Persistent Luminescence from Eu^{3+} in SnO_2 Nanoparticles

- Supporting Information

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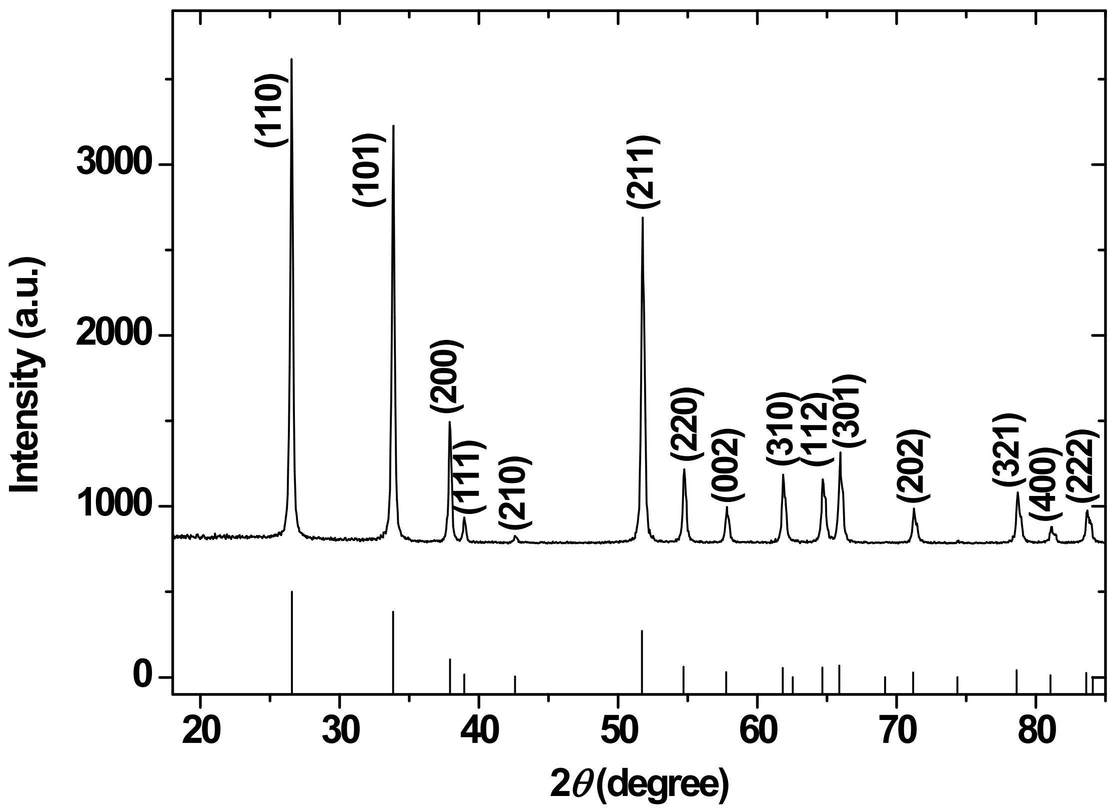

Figure S1. XRD pattern of SnO_2:Eu^{3+} nanoparticles (NPs). The bars at the bottom represent the standard diffraction lines of rutile-phase SnO_2 (JCPDS No. 77-0449).

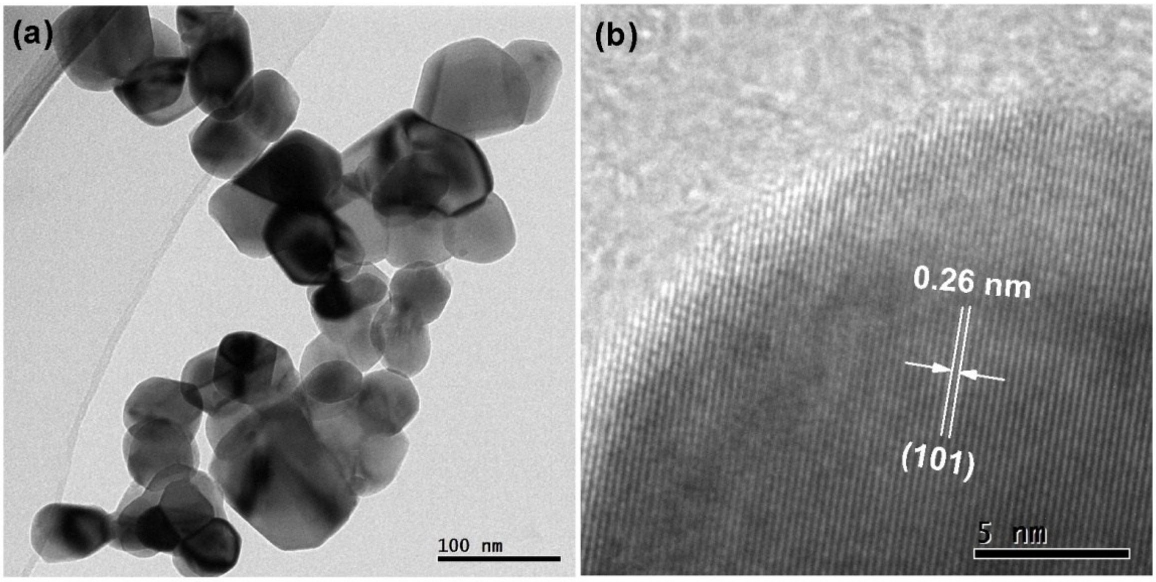

Figure S2. (a) TEM and (b) HRTEM images of $SnO_2:Eu^{3+}$ NPs. The HRTEM image shows clear lattice fringes for an individual NP, with an observed *d* spacing of 0.26 nm, which is in good agreement with the lattice spacing of the (101) plane of rutile SnO_2.

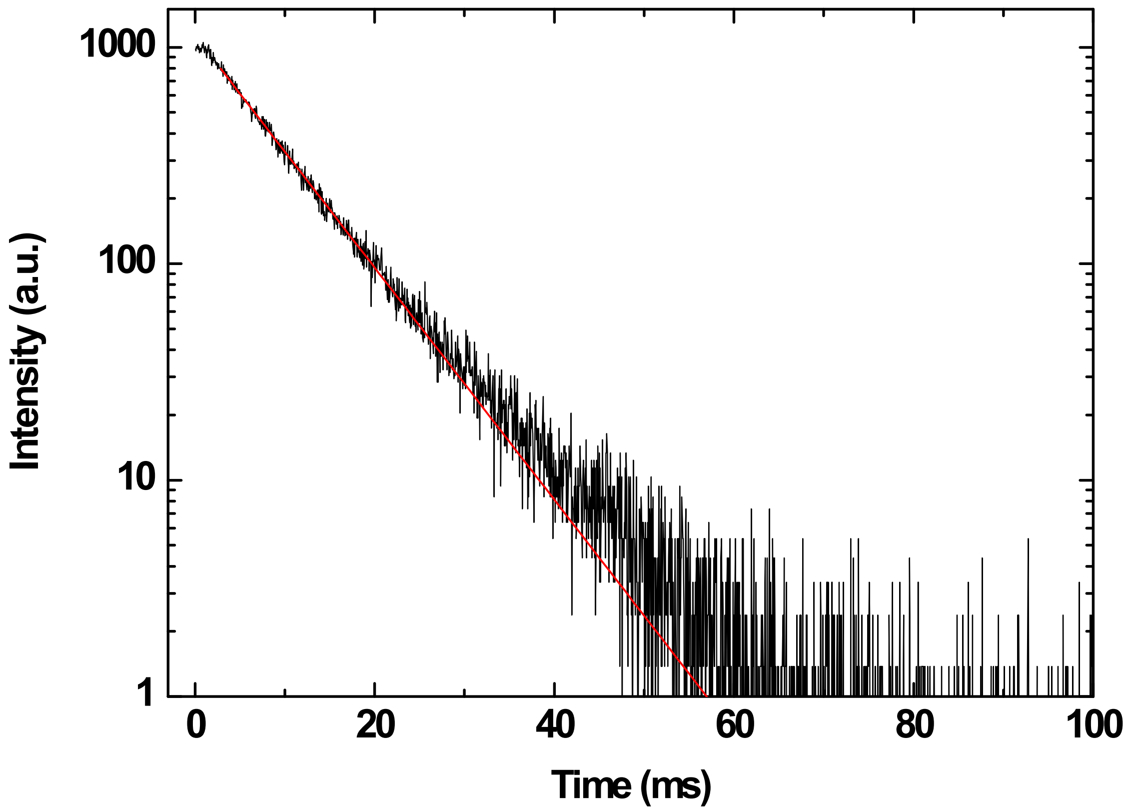

Figure S3. PL decay curve of SnO_2:Eu^{3+} microparticles (MPs) by monitoring the Eu^{3+} emission at 588.0 nm at 300 K. By fitting the decay curve with a single-exponential function (red line), the $^5D_0$ lifetime of Eu^{3+} was determined to be 8.1 ms.

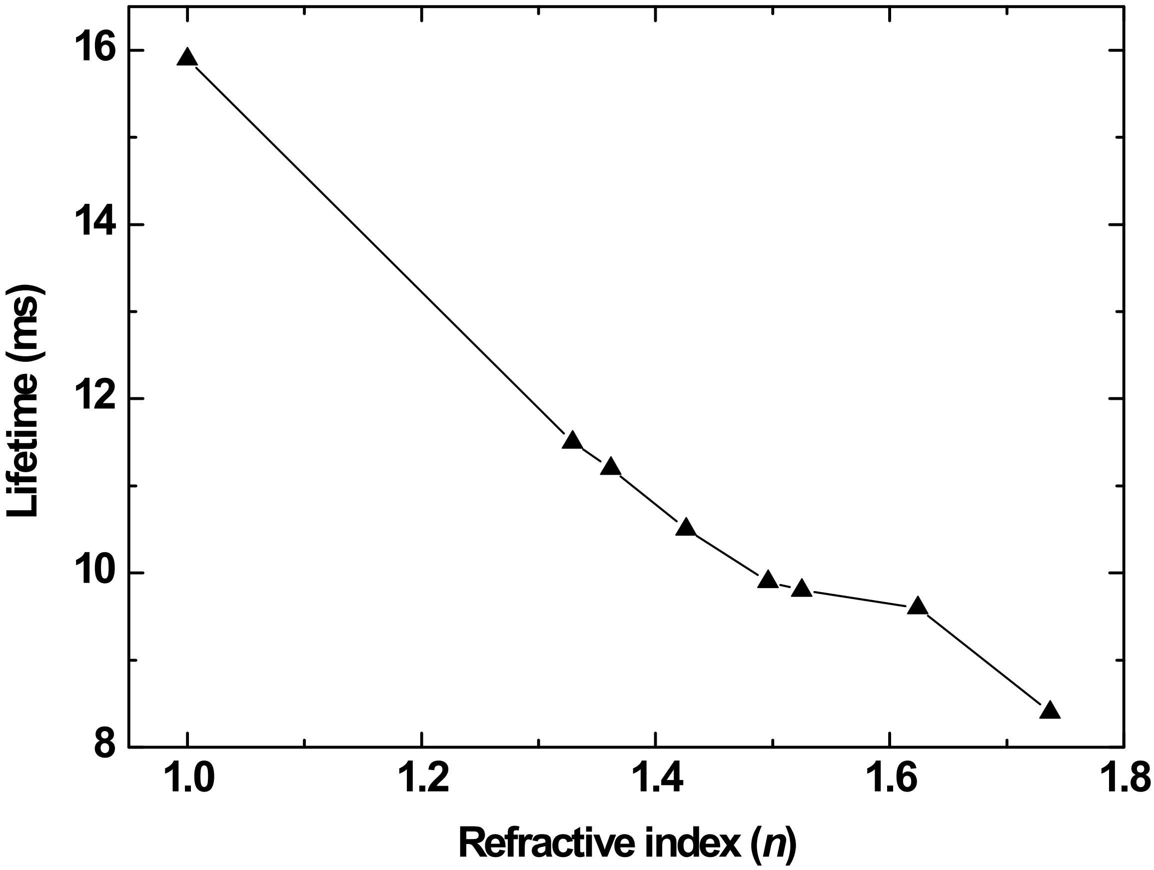

Figure S4. Dependence of the $^5D_0$ PL lifetime of Eu^{3+} in SnO_2 NPs on the refractive index (n) of the surrounding media. The media are, in turn, air (n = 1), methanol (1.329), ethanol (1.362), cyclohexane (1.426), toluene (1.496), chlorobenzene (1.525), carbon disulfide (1.624), and diiodomethane (1.737).

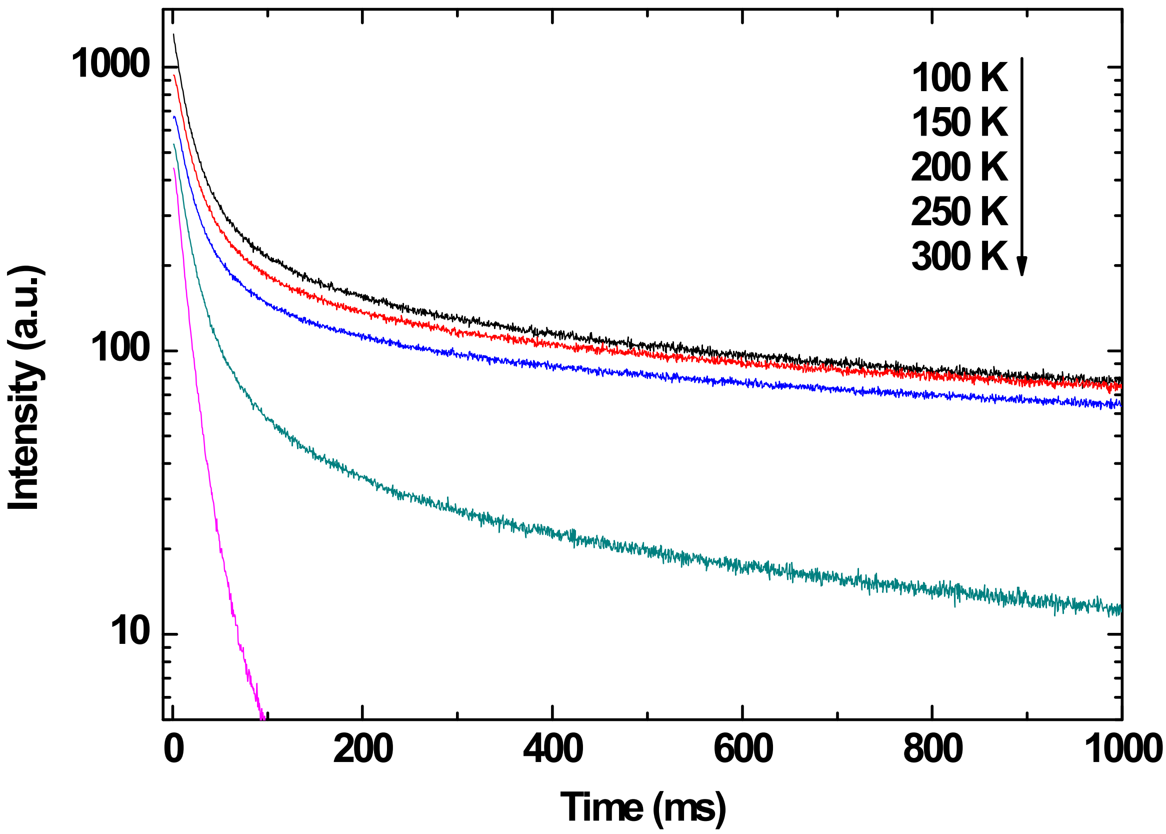

Figure S5. PL decay curves of $SnO_2:Eu^{3+}$ MPs in the temperature range of 100-300 K. The long-lasting decay tails at temperatures below 250 K indicate the persistent luminescence feature of $SnO_2:Eu^{3+}$ MPs.

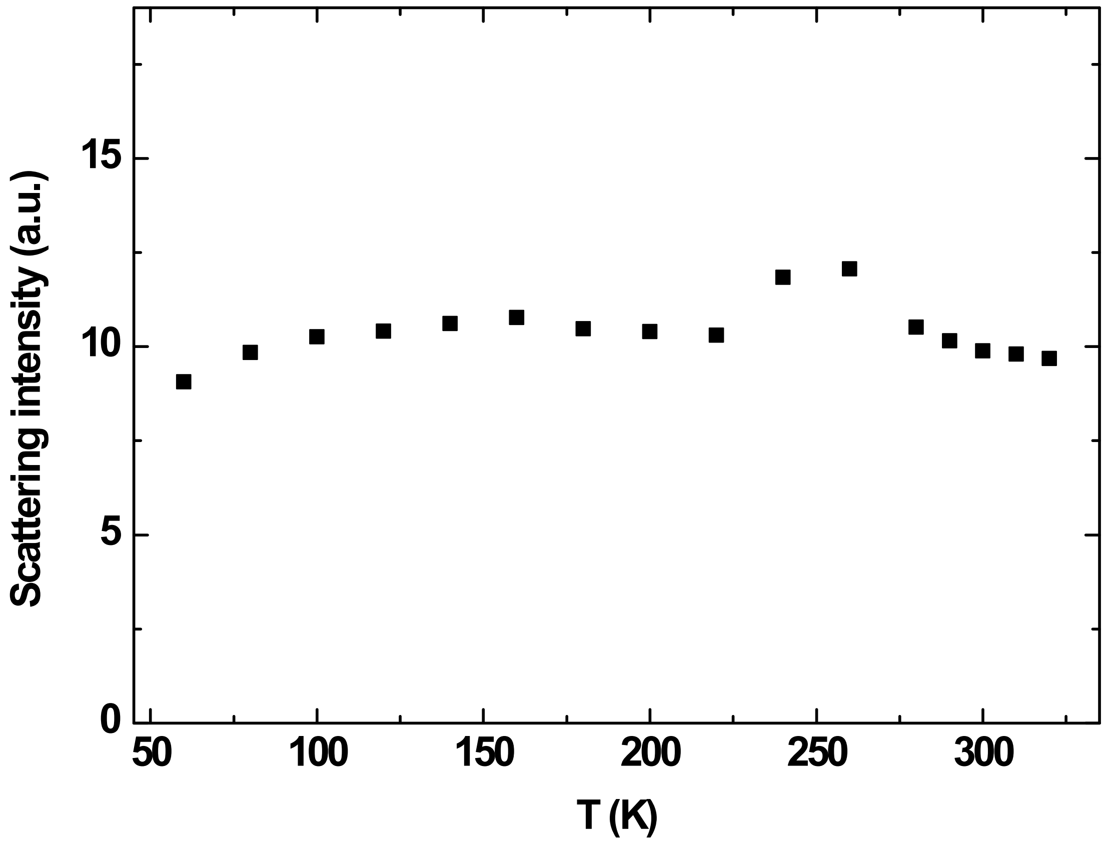

Figure S6. The scattering of SnO_2:Eu^{3+} NPs to the excitation light at 300 nm as a function of temperature.

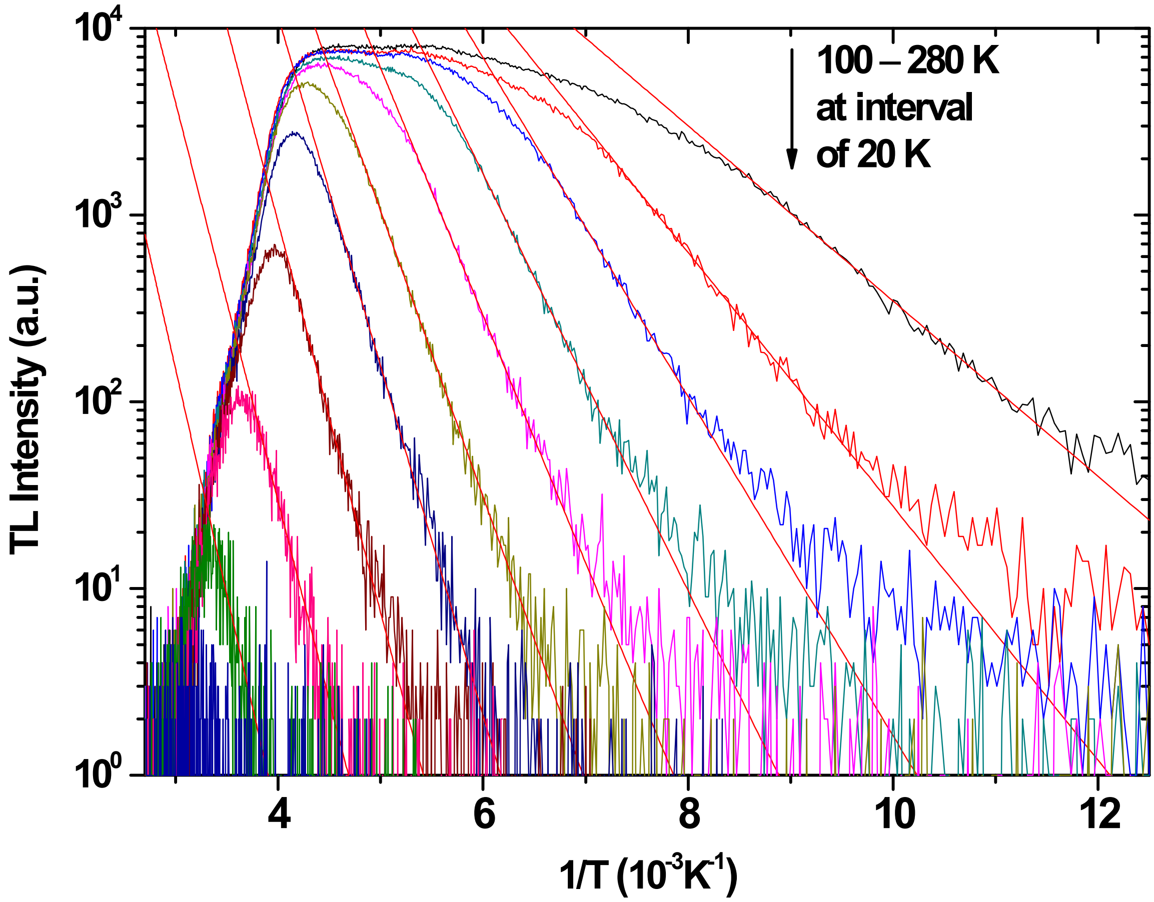

Figure S7. Thermoluminescence (TL) glow curves of SnO_2:Eu^{3+} NPs with excitation at 100 K and varying thermal cleaning temperatures from 120 to 280 K in ln(*I*) versus 1/*T* plot. By utilizing the initial rise analysis, namely, fitting the low-temperature side of the curves with $I(T) = C exp(-E_T/k_B T)$, where *C* is a constant and k_B is Boltzman's constant (K. Van den Eeckhout, A. J. J. Bos, D. Poelman and P. F. Smet, *Phys. Rev. B*, 2013, **87**, 045126), the trap depths (E_T) were determined (red lines).

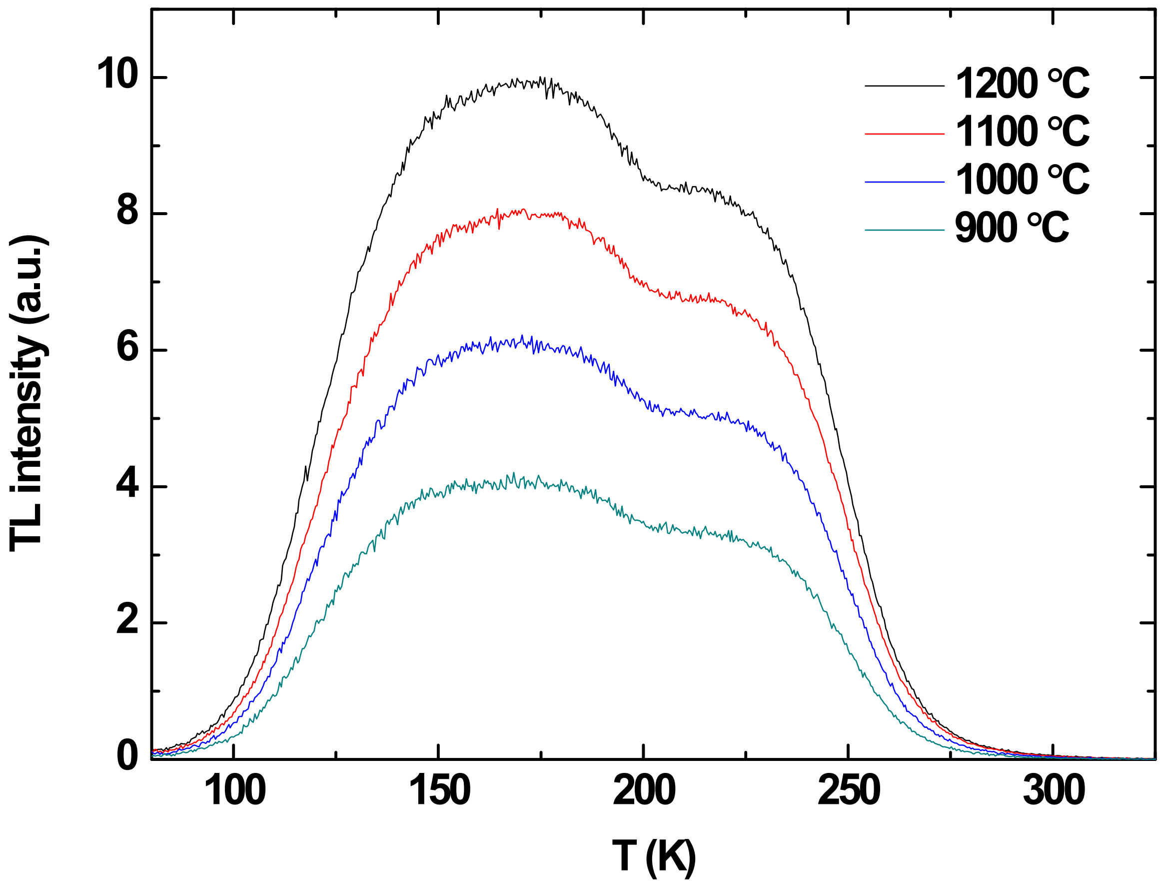

Figure S8. TL glow curves of SnO_2:Eu^{3+} NPs synthesized at different annealing temperatures from 900 to 1200 °C. The shapes of the TL glow curves are almost identical, indicating that the traps and their depth distribution are independent of the annealing temperature.

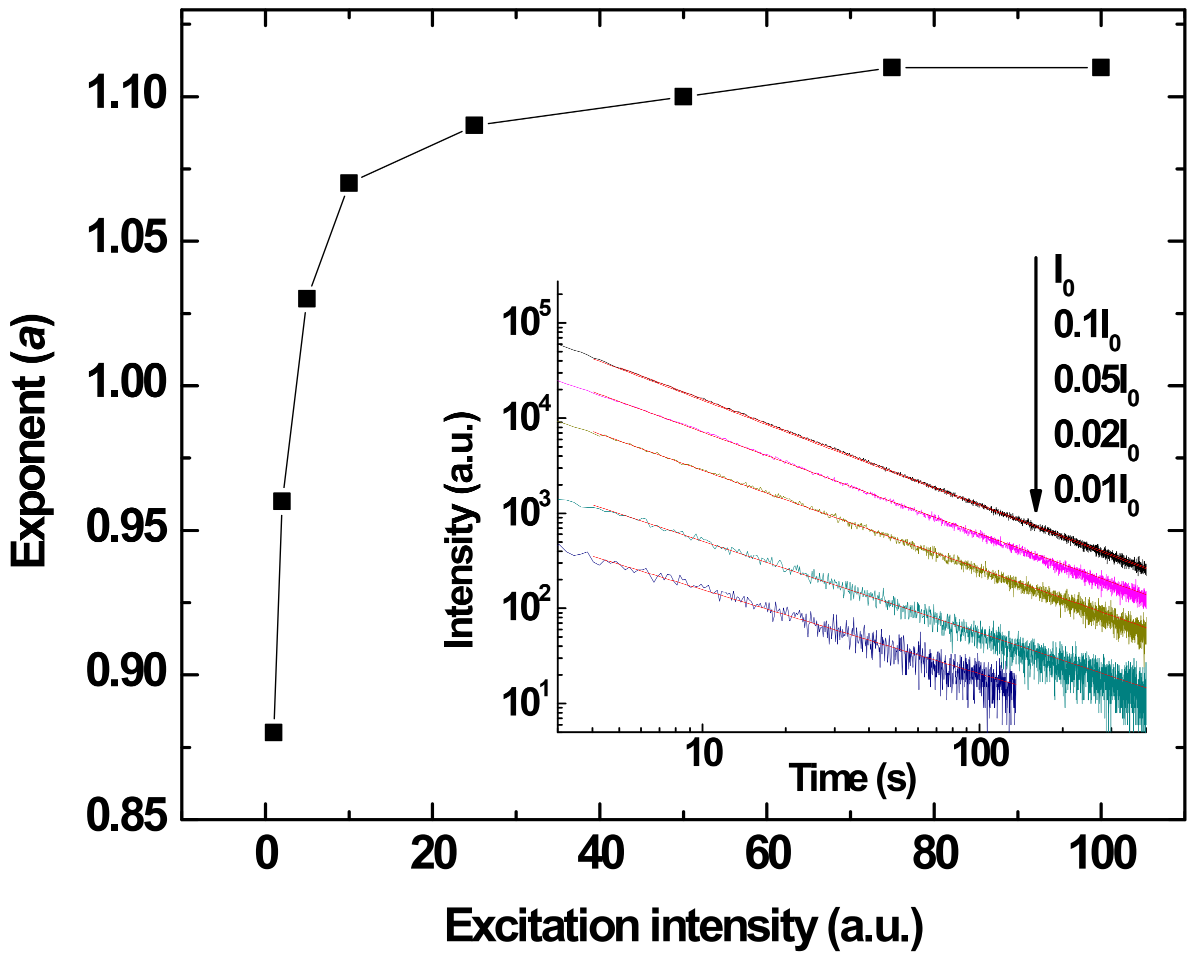

Figure S9. Dependence of the inverse power-law exponent on the excitation intensity. The inset shows the persistent luminescence decay curves of SnO_2:Eu^{3+} NPs measured under excitation at 180 K. The exponents were determined by fitting the decay curves with the inverse power law.

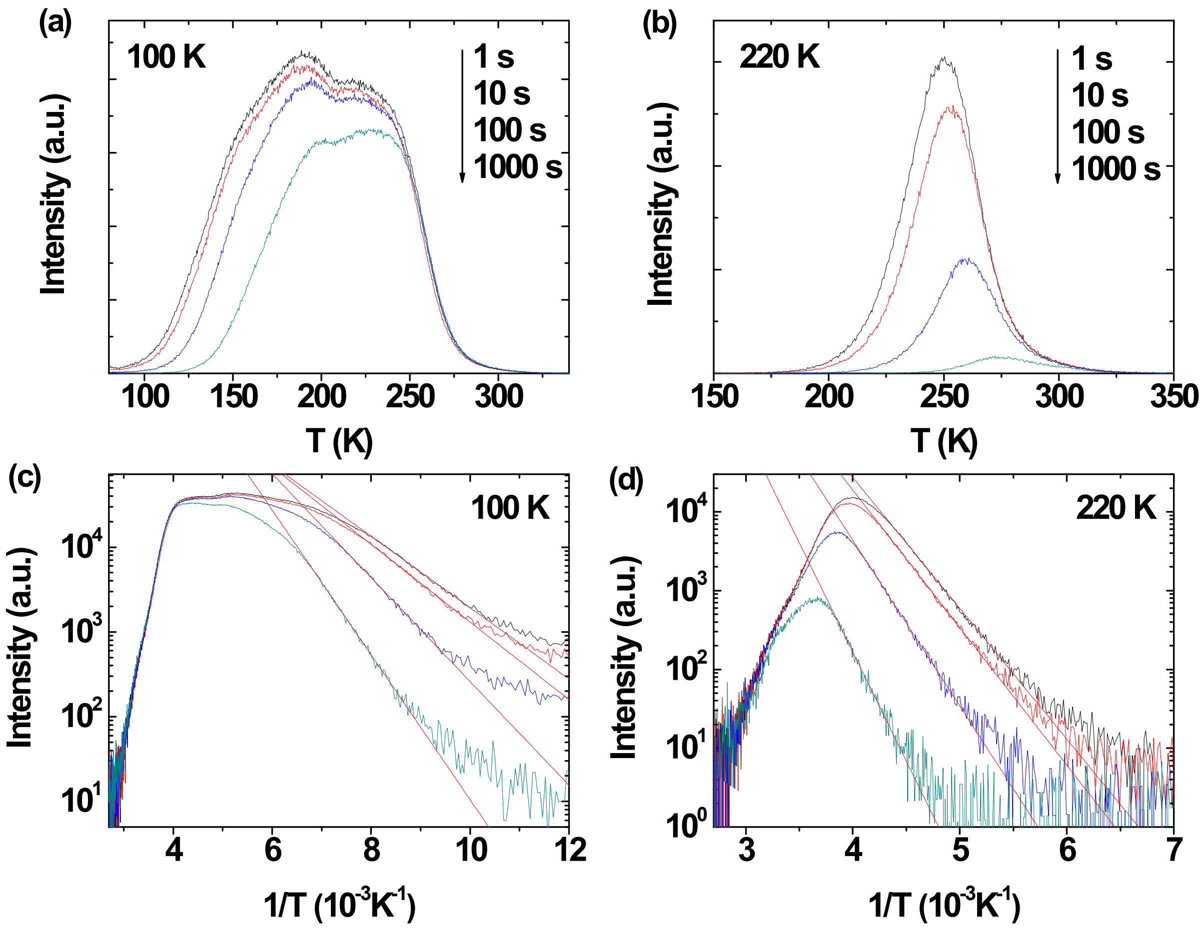

Figure S10. TL glow cruves of SnO_2:Eu^{3+} NPs measured under excitation at (a) 100 K and (b) 220 K by varying the delay time from 1 to 1000 s. (c) and (d) are the corresponding ln(I) versus 1/T plot of the TL glow curves in (a) and (b), respectively. The trap depths were determined through the initial rise analysis as described in Figure S7 (red lines).