Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supporting Information

Tunable luminescence in Eu^{3+}/Sm^{3+} single-doped $LuNbO_4$ for optical thermometry and anti-counterfeiting

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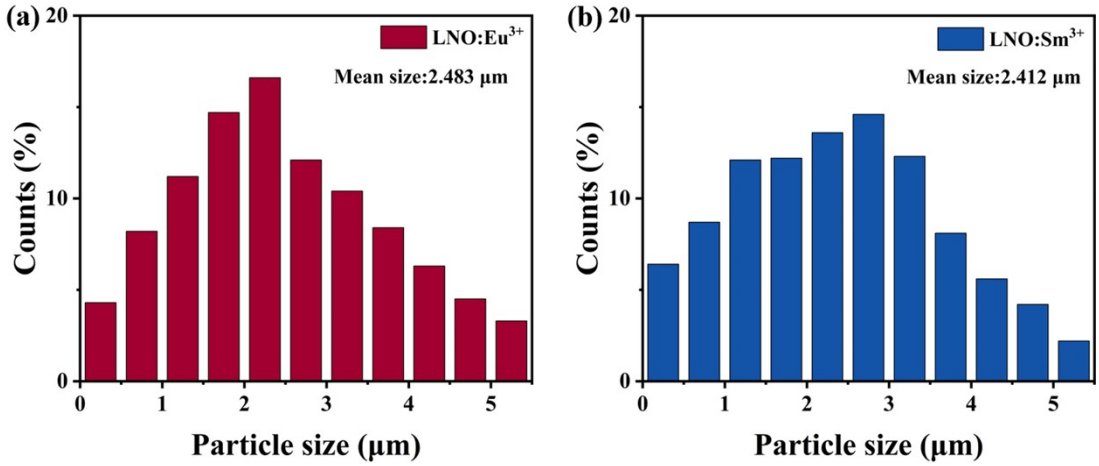

Fig. S1 The average size of (a) LNO:0.05Eu^{3+}, (b) LNO:0.05Sm^{3+} phosphors.

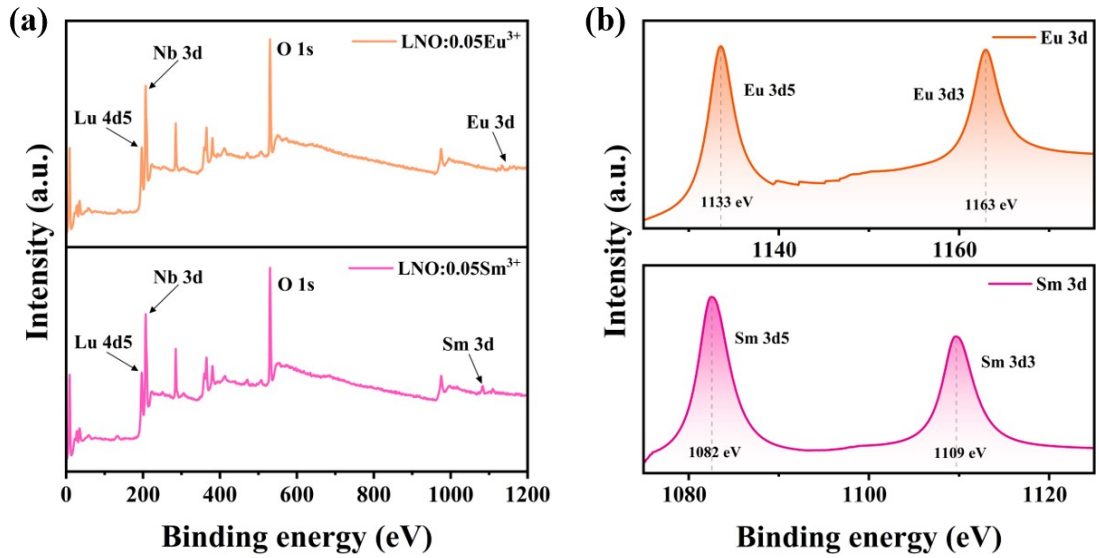

Fig. S2 (a) XPS of LNO:0.05 Eu^{3+}/Sm^{3+} phosphors. (b) Magnified XPS spectra of Eu 3d and Sm 3d electron for LNO:0.05 Eu^{3+}/Sm^{3+} phosphors.

Fig. S3 luminescence photographs of the LNO:xEu^{3+}/ySm^{3+} ($0 \le x \le 0.07$, $0 \le y \le 0.07$) upon the daylight or UV lamp (λ_{ex}=261 nm).

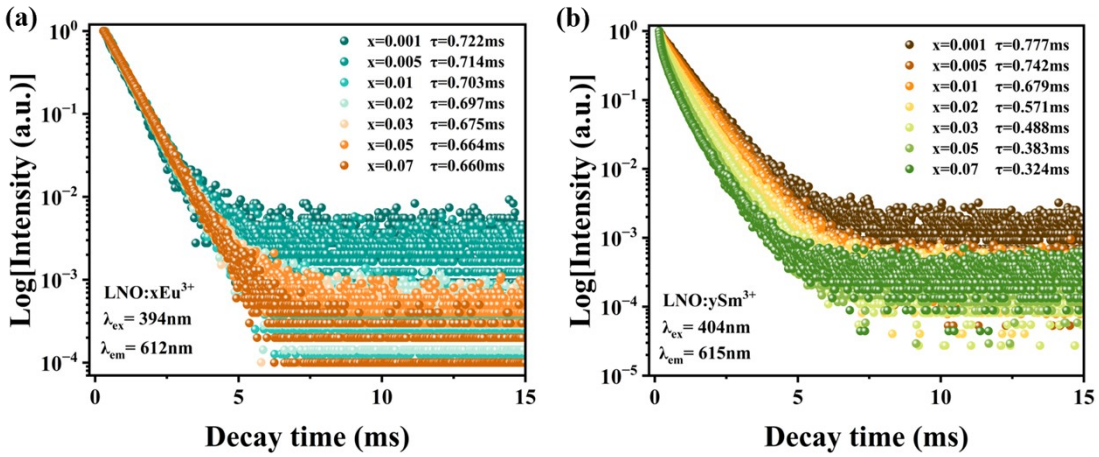

Fig. S4 The PL decay curves of the (a) LNO:0.05Eu^{3+} (λ_{ex}=394 nm, λ_{em}=612 nm), (b) LNO:0.05Sm^{3+} (λ_{ex}=404 nm, λ_{em}=615 nm) phosphors.

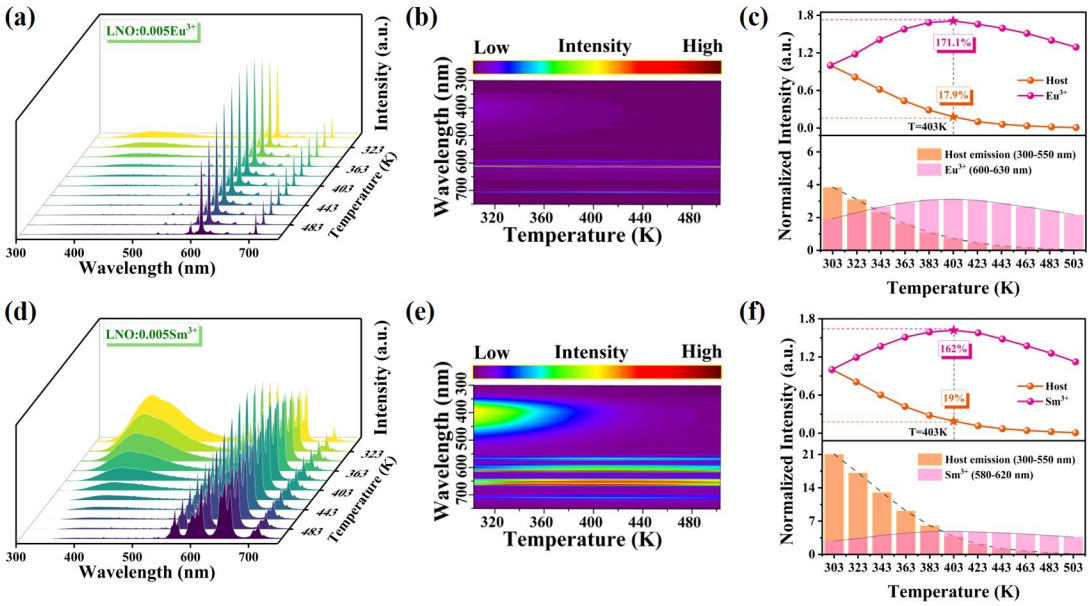

Fig. S5 The temperature-dependence PL spectra upon 261 nm excitation and corresponding contour map of thermal evolution PL spectra and host, Eu^{3+}/Sm^{3+} normalized emission at various temperatures images of (a-c) LNO:0.005Eu^{3+}, (d-f) LNO:0.005Sm^{3+}.

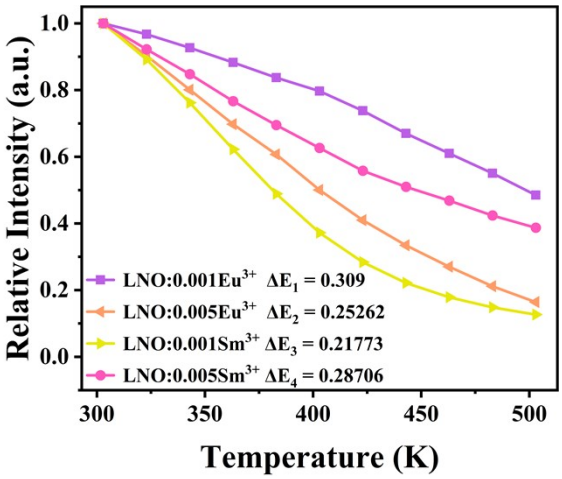

Fig. S6 The integrated PL intensities of the LNO:xEu^{3+} (x=0.001, 0.005) and LNO:ySm^{3+} (y=0.001, 0.005) and the corresponding activation energy.

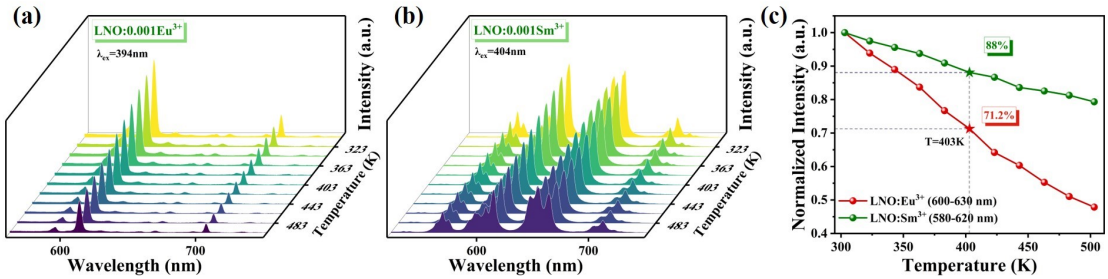

Fig. S7 (a-b) The temperature-dependence PL spectra of LNO:0.001Eu^{3+}/Sm^{3+} under the excitation of 394 and 404 nm, respectively. (c) Integrated emission intensity of Eu^{3+}/Sm^{3+} for LNO:0.001Eu^{3+}/Sm^{3+} phosphors.

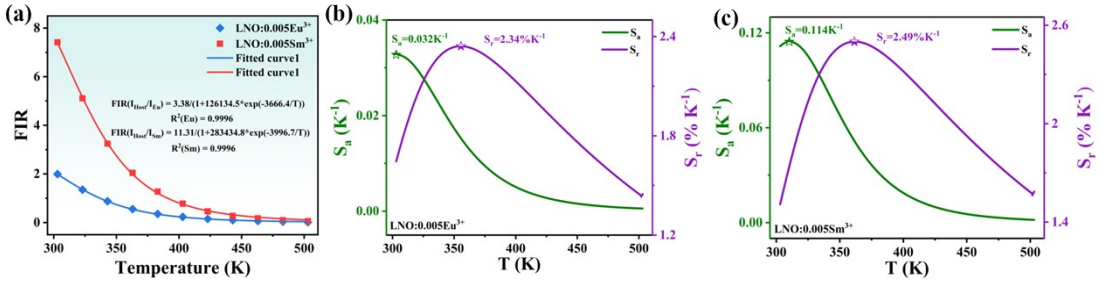

Fig. S8 (a) The fitting curve of temperature-dependent FIR (I_{host}/I_{Eu} and I_{host}/I_{Sm}). (b-c) The S_a, S_r values with different temperatures for LNO:0.005Eu^{3+}/Sm^{3+}, respectively.

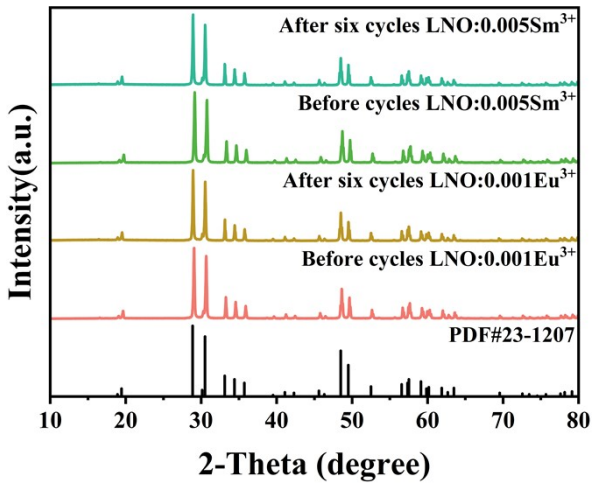

Fig. S9 XRD patterns of obtained LNO:0.001Eu^{3+} and LNO:0.005Sm^{3+} phosphors before and after six cycles.

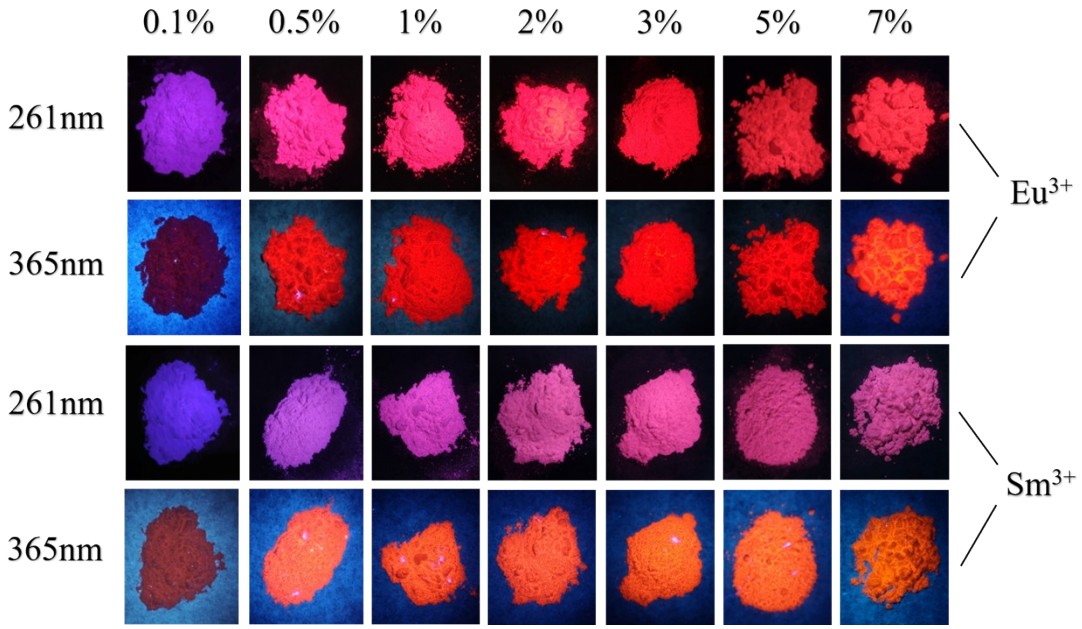

Fig. S10 Photographs of the LNO: xEu^{3+}/ySm^{3+} samples upon 261 and 365 nm light excitation with different Eu^{3+}/Sm^{3+} doping concentrations.

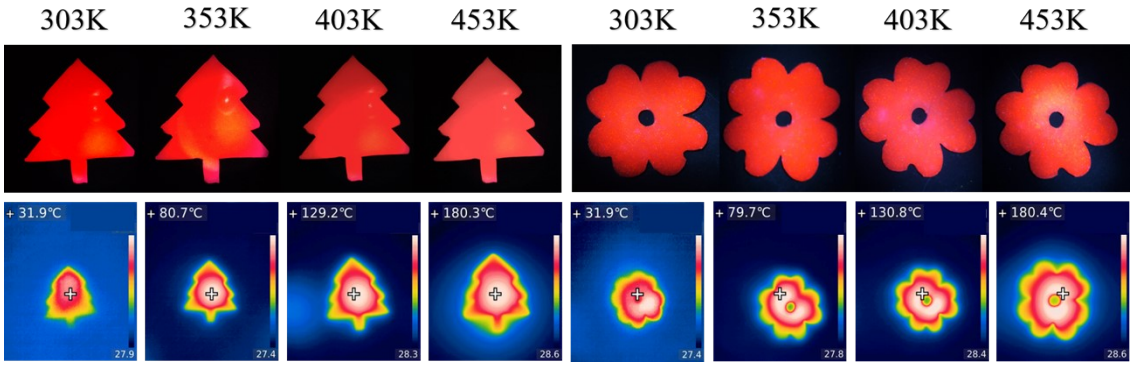

Fig. S11 The photographs of LNO:0.005Eu^{3+}/Sm^{3+}-PDMS films upon 365 nm excitations from 303 to 453K and the corresponding thermographs.

Table S1 Rietveld refinement data of the LNO:xEu^{3+} (0≤x≤0.07) samples

	LNO:xEu^{3+}							
	x=0	**x=0.001**	**x=0.005**	**x=0.01**	**x=0.02**	**x=0.03**	**x=0.05**	**x=0.07**
a, Å	5.2319	5.2329	5.2341	5.2351	5.238	5.2355	5.2412	5.2423
b, Å	10.831	10.834	10.8359	10.8376	10.8402	10.8467	10.8512	10.8533
c, Å	5.0441	5.0449	5.0461	5.047	5.0481	5.0492	5.0504	5.052
α	90	90	90	90	90	90	90	90
β	94.4184	94.4181	94.4147	94.412	94.41	94.398	94.391	94.387
γ	90	90	90	90	90	90	90	90
V, Å^3	284.984	285.1985	285.3354	285.4969	285.8226	286.1728	286.3305	286.5904
R_{wp}	8.31	8.29	7.919	8.498	7.801	7.89	7.86	7.834
R_p	6.353	6.365	6.158	6.54	6.048	5.861	6.04	5.82
x^2	1.327	1.852	1.734	1.871	1.667	1.634	1.67	1.709

Table S2 Rietveld refinement data of the LNO:ySm^{3+} (0≤x≤0.07) samples

	LNO:ySm^{3+}							
	y=0	**y=0.001**	**y=0.005**	**y=0.01**	**y=0.02**	**y=0.03**	**y=0.05**	**y=0.07**
a, Å	5.2319	5.23495	5.23517	5.2371	5.2399	5.2401	5.2421	5.2439
b, Å	10.831	10.8372	10.8378	10.8425	10.8478	10.849	10.8519	10.8581
c, Å	5.0441	5.04694	5.04695	5.04809	5.0475	5.0486	5.0499	5.053
α	90	90	90	90	90	90	90	90
β	94.4184	94.4178	94.4167	94.4158	94.41	94.4060	94.4050	90.4010
γ	90	90	90	90	90	90	90	90
V, Å^3	284.984	285.4737	285.501	285.7983	286.0594	286.2905	286.5213	286.8672
R_{wp}	8.31	7.384	6.52	6.186	7.014	6.122	7.472	7.749
R_p	6.353	5.775	5.007	4.788	5.469	4.708	5.390	5.527
x^2	1.327	1.476	1.311	1.267	1.47	1.33	1.479	1.669

Table S3 The EDS elemental analysis of LNO:0.05Eu^{3+} sample

Sample	Element	Weight(%)	Atomic(%)	Error(%)
LNO:0.05Eu^{3+}	Lu	19.72	3.13	5.56
	Nb	27.79	8.29	5.47
	O	50.94	88.3	9.62
	Eu	1.54	0.28	14.54

Table S4 The EDS elemental analysis of LNO:0.05Sm^{3+} sample

Sample	Element	Weight(%)	Atomic(%)	Error(%)
LNO:0.05Sm^{3+}	Lu	31.96	5.86	3.84
	Nb	24.69	8.53	5.96
	O	42.59	85.45	9.69
	Sm	0.76	0.16	23.6

Table S5 Temperature sensing properties based on FIR technology of different phosphors

Phorphors	λ_{ex} (nm)	Temperature range (K)	S_a (K^{-1})	S_r (%K^{-1})	Ref.

$CaNb_2O_6$: Pr^{3+}	270	303-523	0.0049	2.25	[1]
$Y_{0.985}Nb_{0.8}Ta_{0.2}O_4$:$Bi^{3+}$,$Eu^{3+}$	305	303-523	0.086	1.8	[2]
$NaLuO_4$:Eu^{3+}@g-C_3N_4	394	303-503	0.0057	0.455	[3]
$LuNbO_4$:Pr^{3+}, Tb^{3+}	305	283-493	0.024	1.26	[4]
Ba_2LaNbO_6:Mn^{4+}, Eu^{3+}	396	303-523	0.069	2.08	[5]
$Ca_3LiMgV_3O_{12}$:Sm^{3+}	332	303-513	9.11	1.99	[6]
Ca_2MgWO_6:Er^{3+},Yb^{3+}	980	303-573	0.82	0.92	[7]
$LuNbO_4$:0.001Eu^{3+}	261	303-503	0.18	2.45	This work
$LuNbO_4$:0.005Sm^{3+}	261	303-503	0.114	2.49	This work

Reference

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