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Luminescent Nanothermometry based on Er^{3+}/Yb^{3+} co-doped GdF_3 nanoparticles for biological applications

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Luminescent nanothermometry explores the relationship between temperature and the luminescent properties of materials to achieve thermal sensing through spectroscopic analyses [1]. Fluoride based nanoparticles doped with Ln^{3+} ions are highly versatile, typically exhibiting narrow emission bands, high emission quantum yield, and stability [2]. In this sense, Er^{3+} and Yb^{3+} codoped GdF_3 nanoparticles were prepared by hydrothermal synthesis starting from rare earth (RE) nitrate, NH_4F precursors and polyethylene glycol 8000 (PEG) as precursors. Uniform orthorhombic crystalline GdF_3 nanoparticles, with size of around 200 nm exhibited up conversion (UC) emission under excitation at 980 nm. Dynamics of the UC emission was investigated. UC spectra showed emissions attributed to the Er^{3+} ions $^4S_{3/2}$, $^2H_{4/2} \rightarrow {}^4I_{15/2}$ and $^2F_{9/2} \rightarrow {}^4I_{15/2}$ transitions respectively, under excitation at 980. The intensities of the thermally coupled $^4S_{3/2}$, $^2H_{4/2} \rightarrow {}^4I_{15/2}$ states were analyzed as a function of temperature, demonstrating their potential as primary thermometers based on luminescence (Figure 1). Through spectral deconvolution with Gaussian functions, the energetic separation (ΔE) between the barycenters of the $^2H_{11/2}$ and $^4S_{3/2}$ emitting levels was determined with a value of 777.3 cm^{-1}. Relative thermal sensitivity (Sr) values were calculated in the temperature range of 293 – 363 K. The To evaluate the performance of luminescent thermometers, the relative thermal sensitivity, Sr was calculated, and a maximum value of 1.3 % K^{-1} was obtained at a temperature of 293 K, which is to maximum values reported in the literature for fluorides. These results suggest the potential application of these nanoparticles as thermal sensors in biological range of temperature.

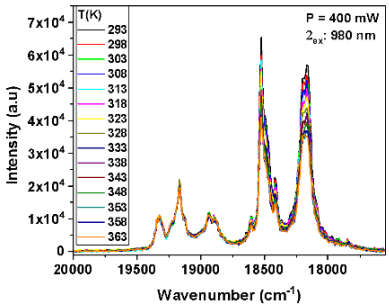

Fig. 1. UC emission spectra from GdF_3 nanoparticle under excitation at 980 nm in the temperature range of 293 – 363 K.

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