

Electronic Supplementary Information (ESI)

The $\text{NaYF}_4\text{:Yb}^{3+}/\text{Er}^{3+}$ nanorods/ TiO_2 mesoporous film for enhanced dye sensitized solar cell

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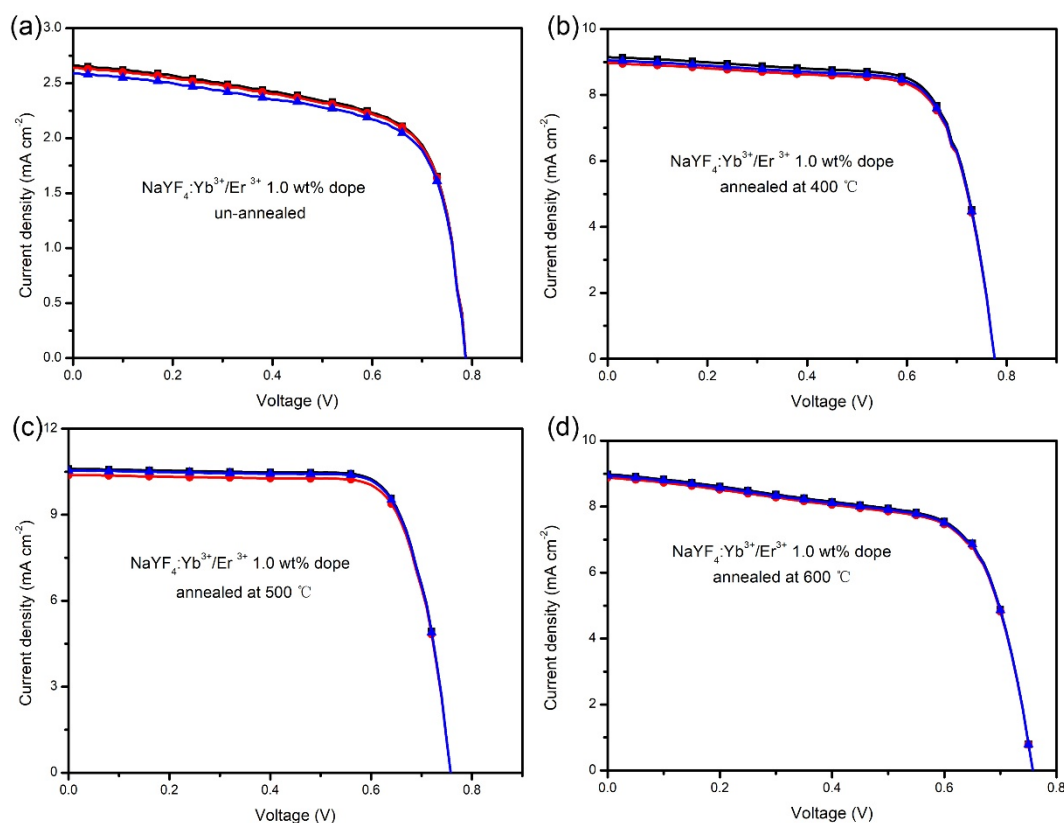


Fig. S1. Three times tested J-V curves of DSSCs based on photoanodes prepared by 1.0 wt% $\text{NaYF}_4\text{:Yb}^{3+}/\text{Er}^{3+}$ NR annealed at different temperatures: (a) un-annealed, (b) 400 °C, (c) 500 °C, (d) 600 °C

Table S1. Average of photovoltaic performance and standard deviation extracted from J-V curves of DSSCs based on photoanodes prepared by 1.0 wt% un-annealed NaYF₄:Yb³⁺/Er³⁺ NR

J _{sc} (mA cm ⁻²)	Average J _{sc} (mA cm ⁻²)	V _{oc} (V)	Average V _{oc} (V)	FF	Average FF	PCE (%)	Average PCE%	Standard Deviation of PCE
2.66	2.63	0.78	0.78	0.67	0.67	1.40	1.38	0.022
2.64		0.78		0.67		1.39		
2.59		0.78		0.67		1.35		

Table S2. Average of photovoltaic performance and standard deviation extracted from J-V curves of DSSCs based on photoanodes prepared by 1.0 wt% NaYF₄:Yb³⁺/Er³⁺ NR annealed at 400 °C

J _{sc} (mA cm ⁻²)	Average J _{sc} (mA cm ⁻²)	V _{oc} (V)	Average V _{oc} (V)	FF	Average FF	PCE (%)	Average PCE%	Standard Deviation of PCE
9.15	9.05	0.78	0.78	0.73	0.73	5.20	5.14	0.045
8.96		0.78		0.73		5.09		
9.05		0.78		0.73		5.14		

Table S3. Average of photovoltaic performance and standard deviation extracted from J-V curves of DSSCs based on photoanodes prepared by 1.0 wt% NaYF₄:Yb³⁺/Er³⁺ NR annealed at 500 °C

J _{sc} (mA cm ⁻²)	Average J _{sc} (mA cm ⁻²)	V _{oc} (V)	Average V _{oc} (V)	FF	Average FF	PCE (%)	Average PCE%	Standard Deviation of PCE
10.60	10.51	0.76	0.76	0.77	0.77	6.20	6.15	0.051
10.38		0.76		0.77		6.08		
10.54		0.76		0.77		6.17		

Table S4. Average of photovoltaic performance and standard deviation extracted from J-V curves of DSSCs based on photoanodes prepared by 1.0 wt% NaYF₄:Yb³⁺/Er³⁺ NR annealed at 600 °C

J _{sc} (mA cm ⁻²)	Average J _{sc} (mA cm ⁻²)	V _{oc} (V)	Average V _{oc} (V)	FF	Average FF	PCE (%)	Average PCE%	Standard Deviation of PCE
8.98	8.93	0.76	0.76	0.67	0.67	4.55	4.53	0.021
8.88		0.76		0.67		4.50		
8.94		0.76		0.67		4.53		

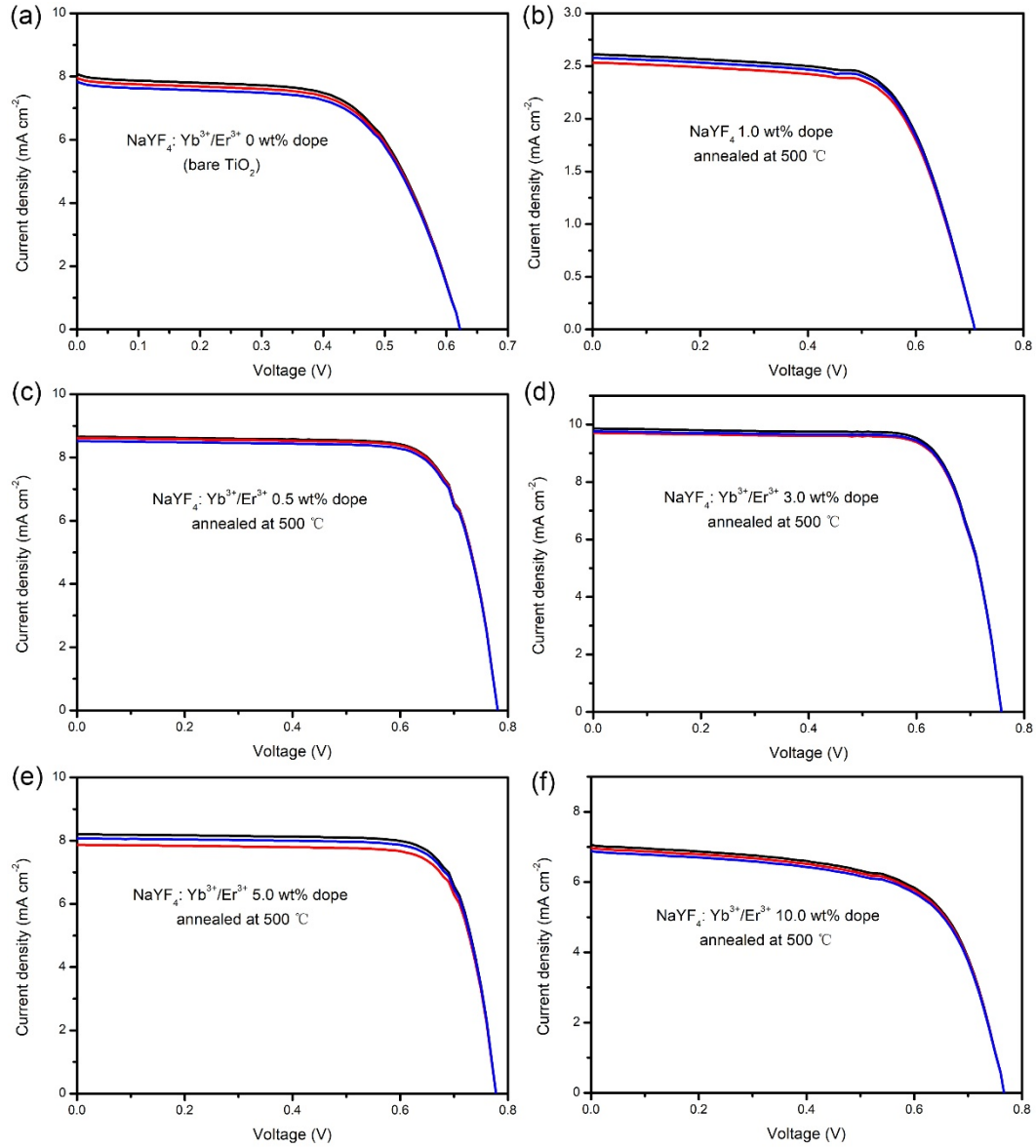


Fig. S2. Three times tested J-V curves of DSSCs based on photoanodes prepared by different dosage of NaYF₄:Yb³⁺/Er³⁺ NR annealed at 500 °C: (a) 0 wt% NaYF₄:Yb³⁺/Er³⁺ NR (bare TiO₂), (b) 1.0 wt% NaYF₄ (without doping of Yb³⁺ and Er³⁺), (c) 0.5 wt% NaYF₄:Yb³⁺/Er³⁺ NR, (d) 3.0 wt% NaYF₄:Yb³⁺/Er³⁺ NR, (e) 5.0 wt% NaYF₄:Yb³⁺/Er³⁺ NR, (f) 10.0 wt% NaYF₄:Yb³⁺/Er³⁺ NR

Table S5. Average of photovoltaic performance and standard deviation extracted from J-V curves of DSSCs based on photoanodes prepared by 0 wt% NaYF₄:Yb³⁺/Er³⁺ NR (bare TiO₂)

J _{sc} (mA cm ⁻²)	Average J _{sc} (mA cm ⁻²)	V _{oc} (V)	Average V _{oc} (V)	FF	Average FF	PCE (%)	Average PCE(%)	Standard Deviation of PCE
8.07	7.95	0.62	0.62	0.63	0.63	3.17	3.11	0.045
7.95		0.62		0.63		3.11		
7.83		0.62		0.63		3.06		

Table S6. Average of photovoltaic performance and standard deviation extracted from J-V curves of DSSCs based on photoanodes prepared by 1.0 wt% NaYF₄ (without doping of Yb³⁺ and Er³⁺) annealed at 500 °C

J _{sc} (mA cm ⁻²)	Average J _{sc} (mA cm ⁻²)	V _{oc} (V)	Average V _{oc} (V)	FF	Average FF	PCE (%)	Average PCE%	Standard Deviation of PCE
2.61	2.58	0.71	0.71	0.67	0.67	1.25	1.23	0.016
2.54		0.71		0.67		1.21		
2.58		0.71		0.67		1.23		

Table S7. Average of photovoltaic performance and standard deviation extracted from J-V curves of DSSCs based on photoanodes prepared by 0.5 wt% NaYF₄:Yb³⁺/Er³⁺ NR annealed at 500 °C

J _{sc} (mA cm ⁻²)	Average J _{sc} (mA cm ⁻²)	V _{oc} (V)	Average V _{oc} (V)	FF	Average FF	PCE (%)	Average PCE%	Standard Deviation of PCE
8.65	8.59	0.78	0.78	0.77	0.77	5.21	5.18	0.034
8.61		0.78		0.77		5.19		
8.52		0.78		0.77		5.13		

Table S8. Average of photovoltaic performance and standard deviation extracted from J-V curves of DSSCs based on photoanodes prepared by 3.0 wt% NaYF₄:Yb³⁺/Er³⁺ NR annealed at 500 °C

J _{sc} (mA cm ⁻²)	Average J _{sc} (mA cm ⁻²)	V _{oc} (V)	Average V _{oc} (V)	FF	Average FF	PCE (%)	Average PCE%	Standard Deviation of PCE
9.86	9.81	0.76	0.76	0.77	0.77	5.77	5.74	0.024
9.76		0.76		0.77		5.71		
9.81		0.76		0.77		5.74		

Table S9. Average of photovoltaic performance and standard deviation extracted from J-V curves of DSSCs based on photoanodes prepared by 5.0 wt% NaYF₄:Yb³⁺/Er³⁺ NR annealed at 500 °C

J _{sc} (mA cm ⁻²)	Average J _{sc} (mA cm ⁻²)	V _{oc} (V)	Average V _{oc} (V)	FF	Average FF	PCE (%)	Average PCE%	Standard Deviation of PCE
8.20	8.05	0.78	0.78	0.78	0.78	5.00	4.90	0.087
7.87		0.78		0.78		4.79		
8.07		0.78		0.78		4.92		

Table S10. Average of photovoltaic performance and standard deviation extracted from J-V curves of DSSCs based on photoanodes prepared by 10.0 wt% NaYF₄:Yb³⁺/Er³⁺ NR annealed at 500 °C

J _{sc} (mA cm ⁻²)	Average J _{sc} (mA cm ⁻²)	V _{oc} (V)	Average V _{oc} (V)	FF	Average FF	PCE (%)	Average PCE%	Standard Deviation of PCE
7.05	6.97	0.77	0.77	0.65	0.64	3.50	3.46	0.033
6.97		0.77		0.64		3.46		
6.88		0.77		0.64		3.42		