$CaSO_4$:Ce,Mn: A Novel, Highly Sensitive TL/OSL Phosphor Synthesized via the Slow Evaporation Method

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In this study, a new $CaSO_4$ crystal doped with cerium and manganese is described and its potential for dosimetric applications is evaluated. Cerium and manganese were incorporated into $CaSO_4$ at a concentration of 0.1 mol% each. The crystal growth parameters were established based on previous studies [1-2], utilizing the slow evaporation route and were prepared in pellet form with the addition of Teflon. The crystalline structure and optical properties of the crystals were analyzed using X-ray diffraction (XRD) and photoluminescence (PL) techniques. In addition, thermoluminescence (TL) and optically stimulated luminescence (OSL) were used to comprehensively investigate the dosimetric properties of the phosphors, such as the TL glow curve and continuous wave OSL (CW-OSL) curves, dose-response and its reproducibility, fading, sensitivity, variation of TL intensity with the heating rate, correlation between TL and OSL emissions, and determination of the minimum detectable dose (MDD). The phosphor was synthesized efficiently using a slow evaporation route, with results from both PL and TL emission spectra confirming the presence of dopant ions in the crystal matrix. At a heating rate of 5 °C/s, the $CaSO_4$:Ce,Mn samples exhibited a TL emission curve at 145°C, characterized by three overlapping peaks. The samples showed a typical exponential OSL decay curve with a predominant fast decay component, indicating that the charge traps have a high photoionization cross-section for blue LEDs. The luminescent signals exhibited linearity and reproducibility within the investigated dose range (169 mGy–100 Gy). Furthermore, the incorporation of cerium as a co-dopant in the $CaSO_4$:Mn matrix resulted in a notable increase in TL/OSL sensitivity, showing potential compared to mono-doped $CaSO_4$ dosimeters [2] and commercially available alternatives.

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