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Optical Characterization of Dysprosium Oxide-Doped Fluorophosphate Glass and Its Application in Thermoluminescent Dosimetry

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Dosimeters are critical devices for radiological safety in diverse environments, and rare-earth-doped materials, such as dysprosium (Dy), have shown promising potential due to their optical and luminescent properties[1]. This study investigates six Dy_2O_3-doped $NaPO_3$-CaF_2-AlF_3 (NCAL) fluorophosphate glass matrices subjected to different thermal treatment times (1, 2, 3, 6, 10, and 20 hours) to evaluate their dosimetric applicability. Optical characterization techniques revealed key insights into the material's behavior. UV-Vis absorption spectroscopy identified electronic transitions and an energy bandgap in the visible region, linked to photoluminescence (PL) and electron trapping, which confirmed the material's luminescent potential. Temperature-dependent PL analysis demonstrated stable emission wavelengths and energy transfer between bands at elevated temperatures. Luminescence lifetime spectroscopy indicated that irradiation did not significantly alter the glass matrix structure, suggesting robustness under radiation exposure. Thermoluminescence (TL) dosimetry highlighted the sample treated for 2 hours as the most stable, exhibiting a linear dose-response between 1 and 9 Gy, favorable for practical applications. Additionally, samples with 1h, 2h, and 10h thermal treatments showed enhanced structural stability and luminescent properties. These findings underscore the viability of Dy-doped NCAL glass matrices, particularly those with optimized thermal processing, as robust materials for dosimeters. The study provides a foundation for further exploration of rare-earth-doped glasses in precision dosimetry and radiation detection technologies.

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References
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