region

S. Shezi, H.A.A. Abdelbagi, L. Mdletshe, M. Dubazane, S.S Ntshangase
1PhysicsDepartment, University of Zululand,KwaDlangezwa, 3886, South Africa

Abstract

The radiation shielding properties of the glass system 32GeO2-15B2O3-3ZnO-5P2O5-45Tb2O3 doped with Ho2O3, Pr6O11, Er2O3, Nd2O3, Dy2O3, and CeO2 within the X-ray energy range of 0.03–0.3 MeV have been investigated.The linear attenuation coefficient (LAC) of the glasses was calculated using Phys-X/PSD,XCOM, and Geant4 softwares at different energies. It was found that the LAC of the GeO2-B2O3-ZnO-P2O5-Tb2O3 glass system increases after incorporating the RE oxides. The LAC of the samples depends on the types of dopants and the density of the RE oxides. It was found that the glass doped by H2O3 (coded asT45-Ho) has higher LAC than the other glasses with RE, while the glass not being doped by any rare earth ion (coded as T45) has the lowest LAC. The effective atomic number (Zeff) results demonstrated that the Zeff for the glasses doped with the RE oxides are improved relative to the Zeff for the reference glass (i.e., glass without RE). The glass with Er2O3 (coded as T45-Er) has slightly higher Zeff than the other glasses with RE oxides, while T45-Ce has the minimum Zeff. The results showed that rare-earth dopants, especially Ce and Nd, significantly improved the shielding capabilities of the glass systems, with notable increases in MAC and Zeff values compared to undoped glasses. These findings highlight the potential of rareearth-doped glasses for enhanced radiation shielding applications, providing a lightweight and efficient alternative for protective materials in various industries.

Notes

Primary authors: SHEZI, Sgananda; Dr ABDELBAGI, H.A.A.; Dr MDLETSHE, L; Dr DUBAZANE, M; Prof. NTSHANGASE, SS; Mr MTHALANE, S

Presenters: Dr MDLETSHE, L; Dr DUBAZANE, M; Prof. NTSHANGASE, SS