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Multiple ratiometric thermometry using electronic transitions between Stark sublevels of Er^{3+} for reliable temperature detection

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A B S T R A C T

Under 980 nm wavelength excitation, green upconversion emission spectra of Er^{3+} ions in $NaYF_4$(NYF) micro-crystals were measured in the temperature range of 298-383 K. A multiple ratiometric thermometry is proposed to realize reliable temperature sensing. It considers six luminescence intensity ratios(LIRs) involving two peaks at 530 nm emission band and three peaks at 550 nm emission band, which concern electronic transitions between crystal-field Stark sublevels of Er^{3+}. The six LIR schemes display similar temperature characteristics with high thermometric efficiency. The temperature can be overall determined by the six LIR schemes, largely increasing measurement reliability. The study also shows that the 980 nm excitation power adopted neither induces a detectable temperature change nor has a noticeable effect on the LIR value. In addition, the Er^{3+}-doped NYF phosphor displays intense green emissions and thermally stable spectral structure which are desired for the multiple ratiometric thermometry.

Keywords: Sensors; Nanocrystalline materials; Luminescence; Thermal properties.

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