Electronic Supplementary Material (ESI) for RSC Advances.

$K_3LaTe_2O_9$:Er: A Novel Green Up-conversion Luminescence Material

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Supporting Information

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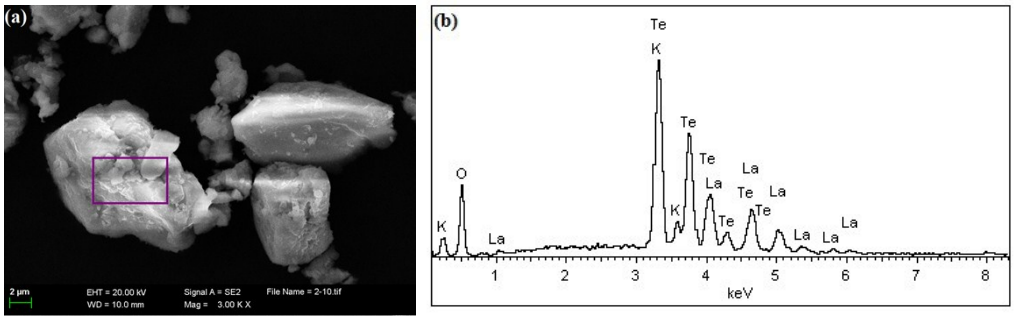

Fig. S1 SEM (a), and EDS (b) spectra of the $K_3LaTe_2O_9$ sample.

Table S1 The concentration of element in the K_3LaTe_2O crystal

Element	*Wt%*	*At%*
O K	19.04	55.71
K K	18.35	21.97
Te L	41.00	15.04
La L	21.61	7.28
Total Mass	100.00	

The micrograph shows block particles with 5 – 10 µm diameter (Fig. S1a). Like most micron particles prepared by solid phase method, the surface of the $K_3LaTe_2O_9$: Er crystals is not smooth and attached some small particles. The EDS of the sample was analyzed to determine the elements in the obtained sample (Fig. S1b). The main diffraction peaks in the spectrum correspond to O, K, Te and La elements. The molar ratio of K, La, Te, and O element is 3.0:1:2.1:7.7 (Tab. S1).

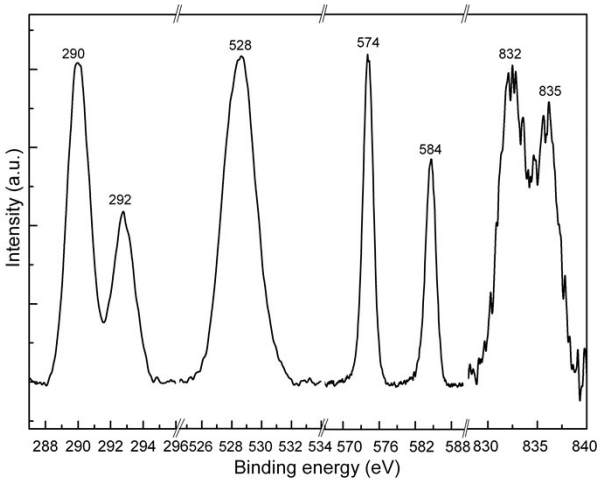

Fig. S2 XPS spectrum of the $K_3LaTe_2O_9$: 38%Er sample.

The element composition and oxidation states of the samples were determined by XPS analysis. As shown in Fig. S2, the binding energies of the diffraction peaks in the XPS pattern can be well indexed in accord with, K (290, 292 eV), O (528 eV), Te (574 eV), and La (832, 835 eV) elements corresponding to +1, -2, +6, +3 oxidation states, respectively. Subsequently, the atomic concentration of all elements in $K_3LaTe_2O_9$: 38% Er sample was obtained by elemental sensitivity factor method. The relative concentration values of K, O, Te, La, and Er atoms are 61.88, 18.47, 12.31, and 7.34 %, respectively, which are close to the theoretical calculated values.

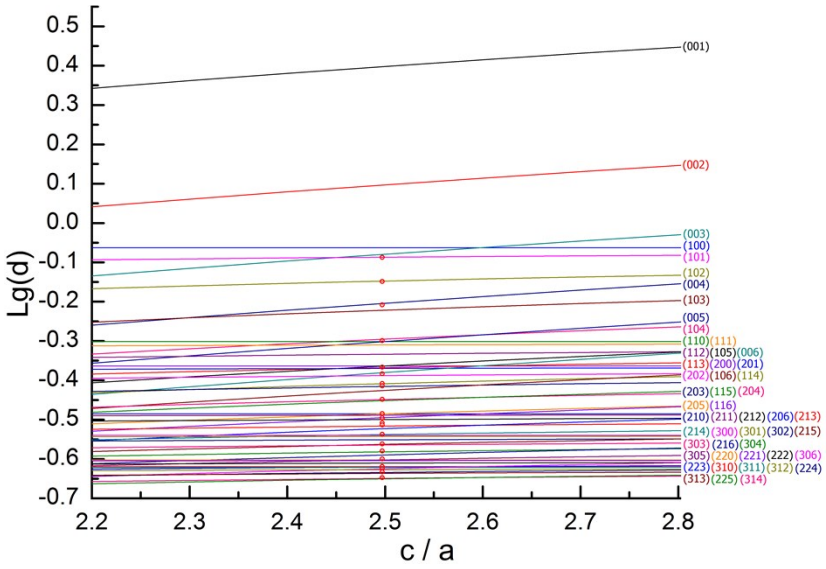

Fig. S3 Bunn crystal index calibration patterns of the hexagonal $K_3LaTe_2O_9$:0.02Er.

For a hexagonal crystal,

$$d = \frac{1}{\sqrt{4\left(\frac{h^2+hk+k^2}{3a^2}\right)+\frac{l^2}{c^2}}}, \qquad (1)$$

where d is the interplanar spacing; h, k, and l are the indices of the lattice planes; and a and c are the lattice constants.

Eq. S1 can be rewritten as

$$\lg d = -\frac{1}{2}\lg\left[\frac{4}{3}(h^2+hk+k^2-l^2)+l^2\left(\frac{4}{3}+\frac{1}{(c^2/a^2)}\right)\right]. \qquad (2)$$

The Bunn crystal index calibration patterns of the hexagonal crystal with h, k and $l \leq 6$ are shown in Fig. S3 according to Eq. S2 with the c/a ratio as the horizontal axis and lgd as the vertical axis[1]. According to Bragg equation,

$$2d\sin\theta = k\lambda, \qquad (3)$$

where θ is the diffraction angle, k is the diffraction orders, and λ is the X-ray wavelength. The whole interplanar spacing d and lgd of $K_3LaTe_2O_9$:0.02Er can be calculated based on Eq. S3 and the XRD data in Fig. 1a. The lgd of all diffraction peaks is shown in Fig.S3 as circles according to the Bunn crystal index method. Tab. S2 shows the XRD index data of the $K_3LaTe_2O_9$ sample.

Table S2 XRD index data of the $K_3LaTe_2O_9$:0.02Er sample

Serial number	2-Theta	d (Å)	h	k	l	I(f)	I(v)
1	17.98	4.9335	1	0	1	45	34
2	20.76	4.2787	1	0	2	32	25
3	23.84	3.7324	0	0	4	13	11
4	29.50	3.0279	1	1	0	100	100
5	34.56	2.5953	1	0	5	16	18
6	36.02	2.4934	0	0	6	12	12
7	38.20	2.3560	1	1	4	3	3
8	38.78	2.3221	2	0	3	6	5
9	42.08	2.1473	2	0	4	49	32
10	45.96	1.9746	2	0	5	12	19
11	47.20	1.9256	1	1	6	26	29
12	48.68	1.8705	2	1	3	14	14
13	52.26	1.7505	3	0	0	33	36
14	55.56	1.6541	2	1	5	14	16
15	58.08	1.5882	3	0	4	7	10
16	61.12	1.5162	2	2	0	20	20
17	64.20	1.4507	2	2	3	7	8
18	64.28	1.4491	3	1	1	7	8
19	65.08	1.4332	3	0	6	11	14
20	66.58	1.4045	2	2	4	4	5
21	69.18	1.3580	3	1	4	10	11

Table S3 The sensitivity of different materials based on fluorescence intensity ratio of Er^{3+} ions.

Matrix	Sensitivity (10^{-4}/K)	Ref.
$NaGdTiO_4$	40	[2]
$BaTiO_3$	45	[3]
β-$NaYF_4$	48	[4]
$Y_2Ti_2O_7$	67	[5]
$YNbO_4$	73	[6]
$BaMoO_4$	109	[7]
$NaY(MoO_4)2$	114	[8]
YVO_4	117	[9]
Y_2O_3	130	[10]

The temperature sensitivity of different materials must be compared at the same experimental conditions (such as temperature, doping concentration and types etc.). The scientific reports on temperature sensitivity are focused on Yb,Er codoped upconversion materials. It is not comparable between previously reports and present work. Whereas, the temperature sensitivities data were provided in Tab.S3 to qualitatively assess the temperature sensitivity of different materials.

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