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Using the upconversion luminescence of the  $\text{CaWO}_4:\text{Yb}^{3+}-\text{X}^{3+}$  ( $\text{X}=\text{Er}/\text{Ho}/\text{Tm}$ ) phosphors for ratiometric thermal sensing

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**Using the upconversion luminescence of the  $\text{CaWO}_4:\text{Yb}^{3+}-\text{X}^{3+}$  ( $\text{X}=\text{Er}/\text{Ho}/\text{Tm}$ )****phosphors for ratiometric thermal sensing**

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**Abstract**

Based on the luminescence ratiometric method, here we systematically investigate the relative sensitivity ( $S_r$ ) of three pairs of typical thermally coupled energy levels (TCEs), that are, the  ${}^2\text{H}_{11/2}/{}^4\text{S}_{3/2}$  levels of  $\text{Er}^{3+}$ , the two sub-Stark  ${}^5\text{F}_5$  levels of  $\text{Ho}^{3+}$ , and the  ${}^3\text{F}_3/{}^3\text{H}_4$  levels of  $\text{Tm}^{3+}$ , embedded in the  $\text{CaWO}_4$  host. On the basis of the emission spectra of the  $\text{CaWO}_4:\text{Yb}^{3+}-\text{X}^{3+}$  ( $\text{X}=\text{Er}/\text{Ho}/\text{Tm}$ ) phosphors, the gaps that separate the  ${}^2\text{H}_{11/2}/{}^4\text{S}_{3/2}$ , the two sub-Stark  ${}^5\text{F}_5$ , and the  ${}^3\text{F}_3/{}^3\text{H}_4$  TCEs are calculated

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