Supporting information

All-in-one Thermometer-Heater Up-converting Platform YF_3: Yb^{3+}, Tm^{3+} Operating in the First Biological Window

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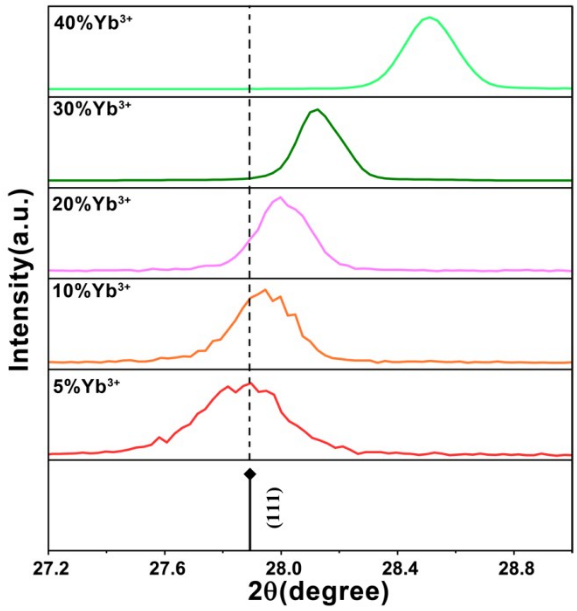

Figure S1. Enlarged main peaks (111) in XRD patterns of YF_3: 0.5%Tm^{3+}, $x$$Yb^{3+}$ (x = 5%, 10%, 20%, 30% and 40%) micro-crystals.

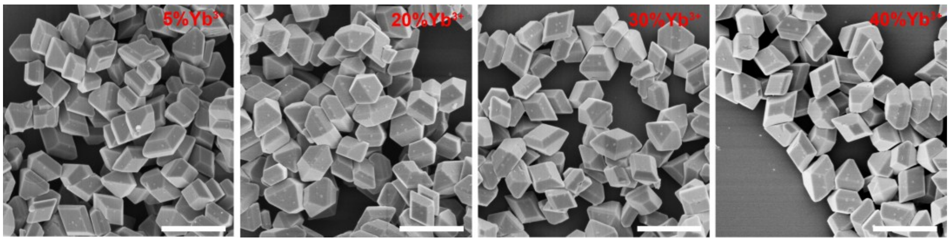

Figure S2. SEM image of YF_3: 0.5%Tm^{3+}, $x$$Yb^{3+}$ (x = 5%, 20%, 30% and 40%) micro-crystals (scale bar, 3 μm).

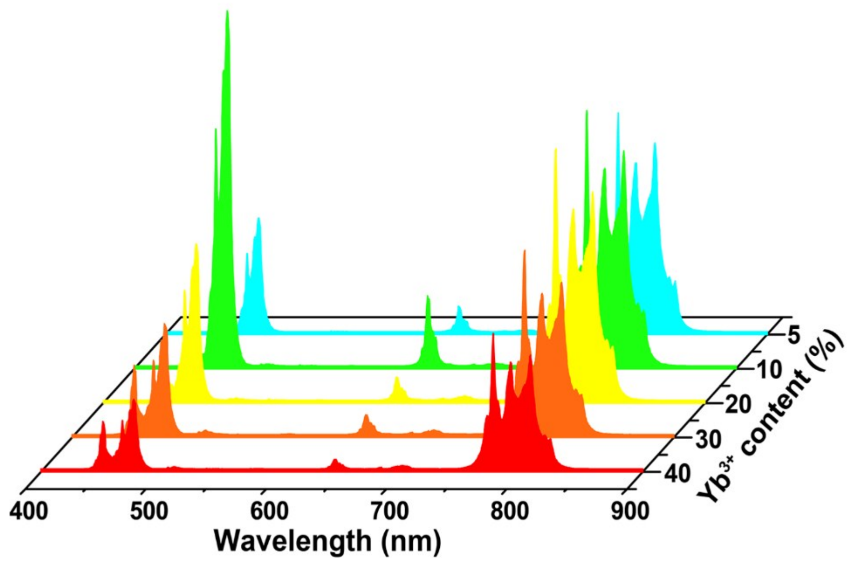

Figure S3. 980 nm excited UC emission spectra of YF_3: 0.5%Tm^{3+}, $x$$Yb^{3+}$ (x = 5~40%) micro-crystals.

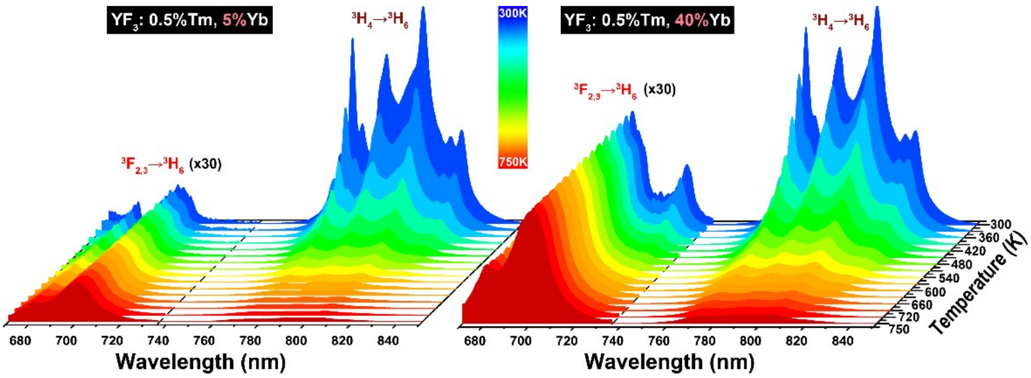

Figure S4. 980 nm excited thermal evolution of UC emission spectra of YF_3: 0.5%Tm^{3+}, $x$$Yb^{3+}$ (x = 5 and 40%) micro-crystals within the BW-I.

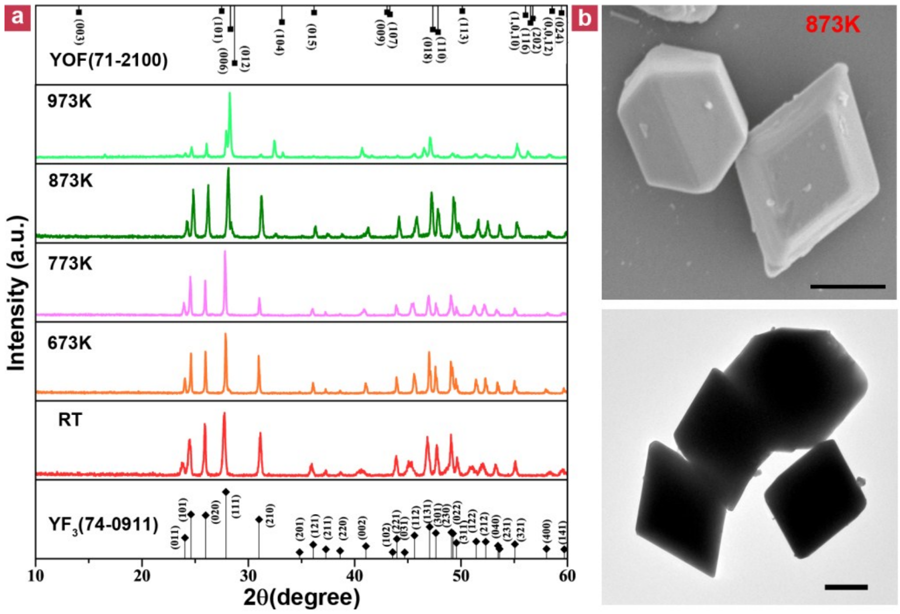

Figure S5. (a) XRD patterns of YF_3: 0.5%Tm^{3+}/10%Yb^{3+} micro-crystals after heating treatment at different temperature from RT to 1073 K; (b) SEM and TEM of 873 K-heated samples. Scale bars, 1μm.

Table S1. Energy separations (ΔE) between TCLs of different fluorescence centers

Fluorescence centers	Transitions	ΔE (cm^{-1})	λ_{em} (nm)	ref
Er^{3+}	$^2H_{9/2}$, $^4G_{11/2} \rightarrow {}^4I_{15/2}$	~1530	384, 408	[1]
	$^4D_{7/2}$, $^4G_{9/2} \rightarrow {}^4I_{15/2}$	~265	256, 276	[2]
	$^4S_{3/2}$, $^2H_{11/2} \rightarrow {}^4I_{15/2}$	~800	528, 548	[3]
	$^4F_{9/2(1)}$,$^4F_{9/2(2)} \rightarrow {}^4I_{15/2}$	~100	653, 674	
Ho^{3+}	$^5G_6/^5F_1$, $^5F_{2,3}/^3K_8 \rightarrow {}^5I_8$	~1500	460, 487	[4]
	$^5F_4$, $^5S_2 \rightarrow {}^5I_8$	~180	538, 543	[5]
	$^5F_{5(1)}$, $^5F_{5(2)} \rightarrow {}^5I_8$	~60	650, 660	[6]
Dy^{3+}	$^4I_{15/2}$, $^4F_{9/2} \rightarrow {}^6H_{15/2}$	~1000	455, 481	[7]
Nd^{3+}	$^4F_{7/2}$, $^4F_{3/2} \rightarrow {}^4I_{9/2}$	~1895	755, 872	[8]
	$^4F_{5/2}$, $^4F_{3/2} \rightarrow {}^4I_{9/2}$	~1005	805, 872	
	$^4F_{7/2}$, $^4F_{5/2} \rightarrow {}^4I_{9/2}$	~920	755, 805	
	$^4F_{3/2(1)}$, $^4F_{3/2(2)} \rightarrow {}^4I_{9/2}$	~110	938, 947	[9]
Gd^{3+}	$^6P_{5/2}$, $^6P_{7/2} \rightarrow {}^8S_{7/2}$	~460	307, 313	[10]
	$^6I_{9/2}$, $^6I_{7/2} \rightarrow {}^8S_{7/2}$	~280	277, 280	
Sm^{3+}	$^4F_{3/2}$, $^4G_{5/2} \rightarrow {}^6H_{5/2}$	~1000	530, 570	[11]
Eu^{3+}	$^5D_1$, $^5D_0 \rightarrow {}^7F_1$	~1700	535, 590	
Tm^{3+}	$^1G_{4(1)}$, $^1G_{4(2)} \rightarrow {}^3H_6$	~340	479, 484	[12]
	$^3F_{2,3}$, $^3H_4 \rightarrow {}^3H_6$	~1700	700, 776	This work

Table S2. The lattice constants of YF_3 micro-crystals with different Yb^{3+} contents.

Yb^{3+} contents	*a* (Å)	*b* (Å)	*c* (Å)	*volume* (Å^3)
5%Yb^{3+}	6.356	6.869	4.444	194.022
10%Yb^{3+}	6.347	6.866	4.424	192.791
20%Yb^{3+}	6.346	6.859	4.415	192.172
30%Yb^{3+}	6.333	6.839	4.395	190.353
40%Yb^{3+}	6.236	6.752	4.364	183.749

Reference

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