

## Lanthanide-doped $\text{KYb}_3\text{F}_{10}$ crystals: controllable phases, rich morphologies and $\text{Tb}^{3+}/\text{Eu}^{3+}$ down-conversion emission

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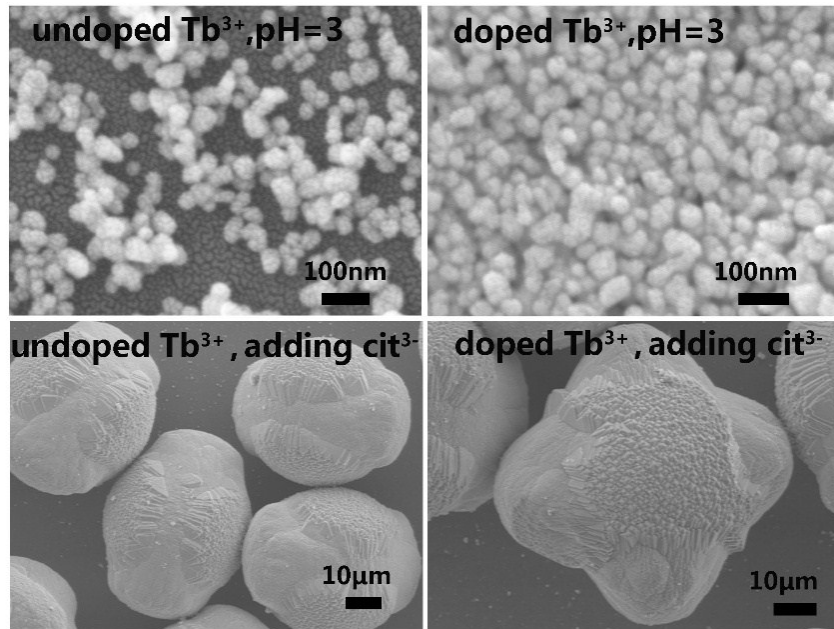
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**Table S1** Crystallographic data for  $\text{KYb}_3\text{F}_{10}$ .

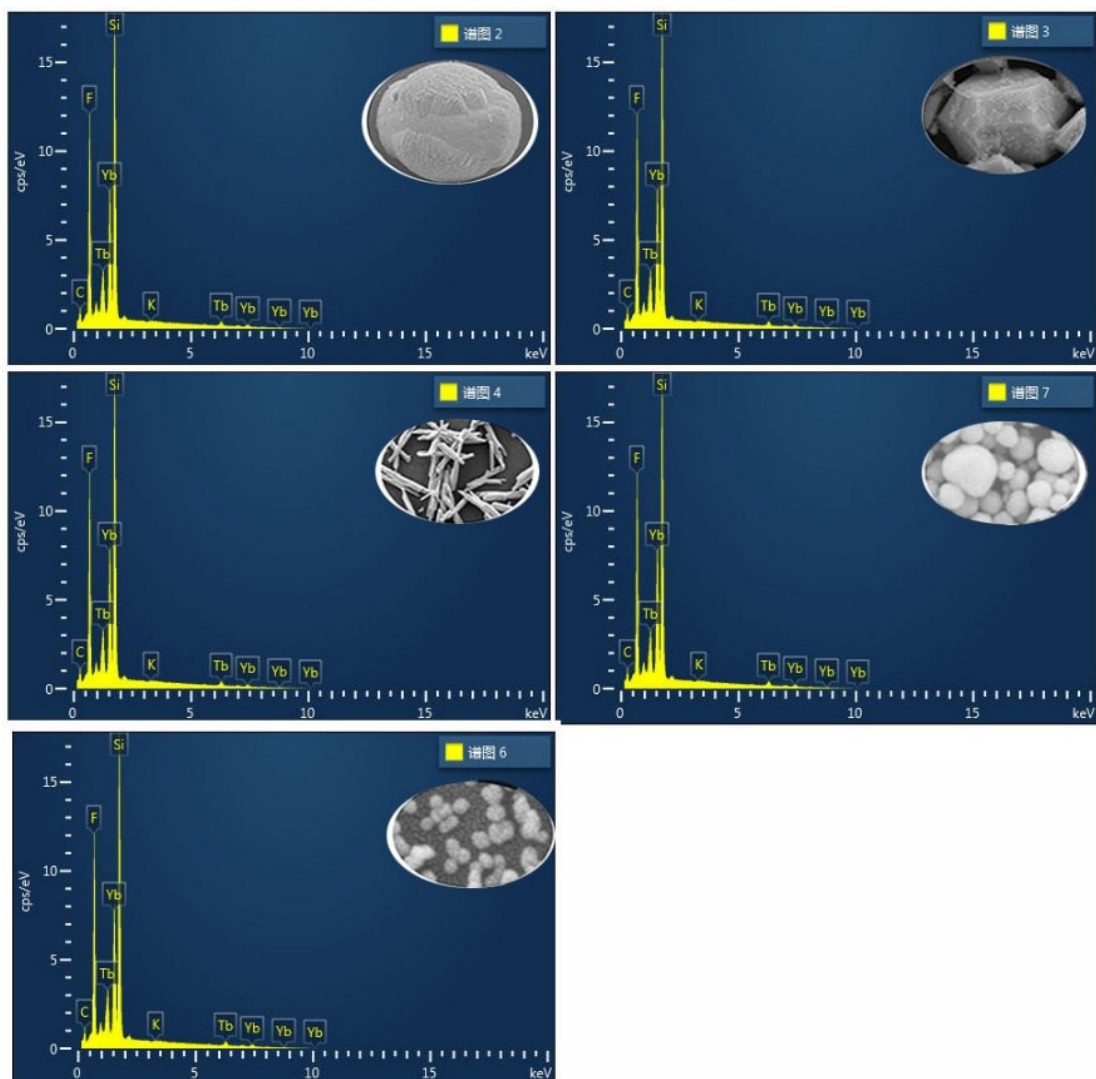
Formula	$\text{KYb}_3\text{F}_{10}$
Crystal system	Cubic
Space group	F m-3m(225)
a/Å	11.431(6)
b/Å	11.431(6)
c/Å	11.431(6)
$\alpha /^\circ$	90
$\beta /^\circ$	90
$\gamma /^\circ$	90
V/Å <sup>3</sup>	1493.66(136)
Z	8
$\rho_{\text{calc}}/\text{gcm}^{-3}$	6.653

**Table S2** The length and diameter of the samples from the SEM images in Fig. 7.

	Length ( $\mu\text{m}$ )	Wide ( $\mu\text{m}$ )
No doping	3.9	3.8
$\text{Er}^{3+}$	2.6	2.2
$\text{Ho}^{3+}$	2.2	1.4
$\text{Tb}^{3+}$	2.4	1.6
$\text{Gd}^{3+}$	1.7	1.5
$\text{Eu}^{3+}$	1.8	0.1
$\text{Sm}^{3+}$	0.5	0.4
$\text{Ce}^{3+}$	0.4	0.3
$\text{La}^{3+}$	0.2	0.2



**Figure S1** SEM images of the  $KYb_3F_{10}$  and  $KYb_{2.97}F_{10}:0.03Tb^{3+}$  crystals under the same reaction conditions.



**Figure S2** EDS spectra of  $\text{KYb}_3\text{F}_{10}:\text{5\%Tb}^{3+}$  with different morphologies.

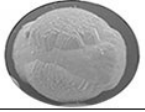
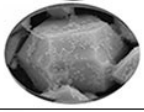
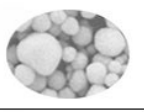
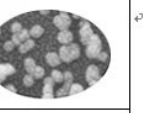
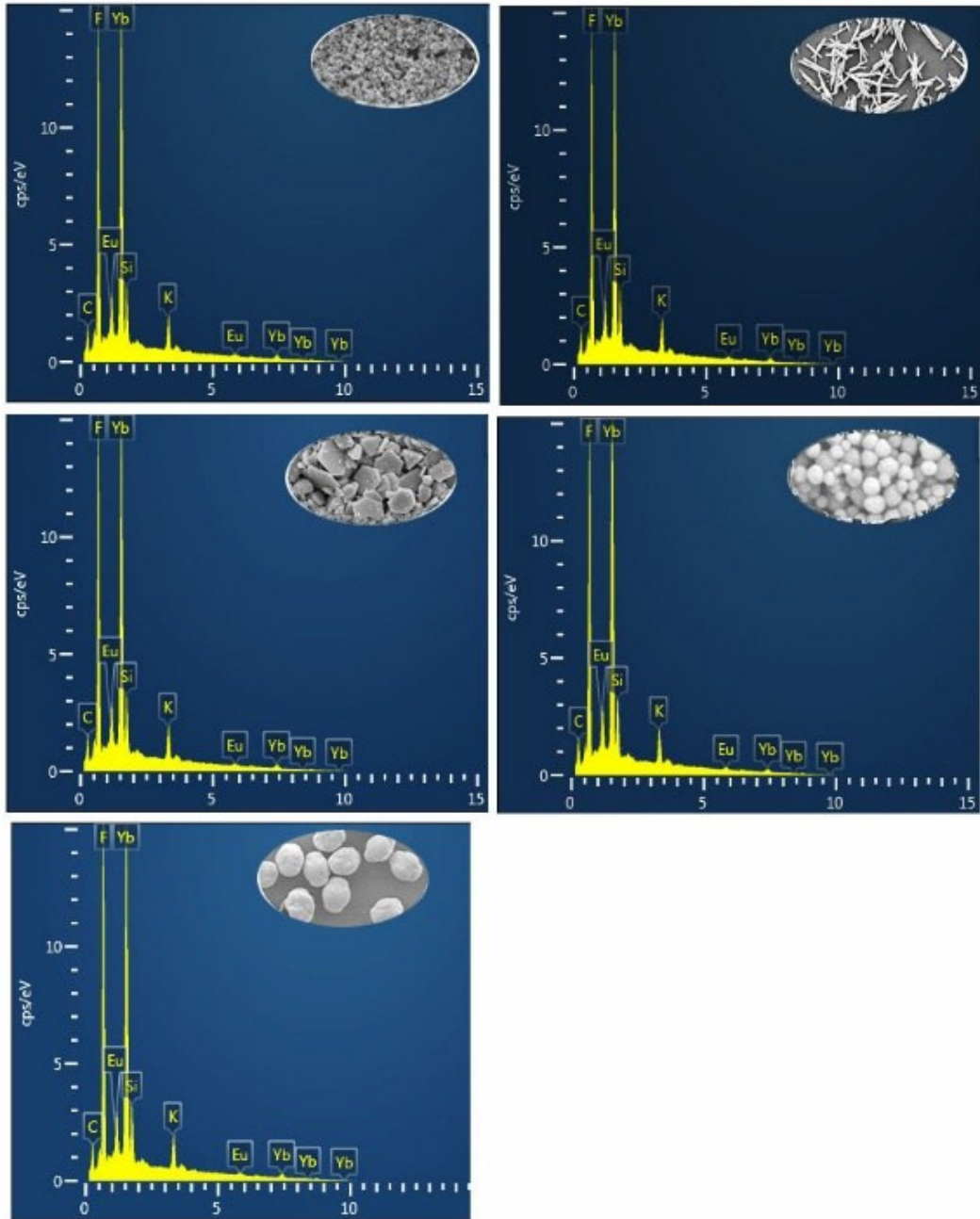
$\text{KYb}_3\text{F}_{10}:\text{5\%Tb}^{3+}$					
Actual content of $\text{Tb}^{3+}$ (%)	3.54	3.55	3.54	3.53	3.52

Figure S3 Actual content of  $\text{Tb}^{3+}$ .



**Figure S4** EDS spectra of  $\text{KYb}_3\text{F}_{10}:5\%\text{Eu}^{3+}$  with different morphologies.

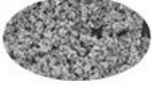

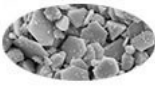
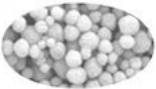
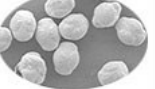
<b>KYb<sub>3</sub>F<sub>10</sub>:5%Eu<sup>3+</sup></b>					
<b>Actual content of Eu<sup>3+</sup>(%)</b>	<b>3.46</b>	<b>3.46</b>	<b>3.46</b>	<b>3.44</b>	<b>3.49</b>

Figure S5 Actual content of Eu<sup>3+</sup>.

<b>KYb<sub>3</sub>F<sub>10</sub>:5%Eu<sup>3+</sup></b>					
<b>Relative ratio of <sup>5</sup>D<sub>0-7</sub>F<sub>1</sub>/<sup>5</sup>D<sub>0-7</sub>F<sub>2</sub></b>	<b>1.77</b>	<b>1.93</b>	<b>2.47</b>	<b>2.71</b>	<b>3.93</b>

**Figure S6** Relative intensity ratio of <sup>5</sup>D<sub>0-7</sub>F<sub>1</sub>/<sup>5</sup>D<sub>0-7</sub>F<sub>2</sub> transitions.

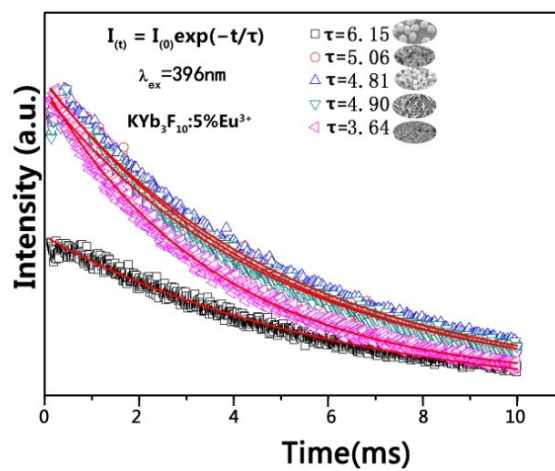
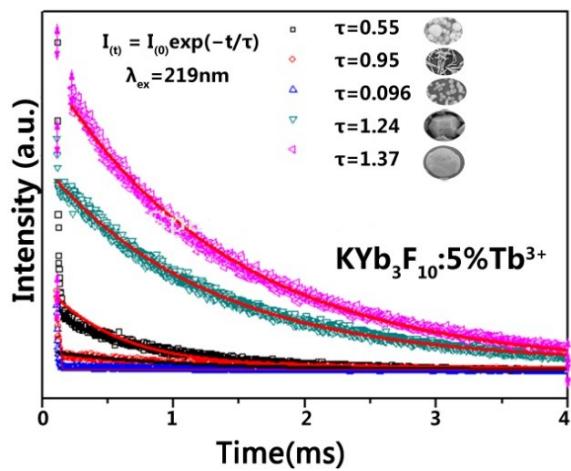


Figure S7 Photoluminescence lifetimes of Tb<sup>3+</sup> and Eu<sup>3+</sup> in different morphologies.