On the luminescence origin in Y2SiO5:Ce and Lu2SiO5:Ce single crystals

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Ce^{3+}-doped rare-earth (RE) oxyorthosilicates RE_2SiO_5 (RE: Y, Lu) have been intensively studied as promising scintillation materials owing to their high density, short luminescence decay time, high light yield, high stopping power, effective atomic number, emission wavelength compatible with common detectors, relatively high radiation hardness, as well as good mechanical properties and chemical stability.

The luminescence characteristics of YSO:Ce and LSO:Ce were intensively studied. In their emission spectra, two main emission bands were observed, the intense violet doublet band and weaker broad blue band. The origin of violet band usually ascribed to the allowed $5d_1 \rightarrow {}^2F_{5/2}$, ${}^2F_{7/2}$ transitions of the Ce^{3+} ions, while the origin of the blue emission is not clear and still under discussion.

In present work, photoluminescence characteristics of single crystals of Ce^{3+}-doped LSO and YSO with different Ce^{3+} concentrations are studied in wide temperature range by the steady-state and time-resolved spectroscopy methods. The concentrations of single and dimer Ce^{3+}-related centers of different types in the investigated crystals are evaluated from their EPR spectra. On the basis of the obtained results the origin of the Ce^{3+}-related centers responsible for the luminescence of these crystals is clarified and a new interpretation of their luminescence spectra is proposed. The suggestion is made that the dominating violet doublet emission band arises from the Ce^{3+} ions substituting for the host crystal lattice rare-earth ions in two lattice sites and, thus, can be considered as the superposition of the strong Ce1 and weak Ce2 emission bands. The weaker blue broad emission band is ascribed to the dimer Ce^{3+}- Ce^{3+} centers.

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