Europium-Doped Lanthanum Hafnate Nanoparticles: Structure, Photoluminescence, and Radioluminescence

KAREEM WAHID, MADHAB POKHREL, YUANBING MAO, University of Texas Rio Grande Valley — Due to their novel physical properties, nanostructured phosphors are of interest for radiation-based imaging and therapeutics. Herein, the structural and luminescent properties of europium-doped lanthanum hafnate \( \text{La}_2\text{Hf}_2\text{O}_7:x\text{mol}\%\text{Eu}^{3+}, \ x = 0 - 35 \) nanoparticles are investigated for use as scintillators. X-ray diffraction, Raman spectroscopy, and scanning electron microscopy confirm samples prepared through a combined co-precipitation and low-temperature molten salt synthetic process homogenously form spherical nanocrystals of \(~36 \text{ nm}\) in the ordered pyrochlore phase. Ultraviolet and X-ray excitation of these samples induce strong red emissions in the 580 - 590 and 612 - 630 nm range corresponding to the \( ^5\text{D}_0 \rightarrow ^7\text{F}_1 \) magnetic dipole and \( ^5\text{D}_0 \rightarrow ^7\text{F}_2 \) electric dipole transitions of \( \text{Eu}^{3+} \). Optical response and quantum yield are optimized at 5\% \( \text{Eu}^{3+} \); a proposed trade-off between quenching mechanisms (defect-states/cross-relaxation) and dopant concentration is discussed. Owing to their high density, large effective atomic number, and bright luminescence, these \( \text{La}_2\text{Hf}_2\text{O}_7:x\text{mol}\%\text{Eu}^{3+} \) nanoparticles warrant further investigation for scintillator applications.

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