Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

The in-depth insight of Yb^{3+} effect in $NaErF_4$-based host sensitization upconversion: a double-edged sword

*Yang Wang,‡ Shuai Zhou,‡ Fuyao Sun, Po Hu, Wei Zhong and Jiajun Fu**

School of Chemical Engineering, Nanjing University of Science and Technology, 210094, China.
E-mail: fujiajun668@gmail.com

Yang Wang and Shuai Zhou contributed equally to this work.

Supporting Figures

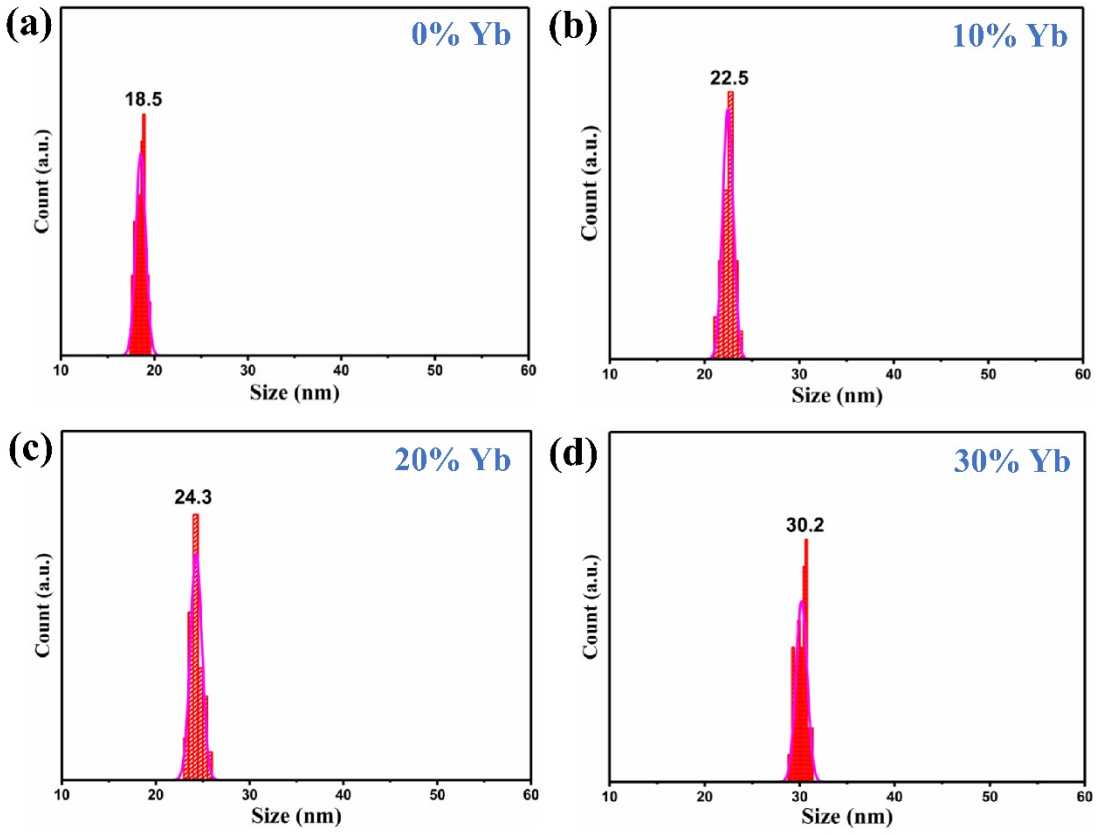

Figure S1. Size distribution diagrams of the $NaErF_4$:Yb core nanoparticles with different Yb^{3+} concentration.

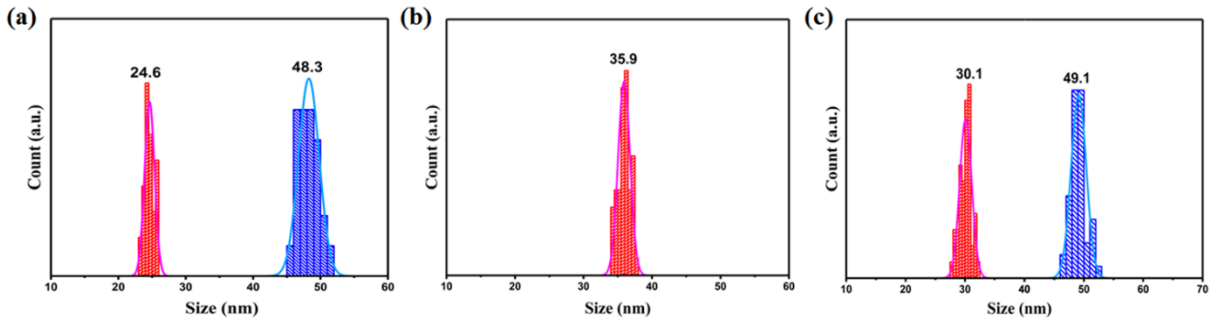

Figure S2. Size distribution diagrams of (a) $NaErF_4$:10%Yb@$NaYF_4$, (b) $NaErF_4$:10%Yb@$NaLuF_4$, and (c) $NaErF_4$:10%Yb@$NaGdF_4$.

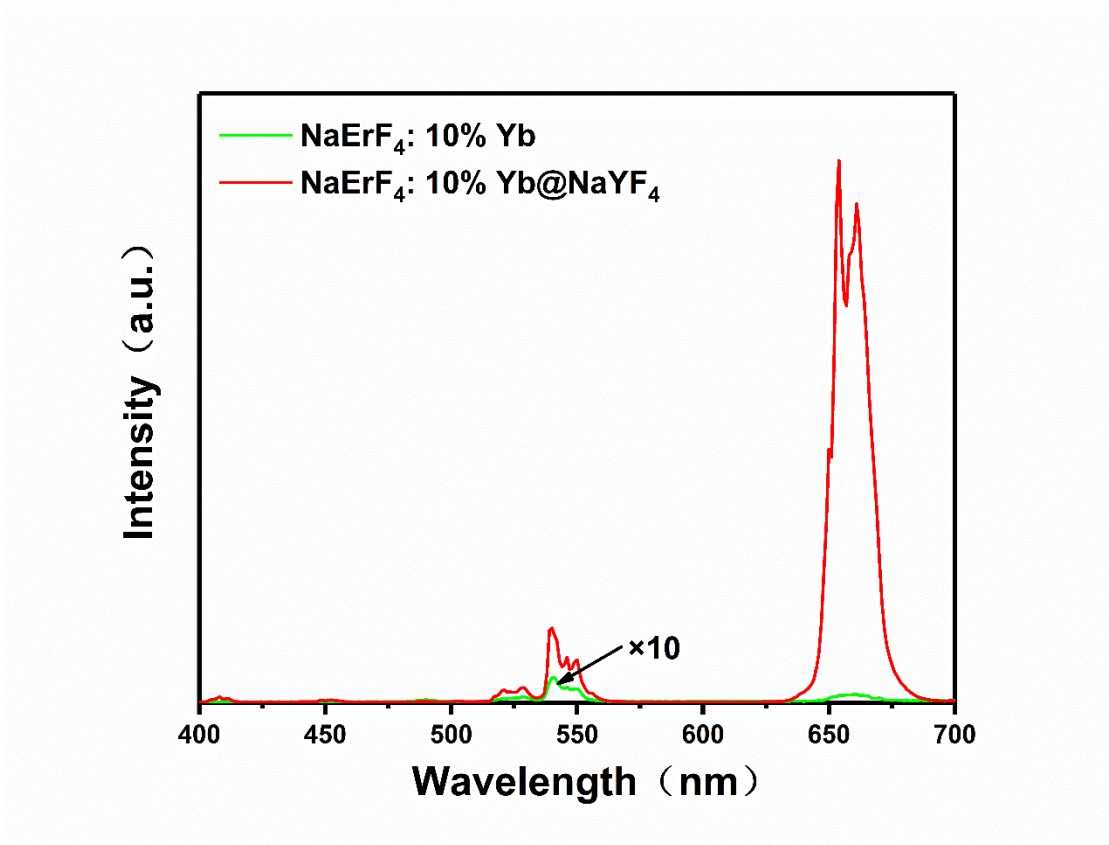

Figure S3. Upconversion luminescence spectra of $NaErF_4$:10%Yb and $NaErF_4$:10%Yb@$NaYF_4$ excited by 980 nm laser (Concentration: 40 mg/mL; power density: 20W/cm^2; solvent: cyclohexane).

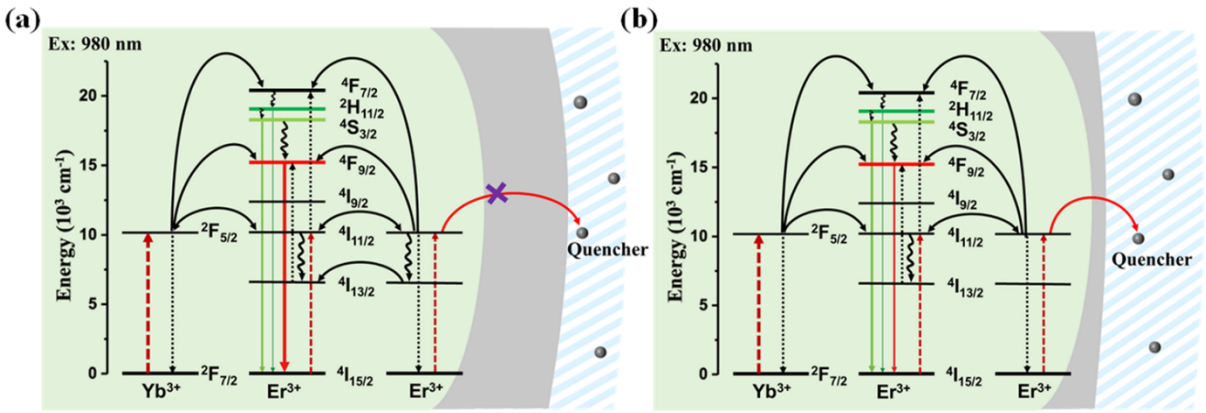

Figure S4. Proposed UC mechanisms for $NaErF_4$:10%Yb@$NaYF_4$/$NaLuF_4$ (a) and $NaErF_4$:10%Yb@$NaGdF_4$ (b) core-inert shell nanoparticles under 980 nm excitation.

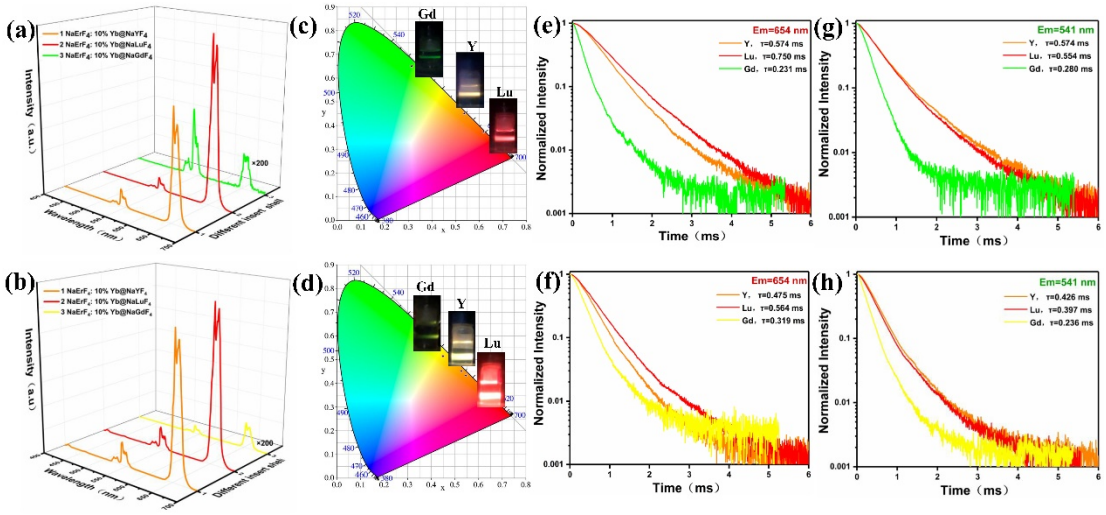

Figure S5. UCL spectra of $NaErF_4$:10%Yb@$NaYF_4$, $NaErF_4$:10%Yb@$NaLuF_4$ and $NaErF_4$:10%Yb@$NaGdF_4$ excited by 808 nm laser (a) and 1550 nm laser (b) (Concentration: 40 mg/mL; power density: 20 W/cm^2; solvent: cyclohexane). CIE chromaticity diagrams of $NaErF_4$:10%Yb@$NaYF_4$, $NaErF_4$:10%Yb@$NaLuF_4$ and $NaErF_4$:10%Yb@$NaGdF_4$ excited by 808 nm laser (c) and1550 nm laser (d). Decay curves of Er^{3+} in its $^4F_{9/2}$ state from $NaErF_4$:10%Yb@$NaYF_4$, $NaErF_4$:10%Yb@$NaLuF_4$ and $NaErF_4$:10%Yb@$NaGdF_4$ excited by 808 nm laser (e) and 1550 nm laser (f). Decay curves of Er^{3+} in its $^4S_{3/2}$ state from $NaErF_4$:10%Yb@$NaYF_4$, $NaErF_4$:10%Yb@$NaLuF_4$ and $NaErF_4$:10%Yb@$NaGdF_4$ excited by 808 nm laser (g) and 1550 nm laser (h).

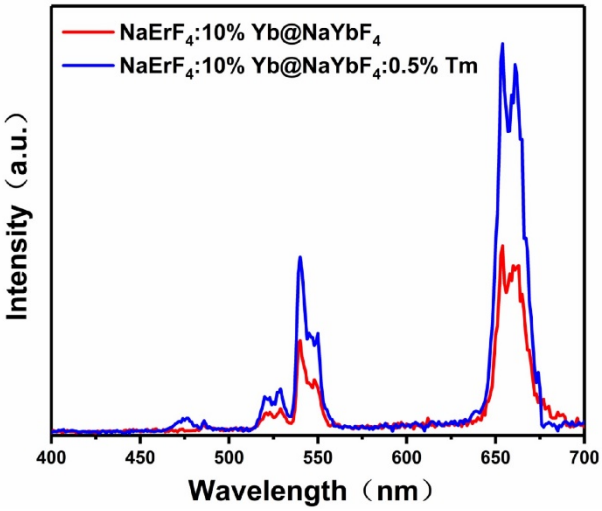

Figure S6. UCL spectra of $NaErF_4$:10%Yb@$NaYbF_4$ and $NaErF_4$:10%Yb@$NaYbF_4$:0.5%Tm excited by 980 nm laser (Concentration: 40 mg/mL; power density: 20 W/cm^2; solvent: cyclohexane).

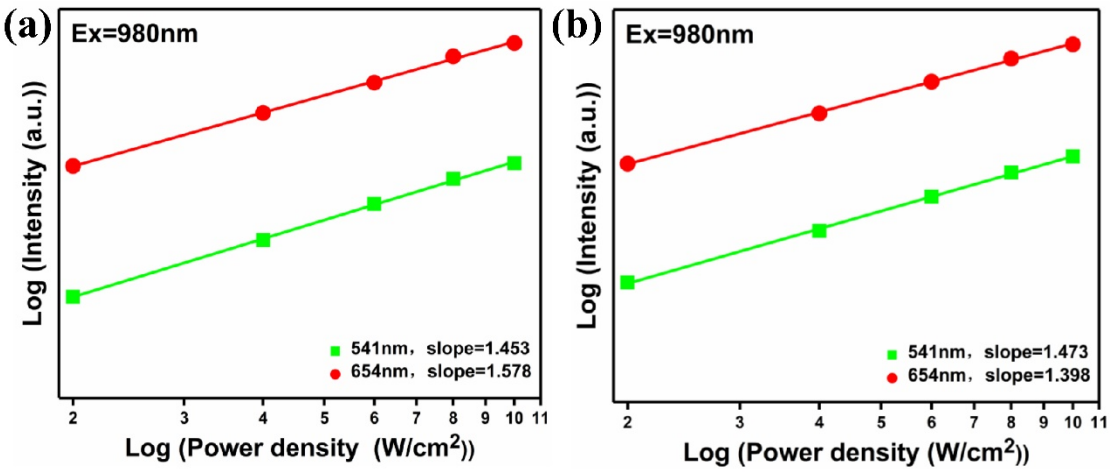

Figure S7. Power density dependence of Er^{3+} emissions in $NaErF_4$:10%Yb@$NaYF_4$ (a) and $NaErF_4$:10%Yb@$NaYF_4$:20%Yb (b) under 980 nm excitation.

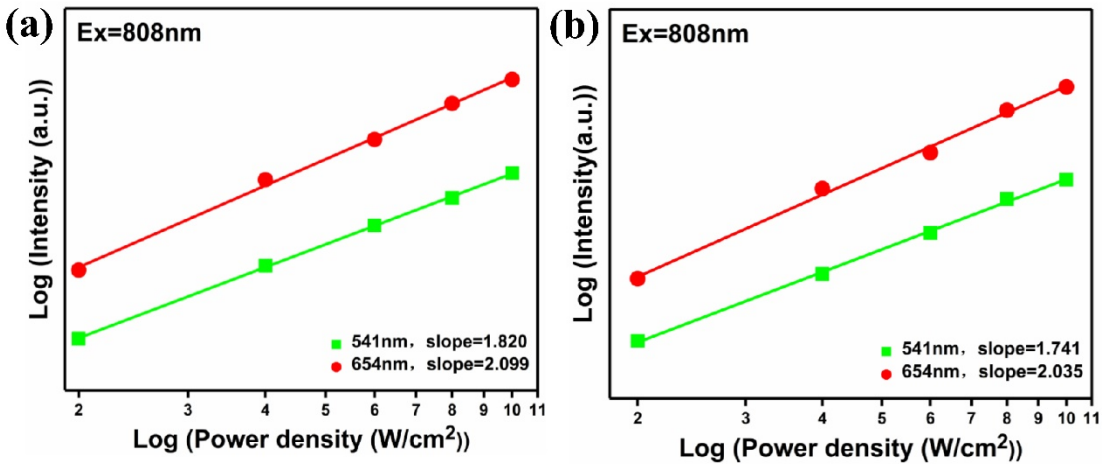

Figure S8. Power density dependence of Er^{3+} emissions in $NaErF_4$:10%Yb@$NaYF_4$ (a) and $NaErF_4$:10%Yb@$NaYF_4$:20%Yb (b) under 808 nm excitation.

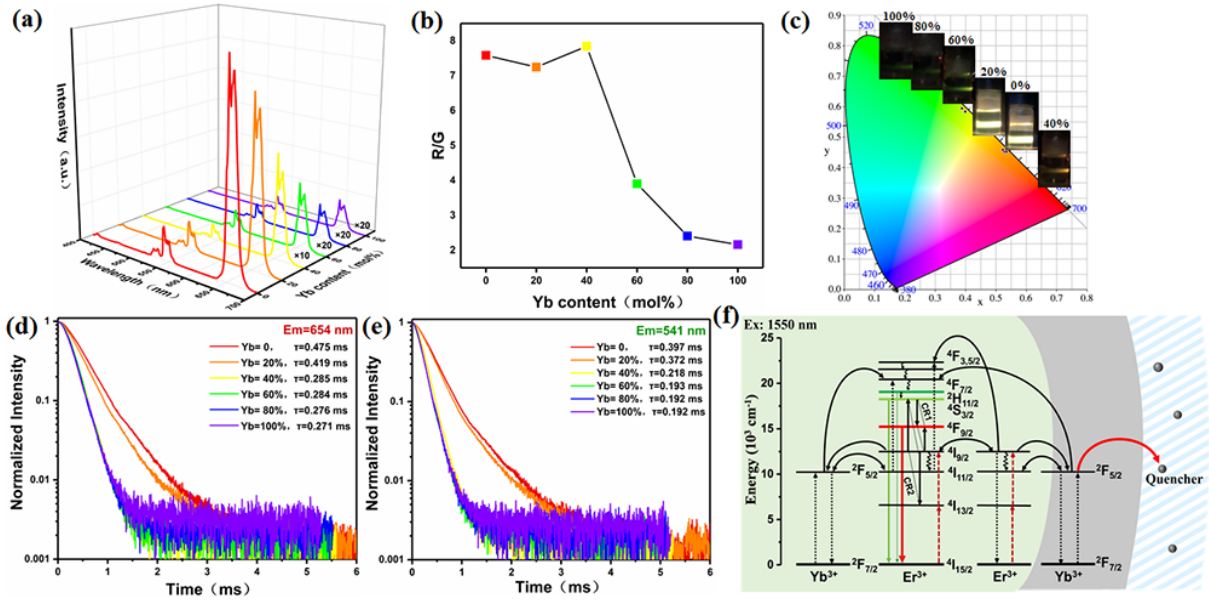

Figure S9. (a) UCL spectra of $NaErF_4$:10%Yb@$NaY_{1-x}F_4$:xYb core-shell nanoparticles (x = 0, 20%, 40%, 60%, 80% and 100%) under 1550 nm excitation (Concentration: 40 mg/mL; power density: 20 W/cm^2; solvent: cyclohexane). (b) G/R ratio of (a) samples. (c) CIE chromaticity diagram of the emissions from (a) samples. Decay curves of Er^{3+} in its $^4F_{9/2}$ state (d)

and $^4S_{3/2}$ (e) in (a) samples under 1550 nm excitation. (f) Proposed energy transfer mechanisms of $NaErF_4$: 10%Yb@$NaYF_4$:Yb under 1550 nm excitation.

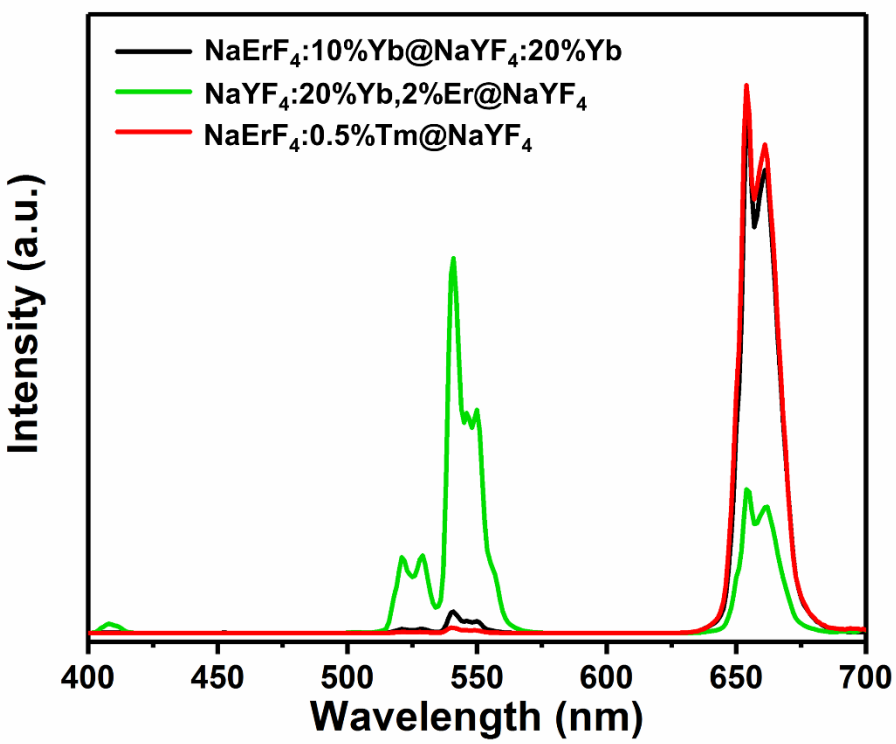

Figure S10. UCL spectra of $NaErF_4$:10%Yb@$NaYF_4$:20%Yb, $NaYF_4$:20%Yb,2%Er@$NaYF_4$ and $NaErF_4$:0.5%Tm@$NaYF_4$ under 980 nm excitation (Concentration: 40 mg/mL; power density: 20 W/cm^2; solvent: cyclohexane).

Table S1. Decay times of $NaErF_4$, $NaErF_4$:10%Yb, $NaErF_4$:20%Yb, and $NaErF_4$:30%Yb monitored at 541 nm under 980 nm excitation.

Core nanoparticles	Decay time at 541 nm	Standard deviation*
$NaErF_4$	6.11 μs	0.074 μs
$NaErF_4$:10%Yb	6.37 μs	0.042 μs
$NaErF_4$:20%Yb	6.95 μs	0.064 μs
$NaErF_4$:30%Yb	7.21 μs	0.057 μs

* The standard deviations were acquired from a single fitting.