Supporting Information

Simultaneous size adjustment and upconversion luminescence enhancement of β-$NaLuF_4$:Yb^{3+}/Er^{3+},Er^{3+}/Tm^{3+} microcrystals by introducing Ca^{2+} for temperature sensing

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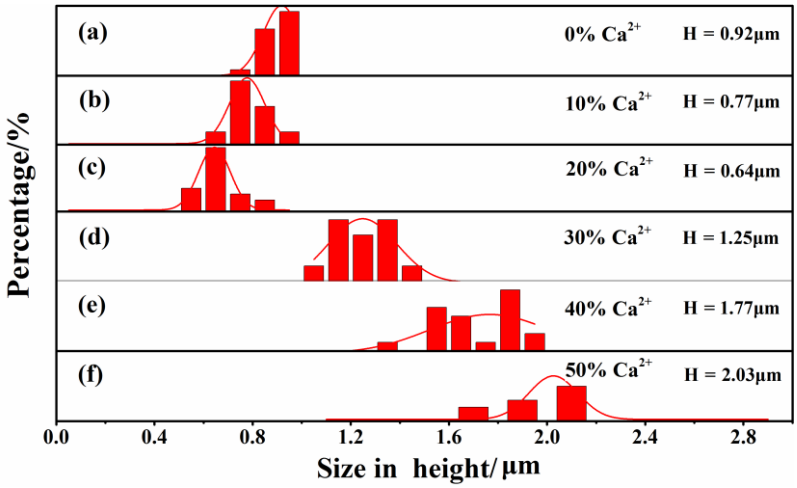

Fig. S1. The size distribution of height in β-$NaLuF_4$:20Yb^{3+}/2Er^{3+}/xCa^{2+} (x=10, 20, 30, 40, 50)

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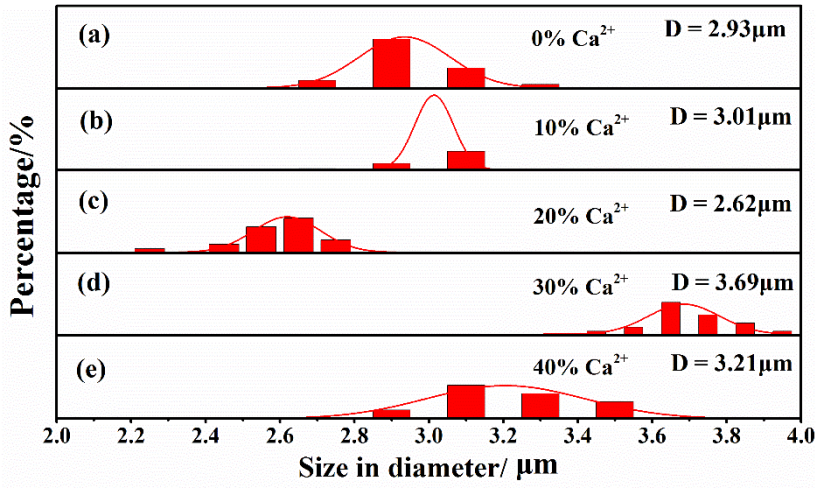

Fig. S2. The size distribution of diameter in β-$NaLuF_4$:20Yb^{3+}/2Er^{3+}/xCa^{2+} (x=10, 20, 30, 40)

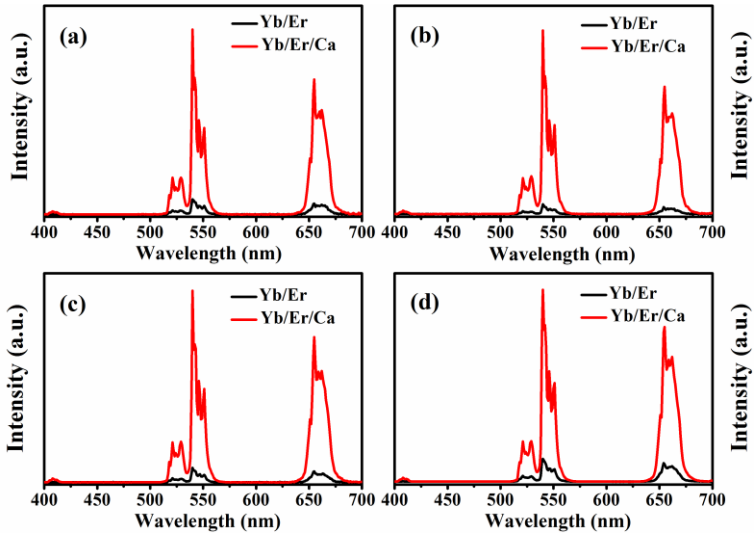

Fig. S3 (a)-(d) The upconversion luminescence of the four repetition groups experiments for β-$NaLuF_4$:20Yb^{3+}/2Er^{3+} (Yb/Er) and β-$NaLuF_4$:20Yb^{3+}/2Er^{3+}/40Ca^{2+} (Yb/Er/Ca) under 980nm excitation under the same condition.

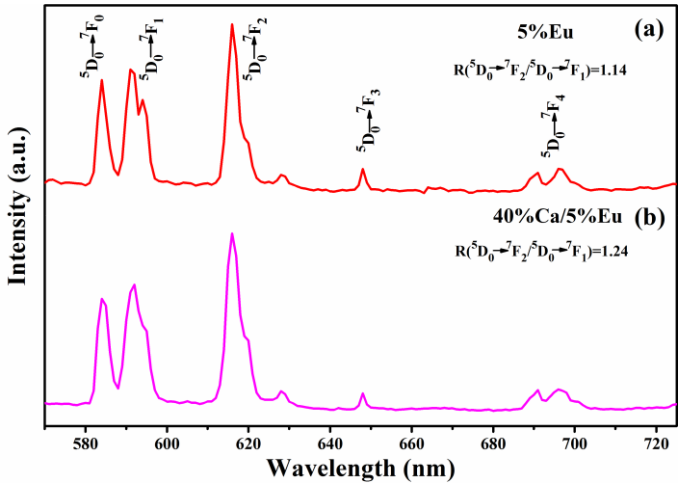

Fig. S4. Photoluminescence spectra of (a) 5%Eu, (b) 40%Ca/5%Eu. The excitation wavelength was 394nm.

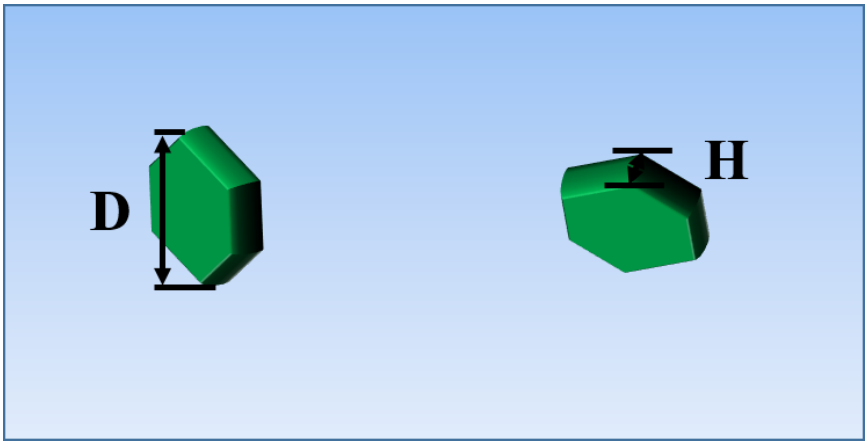

Fig. S5. Schematic diagram showing the β-$NaLuF_4$.

Table S1 Summary of the different concentration of Ca^{2+} ions and the corresponding dimensions, height, and the surface area to volume ratio.

Sample 20Yb/2Er/xCa	Height (H, um)	Diamond (D ,um)	the surface area to volume ratio (R, um^{-1})
0	0.92	2.93	3.75
10	0.77	3.01	4.13
20	0.64	2.62	4.89
30	1.25	3.69	2.85
40	1.77	3.21	2.57
50	2.03	-	-

[a]Particle sizes were counted about 50 particles from the SEM images.

In order to calculate the surface area to volume ratio, the volume (V) of microplate can be calculate as：

$$V=\frac{3\sqrt{3}D^2H}{8}$$

The surface area (S) of microplate can be expressed as:

$$S=\frac{3\sqrt{3}D^2}{4}+3DH$$

Where D is the diameter of a microplate, H is the height of a microplate, as shown in Fig. S4.
So, the surface area to volume ratio (R) can be described as:

$$R=\frac{S}{V}$$

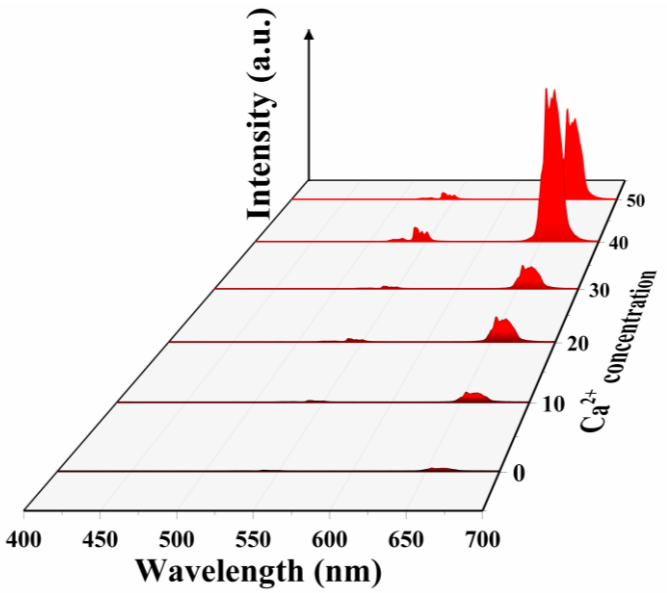

Fig. S6. The upconversion emission spectra of $NaLuF_4$:$2Er^{3+}$/$0.5Tm^{3+}$/xCa^{2+} (x=0, 10, 20, 30, 40, 50) under 980nm excitation.

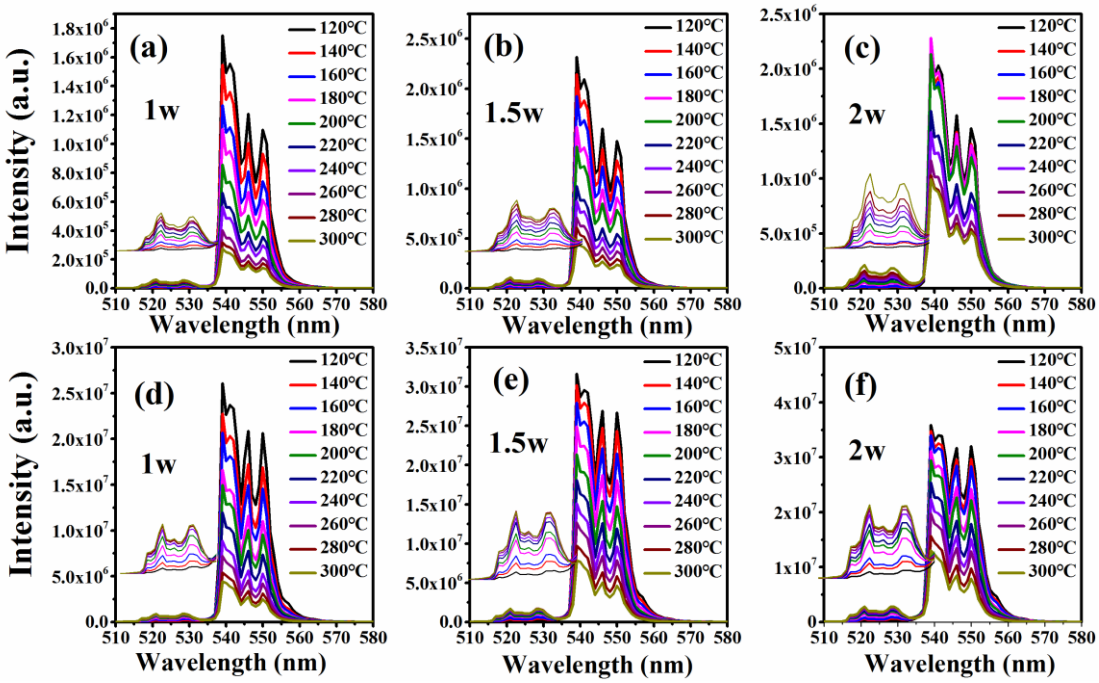

Fig. S7. Temperature-dependent upconversion luminescence spectra of β-$NaLuF_4$:$20Yb^{3+}$/$2Er^{3+}$ under 980nm excitation (laser power=1W (a), 1.5W (b), 2W (c)) and β-$NaLuF_4$:$20Yb^{3+}$/$2Er^{3+}$/$40Ca^{2+}$ under 980nm excitation (laser power=1W (d), 1.5W (e), 2W (f)).

References

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