

Supporting Information

Second Near-Infrared Upconverting and Downshifting Luminescence in a Core-Multishell Nanophotoswitch

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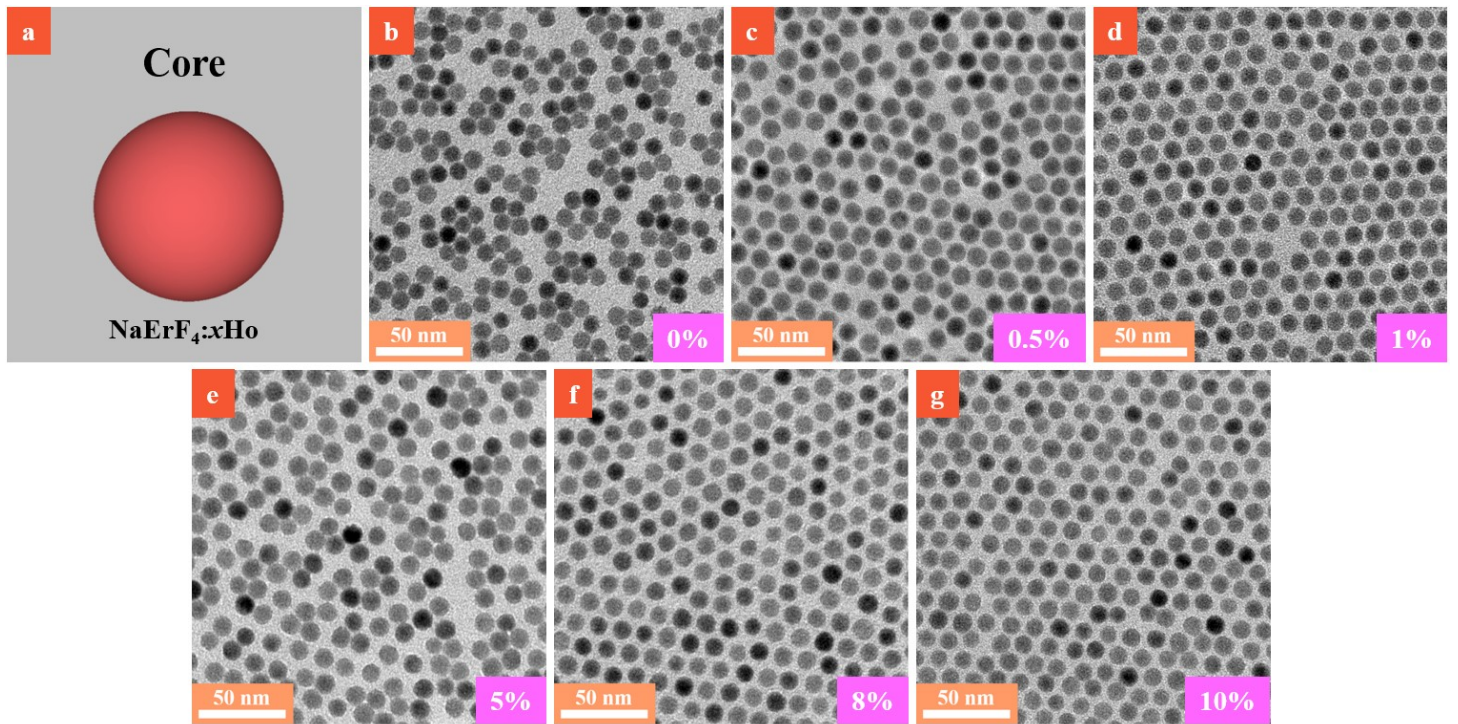


Fig. S1 Schematic model (a) and TEM images (b-g) of NaErF₄:xHo ($x = 0, 0.5, 1, 5, 8, 10\%$) core nanoparticles.

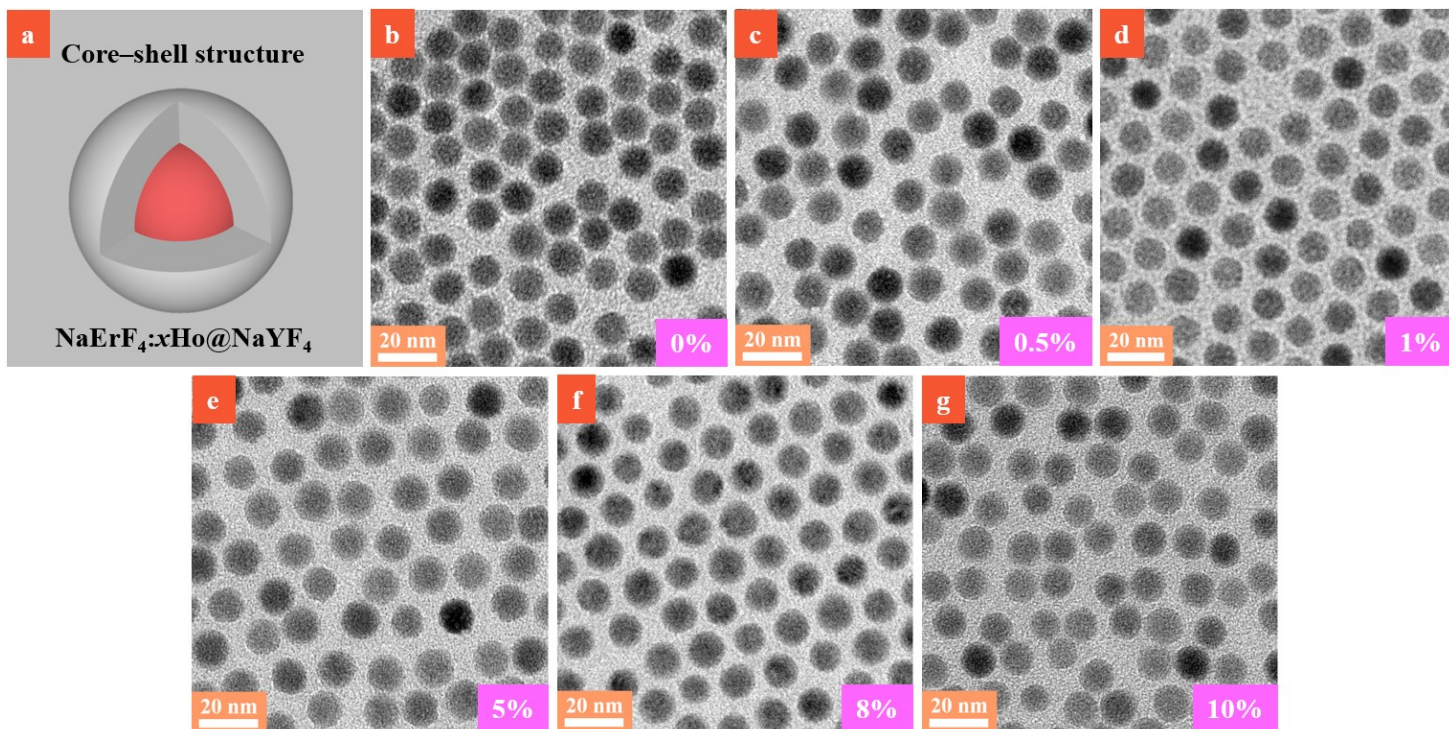


Fig. S2 Schematic model (a) and TEM images (b-g) of $\text{NaErF}_4:x\text{Ho}@NaYF_4$ ($x = 0, 0.5, 1, 5, 8, 10\%$) core/shell nanoparticles.

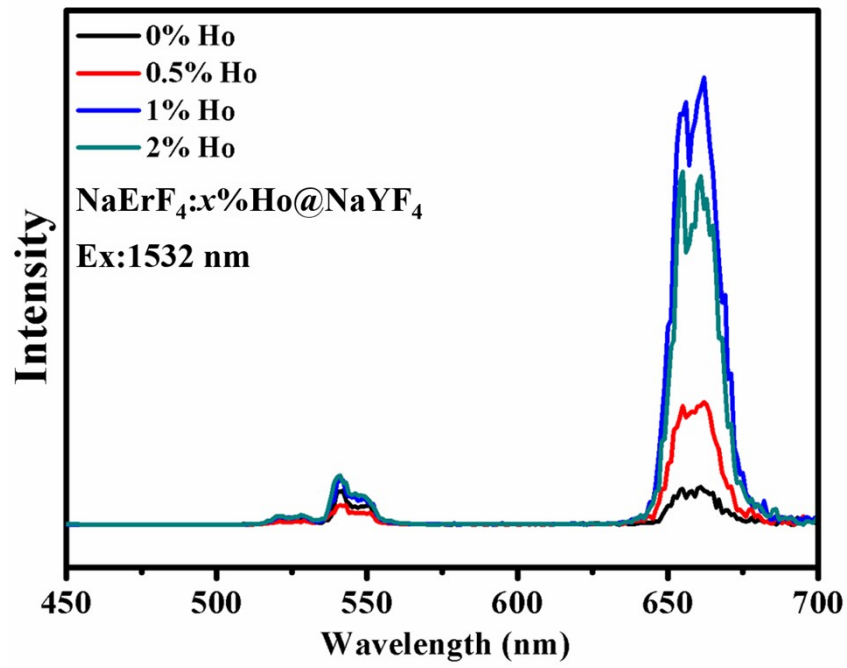


Fig. S3 UC emission spectra of NaErF₄:xHo@NaYF₄ ($x = 0, 0.5, 1, 2\%$) nanoparticles under 1532 nm excitation.

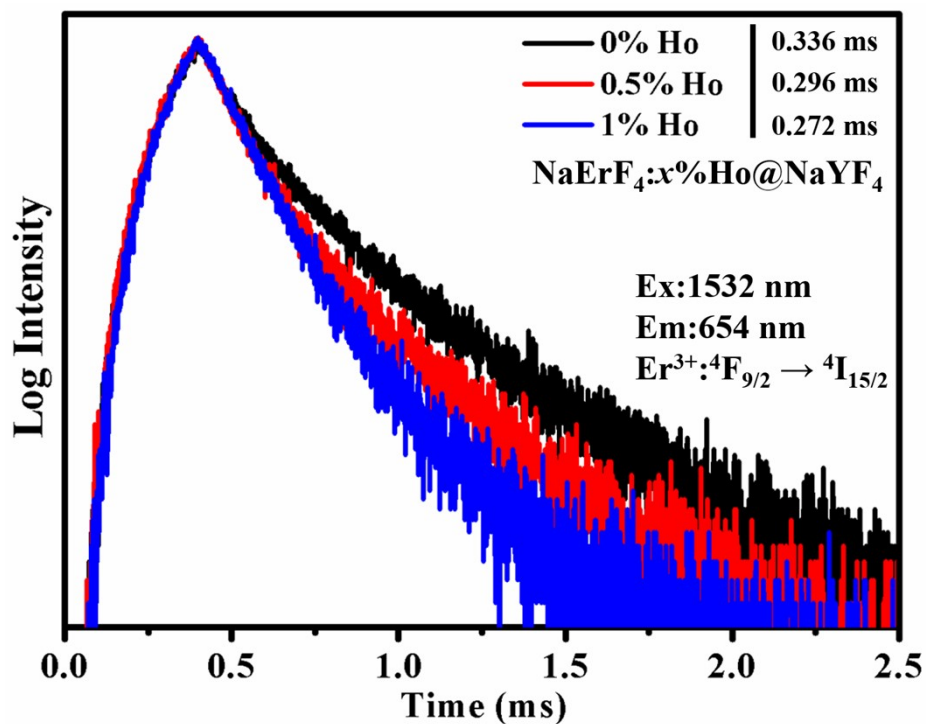


Fig. S4 Decay curves of Er³⁺ 654 nm emission (⁴F_{9/2} → ⁴I_{15/2}) in NaErF₄:xHo@NaYF₄ (x = 0, 0.5, 1%) nanoparticles under 1532 nm excitation.

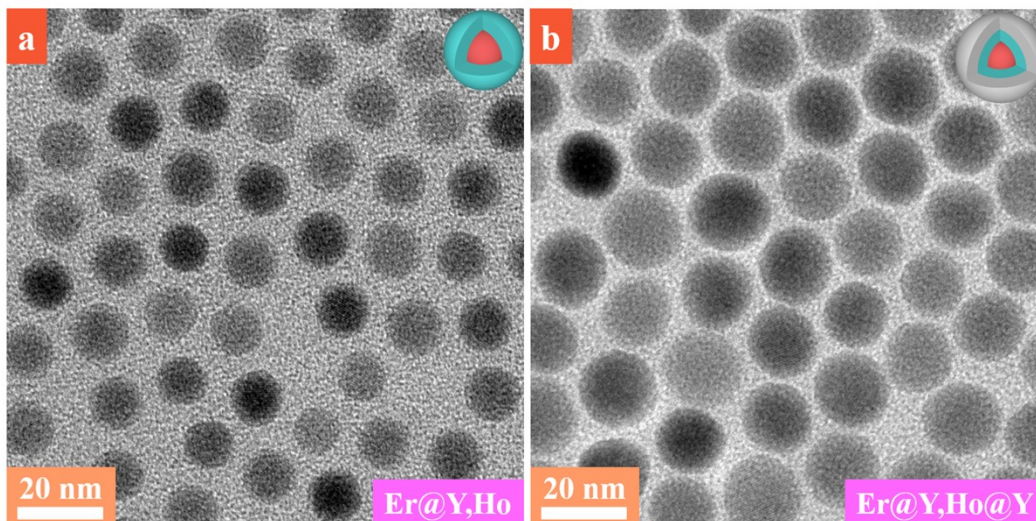


Fig. S5 TEM images (a and b) of $\text{NaErF}_4@ \text{NaYF}_4:2\% \text{Ho}$ and $\text{NaErF}_4@ \text{NaYF}_4:2\% \text{Ho}@ \text{NaYF}_4$ nanoparticles. The upper right of (a and b) are the schematic models of core/shell and core/shell/shell structures.

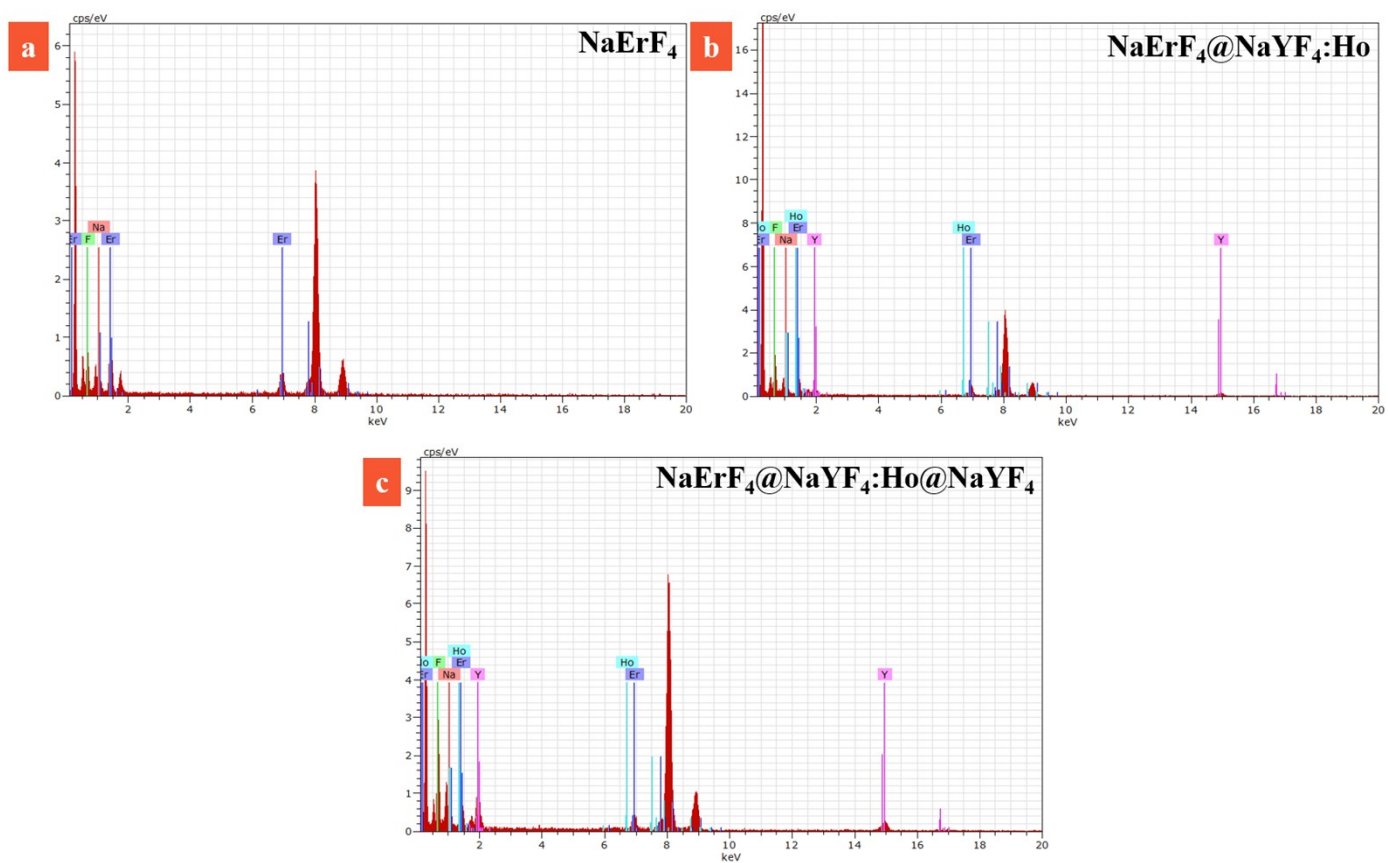


Fig. S6 EDS (a-c) of NaErF_4 , $\text{NaErF}_4@NaYF_4:2\%Ho$ and $\text{NaErF}_4@NaYF_4:2\%Ho@NaYF_4$ nanoparticles, respectively.

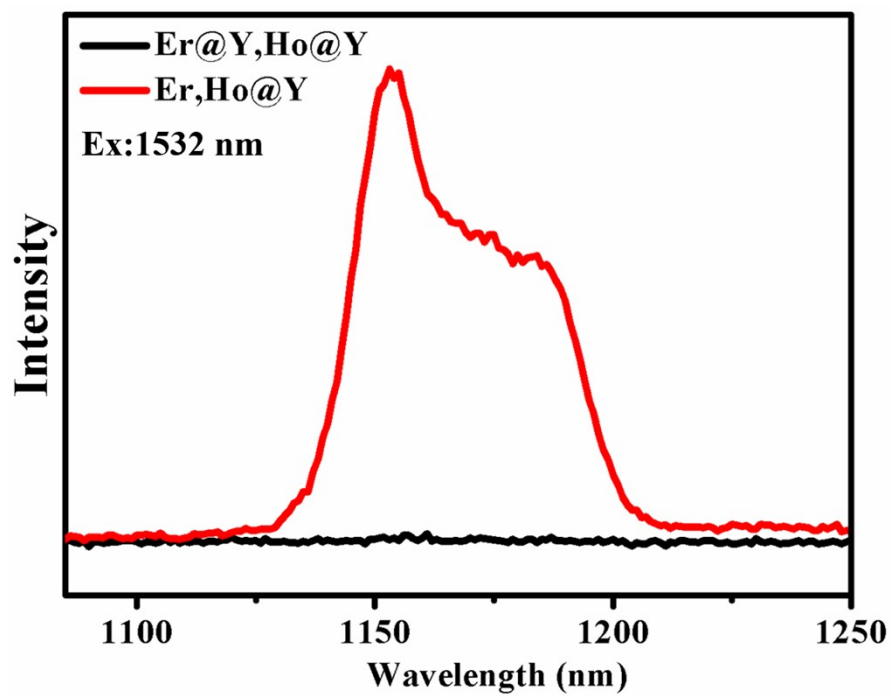


Fig. S7 UC emission spectra of $\text{NaErF}_4@ \text{NaYF}_4: 2\% \text{Ho} @ \text{NaYF}_4$ and $\text{NaErF}_4: 2\% \text{Ho} @ \text{NaYF}_4$ nanoparticles under 1532 nm excitation.

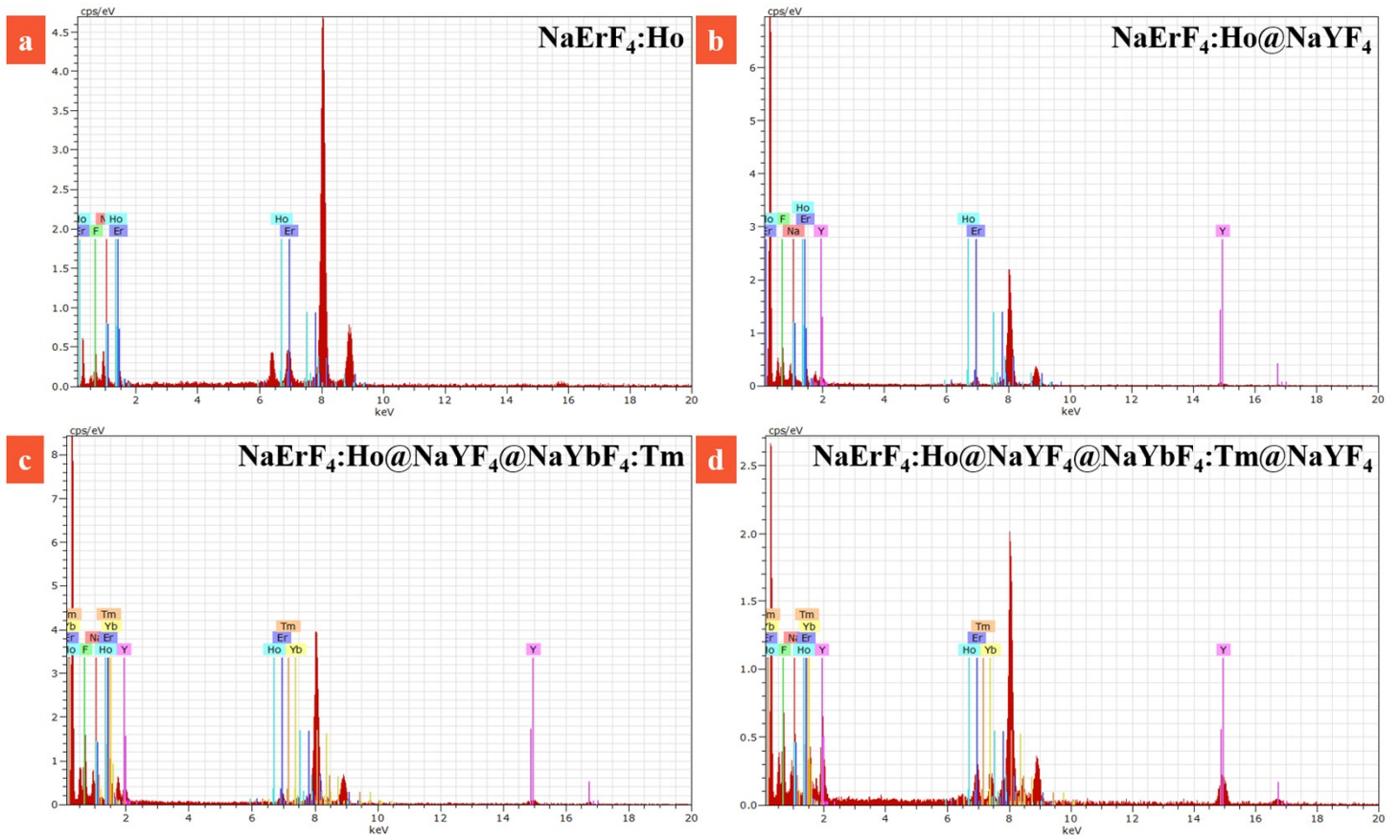


Fig. S8 EDS (a-d) of NaErF₄:2%Ho, NaErF₄:2%Ho@NaYF₄, NaErF₄:2%Ho@NaYF₄@NaYbF₄:0.5%Tm and NaErF₄:2%Ho@NaYF₄@NaYbF₄:0.5%Tm@NaYF₄ nanoparticles, respectively.

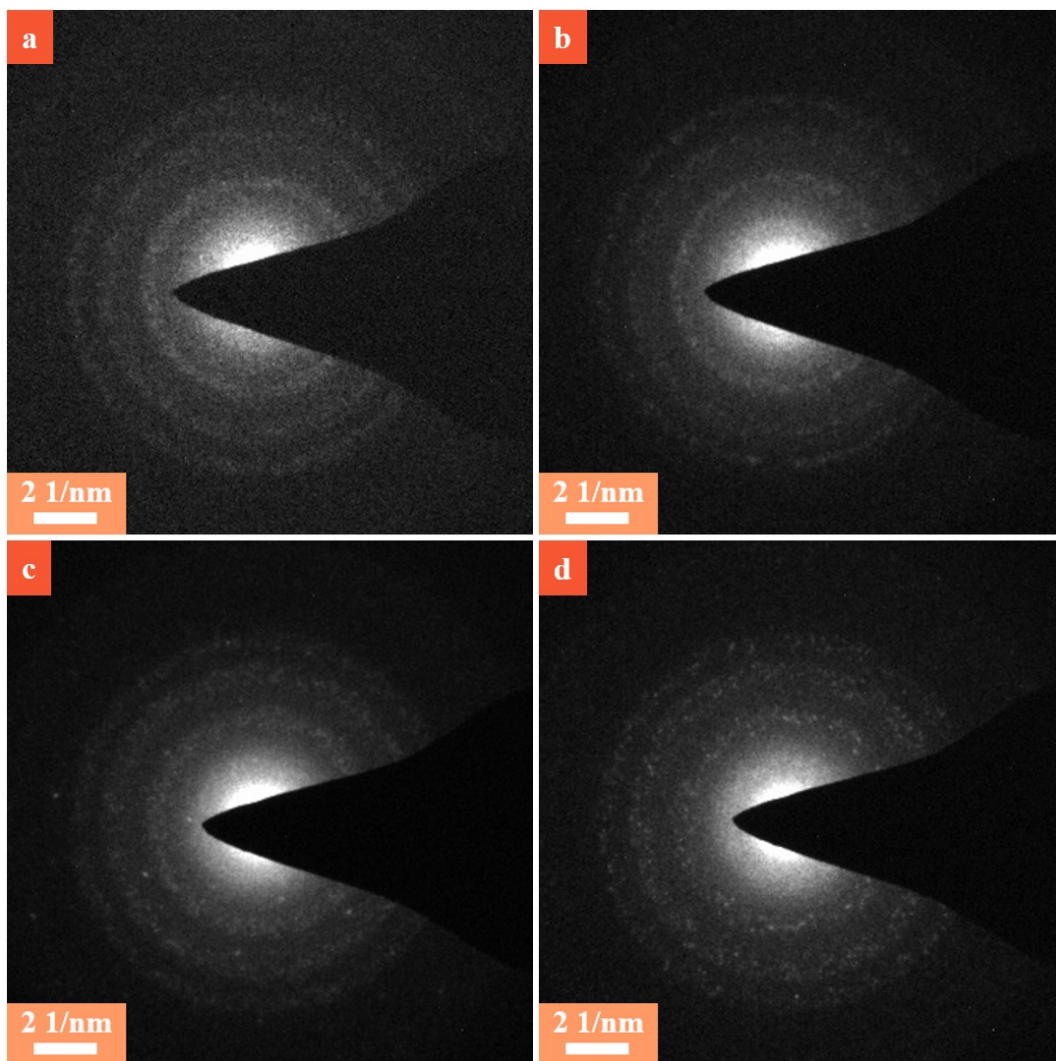


Fig. S9 SAED patterns (a-d) of NaErF₄, NaErF₄:2%Ho, NaErF₄:2%Ho@NaYF₄ and NaErF₄:2%Ho@NaYF₄@NaYbF₄:0.5%Tm nanoparticles, respectively.

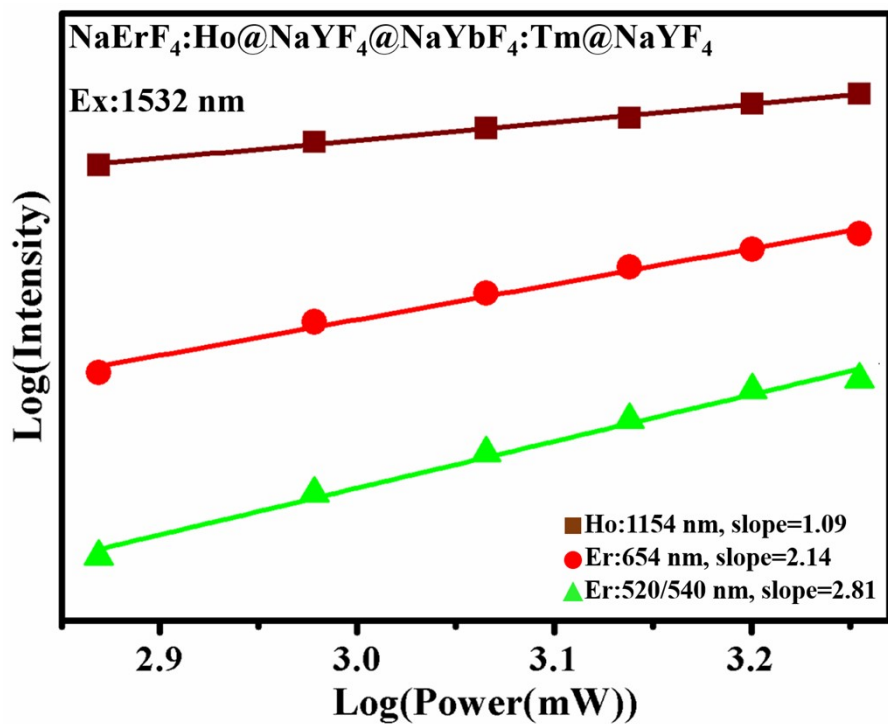


Fig. S10 Power density dependence of Ho³⁺ emission at 1154 nm and Er³⁺ emissions at 654, 520/540 nm in NaErF₄:2%Ho@NaYF₄@NaYbF₄:0.5%Tm@NaYF₄ nanoparticles under 1532 nm excitation.

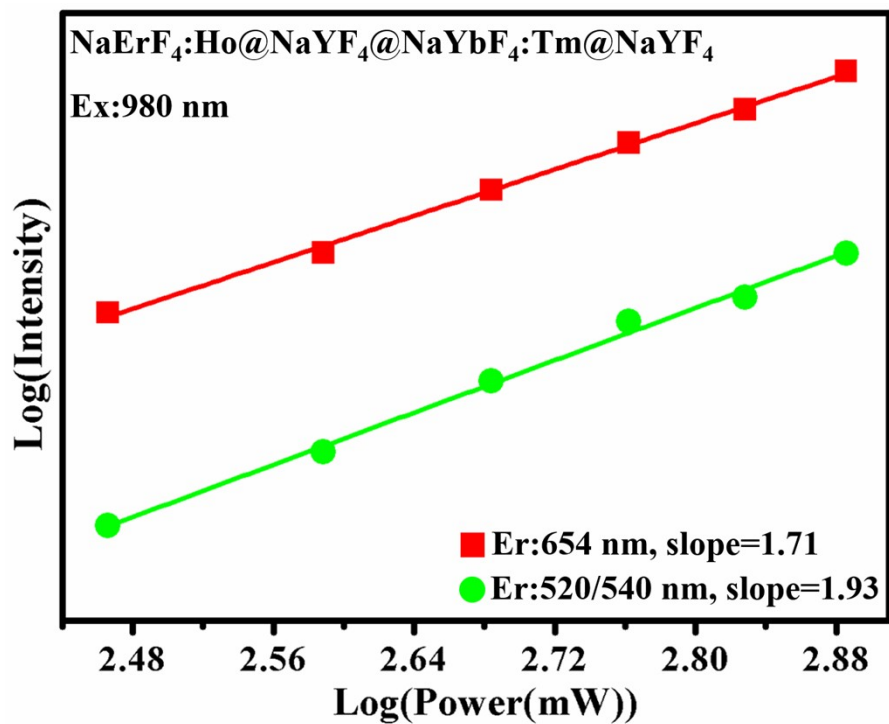


Fig. S11 Power density dependence of Er³⁺ emissions at 654 and 520/540 nm in NaErF₄:2%Ho@NaYF₄@NaYbF₄:0.5%Tm@NaYF₄ nanoparticles under 980 nm excitation.

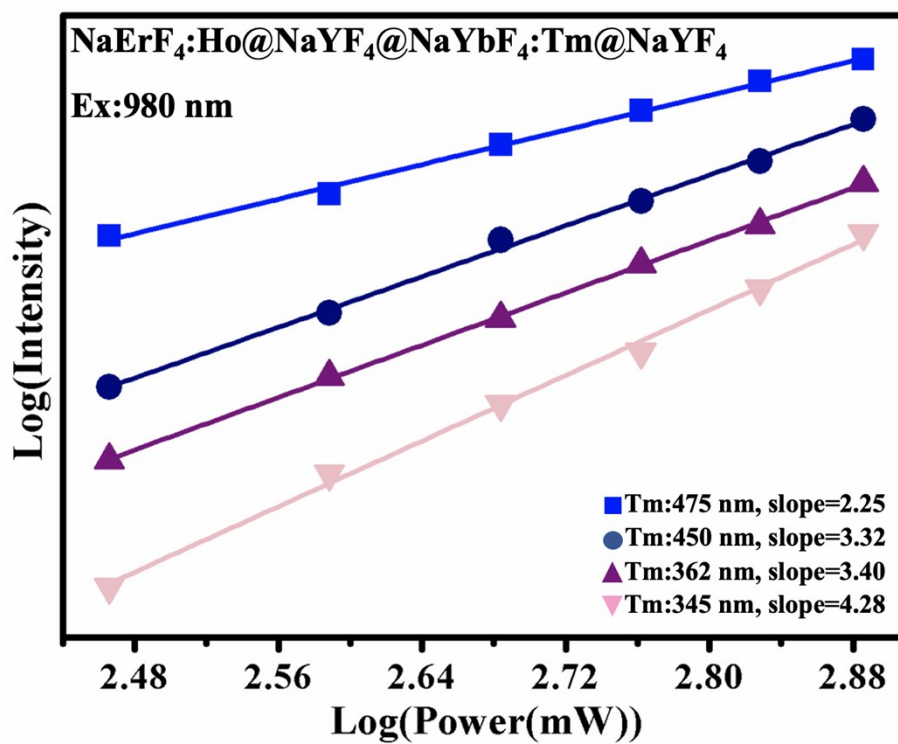


Fig. S12 Power density dependence of Tm³⁺ emissions at 475, 450, 362 and 345 nm in NaErF₄:2%Ho@NaYF₄@NaYbF₄:0.5%Tm@NaYF₄ nanoparticles under 980 nm excitation.

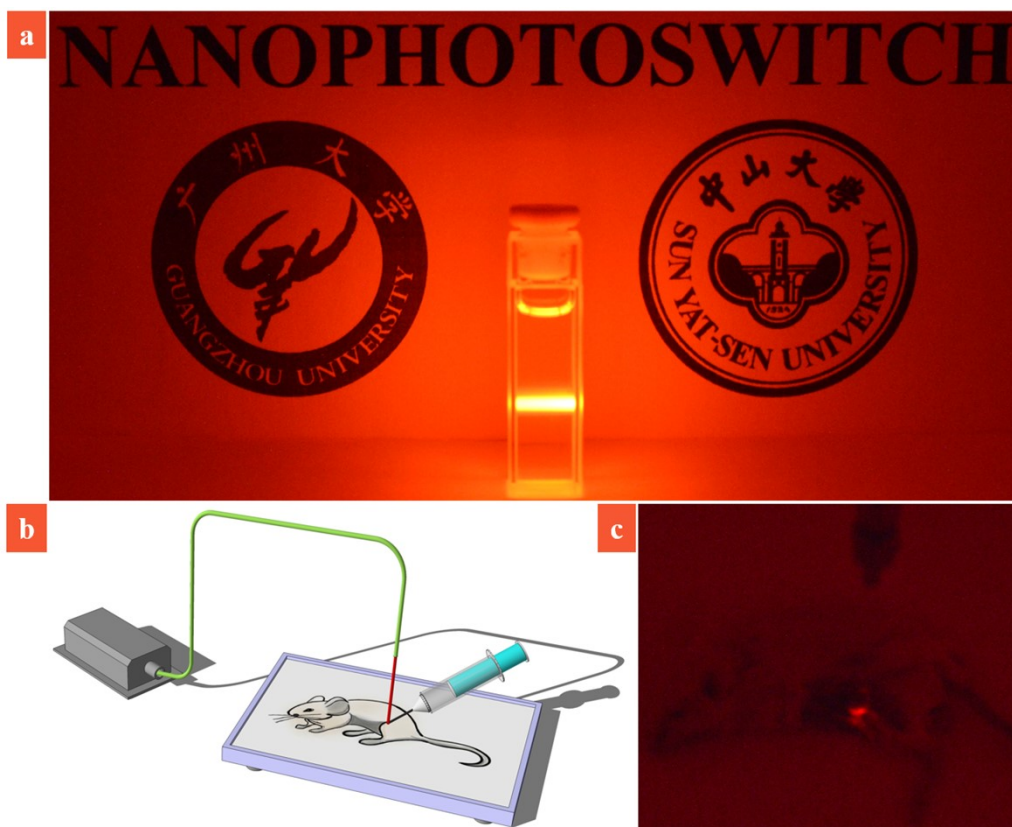


Fig. S13 (a) Photograph of UC luminescence of $\text{NaErF}_4:2\%\text{Ho}@ \text{NaYF}_4@ \text{NaYbF}_4:0.5\%\text{Tm}@ \text{NaYF}_4$ nanoparticles under 1532 nm NIR-II excitation. (b) Model of the nanoparticles injected into the mouse, and (c) the corresponding photograph of UC luminescence under 1532 nm NIR-II excitation.