

Photoluminescent properties of lanthanide-doped sorosilicates

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The compounds described here are part of a detailed study focusing on the optical characterisation of silicates and zirconosilicates doped with lanthanides. Lanthanide-doped silicates became widely and thoroughly studied objects of research because of their applications in technologies, such as plasma display panels or light-emitting diodes (Liu et al., 2009; Zhang et al., 2013).

Here we present luminescence properties of the sorosilicate $\text{BaY}_2\text{Si}_3\text{O}_{10}$ doped with Er^{3+} , Pr^{3+} and Sm^{3+} , and the mixed sorosilicate $\text{BaY}_4(\text{Si}_2\text{O}_7)(\text{Si}_3\text{O}_{10})$ doped with Er^{3+} , Ho^{3+} and Pr^{3+} . The photoluminescence emission spectra of these two materials are presented in Fig. 1. The spectra were obtained from randomly oriented crystals at room temperature using a Horiba Jobin Yvon LabRAM-HR 800 spectrometer with 473 nm diode laser excitation. The crystallographic datasets of doped sorosilicates were collected using a Kappa Apex2 single-crystal X-ray diffractometer with $\text{MoK}\alpha$ radiation.

Luminescence properties of $\text{BaY}_2\text{Si}_3\text{O}_{10}:\text{Er}^{3+}, \text{Pr}^{3+}, \text{Sm}^{3+}$

In the trisilicate $\text{BaY}_{1.6}\text{Sm}_{0.4}\text{Si}_3\text{O}_{10}$, Sm^{3+} causes two dominant luminescence transitions in the visible orange to red spectral range at 600 and 650 nm, which are assigned to the $^4\text{G}_{5/2} \rightarrow ^6\text{H}_{7/2}$ and $^4\text{G}_{5/2} \rightarrow ^6\text{H}_{9/2}$ transition, respectively. The presence of Er^{3+} in $\text{BaY}_{1.3}\text{Er}_{0.7}\text{Si}_3\text{O}_{10}$ causes a dominant luminescence emission in the visible yellow spectral range (between 540 and 570 nm), which can be associated with the $^4\text{S}_{3/2} \rightarrow ^4\text{I}_{15/2}$ transition. Pr^{3+} on the structural Y-site in $\text{BaY}_{1.7}\text{Pr}_{0.3}\text{Si}_3\text{O}_{10}$ results in dominant luminescence bands around 500 nm due to the $^3\text{P}_0 \rightarrow ^3\text{H}_4$ transition, showing a blue-green emitting colour.

Luminescence properties of $\text{BaY}_4(\text{Si}_2\text{O}_7)(\text{Si}_3\text{O}_{10}):\text{Er}^{3+}, \text{Ho}^{3+}, \text{Pr}^{3+}$

Er^{3+} present in the mixed sorosilicate $\text{BaY}_3\text{Er}(\text{Si}_2\text{O}_7)(\text{Si}_3\text{O}_{10})$ causes a similar emission pattern to that of Er^{3+} in the trisilicate structure (compare Figs. 1c and e). This is because luminescence emissions of the same lanthanide dopant appear from identical spectroscopic levels. Note, however, that the fine sub-level splitting is different between the two structures. The crystal-field splitting depends strongly on the cationic crystallographic environment. But, intensity differences between prevailing transitions may change the emitting luminescence colour. For example, Pr^{3+} present in $\text{BaY}_{3.7}\text{Pr}_{0.3}(\text{Si}_2\text{O}_7)(\text{Si}_3\text{O}_{10})$ causes a much more dominant red colour component at 740 nm due to the relatively intensified $^1\text{D}_2 \rightarrow ^3\text{H}_5$, $^3\text{H}_4$ transition (compare Figs. 1b and d). $\text{BaY}_3\text{Ho}(\text{Si}_2\text{O}_7)(\text{Si}_3\text{O}_{10})$, containing Ho^{3+} , shows a dominant characteristic luminescence emission in the red spectral region. This multiplet can be assigned to the $^5\text{F}_5 \rightarrow ^5\text{I}_8$ transition.

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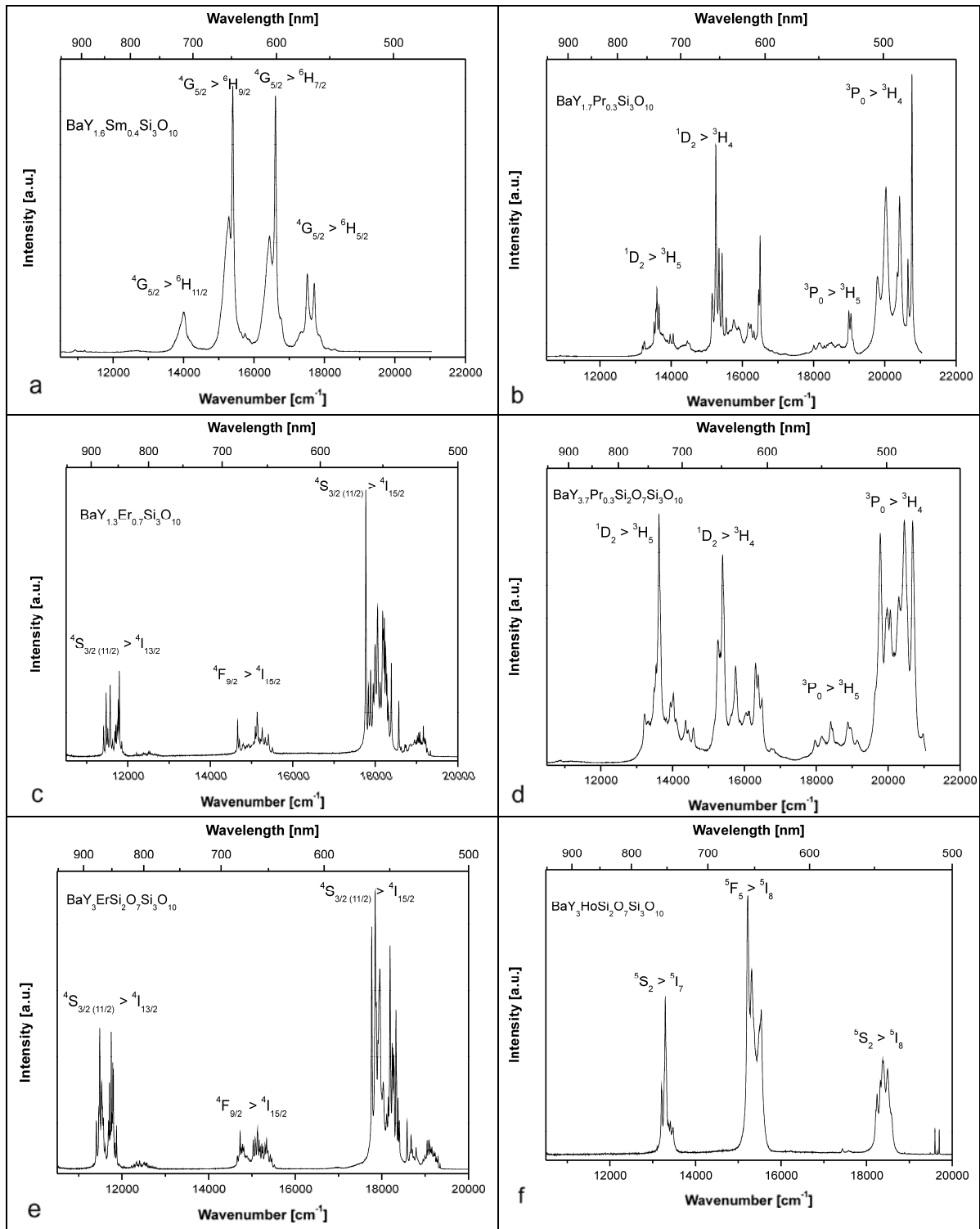


Fig. 1. The luminescence emission (473 nm excitation) spectra of $BaY_2Si_3O_{10}:Er^{3+}, Pr^{3+}, Sm^{3+}$ (a–c) and $BaY_4(Si_2O_7)(Si_3O_{10}):Er^{3+}, Ho^{3+}, Pr^{3+}$ (d–f).

References:

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