

Efficient $\text{Sr}_2\text{Ta}_2\text{O}_7\text{:Bi}^{3+},\text{Ln}^{3+}$ ($\text{Ln}^{3+} = \text{Eu}^{3+},\text{Sm}^{3+}$) phosphors for optical thermometry and anti-counterfeiting

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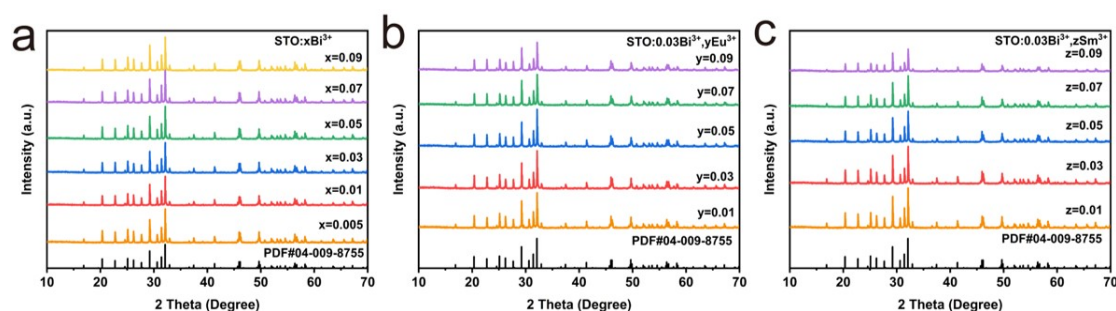


Fig. S1. XRD patterns of STO:xBi^{3+} (a), $\text{STO:0.03Bi}^{3+},\text{yEu}^{3+}$ (b) and $\text{STO:0.03Bi}^{3+},\text{zSm}^{3+}$ (c).

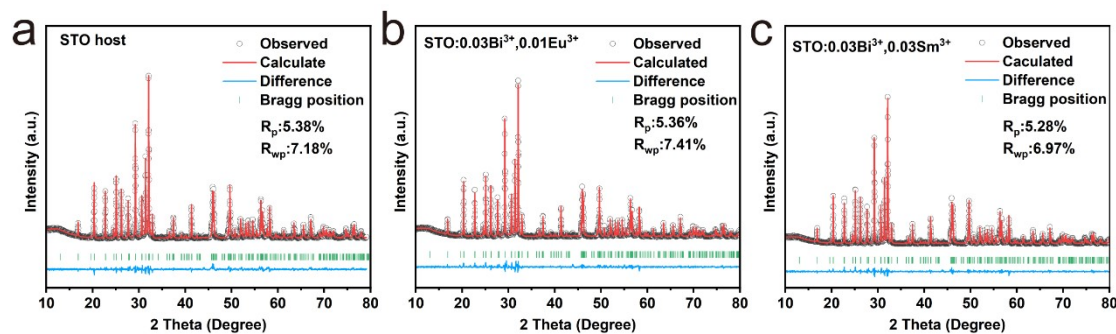


Fig. S2. Rietveld structure refinements of STO (a), $\text{STO:0.03Bi}^{3+},0.01\text{Eu}^{3+}$ (b) and $\text{STO:0.03Bi}^{3+},0.03\text{Sm}^{3+}$ (c).

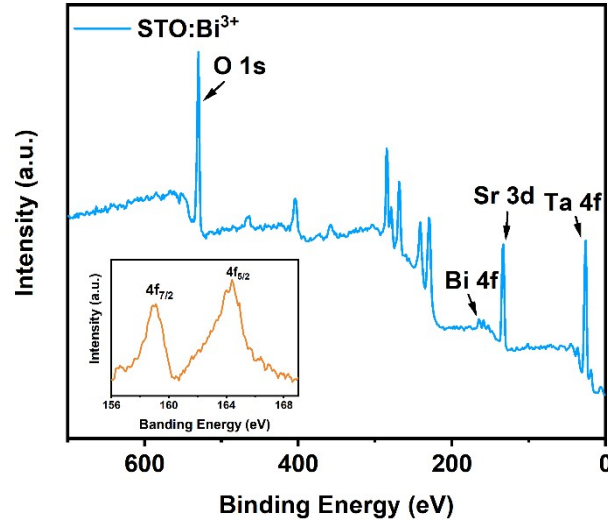


Fig. S3. XPS spectrum of STO:Bi^{3+} . The upper inset shows the XPS spectrum of Bi^{3+} element in STO:Bi^{3+} .

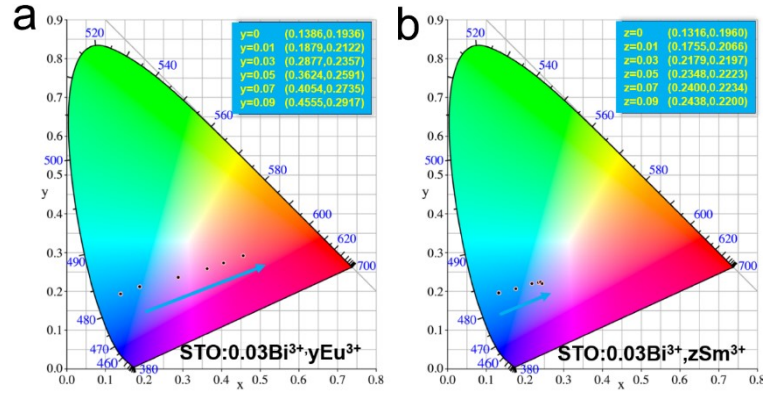


Fig. S4. CIE diagram of the $\text{STO:0.03Bi}^{3+},\text{yEu}^{3+}$ (a) and $\text{STO:0.03Bi}^{3+},\text{zSm}^{3+}$ (b).

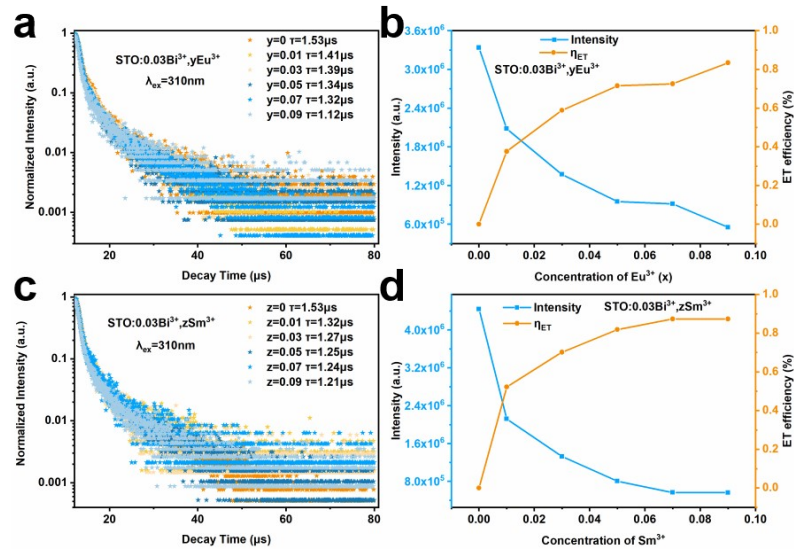


Fig. S5. Decay curves of $\text{STO:0.03Bi}^{3+},\text{yEu}^{3+}$ (a) and $\text{STO:0.03Bi}^{3+},\text{zSm}^{3+}$ (c). Fluorescence lifetime of the Bi^{3+} ions and the energy transfer efficiency from the Bi^{3+} to Eu^{3+} ions with Eu^{3+} -concentration (b) and from the Bi^{3+} to Sm^{3+} ions with Sm^{3+} -concentration (d).

Table S1. Refined Structure Parameters of compound STO

element	occupancy	x	y	z	uiso
Sr1	1	0.00000	0.28951	0.25000	0.000
Sr2	1	0.00000	0.44794	0.75000	0.000
Ta1	1	0.50000	0.33988	0.75000	0.000
Ta2	1	0.50000	0.44474	0.25000	0.000
O1	1	0.50000	0.28602	0.050819	0.000
O2	1	0.00000	0.35148	0.75000	0.020
O3	1	0.50000	0.40196	0.50071	0.000
O4	1	0.00000	0.45878	0.25000	0.000
O5	1	0.50000	0.50000	0.50000	0.000

¹Symmetry, Orthorhombic; space group, Cmc₂m; a = 3.94956 Å, b = 27.20550 Å, c = 5.69369 Å, V = 611.739096 Å³; R_{wp} = 7.18%, R_p = 5.38%, χ^2 = 2.72.

Table S2. Refined Structure Parameters of compound STO:Bi³⁺.

element	occupancy	x	y	z	uiso
Sr1	1	0.00000	0.28912	0.25000	0.003
Sr2	0.97	0.00000	0.44749	0.75000	0.003
Bi1	0.03	0.00000	0.44749	0.75000	0.003
Ta1	1	0.50000	0.34005	0.75000	0.000
Ta2	1	0.50000	0.44445	0.25000	0.000
O1	1	0.50000	0.28977	0.49991	0.000
O2	1	0.00000	0.34989	0.75000	0.017
O3	1	0.50000	0.40240	0.49676	0.000
O4	1	0.00000	0.45647	0.25000	0.003
O5	1	0.50000	0.50000	0.50000	0.000

¹Symmetry, Orthorhombic; space group, Cmc₂m; a = 3.94877 Å, b = 27.18790 Å, c = 5.69191 Å, V = 611.076419 Å³; R_{wp} = 7.41%, R_p = 5.82%, χ^2 = 3.23.

Table S3. Refined Structure Parameters of compound STO:Bi³⁺,Eu³⁺.

element	occupancy	x	y	z	uiso
Sr1	1	0.00000	0.28879	0.25000	0.000
Sr2	0.96	0.00000	0.44699	0.75000	0.000
Bi1	0.03	0.00000	0.44749	0.75000	0.000
Eu1	0.01	0.00000	0.44749	0.75000	0.000
Ta1	1	0.50000	0.34003	0.75000	0.000
Ta2	1	0.50000	0.44450	0.25000	0.000
O1	1	0.50000	0.29086	0.51421	0.000
O2	1	0.00000	0.35509	0.75000	0.023
O3	1	0.50000	0.40378	0.49660	0.000
O4	1	0.00000	0.45629	0.25000	0.000
O5	1	0.50000	0.50000	0.50000	0.000

¹Symmetry, Orthorhombic; space group, Cmcm; a = 3.94919 Å, b = 27.19420 Å, c = 5.69206 Å, V = 611.299136 Å³; R_{wp} = 7.41%, R_p = 5.36%, χ^2 = 2.97.

Table S4. Refined Structure Parameters of compound STO:Bi³⁺,Sm³⁺.

element	occupancy	x	y	z	uiso
Sr1	1	0.00000	0.28854	0.25000	0.000
Sr2	0.94	0.00000	0.44795	0.75000	0.000
Bi1	0.03	0.00000	0.44749	0.75000	0.000
Sm1	0.03	0.00000	0.44749	0.75000	0.000
Ta1	1	0.50000	0.33962	0.75000	0.000
Ta2	1	0.50000	0.44478	0.25000	0.000
O1	1	0.50000	0.28999	0.51412	0.000
O2	1	0.00000	0.35044	0.75000	0.034
O3	1	0.50000	0.40304	0.50121	0.000
O4	1	0.00000	0.45880	0.25000	0.000
O5	1	0.50000	0.50000	0.50000	0.000

¹Symmetry, Orthorhombic; space group, Cmcm; a = 3.94931 Å, b = 27.17540 Å, c = 5.68993 Å, V = 610.666498 Å³; R_{wp} = 6.97%, R_p = 5.28%, χ^2 = 2.76.