Influence of Eu^{3+}-doping concentration in the structure and luminescence of $MgAl_2O_4:Eu^{3+}$

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Eu^{3+} based luminescent materials may be applied in light-emitting diodes, biomarkers, solar cells, etc. For that, it is desirable to insert the ion in a crystalline matrix to work around the low molar absorptivity of Eu^{3+} *f-f* transitions.[1] The host $MgAl_2O_4$ features a cubic structure (spinel) in which $Al_2O_4^{2-}$ is organized in cubic sites while Mg^{2+} and Al^{3+} occupy tetrahedral and octahedral polyhedra.[2] Eu^{3+} may replace Mg^{2+} local site due to its lower symmetry,[3] yet the doping may introduce structural defects due to the charge difference. In this line, this study deals with the synthesis via modified Pechini route of $MgAl_2O_4:Eu^{3+}$ (0, 2 and 3 at.%) [3] evaluating the impacts of doping concentration on structure and luminescence. XRD data confirm that all samples are monophasic in accordance with the $MgAl_2O_4$ phase. In FTIR spectra, doped samples display a shift in the bands relative to vibrational modes of the host, suggesting that Eu^{3+} replaces Mg^{2+} sites due to the lowest ionic radii in the lattice. In the excitation spectra, doped samples feature bands assigned to intraconfiguration *f-f* Eu^{3+} electronic transitions and a broad excitation band at higher energy attributed to a charge transfer process. The emission spectra, on the other hand, is a set of narrow bands assigned to $^5D_0 \rightarrow {}^7F_J$ (J = 0–4) Eu^{3+} electronic transitions in the orange–red spectral region while the hypersensitive $^5D_0 \rightarrow {}^7F_2$ band is the most intense one, indicating the low local symmetry of Eu^{3+} sites. Finally, the 2 %-doped sample features the highest emission relative intensity, confirming that this concentration is optimal within the studied series.

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References:

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