Electronic Supplementary Information

Spatially Confined Luminescence Process in Tip-modified Heterogeneous-Structured Microrods for High-level Anti-counterfeiting

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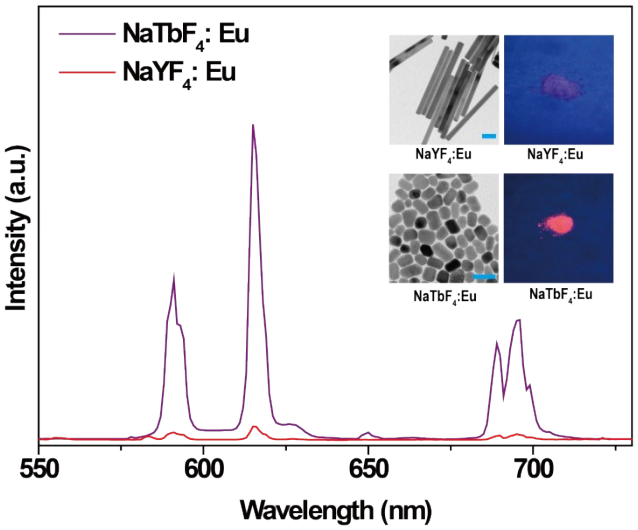

Fig. S1 The downconversion luminescence spectra of $NaTbF_4$:Eu and $NaYF_4$:Eu particles under 365 nm wavelength light excitation. The insets show TEM images of $NaTbF_4$:Eu (the scale bar is 50 nm) and $NaYF_4$:Eu (the scale bar is 100 nm) rods and their luminescence pictures under 365 nm excitation.

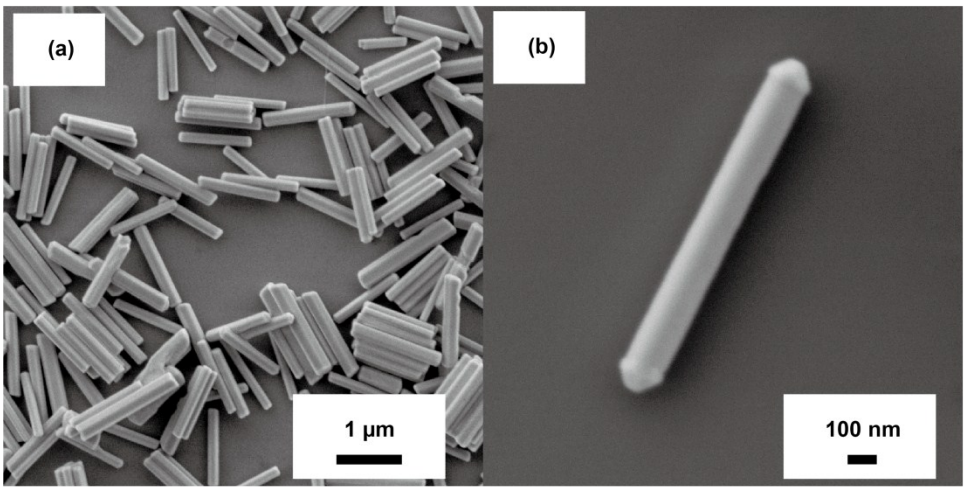

Fig. S2 TEM images of the as-synthesized samples: (a) ligand –removed $NaYF_4$:Yb/Tm and (b) tip-modified $NaYF_4$:Yb/Tm@$NaTbF_4$:Eu microrod.

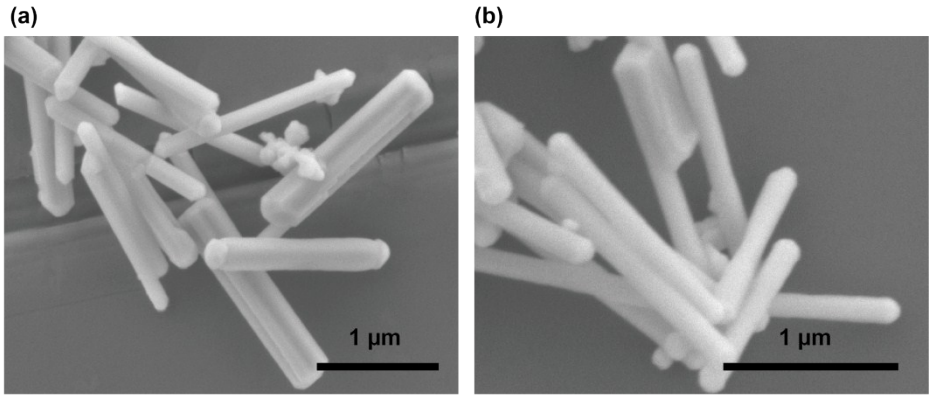

Fig. S3 TEM images of the as-synthesized (a) $NaYF_4$:Yb/Er@$NaTbF_4$ samples without adding of EDTA-2Na and (b) tip-modified $NaYF_4$:Yb/Er@$NaTbF_4$:Eu microrods obtained under reaction temperature 220 ℃ for 24h.

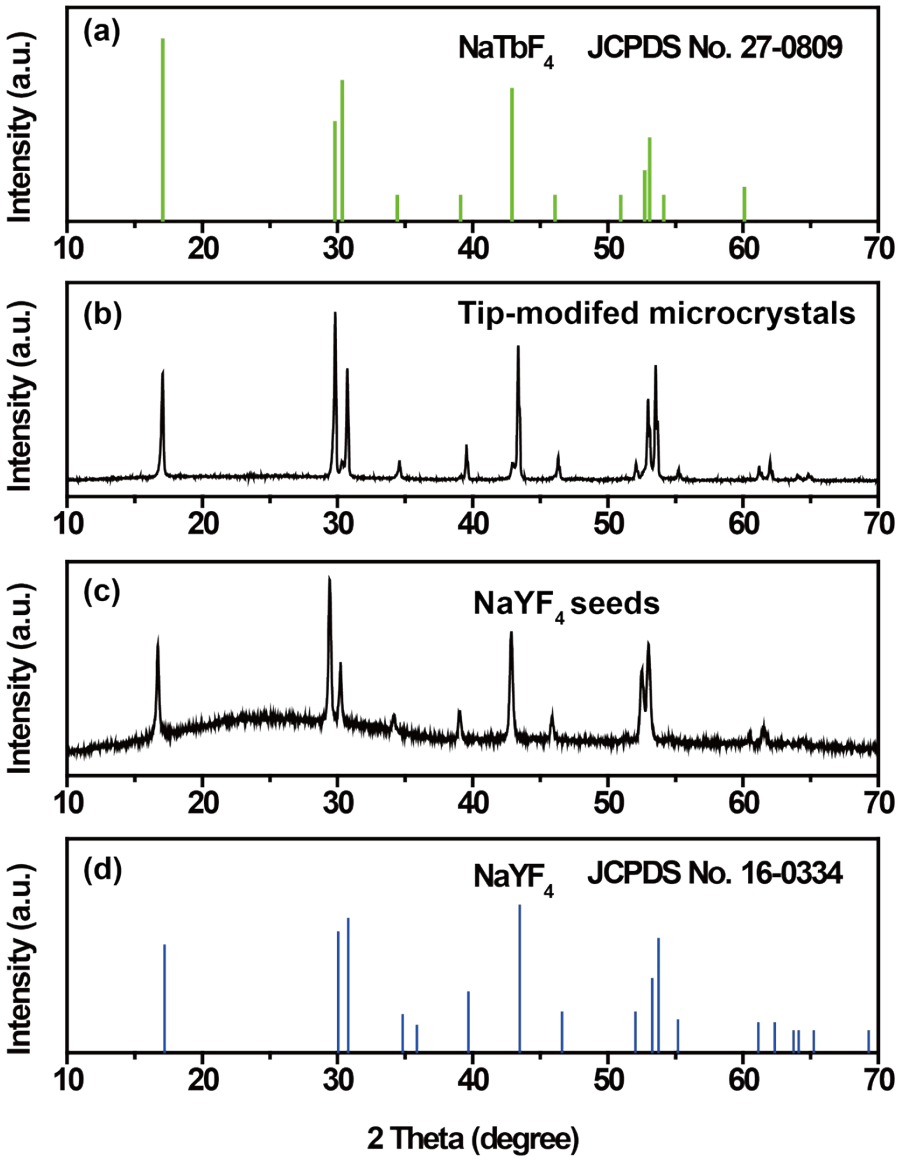

Fig. S4 (a) Standard XRD patterns of $NaTbF_4$ (JCPDS: No. 27-0809); (b-c) XRD characterization of the as-prepared tip-modified $NaYF_4$@$NaTbF_4$ microrods and $NaYF_4$ seeds; (d) Standard XRD patterns of $NaYF_4$ (JCPDS: No. 16-0334).

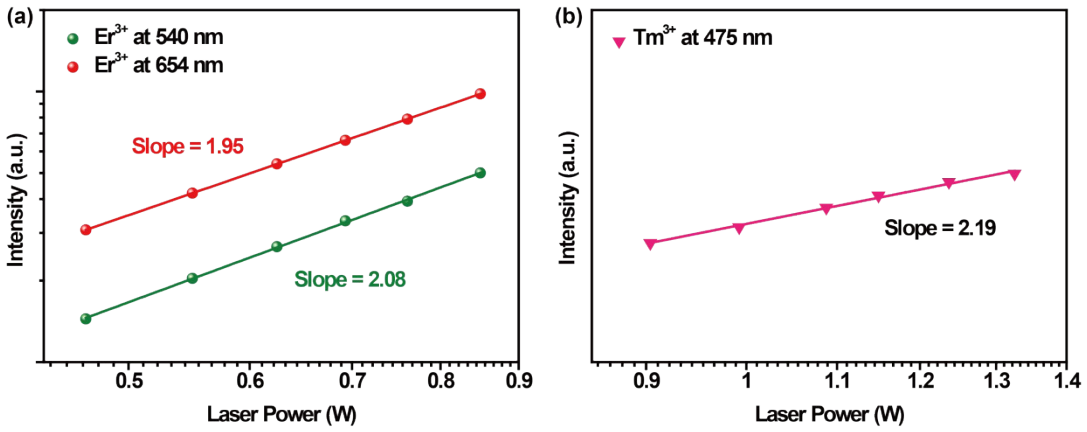

Fig. S5 Log-log plots of the upconversion emission intensity versus NIR excitation power for 540 nm and 654 nm emissions of $NaYF_4$:Yb/Er@$NaTbF_4$:Eu (a) and 475 nm emission of $NaYF_4$:Yb/Tm@$NaTbF_4$:Eu (b).