Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supplementary information of

Exploiting the silent upconversion emissions from a single β-$NaYF_4$:Yb/Er microcrystal via saturated excitation

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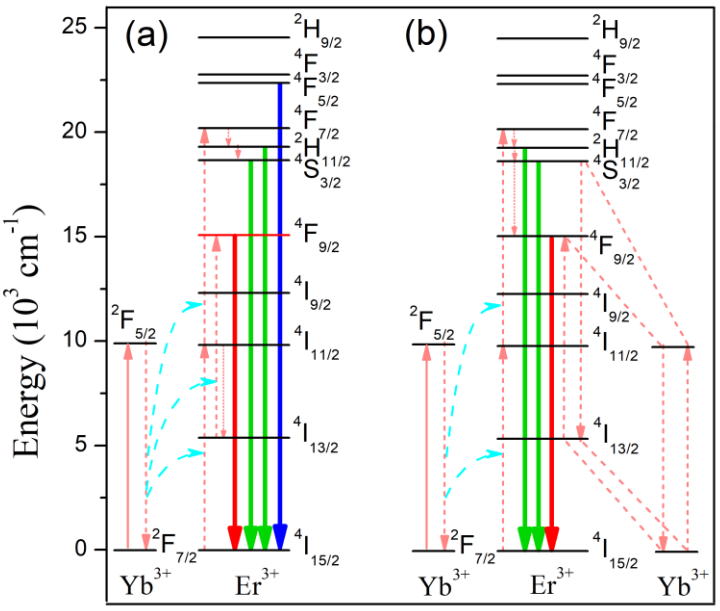

Fig. S1. Schematic diagram of energy transfer mechanism in the (a) $NaYF_4$:Yb/Er (20/1%) and (b) $NaYF_4$:Yb/Er (99/1%) microcrystals.

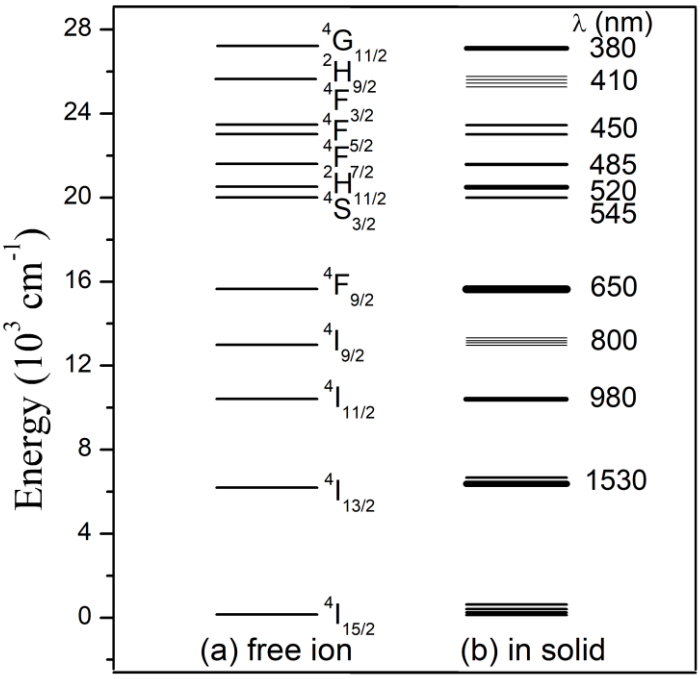

Fig. S2. Energy states of trivalent erbium (Er^{3+}) and its corresponding transition wavelength for (a) free ion and (b) in solid host lattices.

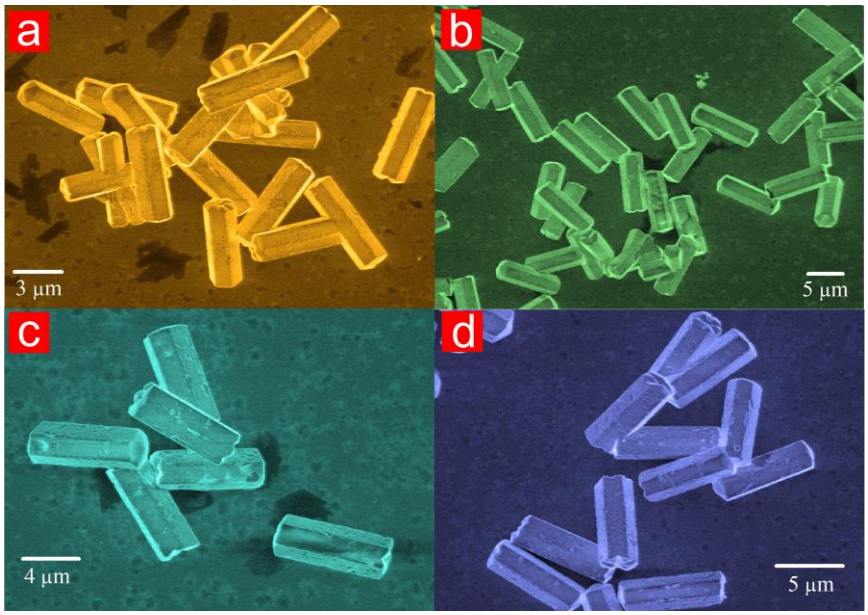

Fig. S3. SEM micrographs of the β-$NaYF_4$:Yb/Er (x/1%) microcrystals, (a) 40%Yb, (b) 10%Yb, (c) 5%Yb, (d) 2%Yb.

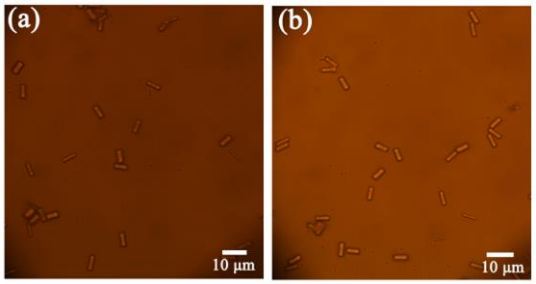

Fig. S4 The microscope images of well-separated (a) β-$NaYF_4$:Yb/Er (20/1%) and (b) β-$NaYF_4$:Yb/Er (99/1 %) microcrystals measured in our experiment.

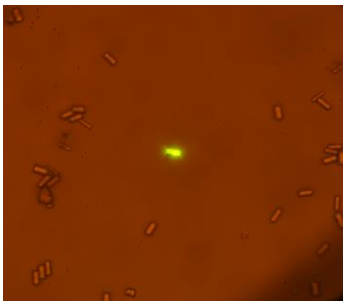

Fig. S5 The microscope image of a single β-$NaYF_4$:Yb/Er (20/1%) microcrystal excited under the 980 nm CW laser light.

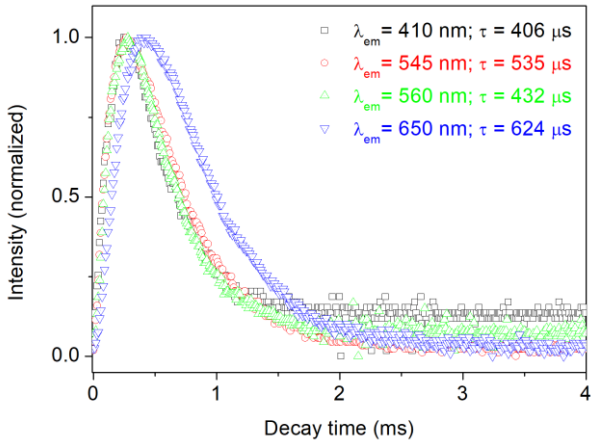

Fig. S6 Decay curves for UC emissions of β-$NaYF_4$:Yb/Er (20/1%) microcrystals under low excitation intensity. All excitation wavelengths are at ~980 nm.

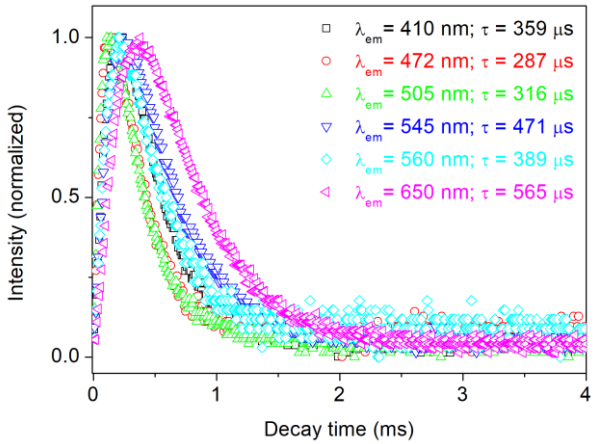

Fig. S7 Decay curves for UC emissions of β-$NaYF_4$:Yb/Er (20/1%) microcrystals under high excitation intensity. All excitation wavelengths are at ~980 nm.

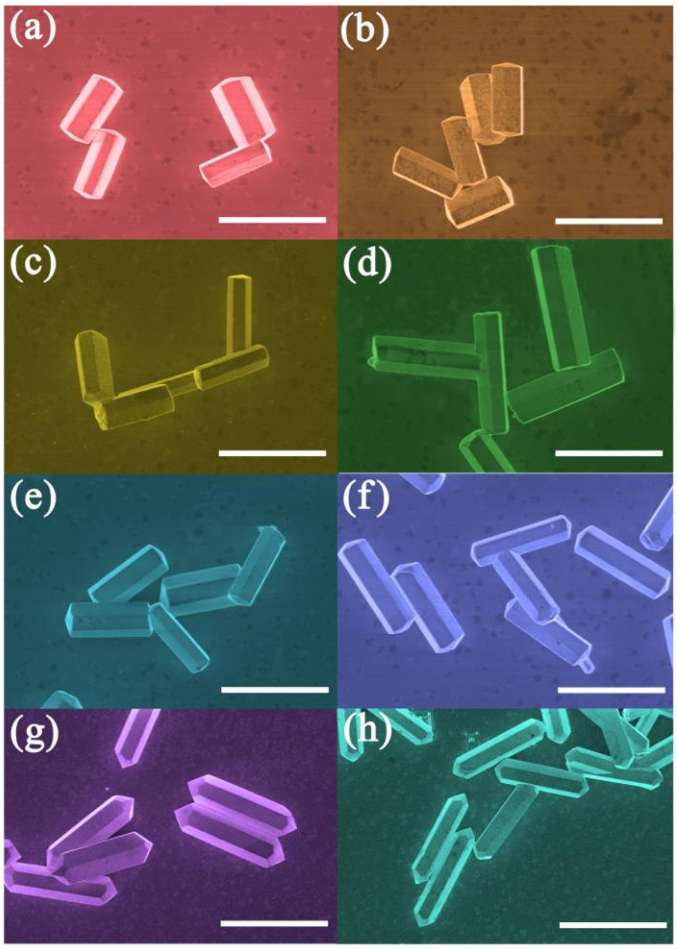

Fig. S8. SEM micrographs of β-$NaYF_4$:Yb/Er microcrystals. (a) 20% Yb, 2% Er; (b) 20% Yb, 6% Er; (c) 20% Yb, 10% Er; (d) 20% Yb, 15% Er; (e) 40% Yb, 4% Er; (f) 40% Yb, 8% Er; (g) 80% Yb, 4% Er; (h) 80% Yb, 8% Er. Scale bars are 10 μm.

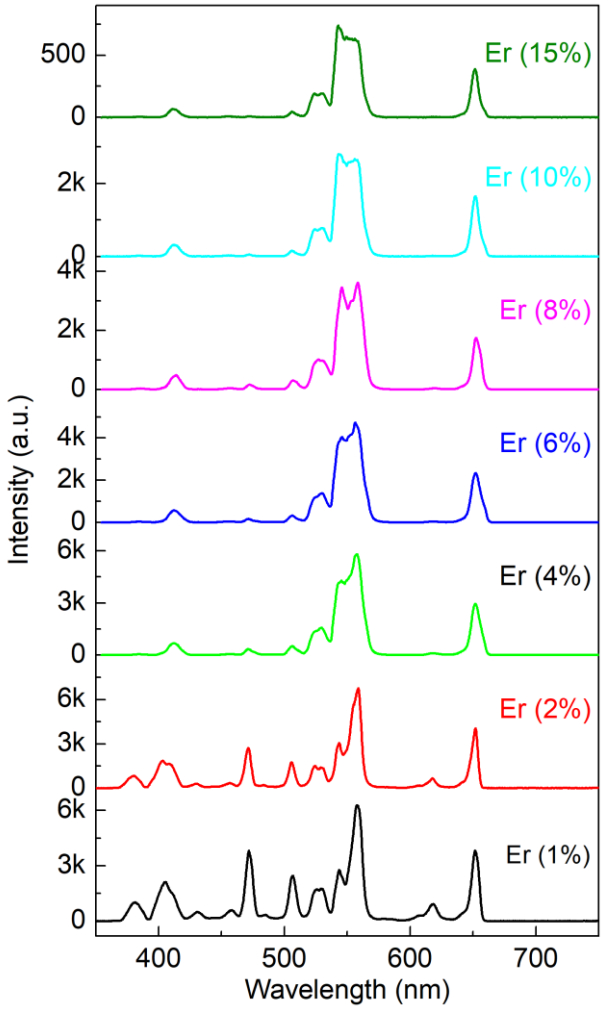

Fig. S9 UC luminescence spectra from a single β-$NaYF_4$:Yb/Er (20/x%) microcrystal under the excitation intensity of 796 KW/cm^2. All excitation wavelengths are at ~980 nm.

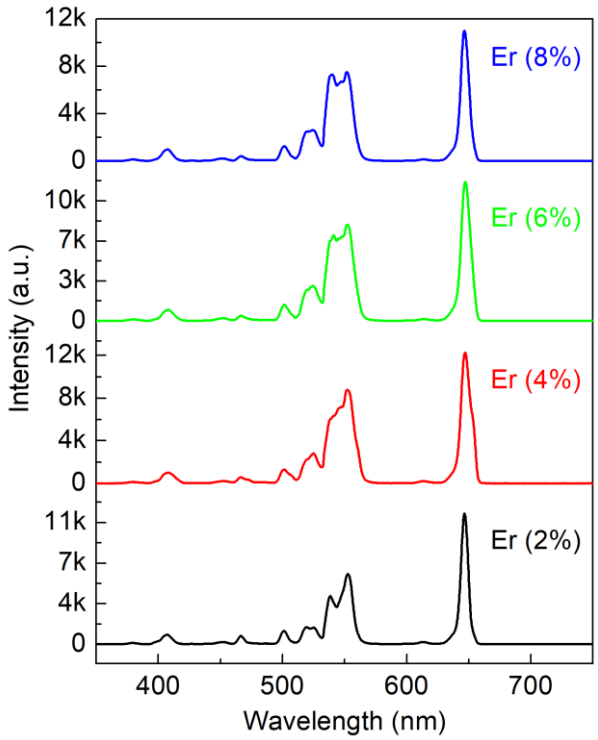

Fig. S10 UC luminescence spectra from a single β-$NaYF_4$:Yb/Er (40/x%) microcrystal under the excitation intensity of 796 KW/cm^2. All excitation wavelengths are at ~980 nm.

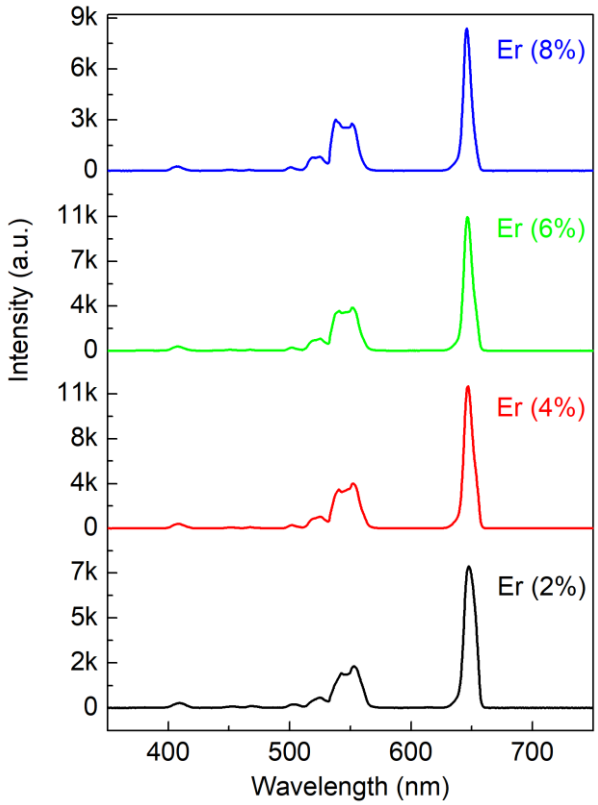

Fig. S11 UC luminescence spectra from a single β-$NaYF_4$:Yb/Er (80/x%) microcrystal under the excitation intensity of 796 KW/cm^2. All excitation wavelengths are at ~980 nm.

Table S1 Calculated CIE coordinates for the single β-$NaYF_4$:Yb/Er (x/1%) microcrystal under different excitation intensity. All excitation wavelengths are at ~980 nm.

β-$NaYF_4$:Yb/Er (20/1%)		β-$NaYF_4$:Yb/Er (99/1%)	
Excitation intensity (KW/cm^{-2})	CIE	Excitation intensity (KW/cm^{-2})	CIE
0.716	(0.303, 0.664)	4.6	(0.416, 0.533)
9.95	(0.318, 0.605)	9.55	(0.401, 0.516)
63.7	(0.322, 0.548)	47.7	(0.393, 0.503)
796	(0.323, 0.395)	796	(0.367, 0.469)