

Eu²⁺ emission from thermally coupled levels – new frontiers for ultrasensitive luminescence thermometry.

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Streszczenie

Designing luminescent thermometers operating in a broad T -range, spanning hundreds of degrees, presenting high thermal sensitivity and good resolution is one of the greatest challenges in the field. In this paper, we present $\text{SrB}_4\text{O}_7:\text{Eu}^{2+}$, a novel luminescent thermometer, operating in the T -range of 11–600 K and presenting unprecedentedly high relative thermal sensitivity, *i.e.*, up to $\approx 10.5\%/K$ and $\approx 22.6\%/K$, using either Eu^{2+} luminescence decay time or intensity ratio as thermometric parameters, respectively. Such good performance classifies the $\text{SrB}_4\text{O}_7:\text{Eu}^{2+}$ phosphor as the most sensitive inorganic luminescent thermometer ever reported. The temperature dependences of both luminescence intensity ratios and the emission decay time result from the same physical effect, *i.e.*, thermal coupling of the lowest $5d_1$ excited level of Eu^{2+} and the ${}^6P_{7/2}$ excited level of the $4f^7$ configuration of the dopant. The latter one is located $\approx 130\text{ cm}^{-1}$ below the $5d_1$. Such a strong coupling changes the contribution of the emission from the two levels, in response to the temperature change, but without any significant luminescence thermal quenching. This beneficial situation allows measuring spectra with a high signal-to-noise ratio, which lowers the uncertainty of the temperature measurement (improves resolution) in the whole operating T -range. The $\text{SrB}_4\text{O}_7:\text{Eu}^{2+}$ material offers a broad operating T -range, as well as unprecedentedly high relative thermal sensitivity and low uncertainty of the temperature measurement.

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