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Synthesis, optical, and radiation attenuation properties of CaF_2-TeO_2-$Na_2B_4O_7$-CuO glass system for advanced shielding applications

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Abstract We fabricated a new series of sodium tetraborate ($Na_2B_4O_7$) containing TeO_2, CaF_2, and CuO for advanced performance in optical and radiation applications. PHILIPS (Xpert PRO) X-ray diffractometer was employed at room temperature (RT) to investigate the fabricated specimens' amorphous nature. Furthermore, UV–visible spectra and EPR spectra (~9.7 GHz and field modulation 100 kHz) were also achieved for the involved glass system. Moreover, FLUKA Monte Carlo simulations were successfully designed to describe the gamma transmission properties through the fabricated glass specimens. The results reveal that the optical band gap (E_g) decreased from 3.079 to 2.605 eV as the CaF_2 content increased from 0 to 50 mol %. In the EPR spectra, fourth parallel hyperfine splittings in the high field are merged with the perpendicular hyperfine splitting's resulting in a single intense line. The gamma transmission studies show that the gamma absorption in the present glasses were highest at the least energy with the value of within the range: 0.0789–0.0229, 0.0789–0.0232, 0.0790–0.0236, 0.0790–0.0241, 0.0791–0.0246, and 0.0792–0.0253 cm^2g^{-1} for CaF_2 content of 0, 10, 20, 30, 40, and 50 mol %, respectively. It can be concluded that the present fabricated glass system has excellent and promising properties to use for optical and radiation applications.

1 Introduction

In the last few decades, alkali borate glasses have become more important in glass research and industrial applications. Such applications can be found in nonlinear devices, optical fibers, solar conductors, solid-state laser, a piezoelectric actuator, and radiation shields (e.g. X-ray rooms) [1–3]. The addition of alkali content to borate glasses up to 33.3 mol% transforms the glass network units from BO_3 to BO_4 [4]. Further addition of alkali content beyond

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