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# Effect of $Sb_2O_3$ addition on radiation attenuation properties of tellurite glasses containing $V_2O_5$ and $Nb_2O_5$

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**Abstract**

In the present work, we have studied the effect of $Sb_2O_3$ addition on gamma, neutron, and charged particles attenuation properties of tellurite glasses in the chemical structure of $84TeO_2 + xSb_2O_3 + 1V_2O_5 + (15\text{-}x)Nb_2O_5$, where x is between 0 and 15 mol% with step of 5. Monte Carlo simulations (by using FLUKA code) were employed to investigate the gamma attenuation parameters for photon energies of 0.6, 1.25, 1.5, 2, 3, 5, and 10 meV. For every photon energy, the results of FLUKA simulations were theoretically approved using the XCOM approach. The obtained results show that the $Sb_2O_3$ addition increased the mass attenuation coefficient ($\mu/\rho$) ranges from 0.03318 to 0.08003, 0.03334–0.08021, 0.03349–0.08038, and 0.03363–0.08054 $cm^2\ g^{-1}$ for TSVN1, TSVN2, TSVN3, and TSVN4, respectively. For the studied glasses, the maximum (minimum) effective atomic number ($Z_{eff}$) was obtained at 10 meV (1.25 meV) with corresponding values of 28.85 (21.58), 29.80 (22.27), 30.77 (23.00), and 31.78 (23.77). The exposure rate (ER) follows the trend: $(ER)_{TSVN4} > (ER)_{TSVN3} > (ER)_{TSVN2} > (ER)_{TSVN1}$. Different effects of $Sb_2O_3$ addition were observed on the shielding properties for the thermal and fast neutrons. Finally, the influences of $Sb_2O_3$ addition on the attenuation features of the studied glasses were discussed in detail for charged particles such as protons, alpha particles, and electrons. It is concluded that the investigated glass specimens can be utilized for various nuclear applications as non-toxic shields against the radiation of gamma, neutron, and charged particles.

**Keywords** Tellurite glasses · Attenuation properties · Shielding · Radiation

## 1 Introduction

In the past few years, different compositions of tellurite glasses have attracted immense attention because of their promising properties and applications [1–6]. The important properties of these glasses can be summarized by their extended transmission range for the visible light and infrared rays [7, 8]. Moreover, such glasses ($TeO_2$ based glasses) find various uses in different applications due to their high polarizability and their excellent shielding abilities against gamma rays, neutron, and charged particles [9, 10].

Consistently, people are exposed to ionizing radiation from natural sources and synthetic sources. Radiation from natural sources refers to radioactivity present in the air, soil, rocks, and water. Additionally, radon extracted from the soil and cosmic rays also acts as sources of natural radiation. Conversely, radiation from synthetic sources can be characterized as the ones that originate from nuclear power generation and medical equipment employed for treatments like X-ray machines. Therefore, finding a suitable shielding material against damaging radiation is an urgent demand for

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