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# Effect of CdO addition on photon, electron, and neutron attenuation properties of boro-tellurite glasses

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A B S T R A C T

This research article aims to study the effect of CdO addition on the radiation shielding characteristics of boro-tellurite glasses in the composition of $50B_2O_3$ - (50-x) TeO2- xCdO, where x = 0, 10, 20, 30, 40 and 50 mol%. These glasses were exposed to gamma radiation and the transmitted gamma photons were evaluated for energies varying from 15 keV to 15 MeV using Geant4 simulation toolkit. The number of transmitted photons was then used to characterize the gamma shielding for the studied glasses in terms of linear/mass attenuation coefficients, MFP, $Z_{eff}$, and HVL. The simulation outcomes were theoretically confirmed by using Phy-X software. The beta (electron) shielding characterization of the involved glasses was also investigated by determining the projectile range and stopping power using ESTAR software. Additionally, the fast neutron shielding characterization of the glasses was achieved by evaluating removal cross-section ($\Sigma_R$). The results reveal that the CdO has a small influence on the shielding performance of the boro-tellurite glasses against gamma, beta, and neutron radiations. The shielding performance of the boro-tellurite glasses was compared with that of common shielding materials in terms of MFP. It can be concluded that the boro-tellurite glasses regardless of the concentration of CdO content have promising shielding performance to be used for radiation applications.

## 1. Introduction

In recent years, there has been an increasing interest in Synthesis, structure and physical properties of glasses with different metal oxides such as tellurium and cadmium due to their high refractive indices, high infrared transparency, and good absorption of X-ray radiation [1,2]. Borate glass is one of the well-known glass-forming materials that are excellent for withstanding high temperatures and neutron absorption [3]. When transition oxides are added to $B_2O_3$, the covalent lattice of amorphous boron oxide causes significant changes, resulting in the creation of electron sites that accommodate the cations formed [1–4]. Boron glasses with tellurite added are very promising for nonlinear optical applications, due to some of its distinctive features, such as its high refractive index, low maximum phonon and low melting point [5]. $TeO_2$ is an important glass former and it needs a modified ion like CdO to easily create the glass sample. The basic structure form of tellurite glass is $TeO_4$, a two-pyramid triangle containing a single pair of electrons (e.g. Te – O – Te bond to form the glass) [5].

Sustaining the present and future use of radiations such as gamma-rays, X-radiation, neutrons, and electrons in different ways has been recognized to hinge majorly on the prevention of undeliberate and avoidable exposure of the human environment to these radiations. This to a large extent has made provision of radiation protection protocols an integral part of radiation science and technology. In any radiation facility, a radiation protection protocol without the identification of shielding materials and the provision of structural or source shields in such a facility is incomplete. Although, many materials have been used in the past as radiation shields, the use of glass materials of different composites as source or structural shield is gaining wide acceptance. This is due to the fact that many

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