Unusual Thermally Induced Blueshift and Emission Amplification of Mn^{2+} Ions Enable Filter-Free Luminescent Thermal Imaging

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The shift from point-based thermal sensing to filter-free thermal imaging requires luminescent thermometers that exhibit pronounced and thermally driven spectral changes within spectral regions matching the sensitivity profiles of the red, green and blue (RGB) channels of a digital camera. In this work, we introduce such a system, enabled by the synergistic interplay between (i) thermal redistribution among the vibronic components of the $^4T_1$ excited state of Mn^{2+} ions and (ii) thermally assisted population of this state via optical trap sites. These combined processes result in a simultaneous thermal enhancement and blueshift of the Mn^{2+} emission band associated with the $^4T_1 \rightarrow {}^6A_1$ electronic transition. Consequently, the emission intensity recorded in the G channel increases with temperature, while the luminescence signals detected in the B channel exhibit a corresponding decrease. As demonstrated, $Ca_{19}Zn_2(PO_4)_{14}:Mn^{2+}$, Ce^{3+} supports not only sensitive filter-free thermal imaging, but also two additional ratiometric readout schemes: one based on the intensity ratio of Ce^{3+} and Mn^{2+} emissions, and another based on two distinct spectral regions of the Mn^{2+} emission band, yielding maximum relative sensitivities of 0.42 and 2.7%K^{-1}, respectively. This approach introduces a unique thermometric strategy that enables simple, robust, and cost-effective two-dimensional thermal imaging without the need for optical filters or specialized instrumentation.

Słowa kluczowe

luminescence thermometry, optical sensors, ratiometric approach, thermal imaging, thermally enhanced Mn2 luminescence

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