

# GdOCl:Eu<sup>3+</sup> nanoparticles obtained from the thermal decomposition of the precursor Gd(OH)<sub>3</sub>:Eu<sup>3+</sup>: Luminescence with UV-Vis and X-Ray Excitation (XEOL)

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Gadolinium oxychloride doped with europium ions (GdOCl:Eu<sup>3+</sup>, x = 0.5; 1.0; 2.0; 4.0; 8.0 at.%) was synthesized via thermal decomposition of lamellar Gd(OH)<sub>3</sub>:Eu<sup>3+</sup> precursors obtained by hydrothermal method. The precursors were prepared under controlled conditions and subsequently heat-treated at 900 °C for 4 h under dynamic nitrogen atmosphere in the presence of ammonium chloride, yielding the oxychloride phase. X-ray diffraction confirmed the formation of lamellar Gd(OH)<sub>3</sub> precursors and crystalline tetragonal GdOCl after thermal treatment, with no significant secondary phases.

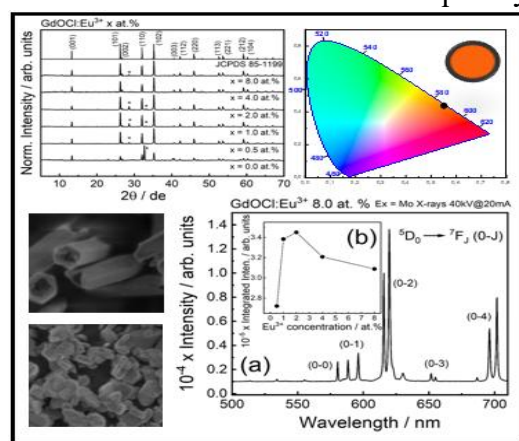
Scanning electron microscopy revealed that the hydrothermally obtained precursors exhibit one-dimensional nanorod morphology, with hexagonal cross-section, lengths ranging from 300 nm to 1 μm and widths between 50 and 300 nm. After thermal decomposition, the oxychlorides presented predominantly spheroidal particles with sizes between 100 and 400 nm, depending on Eu<sup>3+</sup> concentration, indicating loss of topostatic morphology due to high-temperature treatment.

Photoluminescence measurements under UV excitation evidenced the characteristic Eu<sup>3+</sup> emissions arising from <sup>5</sup>D<sub>0</sub> → <sup>7</sup>F<sub>J</sub> (J = 0–4) transitions [1], allowing evaluation of local symmetry and energy transfer processes. Efficient energy transfer from Gd<sup>3+</sup> to Eu<sup>3+</sup> was observed when exciting Gd<sup>3+</sup> absorption bands. X-ray excited optical luminescence (XEOL) measurements revealed emission spectra analogous to those obtained under UV excitation, confirming the role of Gd<sup>3+</sup> → Eu<sup>3+</sup> energy transfer in the scintillation process. Concentration quenching effects were identified for Eu<sup>3+</sup> contents above 2.0 at.%.

These results demonstrate that GdOCl:Eu<sup>3+</sup> compounds obtained from thermally decomposed lamellar precursors exhibit suitable structural and luminescent properties for application as potential scintillators under ionizing radiation excitation.

1. M. O. Krauser, H. H. de Sousa Oliveira, M. A. Cebim, and M. R. Davolos, "Relationship between scintillation properties and crystallite sizes in Y<sub>2</sub>O<sub>3</sub>:Eu<sup>3+</sup>," *Journal of Luminescence*, **203**, 100 (2018)

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(Left) X-ray diffraction patterns of GdOCl:Eu<sup>3+</sup> confirming oxychloride phase formation and SEM images of Gd(OH)<sub>3</sub>:Eu<sup>3+</sup> precursors and GdOCl:Eu<sup>3+</sup> compounds. (Right) Sample coloration and CIE chromaticity diagram from XEOL measurements, and XEOL spectra of all samples under Mo X-ray excitation (20 mA, 40 kV) with integrated luminescence intensity.