Supplementary Information

Boosting the Sensitivity of Nd^{3+}-based Luminescent Nanothermometers

Sangeetha Balabhadra,[a,b] Mengistie L. Debasu,[a] Carlos D. S. Brites,[a] Luís A. O. Nunes,[c] Oscar L. Malta,[d] João Rocha,[b] Marco Bettinelli,[e] Luís D. Carlos[a]*

[a] Department of Physics and CICECO Aveiro Institute of Materials, University of Aveiro, 3810–193 Aveiro, Portugal

[b] Department of Chemistry and CICECO Aveiro Institute of Materials, University of Aveiro, 3810–193 Aveiro, Portugal

[c] Instituto de Física de São Carlos, Universidade de São Paulo - USP, CEP 13560-970, São Carlos - SP, Brazil

[d] Departamento de Química Fundamental-CCEN-UFPE, Cidade Universitária, Recife-PE, 50670-901, Brazil

[e] Luminescent Materials Laboratory, Department of Biotechnology, University of Verona, 37134 Verona, Italy

* Correspondence to: Prof. L.D. Carlos, E-mail: lcarlos@ua.pt

Nanorods Emission Dependence on Moisture

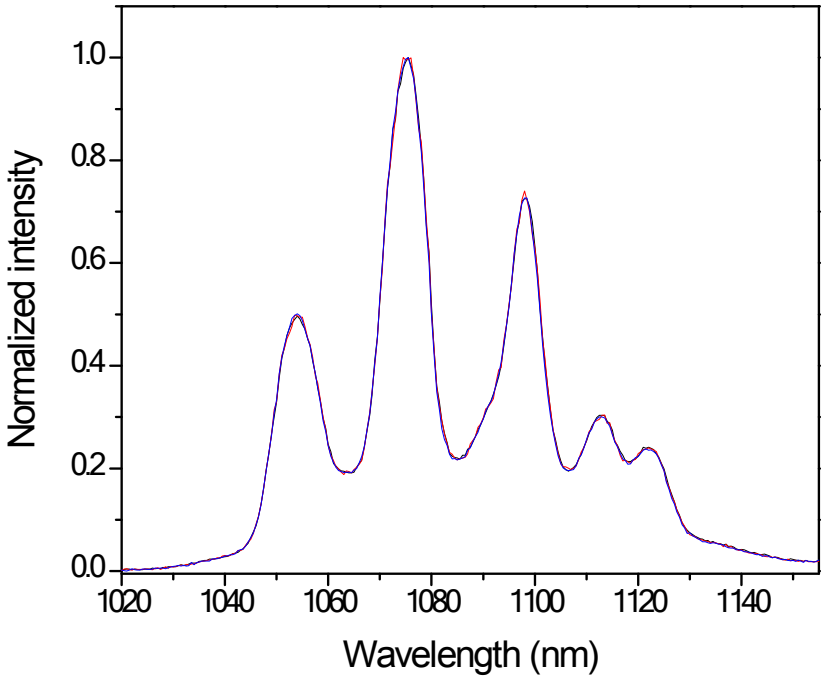

Figure S1. Emission spectra of $(Gd_{0.976}Nd_{0.024})_2O_3$ nanorods recorded as a function of the time exposure to moisture. After synthesis, the sample was kept 1 day (black line), 5 days (red line) and 7 days (blue line) in laboratory atmosphere. The spectra were obtained at room temperature and exciting at 580 nm.

Emission Decay Curves of the $^4F_{3/2}$ level

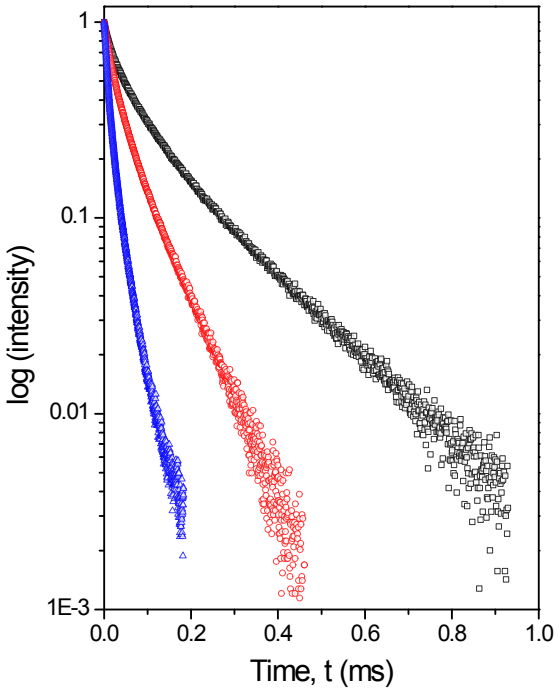

Figure S2. Semi-logarithmic plot of the $^4F_{3/2}$ emission decay curves in $(Gd_{1-x}Nd_x)_2O_3$ nanorods (x=0.009, 0.024 and 0.049, black, red and blue symbols, respectively). The decay curves were obtained at 300 K, exciting at 808 nm, and monitoring the $^4F_{3/2} \rightarrow {}^4I_{11/2}$ transition.

Temperature Dependence of the Emission Decay Curves of the $^4F_{3/2}$ level

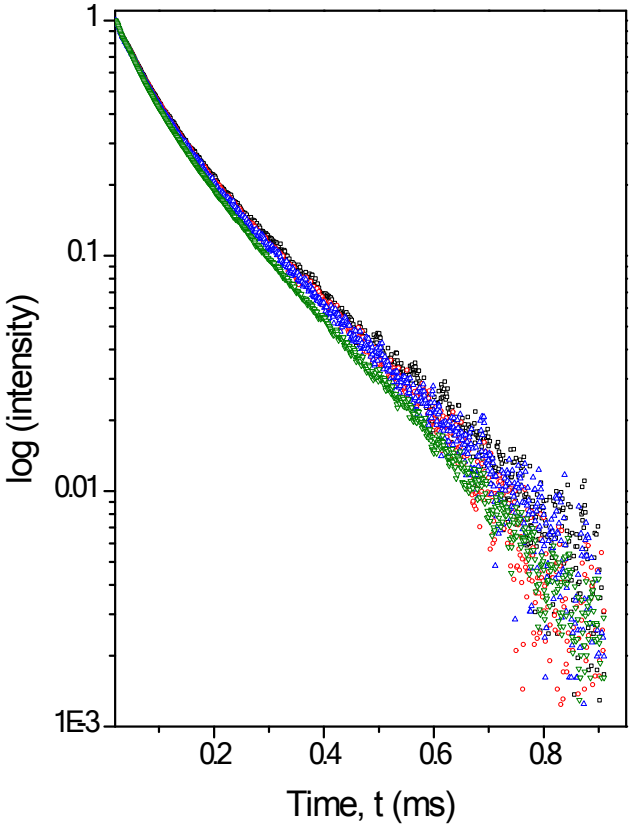

Figure S3. Semi-logarithmic plot of the $^4F_{3/2}$ emission decay curves in $(Gd_{0.991}Nd_{0.009})_2O_3$ nanorods at 133 K, 223 K, 273 K and 323 K, green, blue, red and black symbols, respectively. The decay curves were obtained exciting at 808 nm and monitoring the $^4F_{3/2} \rightarrow {}^4I_{11/2}$ transition.

Barycentre determination

The barycentre of the Nd^{3+} $^4F_{5/2}$, $^4F_{3/2} \rightarrow {}^4I_{9/2}$ transitions were determined using the emission spectra measured using the R928- and InGaAs-based detectors, respectively, and the peak analyser routine of the Origin © software.

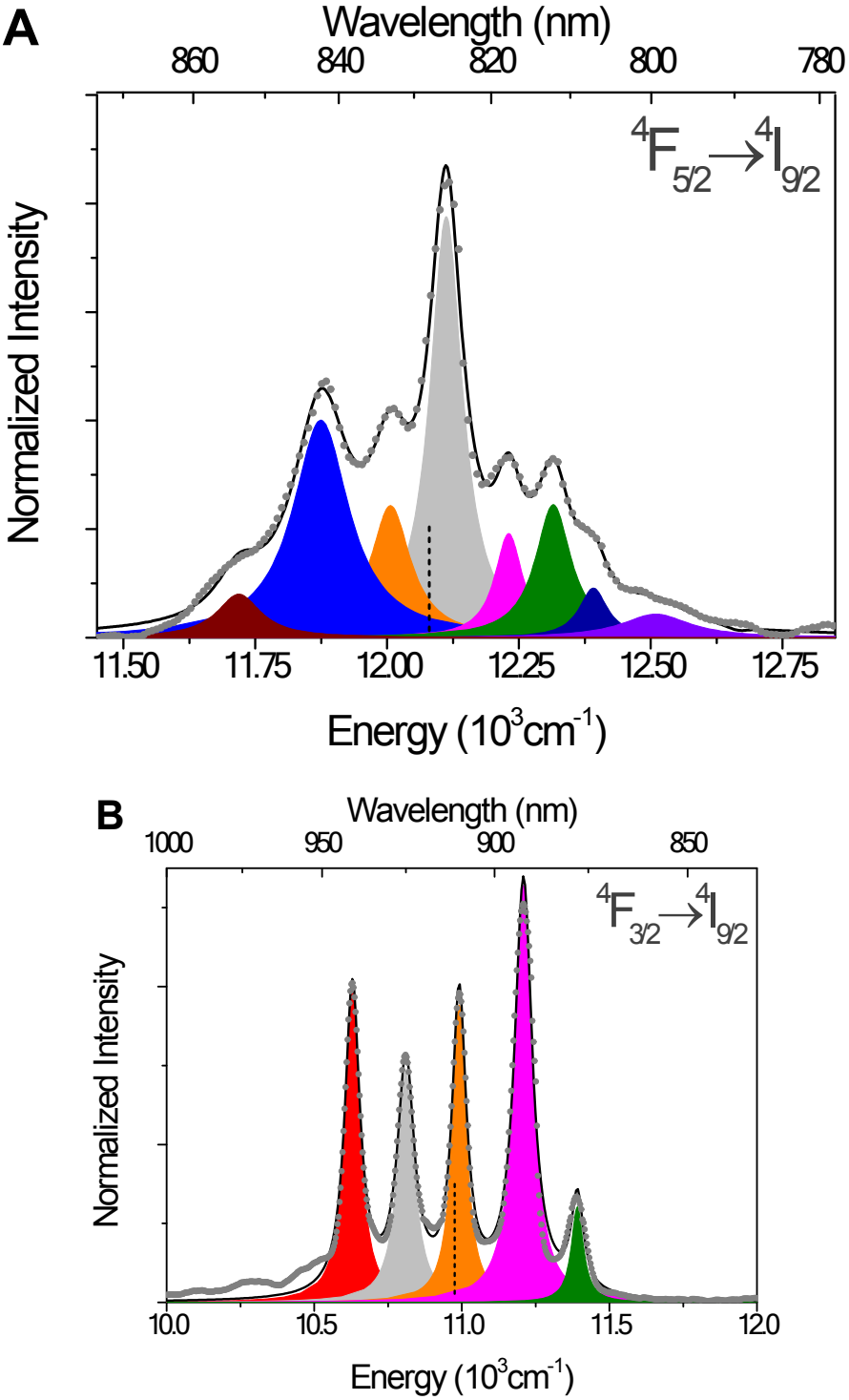

Figure S4. Experimental emission spectra (points) in the spectral region corresponding to the $^4F_{5/2}$, $^4F_{3/2} \rightarrow {}^4I_{9/2}$ (A and B) transitions. The experimental curves were fitted to a set of 8 and 5 Lorentzian peaks, respectively, (r^2>0.991), resulting in the components (shadowed areas) and to the envelope (solid line). The interrupted vertical line marks the position of the centre of gravity of the envelope and was taken as the barycentre of the transition.

Calibration Curve

The experimental thermometric parameter $\Delta=I_1/I_2$ was fitted to a straight line to obtain a local calibration curve in the 288−323K range.

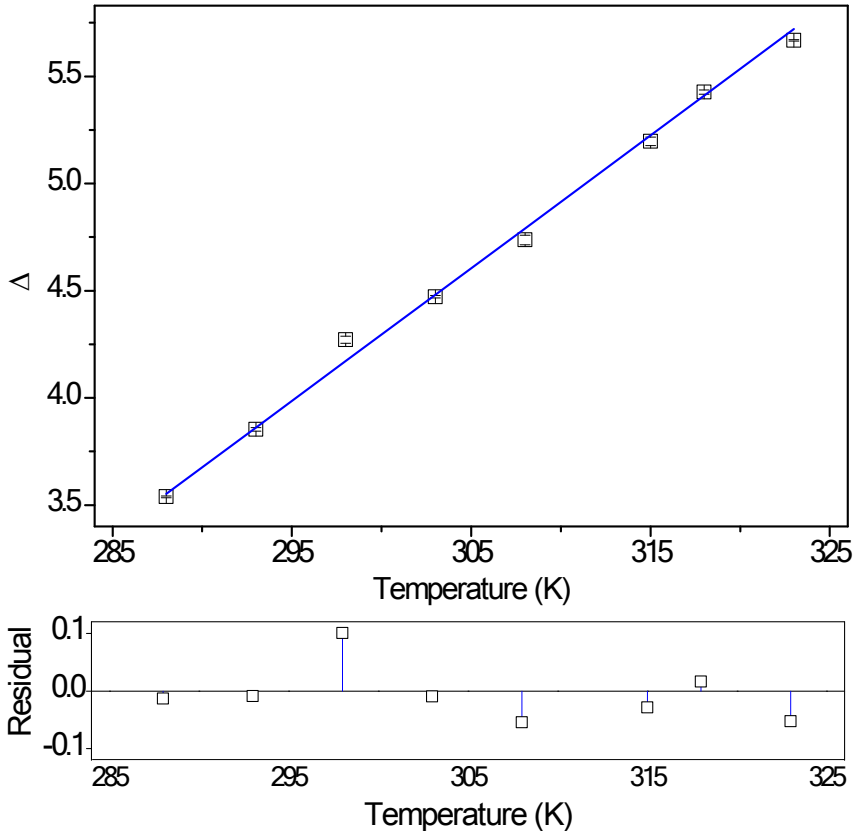

Figure S5. Calibration curve in the 288-323 K range. The open points correspond to the experimental thermometric parameter Δ and the error bars result from the error in the determination of the integrated areas of each transition. The solid line is the best fit of the experimental data to a straight line (r^2>0.996). The fit residuals are presented in the bottom of the plot.

Estimation of the Temperature Uncertainty

The number of atoms in the sample (N_A) were obtained from the volume of the nanorods and the density of Gd_2O_3 at 298 K, 7.41 × 10^3 kg. m^{-3}. The volume of the nanorods was calculated using the diameter (13.5 ± 3.5 nm) and length (91.0 ± 11.0 nm) values shown in Figure 2D and E.

The maximum (δT_{max}) and minimum (δT_{min}) temperature uncertainty values were determined by considering the error in length (10%) and radius (20%) of the nanorods. These values further compared with the value (δT) obtained with the nanorods mean radius and length. The error in the temperature uncertainty corresponds to the maximum deviation, ($\delta T_{max} - \delta T$ or $\delta T - \delta T_{min}$).