

Interplay of Optical Traps and Vibronic Thermalization Governing Mn^{2+} Luminescence in $\text{Ca}_{19}\text{Ce}(\text{PO}_4)_{14}$: Implications for Temperature Sensing and Thermal Threshold Indicator

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Streszczenie

The development of advanced luminescent thermometric materials requires the identification of novel mechanisms capable of inducing temperature-dependent changes in the spectroscopic properties of phosphors. In response to this need, the present work demonstrates a cooperative effect involving the thermalization of the $^4\text{T}_1(^4\text{G})$ -level components of Mn^{2+} ions and trap $\rightarrow ^4\text{T}_1(^4\text{G})$ energy transfer in $\text{Ca}_{19}\text{Ce}(\text{PO}_4)_{14}:\text{Mn}^{2+}$. This interplay results in a simultaneous enhancement of the $^4\text{T}_1(^4\text{G}) \rightarrow ^6\text{A}_1(^6\text{S})$ emission band intensity accompanied by a blue shift of its spectral position with increasing temperature. This phenomenon can be effectively utilized for temperature sensing and imaging applications. Furthermore, the distinct thermal responses of Ce^{3+} and Mn^{2+} luminescence enable not only the determination of the luminescence intensity ratio ($S_R = 4.5\% \text{ K}^{-1}$), but also the development of a luminescent indicator for detecting the crossing of a threshold temperature using the RGB channels of a standard camera. Importantly, the activation temperature of the signal in the G channel, which is governed by the Mn^{2+} ion concentration, provides a means to tune the threshold temperature of the sensor. This allows for precise adjustment of the sensor performance to meet specific application requirements.

Słowa kluczowe

luminescence thermometry, Mn^{2+} , ratiometric approach, RGB

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