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Sol-Gel Preparation and Photoluminescence Properties of Eu and Dy Co-Doped Gd_2O_3 Nanophosphors

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Extended Abstract

This study focuses on the synthesis of Gd_2O_3 nanophosphors via the sol-gel method, incorporating activator doping with Eu and Dy, as well as co-doping with Eu–Dy [1–4]. It examines the effects of varying doping concentrations and calcination temperatures on the structural characteristics and properties of the resulting nanopowders. The research includes structural and morphological analyses using X-ray diffraction (XRD), scanning electron microscopy (SEM), and transmission electron microscopy (TEM), along with optical property evaluations through UV-visible (UV-Vis) spectroscopy and photoluminescence (PL) spectroscopy.

XRD analysis confirms that pure-phase Gd_2O_3, corresponding to the cubic crystal system (card no. 43-1014), can be obtained through the sol-gel method by calcining at 700 °C. The intensity of the diffraction peaks increases with higher calcination temperatures. Doping Gd_2O_3 with ions of varying concentrations does not significantly alter its crystal structure, as the doped ions effectively incorporate into the host lattice. SEM analysis shows that the morphology remains similar across different calcination temperatures, featuring a porous structure. Doping concentration has little effect on grain morphology; however, with increasing temperature, surface agglomeration becomes more pronounced, pore sizes decrease, and surface morphology becomes more defined—indicating improved crystallinity. TEM images reveal that the grains are polygonal and irregular in shape, exhibiting strong polycrystalline characteristics, which further confirms excellent crystallinity. At the highest tested doping concentrations, the dopant ions are well integrated into the Gd_2O_3 lattice.

UV-Vis spectroscopy reveals an absorption peak at 227 nm. In Eu-doped samples, a broad excitation band is observed between 220–300 nm, attributed to the charge transfer band (CTB) between Eu and O. PL analysis shows that the sample doped with 7% Eu exhibits the strongest emission at 613 nm after calcination at 900 °C, indicating a non-centrosymmetric site in the host lattice. The corresponding CIE chromaticity coordinates suggest a luminescent color close to deep red. In contrast, the sample doped with 1% Dy shows the strongest emission at 570 nm under the same conditions, with chromaticity coordinates corresponding to a peach-orange luminescence. For co-doped samples, the emission color shifts toward the orange-red region compared to that of the 1% Eu-doped sample, as shown by their CIE coordinates.

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