

# Luminescent properties of Ce<sup>3+</sup>, Tb<sup>3+</sup> and Eu<sup>3+</sup> doped Lu<sub>2-x</sub>Gd<sub>x</sub>SiO<sub>5</sub>; x=0-0.75 single crystalline films

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Single crystalline films (SCFs) of Ce-, Tb-, and Eu-doped  $Lu_{2-x}Gd_xSiO_5$  (LGSO;  $x = 0-0.75$ ) orthosilicates have attracted significant attention as promising scintillating screens for 2D and 3D microimaging applications based on conventional X-ray and synchrotron radiation (SR) techniques [1,2]. However, the properties of these materials are strongly influenced by their composition, dopant concentration, and preparation conditions.

The aim of this report is to investigate the luminescent properties of Tb<sup>3+</sup>, and Eu<sup>3+</sup> doped  $Lu_{2-x}Gd_xSiO_5$  SCFs additionally codoped with Ce ions, as a function of Gd content ( $x = 0-0.75$ ) using cathodoluminescence and luminescence spectroscopy under SR excitation.

SCFs of Ce-, Tb-, and Eu-doped LGSO with different Gd contents ( $x = 0-0.75$ ) were prepared by the liquid phase epitaxy (LPE) method using melt solutions based on a PbO-B<sub>2</sub>O<sub>3</sub> flux in an air atmosphere on YSO substrates at temperatures of 960-980 °C.

Using conventional and advanced luminescence spectroscopy under synchrotron radiation (SR) excitation, we compared the emission spectra, excitation spectra, and luminescence decay kinetics of Ce-, Tb-, and Eu-doped  $Lu_{2-x}Gd_xSiO_5$  with different Gd contents in the  $x = 0-0.75$  range. We found that the luminescent properties of these SCFs are governed by a complex interplay between the Ce<sup>3+</sup>  $5d^1 \rightarrow 4f$  emission and the energy transfer processes from Gd<sup>3+</sup> cations to Ce<sup>3+</sup>, Tb<sup>3+</sup>, and Eu<sup>3+</sup> ions, respectively.

The differences observed in the emission spectra and decay kinetics of LGSO:Ce, LGSO:Tb, and LGSO:Eu SCFs are attributed to variations in the efficiency of Gd<sup>3+</sup>→Ce<sup>3+</sup>, Gd<sup>3+</sup>→Tb<sup>3+</sup>, and Gd<sup>3+</sup>→Eu<sup>3+</sup> energy transfer, depending on the relative occupancy of Lu/Gd crystallographic sites by the dopant ions, which affects the excitation pathways of Tb<sup>3+</sup> and Eu<sup>3+</sup> luminescence.

We also identified the significant role of Pb-flux-related impurities in the excitation processes of Ce<sup>3+</sup>, Tb<sup>3+</sup>, and Eu<sup>3+</sup> luminescence in LGSO hosts with different Lu/Gd ratios. The obtained results provide insight into the energy transfer mechanisms in doped LGSO SCFs and demonstrate their potential for application in scintillating screen detectors.

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