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Investigation of the radiation shielding properties of borosilicate glass configurations with varying concentration of Ta_2O_5, La_2O_3, and Sm_2O_3

Ionizing radiation, comprising high-energy particles and electromagnetic waves, is prevalent in medical physics, nuclear research, and reactor operations, posing significant biological risks. Effective shielding is critical to minimize radiation exposure, traditionally relying on dense materials like lead and concrete. Lead offers high atomic number advantages but is toxic, while concrete, though less hazardous, is heavy, prone to structural degradation, and reduces visibility. Glass has emerged as a promising alternative, offering transparency, cost-effectiveness, and durability under harsh conditions. This research evaluates glass compositions for their potential to attenuate ionizing radiation, focusing on the material properties such as mass attenuation coefficient (MAC), linear attenuation coefficient (LAC), effective atomic number (Zeff), mean free path (MFP), half-value layer (HVL), and other radiation interaction parameters, which are determined using the Phy-X/PSD, XCOM and Geant4 software programs. The glass samples studied includes (79-x)SiO_2-3Al_2O_3-5Na_2O-13B_2O_3-xTa_2O_3, (79-x)SiO_2-3Al_2O_3-5Na_2O-13B_2O_3-xLa_2O_3, and (79-x)SiO_2-3Al_2O_3-5Na_2O-13B_2O_3-xSm_2O_3, with varying concentration of Ta_2O_3, La_2O_3, and Sm_2O_3, where x = 5, 10, 15, 20, and 25. The synthesis of these glass samples was carried out at the University of Johannesburg, while the testing of their radiation shielding capabilities was performed at the University of Zululand using the MANDELA facility.

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