Explaining green emission of Eu$^{2+}$ in ZnGa$_2$S$_4$

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Luminescent materials emitting a saturated color are of special interest for LED-based display technologies. Suitable phosphor materials for these applications are relatively scarce (1). Several members of the europium doped thiogallate family are nevertheless known to exhibit a relatively narrow emission spectrum and high color purity (2).

In this work the structural and luminescent properties of europium doped zinc thiogallate (ZnGa$_2$S$_4$:Eu$^{2+}$) were investigated in detail. It was reported in literature to be a saturated green phosphor. The microscopic structure of the powders and the incorporation of the Eu$^{2+}$-ions was thoroughly investigated by a powerful combination of analytical techniques: scanning electron microscopy, combined with cathodoluminescence spectroscopy and energy-dispersive X-ray analysis (SEM-CL-EDX), X-ray diffraction (XRD) and X-ray absorption spectroscopy (XAS). We were able to show that the reported luminescence is consistent with EuGa$_2$S$_4$ precipitations which are formed due to the low solubility of Eu$^{2+}$ into the ZnGa$_2$S$_4$ lattice (3).

Figure: SEM-CL-EDX mapping of Zn$_{0.99}$Eu$_{0.01}$Ga$_2$S$_4$ powder, obtained at 250 K. Left: phosphor morphology obtained by backscattered electron imaging. The integrated CL emission intensity is shown as an overlay in false colors. Right: Elemental distribution by EDX, where the colors are determined by color coding with green for Zn and red for Eu. Simultaneous detection would lead to a yellow color.

References: