

Effect of Sintering Aids on Scintillation Properties of Ce:YAG Ceramics

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Ce³⁺-doped yttrium aluminum garnet (Ce:YAG) transparent ceramics are promising alternatives to single crystals for scintillator applications, particularly in synchrotron-based X-ray imaging. In this work, we investigate the influence of SiO₂ and MgO sintering aids on the microstructure, phase formation, and optical and luminescent properties of vacuum-sintered Ce:YAG ceramics. Commercial Ce:YAG powder (0.7 at.% Ce) was processed with varying concentrations of SiO₂ (0.14–0.35 wt.%) and MgO (0.06–0.35 wt.%), followed by two-step vacuum sintering and postsintering air annealing. Structural and microstructural characterization was performed by X-ray diffraction and SEM/EDS, while optical transmittance, photoluminescence (PL/PLE), X-ray excited optical luminescence (XEOL), X-ray fluorescence (XRF), and X-ray absorption near-edge spectroscopy (XANES) were used to assess optical performance and Ce valence state. SiO₂ addition led to enhanced densification, reduced residual porosity, and improved microstructural homogeneity, resulting in the highest in-line transmittance (~60% at 750 nm after annealing). In contrast, MgO additions above its solubility limit promoted the formation of Mg- and Y-rich secondary phases, significantly degrading optical transmittance. XANES confirmed the stability of Ce³⁺ across all thermal treatments, indicating that observed color changes are associated with oxygen-vacancy-related color centers rather than Ce oxidation. PL and XEOL measurements revealed preserved Ce³⁺ emission at ~540 nm, with additional defect- or impurity-related features in selected samples. These results demonstrate that SiO₂ is the more effective sintering aid under the investigated conditions, while highlighting the need for optimized additive incorporation to suppress secondary phases and maximize scintillation performance in Ce:YAG transparent ceramics.

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