Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Lanthanide-doped Sr_2YF_7 nanoparticles: controlled synthesis, optical spectroscopy and biodetection

Yuhan Yang,[ab] Datao Tu,[a] Wei Zheng,[a] Yongsheng Liu,[a] Ping Huang,[ab] En Ma,[a] Renfu Li[a] and Xueyuan Chen[*ab]

[a] *Key Laboratory of Optoelectronic Materials Chemistry and Physics, and Key Laboratory of Design and Assembly of Functional Nanostructures, Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences, Fuzhou, Fujian 350002, China.*

[b] *University of Chinese Academy of Sciences, Beijing 100049, China.*

[*]Corresponding author, E-mail: xchen@fjirsm.ac.cn

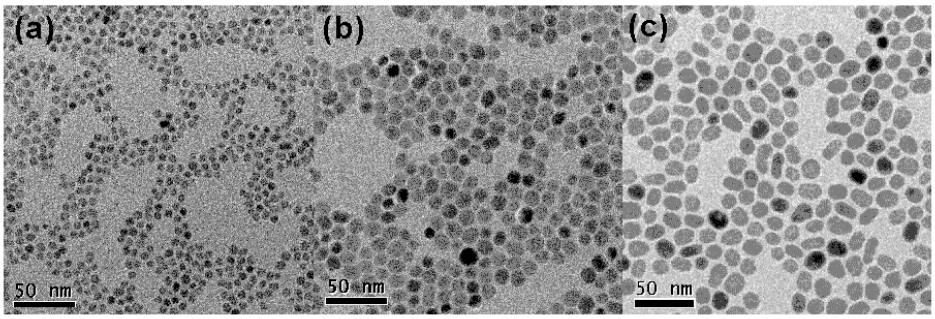

Fig. S1 Transmission electron microscopy images of $Sr_2YF_7:Er^{3+}/Yb^{3+}$ core-only nanoparticles (NPs) with different sizes: (a) 6.1±0.3 nm, (b) 10.7±0.8 nm and (c) 12.9±1.1 nm, which were synthesized when the OA/ODE ratio (v/v) in the reaction solution was 10/7, 9/9 and 7/5, respectively.

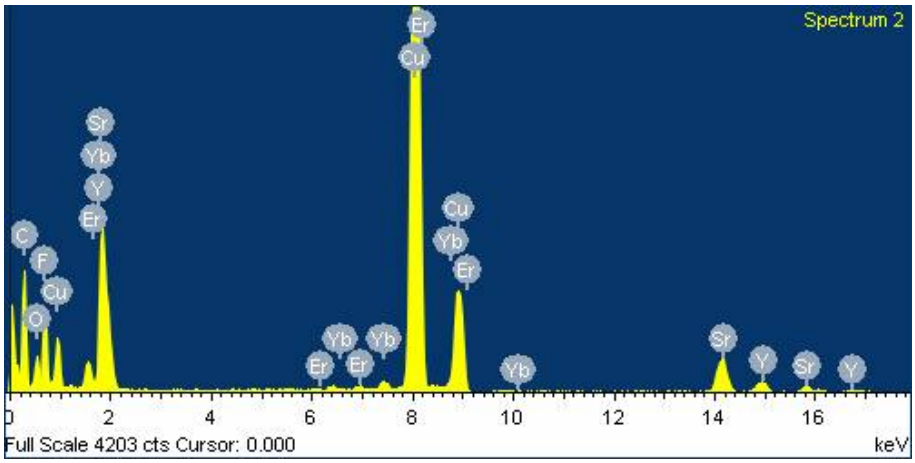

Fig. S2 Energy dispersive X-ray (EDX) spectrum analysis of Sr_2YF_7:0.02Er^{3+}/0.18Yb^{3+} NPs (~10 nm), revealing the successful doping of Er^{3+}/Yb^{3+} into Sr_2YF_7 host.

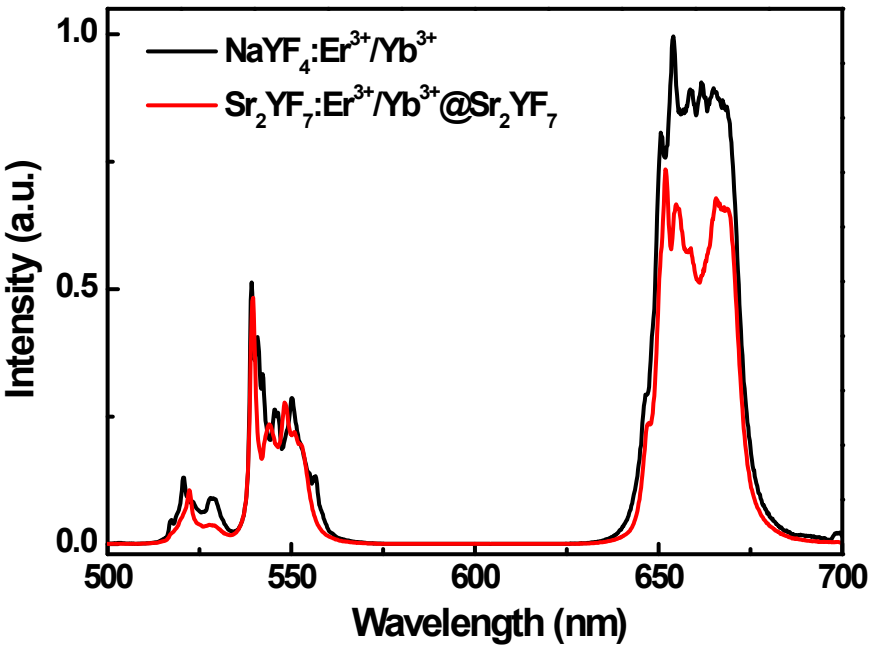

Fig. S3 Upconversion (UC) luminescence spectra of 16-nm $Sr_2YF_7:Er^{3+}/Yb^{3+}@Sr_2YF_7$ core/shell NPs and 15-nm $NaYF_4:Er^{3+}/Yb^{3+}$ NPs synthesized via coprecipitation method (Zhang et al. *Nanotechnology* **2008**, 19, 345606). Upon excitation at 980 nm of the same power density (120 W/cm^2), the UC emission intensity of $Sr_2YF_7:Er^{3+}/Yb^{3+}@Sr_2YF_7$ core/shell NPs was observed to be comparable to that of $NaYF_4:Er^{3+}/Yb^{3+}$ NPs, which indicates that Sr_2YF_7 crystal is a promising UC host material.

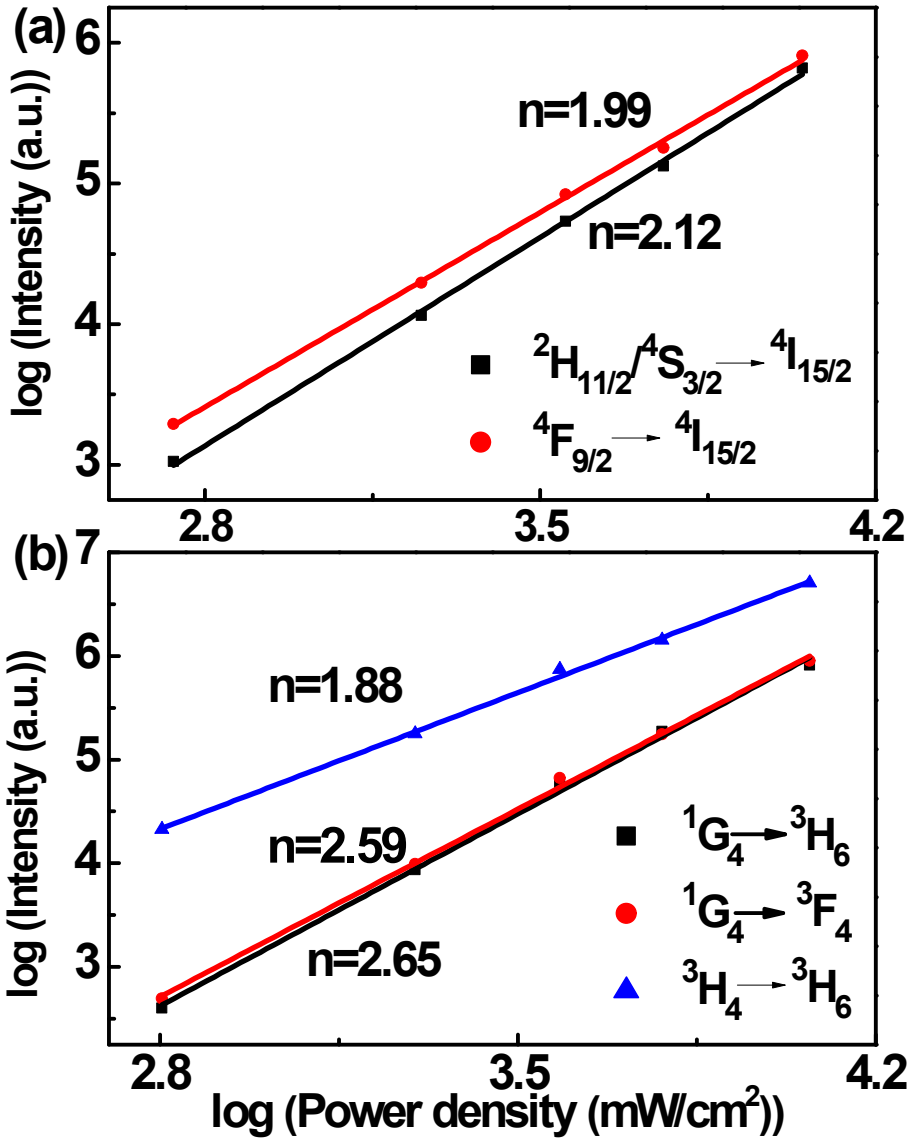

Fig. S4 log-log plots of the UC emission intensity versus near-infrared excitation power density for (a) $Sr_2YF_7:Er^{3+}/Yb^{3+}$ and (b) $Sr_2YF_7:Tm^{3+}/Yb^{3+}$ NPs. Both of the $^2H_{11/2}/^4S_{3/2} \rightarrow {}^4I_{15/2}$ and $^4F_{9/2} \rightarrow {}^4I_{15/2}$ emissions of Er^{3+} were realized via two-photon process. The UC emissions of Tm^{3+} from $^1G_4$ to $^3H_6$ or $^3F_4$ were realized through three-photon process while the UC emission from $^3H_4$ to $^3H_6$ was achieved via two-photon process.

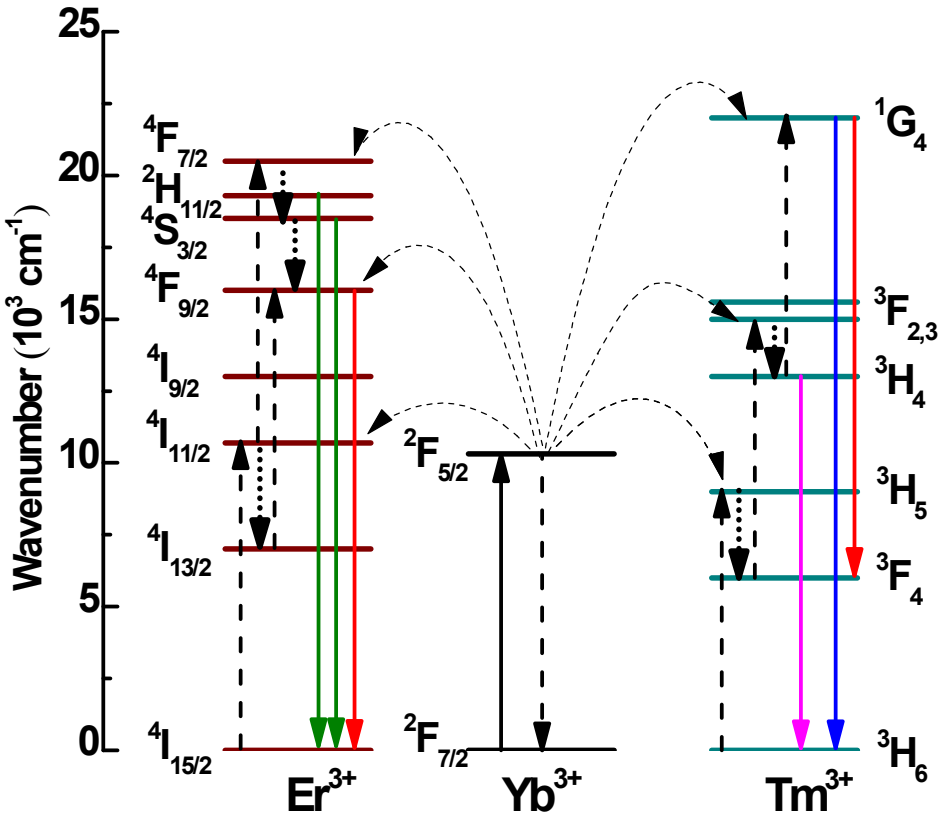

Fig. S5 Schematic energy level diagrams showing typical UC processes for (a) Er^{3+} and (b) Tm^{3+} via the sensitization of Yb^{3+}. The dashed, dotted and full arrows represent the excitation, nonradiative relaxation, and emission processes, respectively.

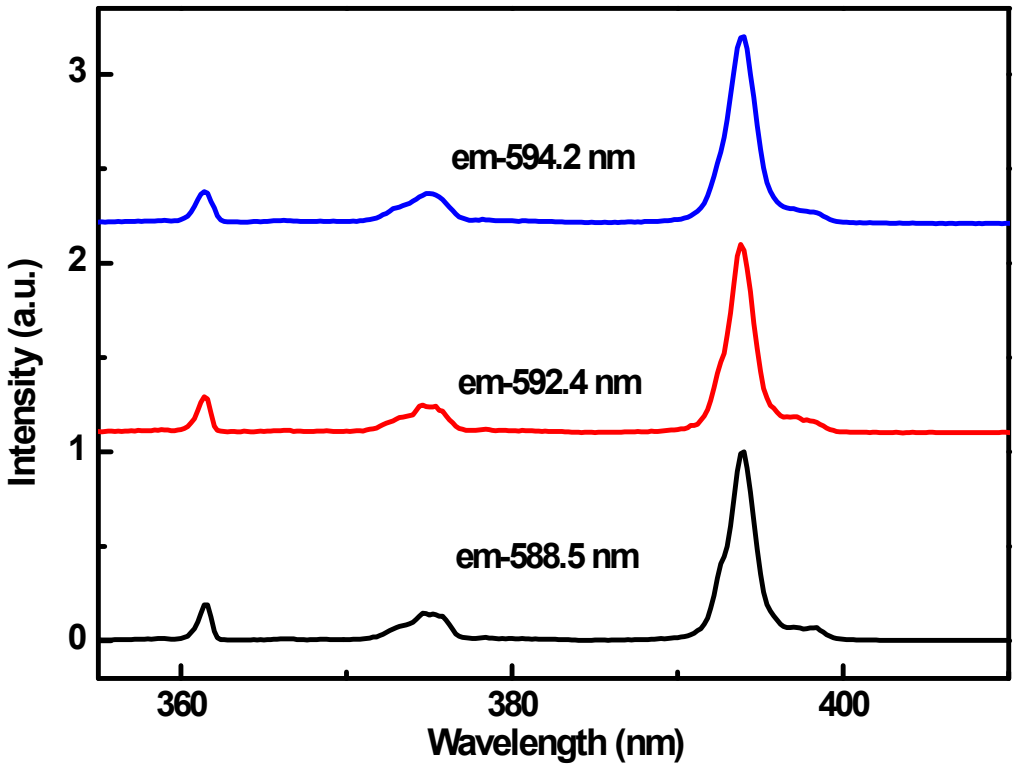

Fig. S6 The 10-K photoluminescence (PL) excitation spectra of $^5D_0 \rightarrow {}^7F_1$ of Eu^{3+} in Sr_2YF_7 NPs by monitoring the emissions at 588.5, 592.4 and 594.2 nm, respectively. The line positions in these excitation spectra were observed to be identical, which indicates that these luminescent peaks originated from Eu^{3+} occupying the same spectroscopic site.

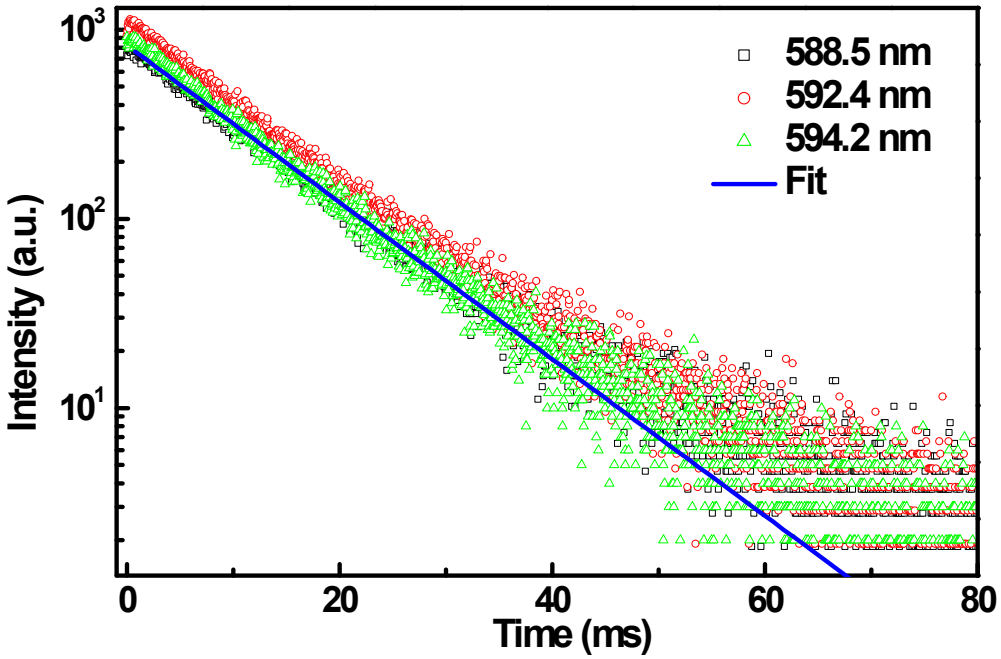

Fig. S7 PL decays from $^5D_0$ of Eu^{3+} in Sr_2YF_7 NPs by monitoring the emissions at 588.5, 592.4 and 594.2 nm at 10 K. The PL lifetimes in all these decays were determined to be 10.5 ms by fitting with single exponential function.

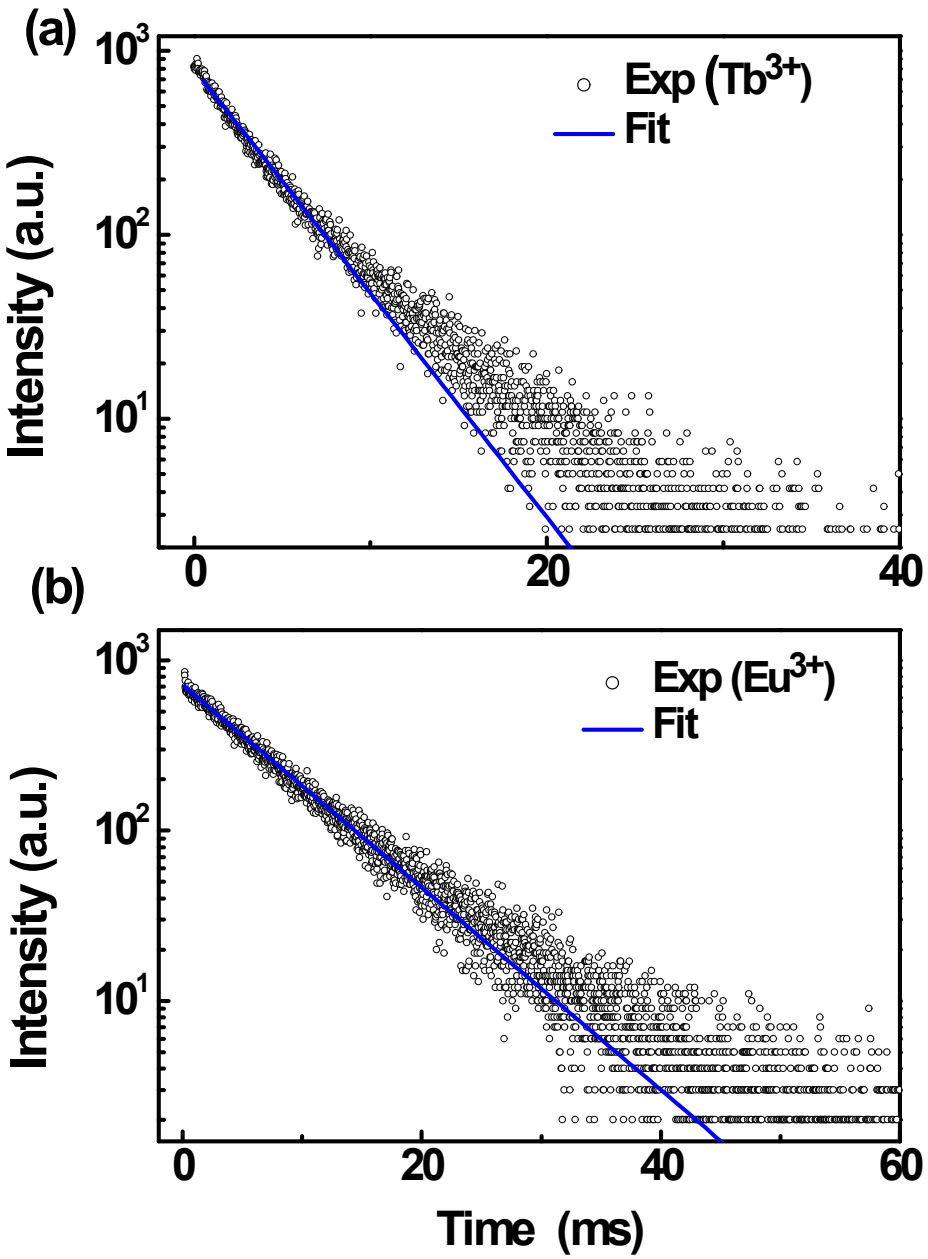

Fig. S8 PL decays from (a) $^5D_4$ of Tb^{3+} and (b) $^5D_0$ of Eu^{3+} in Sr_2YF_7 NPs at room temperature. Both decays were well fitted with single exponential function. The corresponding PL lifetimes were determined to be 3.7 (Tb^{3+}) and 8.1 (Eu^{3+}) ms, respectively.