Electronic Supplementary Material (ESI) for CrystEngComm

Supporting Information

Table S1. Synthetic parameters for preparation of $NaFY_4:Eu^{3+}/Tb^{3+}$, $Y(OH)_3:Eu^{3+}/Y(OH)_3:Tb^{3+}$ with various phase structures and morphologies

Phase structure	Surfactants (mL)	Eu^{3+}/Tb^{3+} (mol.%)	Temp. (°C)	Time (h)	NaOH (g)	NaF (M)	Morphology
β-$NaYF_4$	OA=20	20	200	8	1.2	1.0	Rod
β-$NaYF_4$	OA:OM=17:3	20	200	8	1.2	1.0	Rod
$Y(OH)_3$	OM=20	20	200	8	1.2	1.0	Taper rod
α-$NaYF_4$ β-$NaYF_4$	OA:OM=17:3	**1**	200	8	1.2	1.0	Sphere
α-$NaYF_4$ β-$NaYF_4$	OA:OM=17:3	**3**	200	8	1.2	1.0	Sphere
α-$NaYF_4$ β-$NaYF_4$	OA:OM=17:3	**5**	200	8	1.2	1.0	Sphere Rod
α-$NaYF_4$ β-$NaYF_4$	OA:OM=17:3	**10**	200	8	1.2	1.0	Sphere Rod
β-$NaYF_4$	OA:OM=17:3	**15**	200	8	1.2	1.0	Rod
β-$NaYF_4$	OA:OM=17:3	**20**	200	8	1.2	1.0	Sphere
β-$NaYF_4$	OA:OM=17:3	**25**	200	8	1.2	1.0	Sphere
α-$NaYF_4$	OA:OM=17:3	20	**100**	8	1.2	1.0	Sphere
α-$NaYF_4$ β-$NaYF_4$	OA:OM=17:3	20	**130**	8	1.2	1.0	Sphere Rod
α-$NaYF_4$ β-$NaYF_4$	OA:OM=17:3	20	**160**	8	1.2	1.0	Sphere Rod
β-$NaYF_4$	OA:OM=17:3	20	**180**	8	1.2	1.0	Rod
β-$NaYF_4$	OA:OM=17:3	20	**200**	8	1.2	1.0	Rod
α-$NaYF_4$	OA:OM=17:3	20	200	**1**	1.2	1.0	Sphere
α-$NaYF_4$ β-$NaYF_4$	OA:OM=17:3	20	200	**2**	1.2	1.0	Sphere Rod
β-$NaYF_4$	OA:OM=17:3	20	200	**6**	1.2	1.0	Rod
β-$NaYF_4$	OA:OM=17:3	20	200	**8**	1.2	1.0	Rod
β-$NaYF_4$	OA:OM=17:3	20	200	**10**	1.2	1.0	Rod
β-$NaYF_4$	OA:OM=17:3	20	200	**12**	1.2	1.0	Rod
β-$NaYF_4$	OA:OM=17:3	20	200	**24**	1.2	1.0	Spindle
α-$NaYF_4$ β-$NaYF_4$	OA:OM=17:3	20	200	8	**0.3**	1.0	Sphere Rod
α-$NaYF_4$ β-$NaYF_4$	OA:OM=17:3	20	200	8	**0.6**	1.0	Sphere Rod
α-$NaYF_4$ β-$NaYF_4$	OA:OM=17:3	20	200	8	**0.9**	1.0	Rod
β-$NaYF_4$	OA:OM=17:3	20	200	8	**1.2**	1.0	Rod
β-$NaYF_4$	OA:OM=17:3	20	200	8	**1.8**	1.0	Sphere
β-$NaYF_4$	OA:OM=17:3	20	200	8	1.2	**0.12**	Prism
β-$NaYF_4$	OA:OM=17:3	20	200	8	1.2	**0.48**	Prism
β-$NaYF_4$	OA:OM=17:3	20	200	8	1.2	**0.60**	plate
β-$NaYF_4$	OA:OM=17:3	20	200	8	1.2	**0.84**	plate
β-$NaYF_4$	OA:OM=17:3	20	200	8	1.2	**1.0**	Rod
β-$NaYF_4$	OA:OM=17:3	20	200	8	1.2	**1.2**	Rod

Table S2. Synthetic parameters for preparation of $NaFY_4:Eu^{3+}/Tb^{3+}$, $Y(OH)_3$: $Eu^{3+}/Y(OH)_3:Tb^{3+}$ with various phase structures, sizes, and morphologies synthesized with OA:OM=17:3, Eu^{3+}/Tb^{3+} (mol. %)=20.

Phase structure	Temp. (°C)	Time (h)	NaOH (g)	NaF (M)	Morphology	Size (nm)
α-$NaYF_4$	**100**	8	1.2	1.0	Sphere	10.4
α-$NaYF_4$ β-$NaYF_4$	**160**	8	1.2	1.0	Sphere Rod	21.2
β-$NaYF_4$	**180**	8	1.2	1.0	Rod	23.0
β-$NaYF_4$	**200**	8	1.2	1.0	Rod	24.7
α-$NaYF_4$	200	**1**	1.2	1.0	Sphere	12.3
α-$NaYF_4$ β-$NaYF_4$	200	**2**	1.2	1.0	Sphere Rod	14.0
β-$NaYF_4$	200	**6**	1.2	1.0	Rod	21.3
β-$NaYF_4$	200	**8**	1.2	1.0	Rod	24.7
β-$NaYF_4$	200	**10**	1.2	1.0	Rod	20.0
β-$NaYF_4$	200	**12**	1.2	1.0	Rod	23.2
β-$NaYF_4$	200	**24**	1.2	1.0	Spindle	32.1
α-$NaYF_4$ β-$NaYF_4$	200	8	**0.3**	1.0	Sphere Rod	32.8
α-$NaYF_4$ β-$NaYF_4$	200	8	**0.6**	1.0	Sphere Rod	26.1
α-$NaYF_4$ β-$NaYF_4$	200	8	**0.9**	1.0	Rod	23.7
β-$NaYF_4$	200	8	**1.2**	1.0	Rod	24.7
β-$NaYF_4$	200	8	**1.8**	1.0	Sphere	10.4
β-$NaYF_4$	200	8	1.2	**0.12**	Prism	50.9
β-$NaYF_4$	200	8	1.2	**0.48**	Prism	58.5
β-$NaYF_4$	200	8	1.2	**0.60**	Plate	24.0
β-$NaYF_4$	200	8	1.2	**0.84**	Plate	43.2
β-$NaYF_4$	200	8	1.2	**1.2**	Rod	34.0

Table S3. The lifetimes of different transition of Eu^{3+} and Tb^{3+} in $NaYF_4$:20%Eu^{3+}/Tb^{3+} and $Y(OH)_3$:20%Eu^{3+} nanorods.

Samples	Excitation (nm)	Emission (nm)	Lifetime (ms)	Fitness parameter $X^{2.}$
$NaYF_4$:20%Eu^{3+}	394	592	1.080	0.998
	394	615	1.130	0.999
	394	690	1.090	0.998
	394	696	0.972	0.997
$Y(OH)_3$:20%Eu^{3+}	394	591	0.231	0.999
	394	615	0.224	0.999
	394	690	0.219	0.999
	394	696	0.227	0.999
$NaYF_4$:20%Tb^{3+}	379	491	0.568	0.997
	379	546	0.732	0.999
	379	585	0.746	0.999
	379	620	0.765	0.999

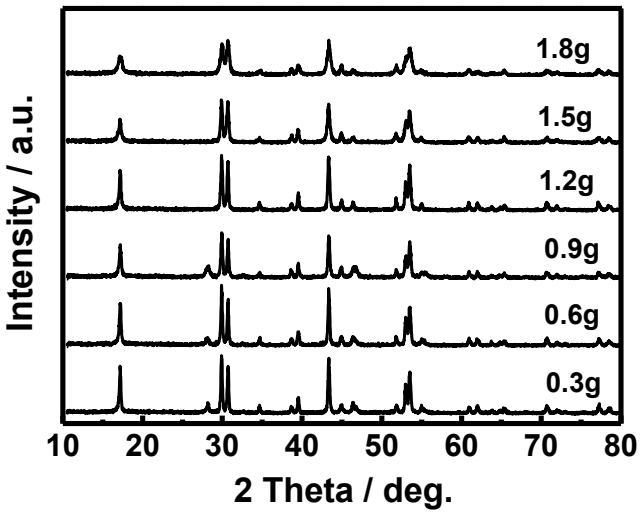

Figure S1. XRD patterns of $NaYF_4$:20%Eu^{3+} synthesized using different amount of NaOH. Other reaction conditions are kept at OA/OM (17/3 mL) and H_2O (9 mL) under 200 ºC for 8 h.

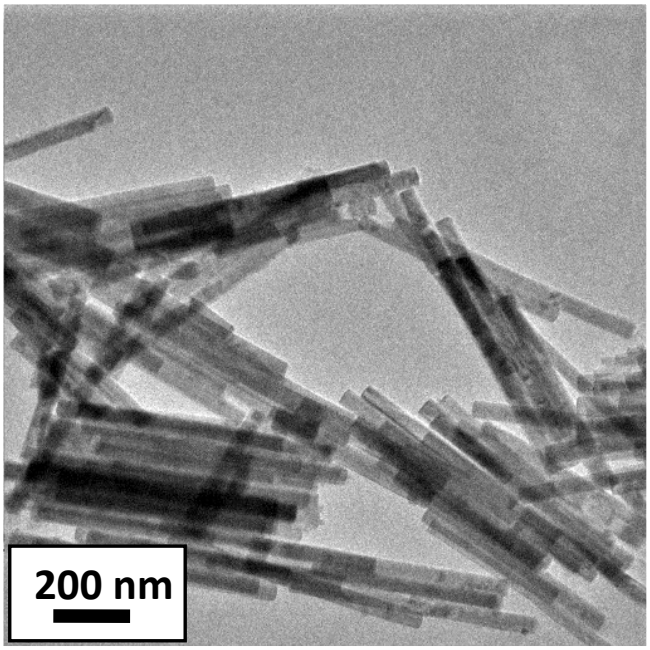

Figure S2. TEM image of $NaYF_4$:20%Eu^{3+} nanorods synthesized using OA/OM (17/3 mL) as capping agents. Other reaction conditions are kept at NaOH (1.2 g), ethanol (10 mL), NaF (1.0 M), and H_2O (9 mL) under 200 ºC for 8 h.

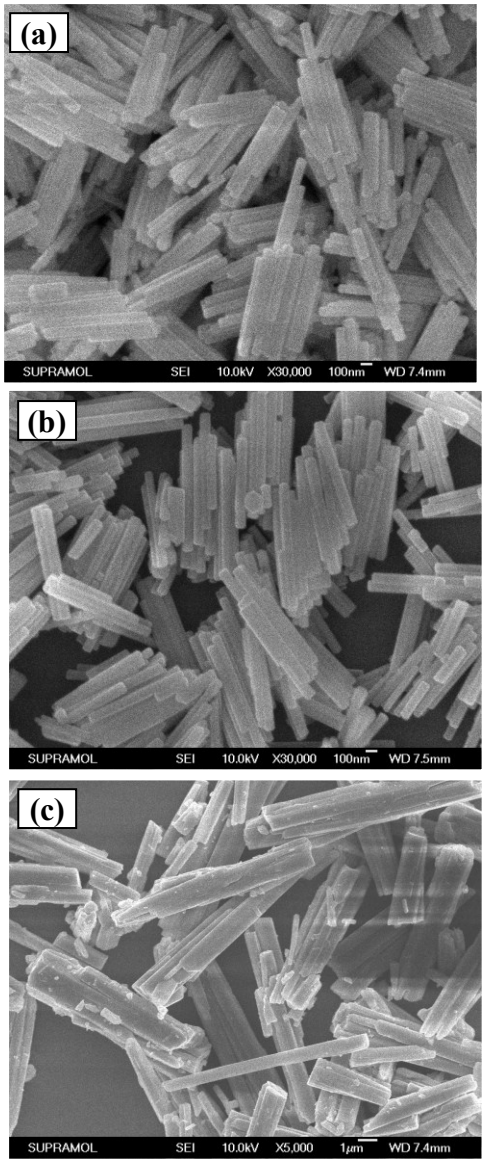

Figure S3. SEM images of $NaYF_4$:20%Tb^{3+} nanorods synthesized using (a) OA (20 mL), (b) OA/OM (17/3 mL) as capping agents and $Y(OH)_3$:20%Tb^{3+} nanorods synthesized using (c) OM (20 mL) as capping agent. Other reaction conditions are kept at NaOH (1.2 g), ethanol (10 mL), NaF (1.0 M), and H_2O (9 mL) under 200 ºC for 8h.

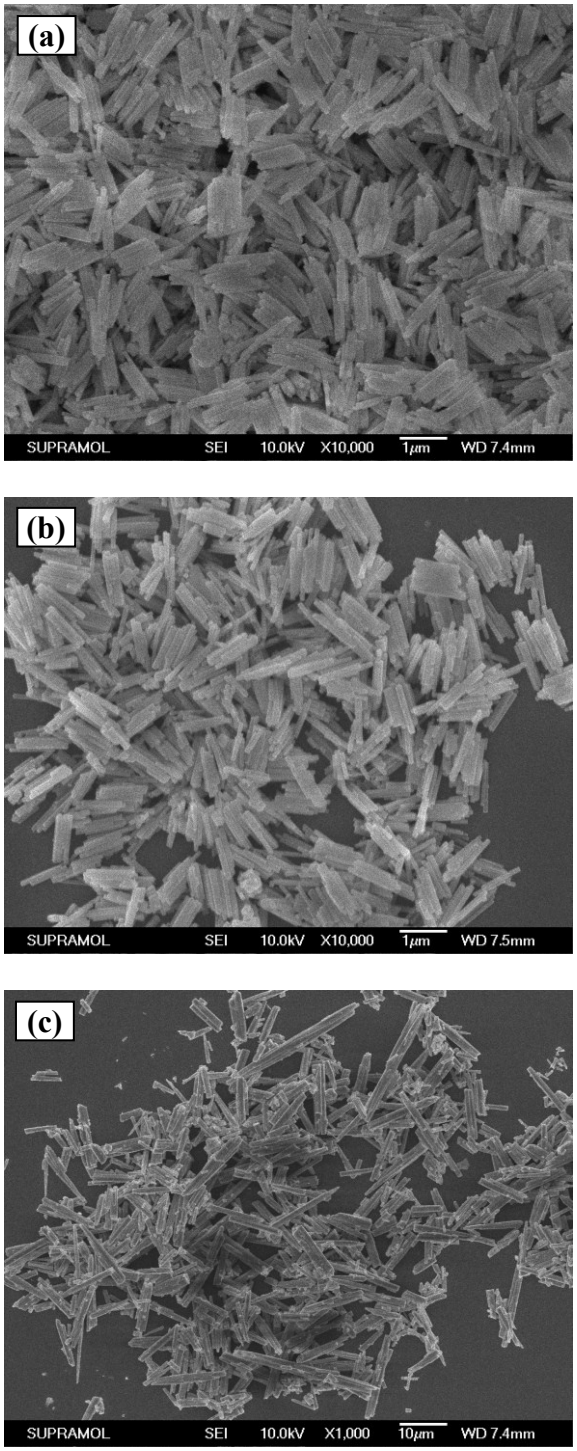

Figure S4. SEM image of $NaYF_4$:20%Tb^{3+} nanorods synthesized using OA/OM (a) 17/3 mL, (b) 10/10 mL, (c) 3/17 mL as capping agents. Other reaction conditions are kept at NaOH (1.2 g), ethanol (10 mL), NaF (1.0 M), and H_2O (9 mL) under 200 ºC for 8 h.

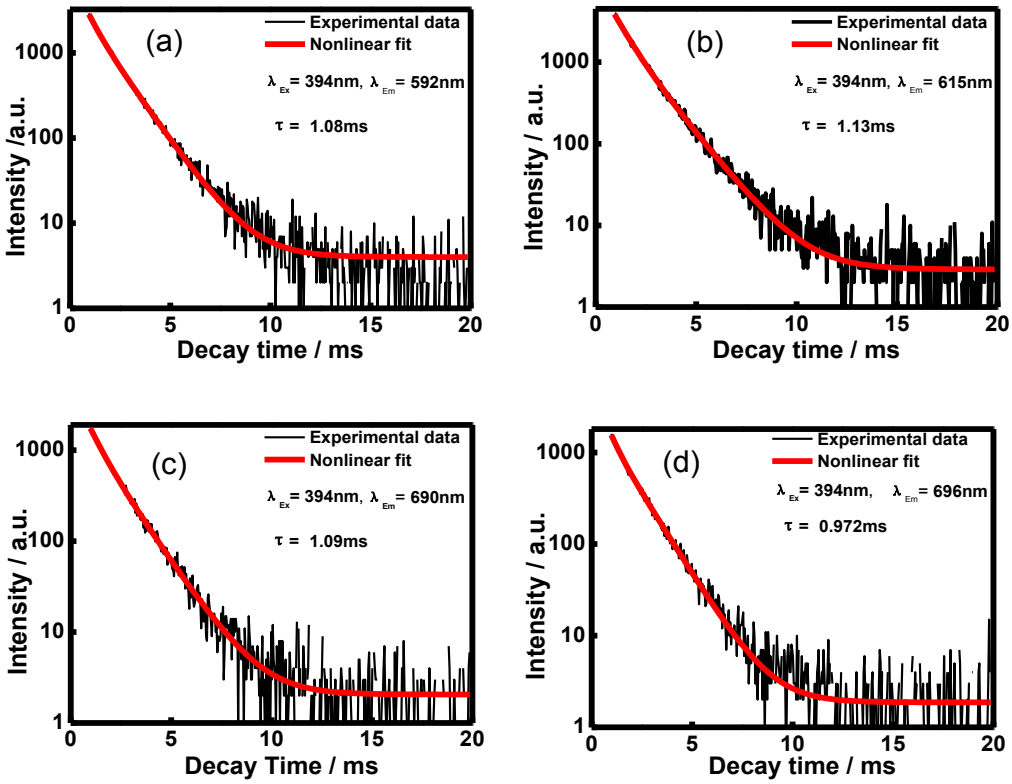

Figure S5. Photoluminescence lifetime spectra of β-$NaYF_4$:20%:Eu^{3+} nanorods synthesized using OA/OM (17/3 mL) as capping agents. Other reaction conditions are kept at NaOH (1.2 g), ethanol (10 mL), NaF (1.0 M), and H_2O (9 mL) under 200 ºC for 8h.

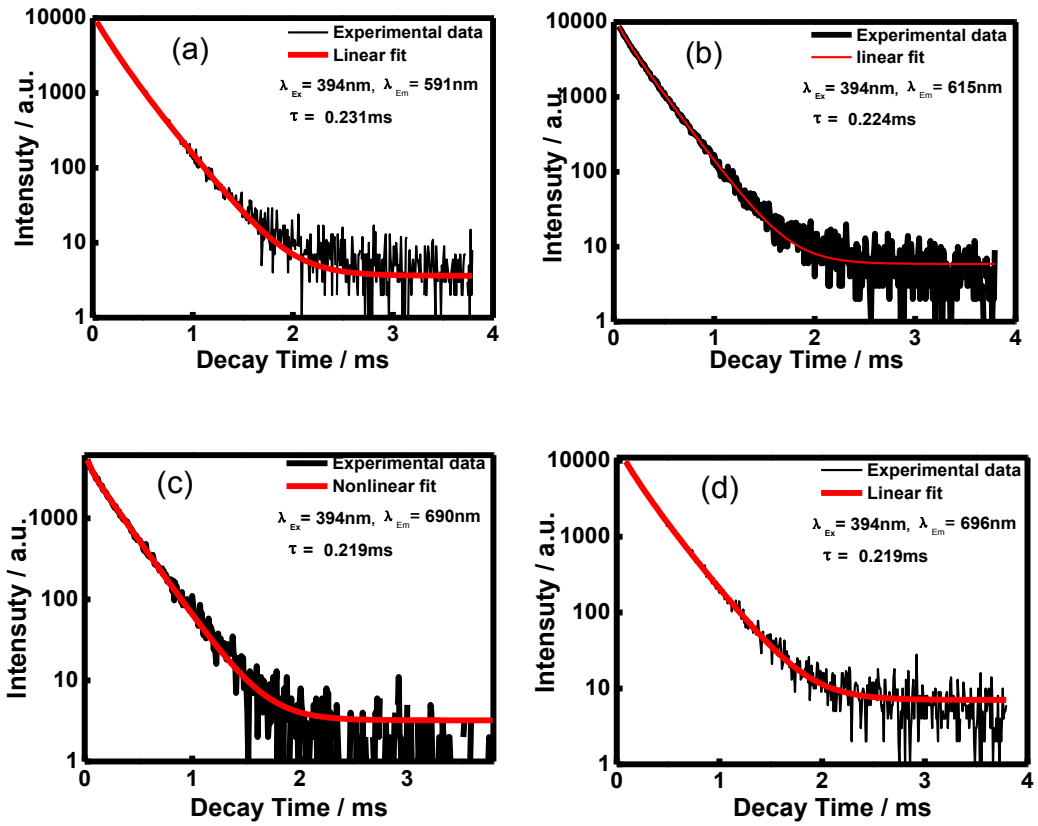

Figure S6. Photoluminescence lifetime spectra of $Y(OH)_3$:20%Eu^{3+} nanorods synthesized using OM (20 mL) as capping agent. Other reaction conditions are kept at NaOH (1.2 g), ethanol (10 mL), NaF (1.0 M), and H_2O (9 mL) under 200 ºC for 8h.

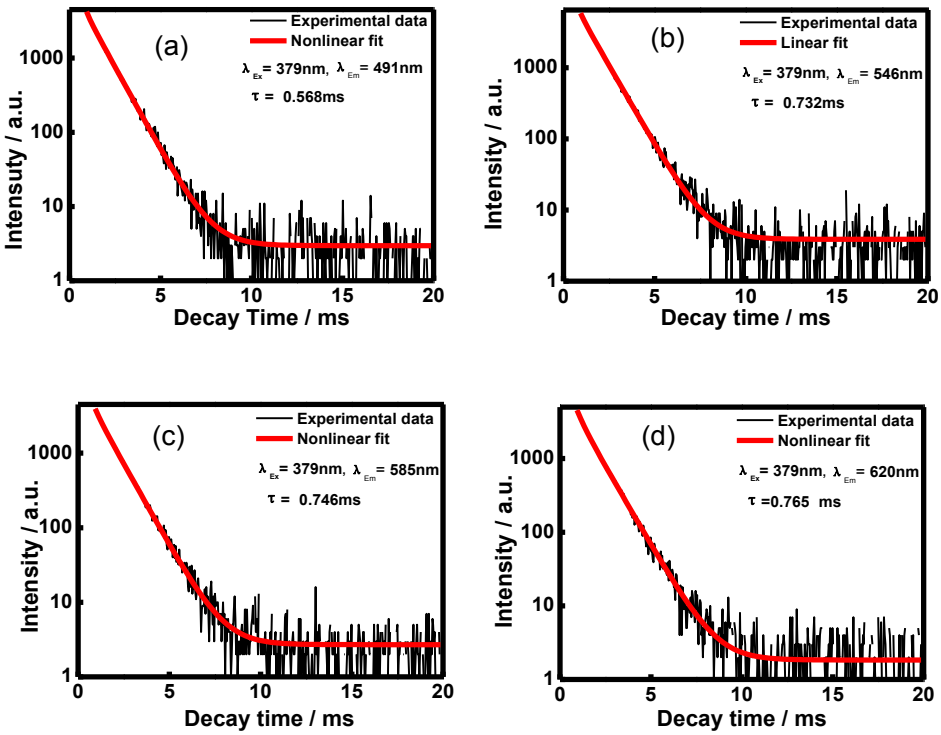

Figure S7. Photoluminescence lifetime spectra of β-$NaYF_4$:20%:Tb^{3+} nanorods synthesized using OA/OM (17/3 mL) as capping agents. Other reaction conditions are kept at NaOH (1.2 g), ethanol (10 mL), NaF (1.0 M), and H_2O (9 mL) under 200 ºC for 8h.

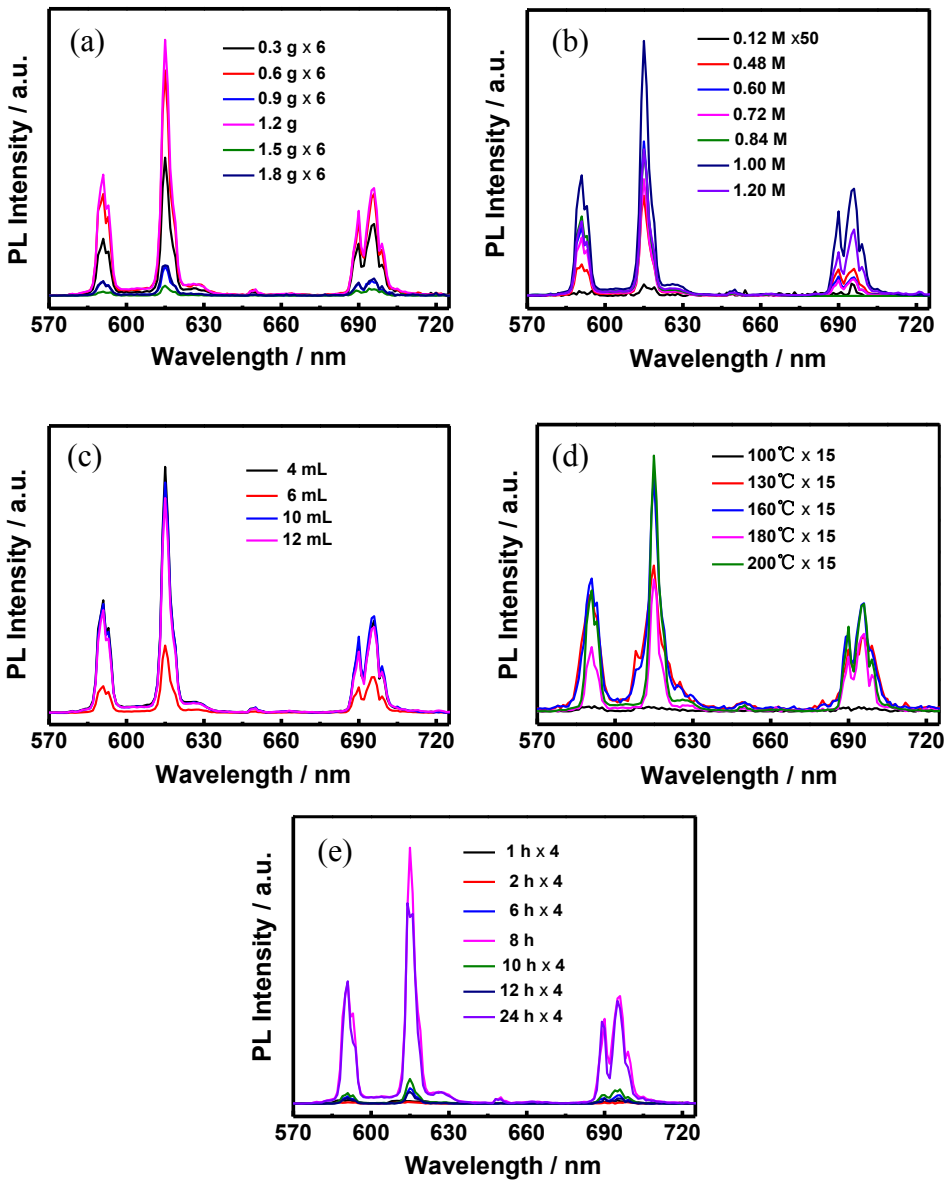

Figure S8. Photoluminescence variation of $NaYF_4$:20%Eu^{3+} nanorods with the amounts of (a) NaOH, (b) NaF, (c) ethanol, and the (d) reaction temperature and (e) time for synthesis. Other reaction conditions are kept at OA/OM (17/3 mL), and H_2O (9 mL).

Scheme S1. Schematic illustration of phase transformation of α-$NaYF_4$ to β-$NaYF_4$ with the changes of the synthetic parameters and their corresponding morphologies.