Supporting Information

Eulytite-type $Ba_3Yb(PO_4)_3$: Tm/Er/Ho as high sensitivity optical thermometer over broad temperature range

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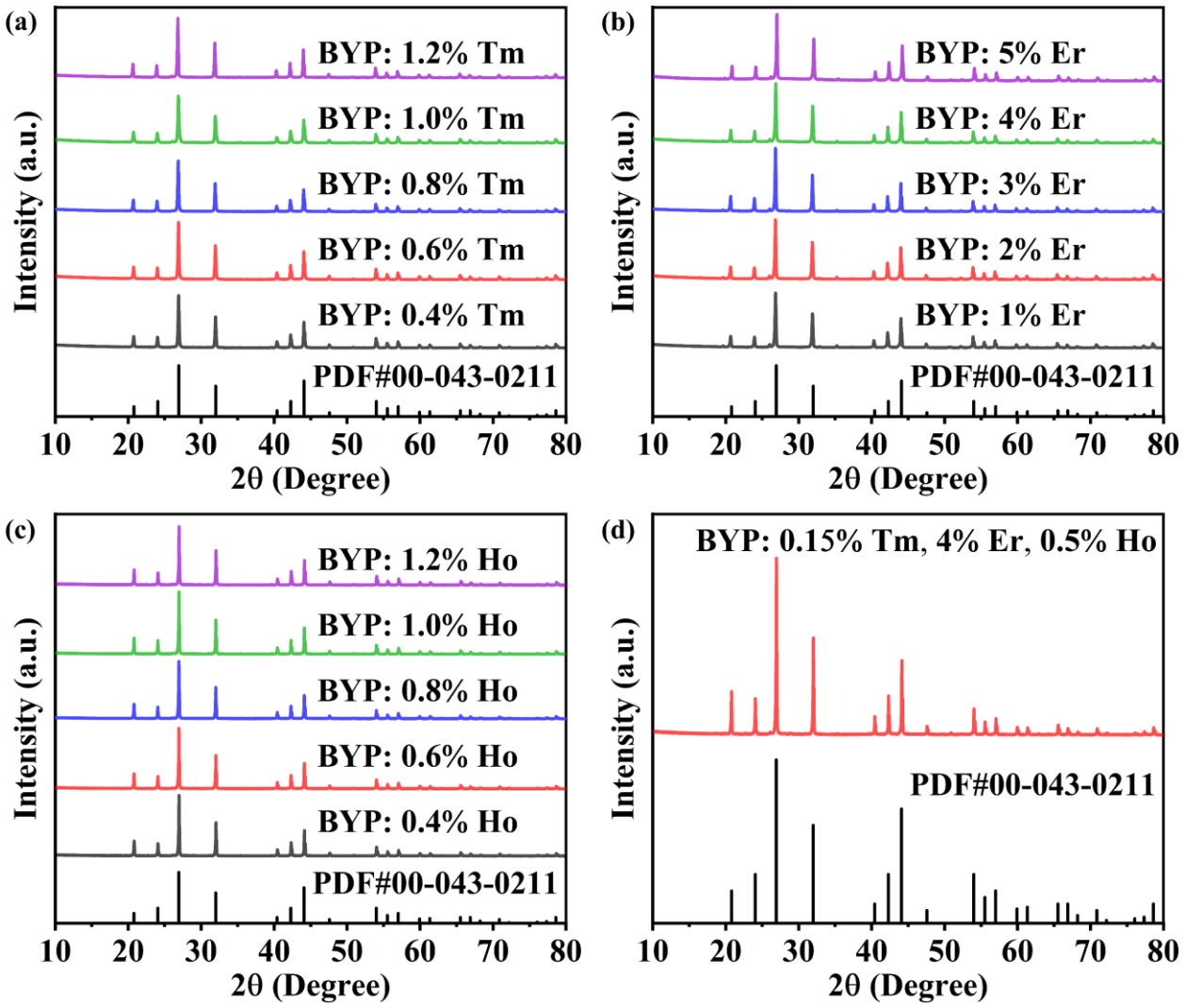

Fig. S1. XRD patterns of **(a)** $Ba_3Yb(PO_4)_3$: Tm^{3+}, **(b)** $Ba_3Yb(PO_4)_3$: Er^{3+}, **(c)** $Ba_3Yb(PO_4)_3$: Ho^{3+}, and **(d)** $Ba_3Yb(PO_4)_3$: 0.15% Tm^{3+}, 4% Er^{3+}, 0.5% Ho^{3+}phosphors.

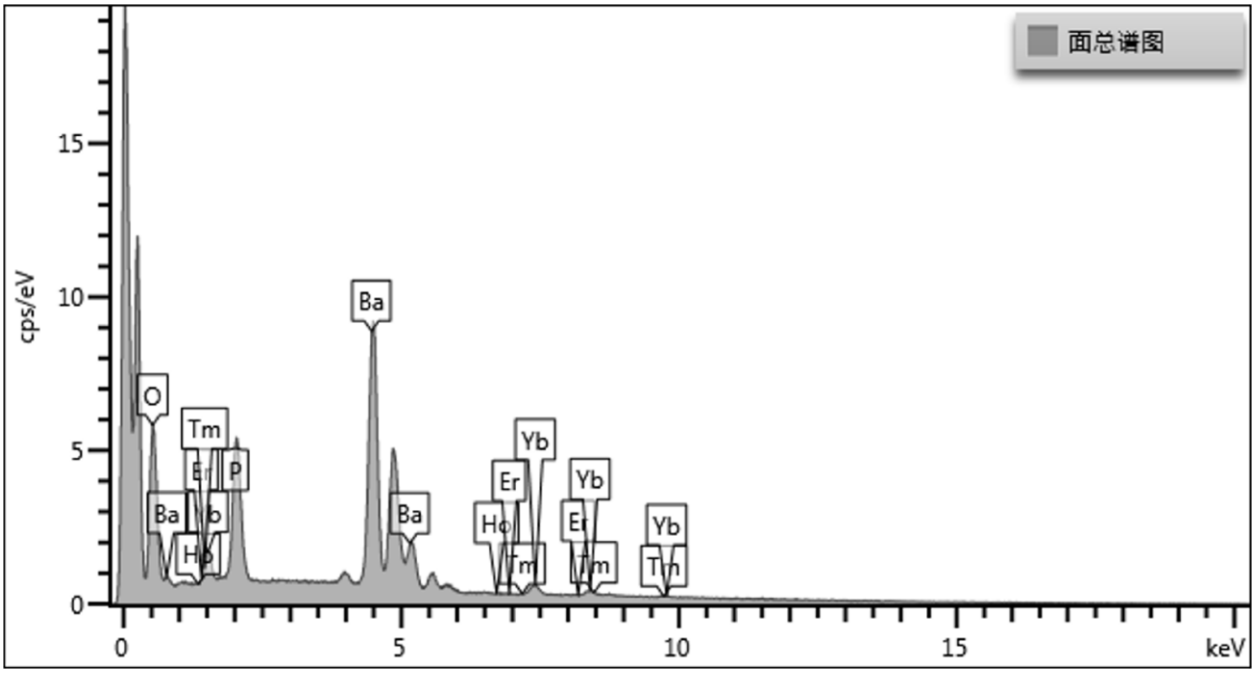

Fig. S2. EDS spectrum of $Ba_3Yb(PO_4)_3$: 0.15% Tm^{3+}, 4% Er^{3+}, 0.5% Ho^{3+} single phase powders.

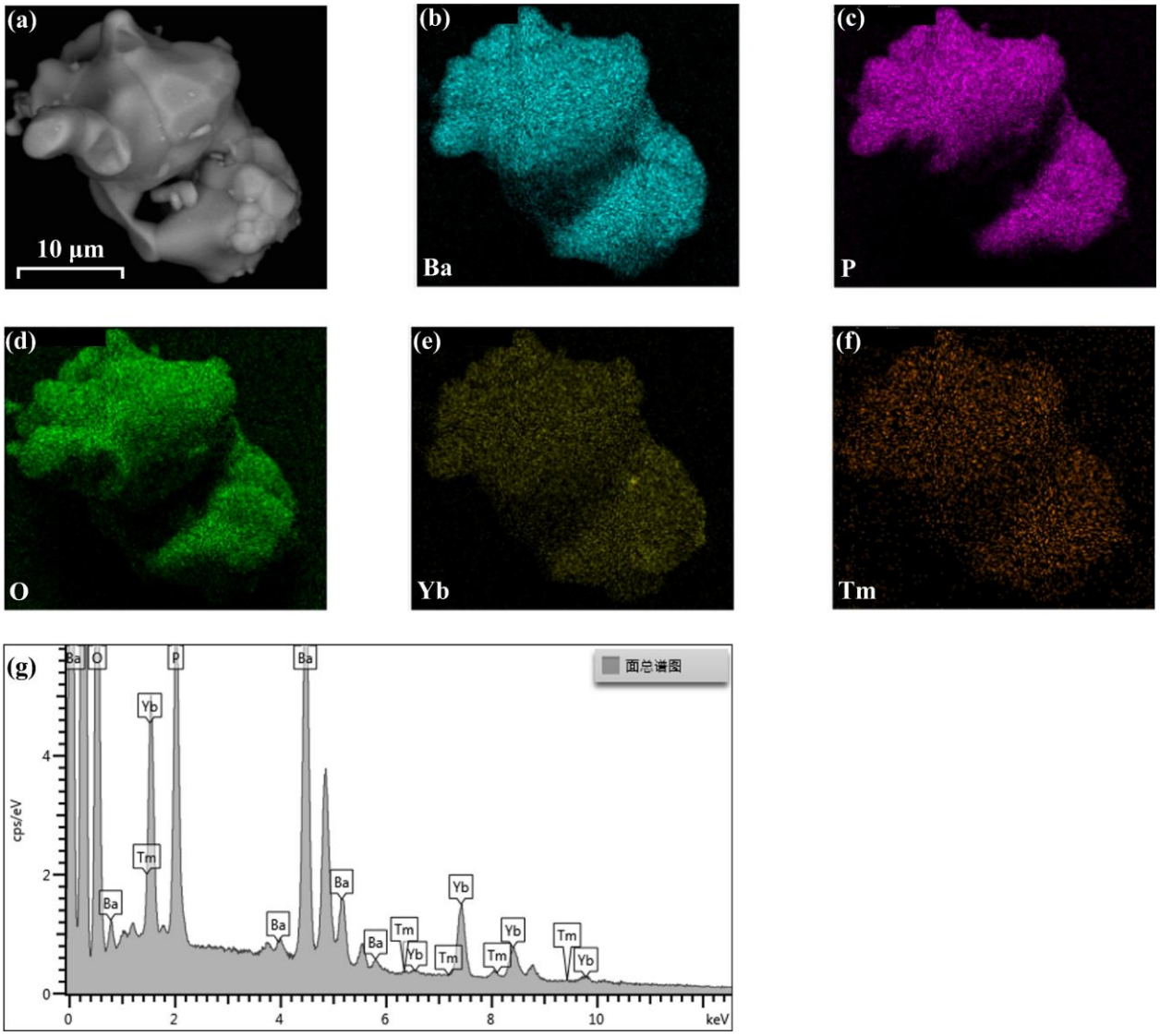

Fig. S3. (a) SEM image, **(b-f)** elemental mapping images and **(g)** EDS spectrum of $Ba_3Yb(PO_4)_3$: 0.8% Tm^{3+} single phase powders.

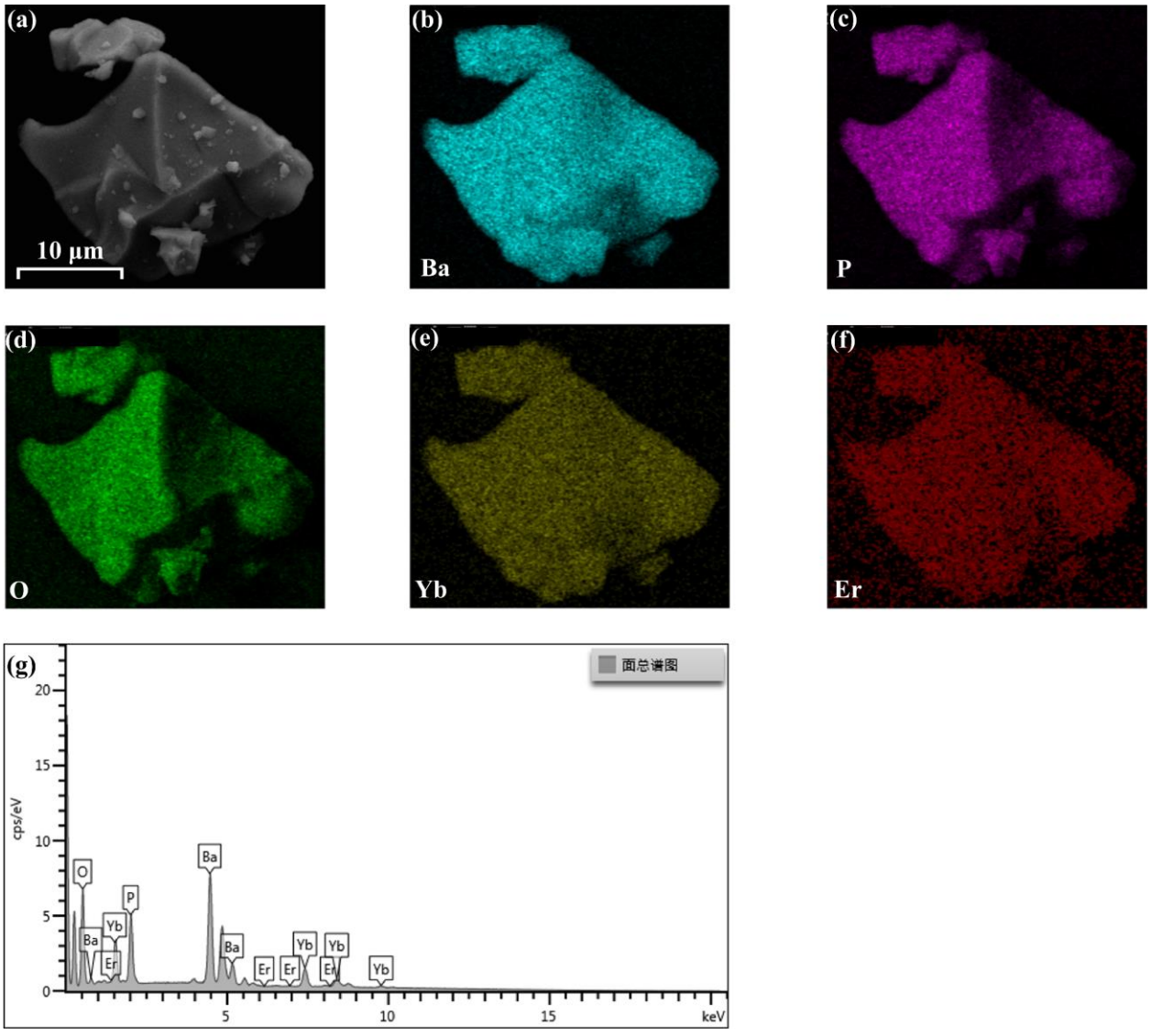

Fig. S4. (a) SEM image, **(b-g)** elemental mapping images and **(h)** EDS spectrum of $Ba_3Yb(PO_4)_3$: 4% Er^{3+} single phase powders.

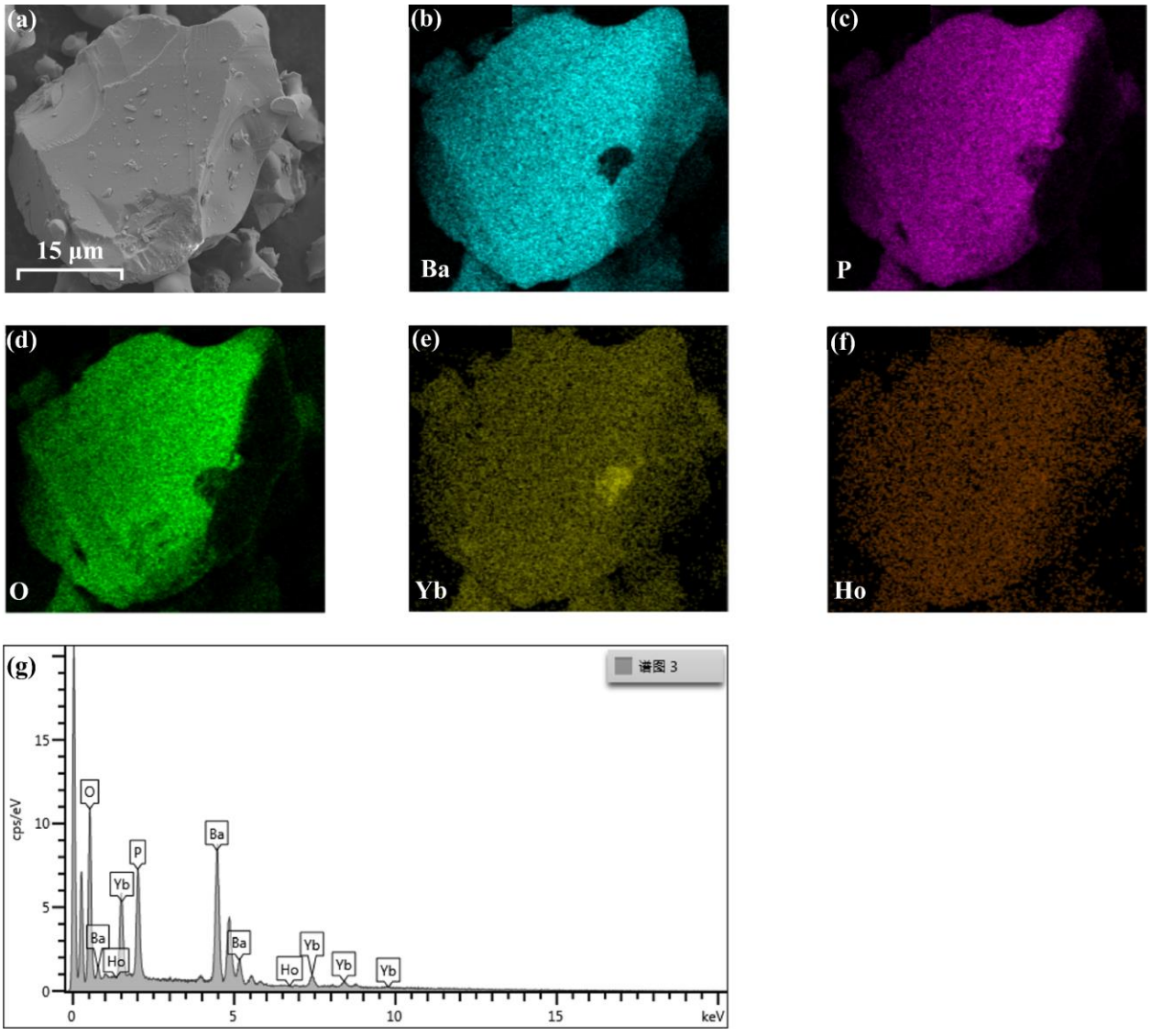

Fig. S5. (a) SEM image, **(b-g)** elemental mapping images and **(h)** EDS spectrum of $Ba_3Yb(PO_4)_3$: 1% Ho^{3+} single phase powders.

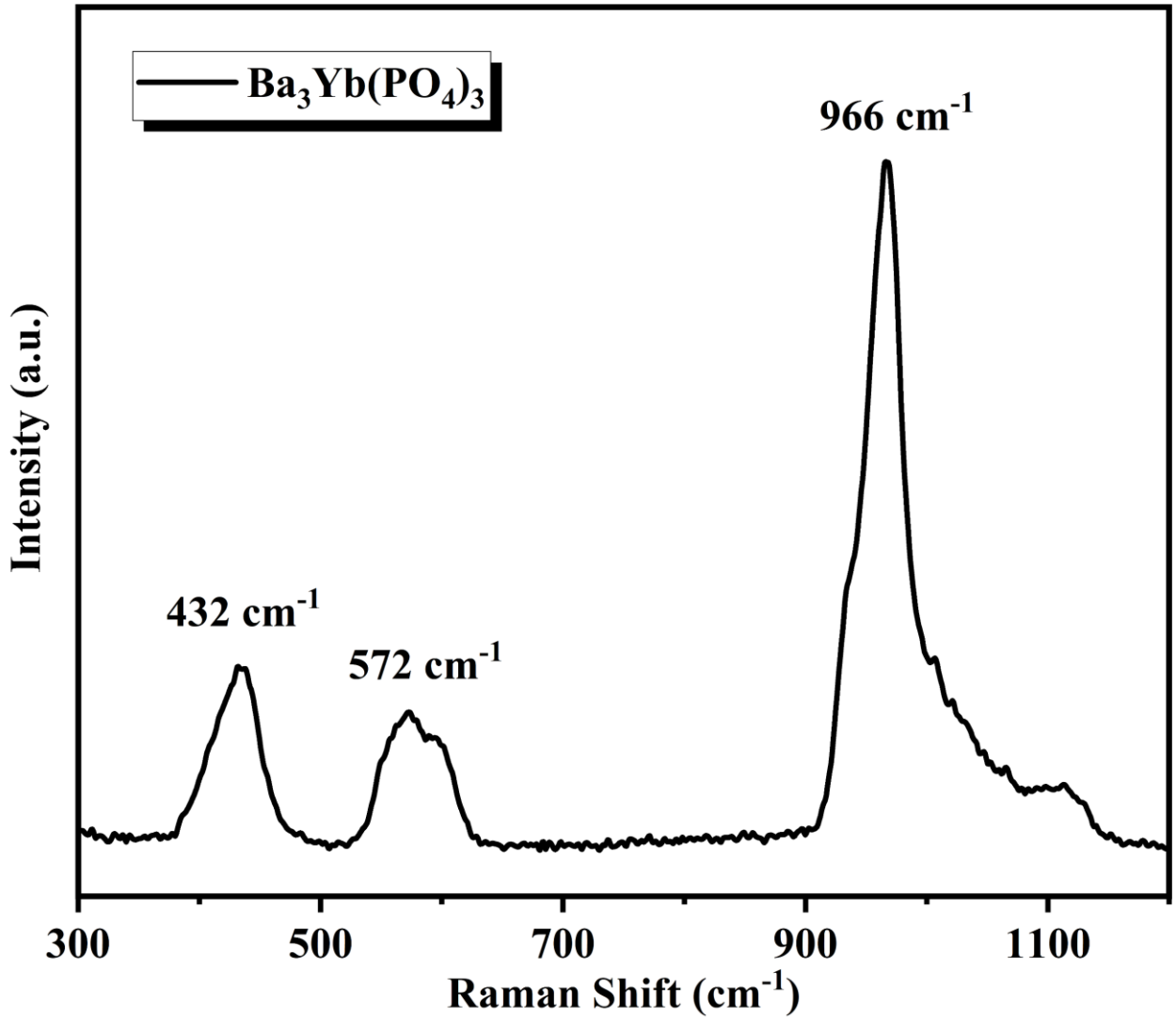

Fig. S6. Raman spectrum of the $Ba_3Yb(PO_4)_3$ host.

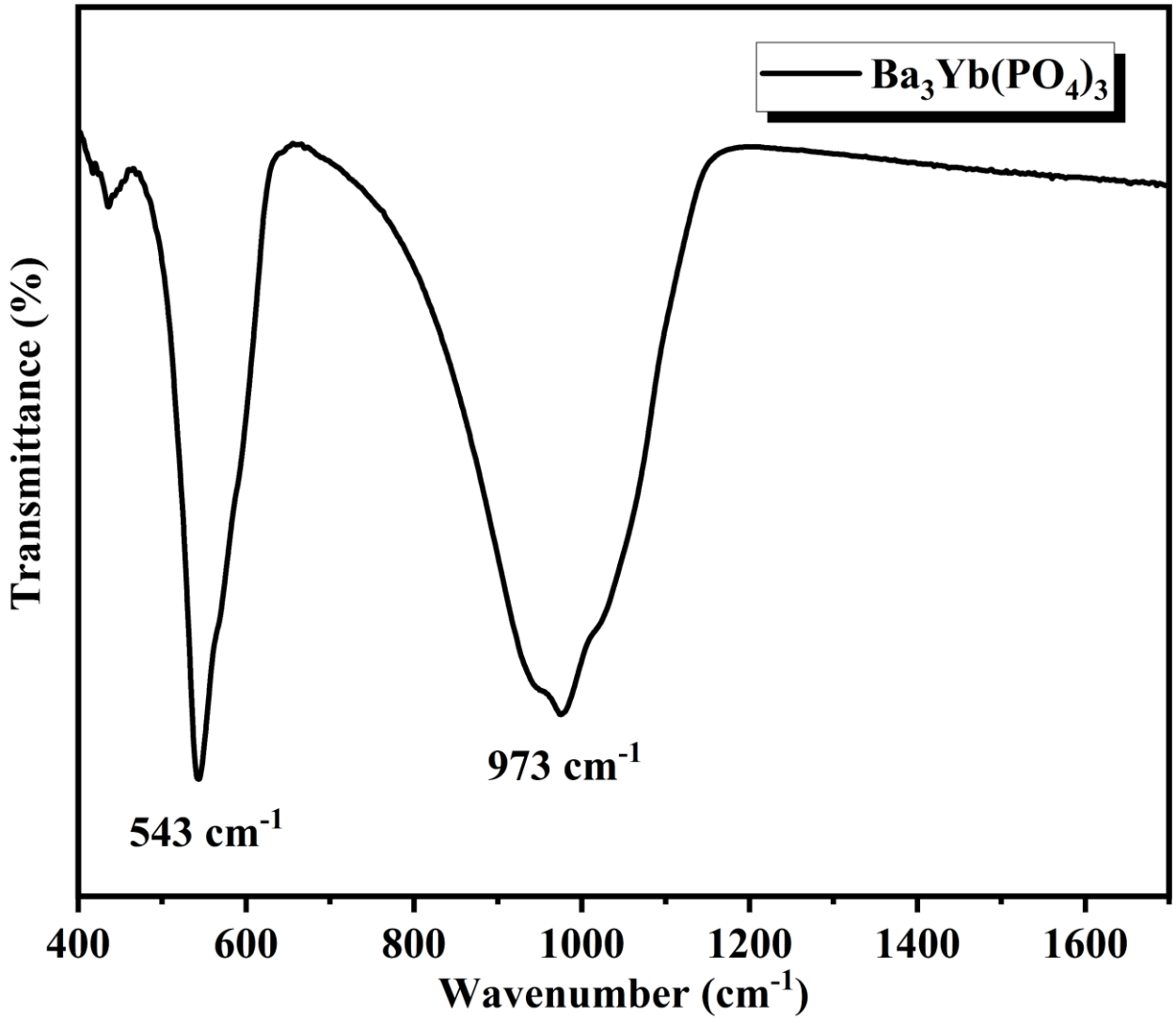

Fig. S7. FT-IR spectrum of the $Ba_3Yb(PO_4)_3$ host.

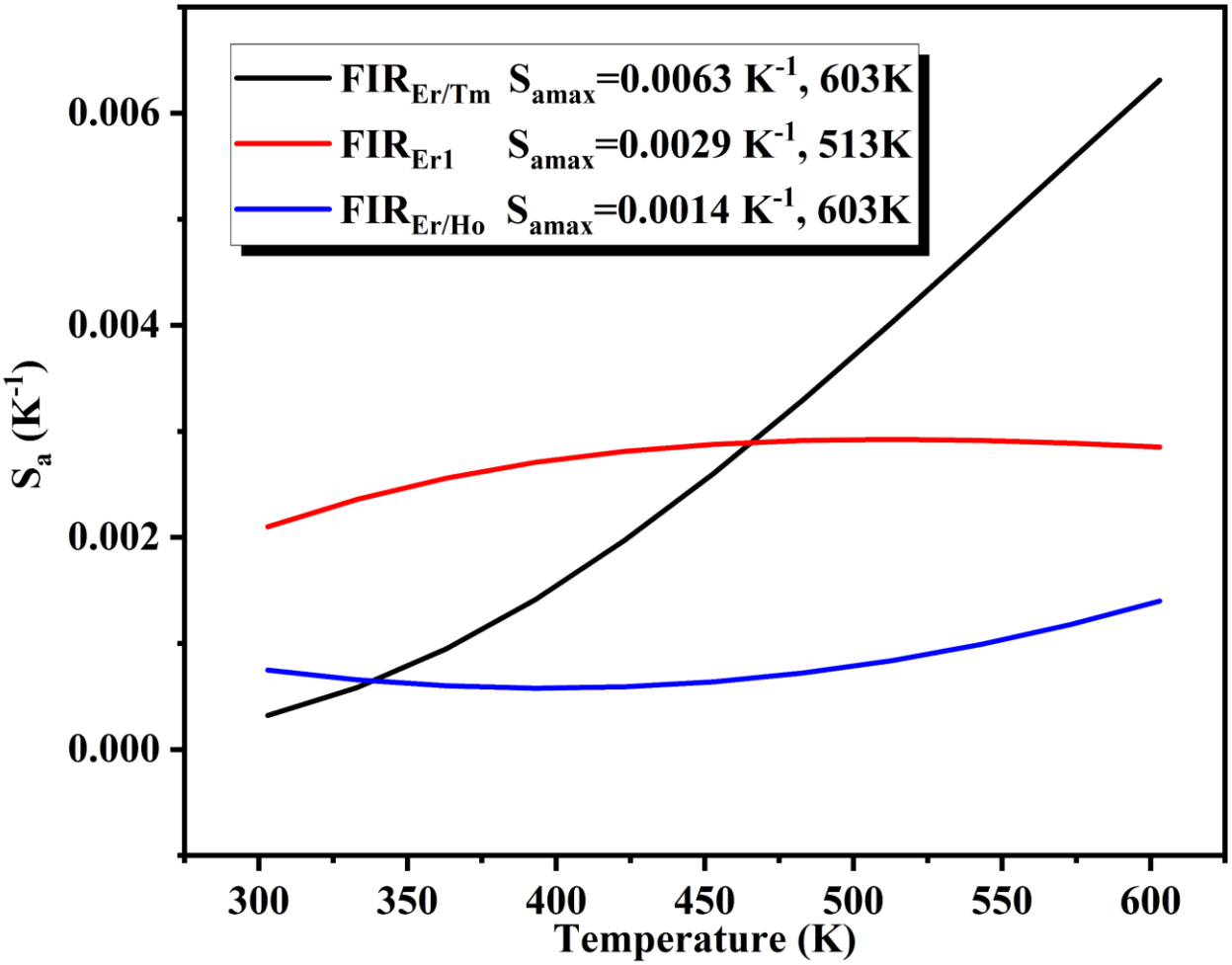

Fig. S8. S_a values of $Ba_3Yb(PO_4)_3$: 0.15% Tm^{3+}, 4% Er^{3+}, 0.5% Ho^{3+} phosphor.

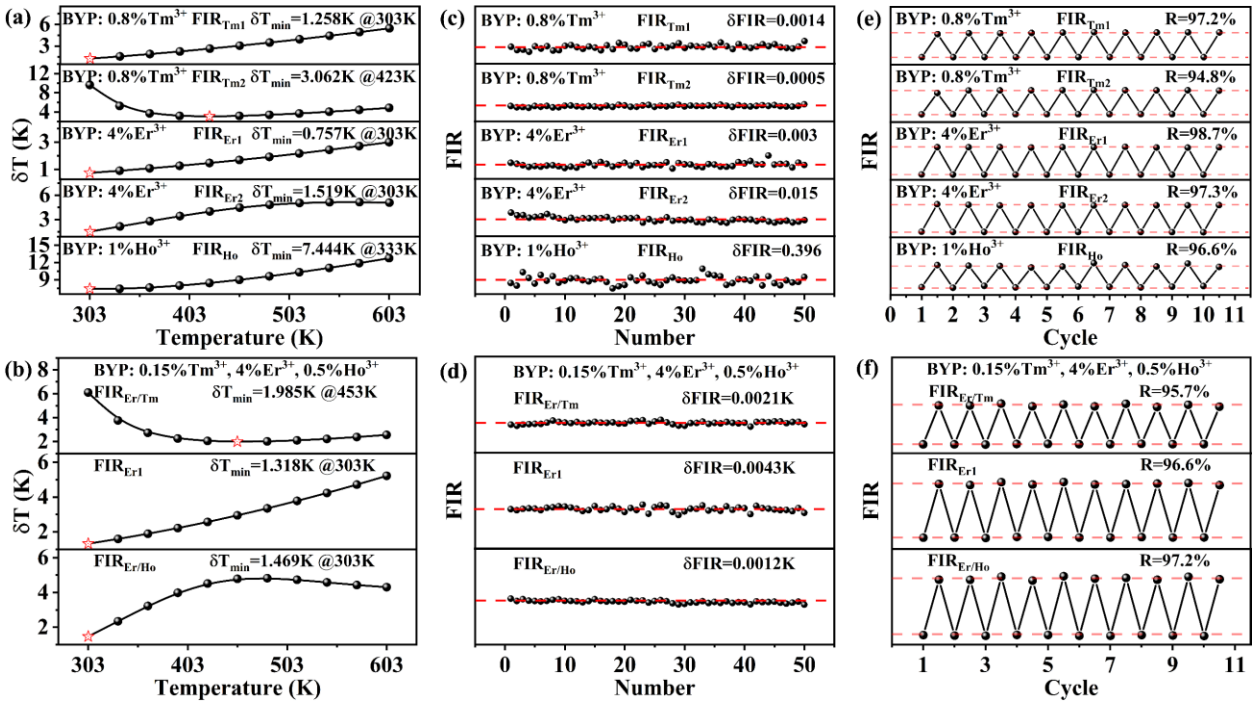

Fig. S9 (a and b) The calculation results of δT, **(c and d)** recorded FIR 50 times consecutively at 303 K, and **(e and f)** repeatability cycles between 303 to 603 K of BYP: 0.8% Tm^{3+}, BYP: 4% Er^{3+}, BYP: 1% Ho^{3+} and BYP: 0.15% Tm^{3+}, 4% Er^{3+}, 0.5% Ho^{3+}.

Table S1. Refined crystallographic parameters of $Ba_3Yb(PO_4)_3$ host.

Ions	Wyckoff sites	x	y	z	Occupancy
Ba1	16c	0.06566	0.06566	0.06566	0.21718
Yb1	16c	0.04731	0.04731	0.04731	0.02581
P1	12a	0.37500	0	0.25000	0.21022
O1	48e	0.28993	0.95317	0.36018	0.76011
O2	48e	0.27901	0.02863	0.41505	0.23249