

Development from a multimodal up-converting luminescent thermometer into a ratiometric visual optical power density meter based on Er^{3+} , Yb^{3+} emission

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This work shows that temperature-dependent changes in the spectroscopic properties of the $\text{Na}_3\text{Sc}_2(\text{PO}_4)_3:\text{Er}^{3+},\text{Yb}^{3+}$ can be efficiently exploited for multimodal remote temperature sensing [1]. As illustrated, $\text{Na}_3\text{Sc}_2(\text{PO}_4)_3:\text{Er}^{3+},\text{Yb}^{3+}$ exhibits multiple ratiometric sensing approaches, utilizing the emission intensity ratios of (i) ${}^2\text{H}_{11/2} \rightarrow {}^4\text{I}_{15/2}$ and ${}^4\text{S}_{3/2} \rightarrow {}^4\text{I}_{15/2}$; (ii) ${}^2\text{H}_{9/2} \rightarrow {}^4\text{I}_{13/2}$ and ${}^4\text{S}_{3/2} \rightarrow {}^4\text{I}_{15/2}$; and (iii) green-to-red emission intensity ratio with corresponding maximum relative sensitivities reaching 2.8% K^{-1} , 3% K^{-1} , and 1.8% K^{-1} . The combination of temperature-dependent changes in the green-to-red emission intensity ratio of Er^{3+} ions and the enhanced optical heating of $\text{Na}_3\text{Sc}_2(\text{PO}_4)_3:\text{Er}^{3+},\text{Yb}^{3+}$ at higher Yb^{3+} concentrations facilitates the establishment of a visual optical power density sensor, achieving relative sensitivities of $S_{R_x} = 1.0\% \text{ W}^{-1} \text{ cm}^2$ and $S_{R_y} = 0.9\% \text{ W}^{-1} \text{ cm}^2$ at 15 W cm^{-2} , as determined from CIE 1931 chromaticity coordinates. This work presents the first reported example of a visual luminescent optical power density sensor. In addition, $\text{Na}_3\text{Sc}_2(\text{PO}_4)_3:\text{Er}^{3+},\text{Yb}^{3+}$ is shown to be effectively applicable for two-dimensional optical power density imaging, allowing spatial mapping of power distribution across an illuminated filed.

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