

X-Ray Excited Optical Luminescence of Rare-Earth Oxychloride, Chloride and Fluoride Nanoparticles Doped with Eu^{3+} , Pr^{3+} and Dy^{3+}

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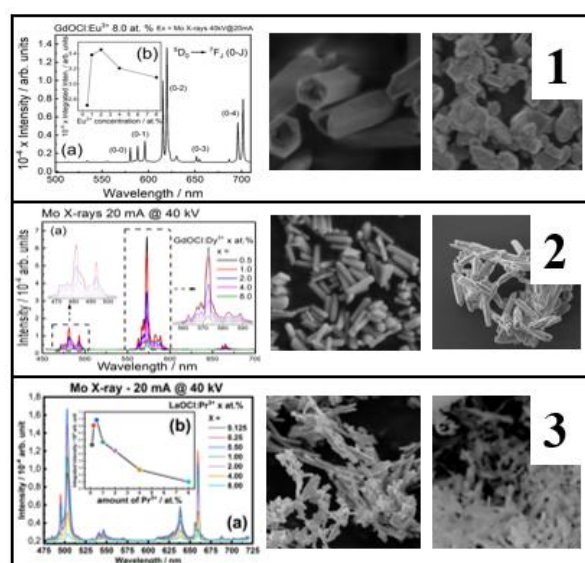
Rare-earth oxychloride, chloride and fluoride nanoparticles doped with Eu^{3+} , Pr^{3+} and Dy^{3+} were synthesized and investigated with emphasis on their X-ray excited optical luminescence (XEOL) properties for potential scintillation applications. The studied systems include GdOCl doped with Eu^{3+} and Dy^{3+} , LaOCl and LuOCl doped with Pr^{3+} , LaF_3 doped with Pr^{3+} , and LaCl_3 doped with Pr^{3+} , with dopant concentrations ranging from 0.5 to 8.0 at.%.

Oxychlorides were obtained from hydroxide precursors prepared by coprecipitation of rare-earth chlorides with ammonium hydroxide, followed by hydrothermal treatment at 200 °C for 12 h and thermal conversion at 900 °C for 4 h under nitrogen in the presence of ammonium chloride. Lanthanum fluoride doped with Pr^{3+} was synthesized by ammonium fluoride precipitation and hydrothermal treatment, while lanthanum chloride doped with Pr^{3+} was obtained by drying mixed chloride solutions and thermal dehydration at 300 °C.

Structural and morphological characterization was performed by X-ray diffraction, FTIR spectroscopy and electron microscopy, while optical properties were investigated by UV–Vis photoluminescence, XEOL and excited-state lifetime measurements. XEOL experiments employed molybdenum X-ray excitation (40 kV, 20 mA) for oxychlorides and copper excitation (30 kV, 20 mA) for chlorides, fluorides and $\text{LuOCl}:\text{Pr}$ samples, using adapted X-ray diffractometers.

All materials exhibited characteristic dopant-related emission under X-ray excitation. Pr^{3+} -doped compounds showed fast decay times on the order of 0.01 ms, whereas Eu^{3+} -doped materials presented longer lifetimes around 1.0 ms, with decay times decreasing as dopant concentration increased. Concentration quenching was observed above 1 at.% for GdOCl doped with Dy^{3+} and Pr^{3+} , and above 2.0 at.% for GdOCl doped with Eu^{3+} , demonstrating the strong influence of host–dopant interactions on XEOL response.

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(1) XEOL spectra and integrated luminescence intensity of $\text{GdOCl}:\text{Eu}$ samples, together with SEM images of the $\text{Gd}(\text{OH})_3:\text{Eu}$ precursor and the corresponding $\text{GdOCl}:\text{Eu}$ compounds. (2) XEOL spectra, integrated intensity and SEM images of $\text{GdOCl}:\text{Dy}$ samples. (3) XEOL spectra, integrated intensity and SEM images of $\text{LaOCl}:\text{Pr}$ samples, showing precursor hydroxides and oxychlorides after thermal treatment.