



PAPER

Role of heavy metal oxides on the radiation attenuation properties of newly developed TBBE-X glasses by computational methods

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Abstract

Geant4 simulations and several theoretical approaches such as WinXCOM and ESTAR were used in this work to understand the role of heavy metal oxides on the radiation attenuation features of newly developed TBBE-X glasses which are in the form of $19.5\text{TeO}_2-30\text{B}_2\text{O}_3-30\text{BaO}-0.5\text{Er}_2\text{O}_3-20\text{X}$. Here X stands for SrO, Al_2O_3 , CdO, ZnO, PbO and Bi_2O_3 . According to X (modifier oxide), the glass samples were labelled as TBBE-S, TBBE-A, TBBE-C, TBBE-Z, TBBE-P, and TBBE-B. Various attenuation features such as mass attenuation coefficient (MAC), buildup factors, equivalent and effective atomic numbers, half value layer (HVL), and neutron cross section were investigated. The inclusion of high atomic number and dense atoms in the modifiers (PbO and Bi_2O_3) in TBBE-P and TBBE-B explains why the energy for the onset of increment in MAC was earliest among the investigated glasses. At a photon energy of 15 keV, HVL of TBBE-S, TBBE-A, TBBE-Z, TBBE-C, TBBE-P, and TBBE-B were 4.67, 5.02, 4.40, 3.91, 3.53, and 3.31 cm respectively. It is found that the TBBE-X glasses have promising shielding properties against gamma radiation comparing to different species of commercial glasses and concrete. The outcomes also reveal that the TBBE-X specimens are comparatively better shields against fast neutron compared to classical shields like graphite, water, and ordinary concrete. Therefore, the TBBE-X glasses have promising shielding properties and can be applied in shielding applications against gamma rays and neutrons beam.

1. Introduction

The effects of radiation on the healthy tissues and cells may include injury. as a result of this, radiopharmaceutical devices should be used with extreme caution in medical applications. Most commonly, concrete is used for shielded radiotherapy facilities, x-ray rooms, and nuclear medicine equipment [1–4]. Concrete also has many drawbacks, such as high toxicity and opaqueness of glare, which makes it almost difficult to see through. in addition, both materials are capable of attenuating the radiation. Several different materials have been tested for radiation shielding applications including steel, resins, polymers, minerals, and composites [5–10].

Recently, many benefits of glasses are identified, including their lower manufacturing costs, ease of manufacturing, and the substantial clarity of glasses for visible light have come to prominence. These advantages encouraged researchers to investigate glasses as attractive materials for radiation shielding against gamma-ray, x-ray and neutron radiation shielding [11–20]. Kebaili *et al* reported the parameters of γ -ray shielding for