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Supporting information of:

Effect of the effective refractive index on the radiative decay rate in nanoparticle thin films

Manuel Romero, Juan Ramón Sánchez-Valencia, Gabriel Lozano, and Hernán Míguez.*

Institute of Materials Science of Seville, Spanish National Research Council – University of Seville, C. Américo Vespucio 49, 41092, Seville, Spain

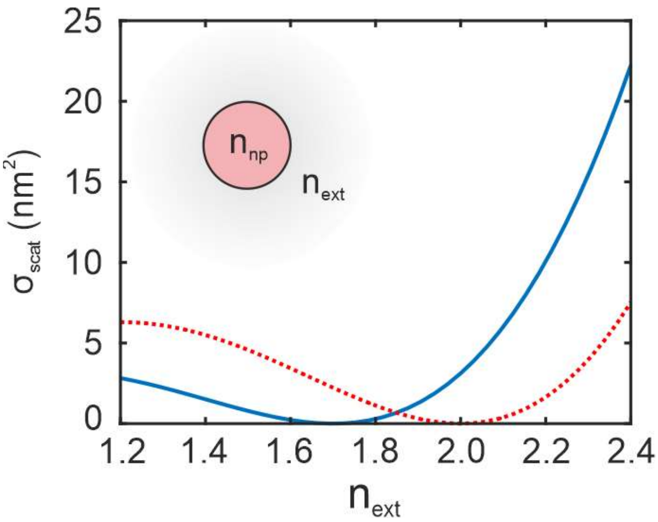

Figure S1. Mie calculations for the scattering cross section of a nanoparticle of 50 nm diameter and a refractive index n_{np}=1.7 (blue solid line) and n_{np}=2.0 (red dashed line) immersed in a homogeneous medium with refractive index n_{ext}. Calculation are shown for λ=620 nm.

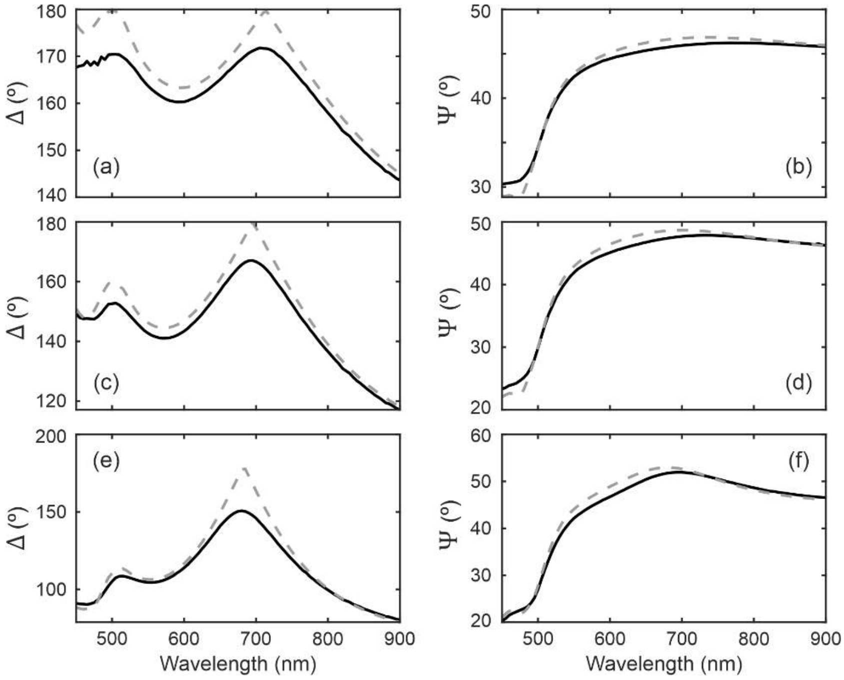

Figure S2. Ellipsometry fittings for three different incident angles: (a-b) $\theta_{\text{in}} = 55°$, (c-d) $\theta_{\text{in}} = 65°$ and (e-f) $\theta_{\text{in}} = 75°$. Measurements correspond to a $\text{GdVO}_4\text{: Eu}^{3+}$ reference sample deposited over a thick gold layer. Theoretical fitting was obtained using n_{eff}=1.4, confirming the results obtained by fitting ballistic transmittance and specular reflectance spectra.

PL decay spectra can be fitted in the Inokuti-Hirayama model using the following function:

$$I(t) = I_0 \cdot \exp\left(-\Gamma_{int} \cdot t - X_S(\Gamma_{int} \cdot t)^{3/J}\right) \quad \text{(S1)}$$

Γ_{int} being the intrinsic decay rate of the cations (the rate if energy transfer between the cations did not occur) and X_S the energy transfer parameter, which depends on cation concentration N_0 and the critical radius R_0 in the following manner:

$$X_s = \frac{4\pi}{3}\gamma(J)\left(1 - \frac{3}{J}\right) N_0\, R_0^3 \quad \text{(S2)}$$

Where $\gamma(J)$ is the gamma function, and J is the multipolar interaction parameter, which takes the value of J=10 for Eu^{3+}.

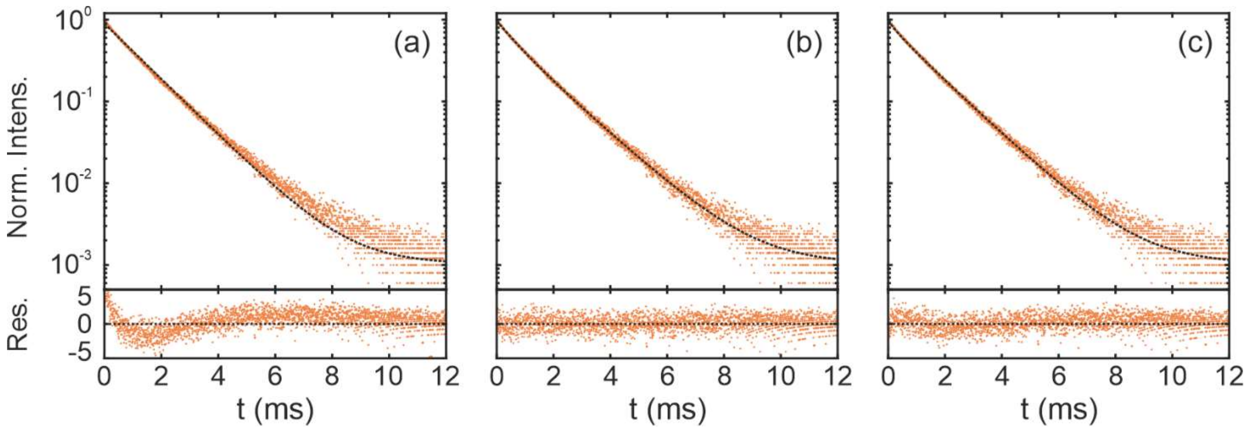

Figure S3. Comparison between PL decay fittings for an only-phosphors sample employing different decay models: (a) single exponential, (b) biexponential and (c) Inokuti-Hirayama model. Calculated reduced chi-square χ^2 values are: (a) 1.80, (b) 1.15 and (c) 1.22.

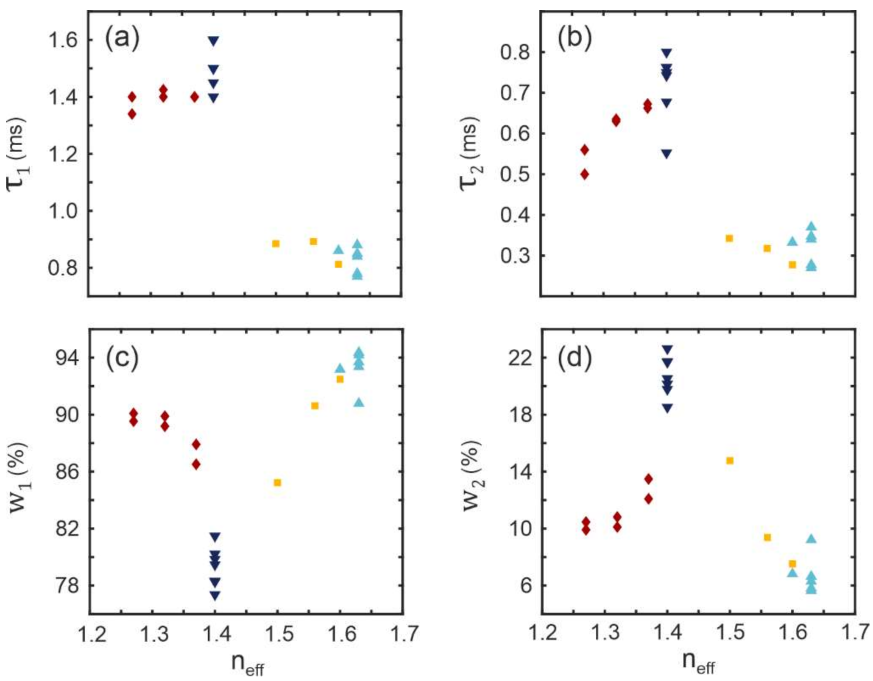

Figure S4. Bi-exponential fitting parameters used for PL decay measurements. Lifetimes of both long (a) and short (b) components are included as well as its corresponding weights (c-d).

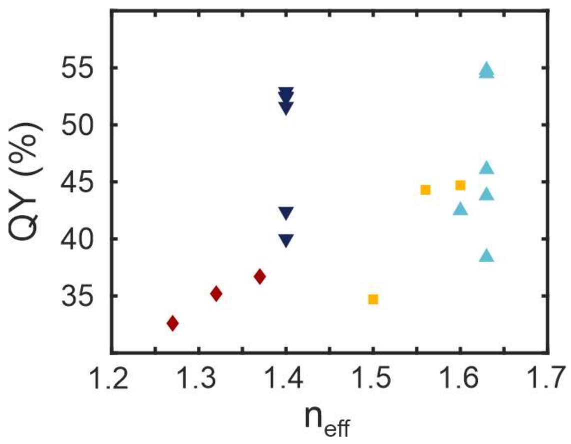

Figure S5. Absolute quantum yield measurements for samples with different effective refractive index.

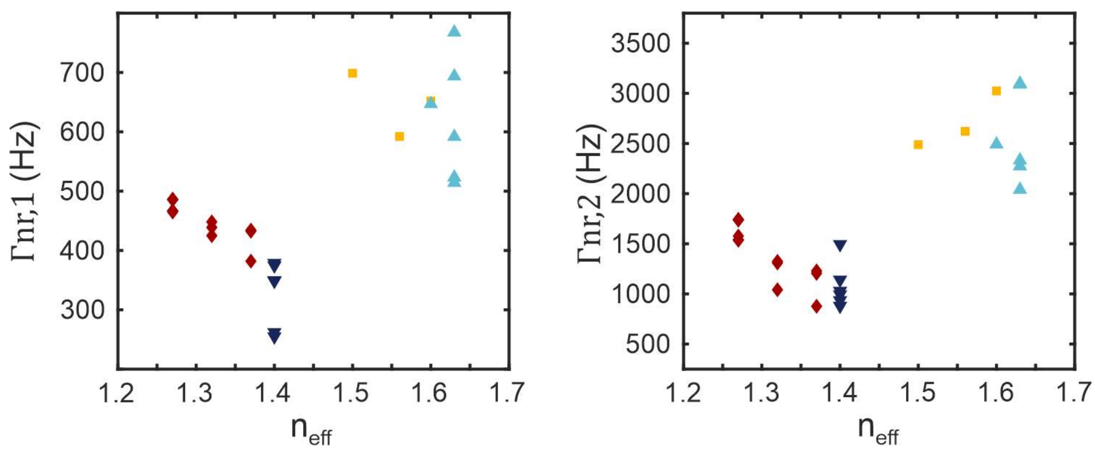

Figure S6. Calculated non-radiative rates for the two components of the bi-exponential PL decay.

The relationship between PLQY and transition rates in the Inokuti-Hirayama model can be made as follows:

$$PLQY = \frac{\Gamma_{rad}}{(1+(R_0/R)^J)\cdot\Gamma_{int}} \quad \text{(S3)}$$

where R is the average distance between RE cations in the nanoparticle, which can be estimated from the doping concentration (10% in our case). Using this expression combined with PL decay fittings and PLQY measurements we can separate between the radiative and non-radiative components of the decay as shown in Figure S7.

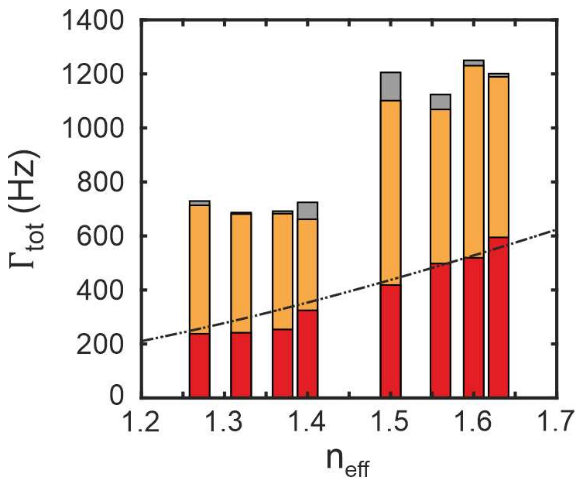

Figure S7. Radiative rate (red bottom bars), non-radiative rate (orange middle bars) and Eu-Eu transfer rate (grey top bars) obtained by using the Inokuti-Hirayama model given by Equations S1-S3. Black dashed dotted line corresponds to our empirical correction (also shown in Figure 5). Each bar corresponds to the average of the samples with the same effective refractive index.