Supporting Information

Self-reduction induced $BaMgP_2O_7:Eu^{2+/3+}$: A multi-stimuli responsive phosphor for X-ray detection, anti-counterfeiting and optical thermometry

Song Li[a], Zhongxian Qiu[a,], Yahuan Mo[a], Hongwu Zhang[b,*], Hongzhou Lian[c,*], Jilin Zhang[a], Shixun Lian[a]*

[a]Key Laboratory of Light Energy Conversion Materials of Hunan Province College, Key Laboratory of Chemical Biology & Traditional Chinese Medicine Research (Ministry of Education), College of Chemistry and Chemical Engineering, Hunan Normal University, Changsha 410081, China; zxqiu@hunnu.edu.cn

[b]Key Lab of Urban Pollutant Conversion, Institute of Urban Environment, Chinese Academy of Sciences, Xiamen, 361021, China; hwzhang@iue.ac.cn

[c]State Key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun 130022, China; hzlian@ciac.ac.cn

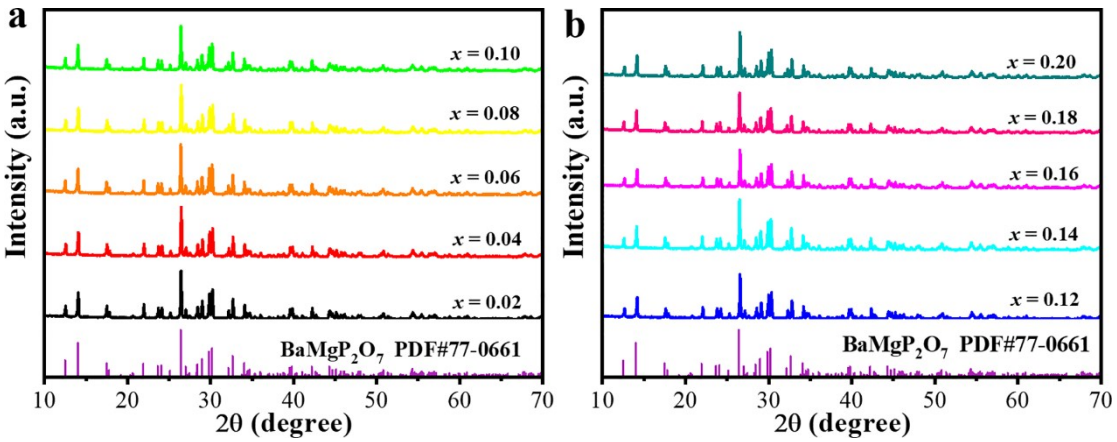

Figure S1. The XRD patterns of BMPO:*x*Eu (x = 0.02–0.20)

Table S1. Unit cell parameters of BMPO:*x*Eu

	a	b	c	α	β	γ
BMPO	5.4830	8.5610	12.6260	90.00	91.32	90.00
BMPO:0.02Eu	5.4733	8.4878	12.5672	90.00	91.29	90.00
BMPO:0.04Eu	5.4627	8.5037	12.5597	90.00	91.12	90.00
BMPO:0.06Eu	5.4635	8.5027	12.5831	90.00	90.99	90.00
BMPO:0.08Eu	5.4618	8.5039	12.5775	90.00	90.73	90.00
BMPO:0.10Eu	5.4134	8.5038	12.5560	90.00	90.17	90.00
BMPO:0.12Eu	5.4188	8.5318	12.6057	90.00	90.12	90.00
BMPO:0.14Eu	5.4224	8.5310	12.6004	90.00	90.03	90.00
BMPO:0.16Eu	5.4227	8.4385	12.5290	90.00	90.33	90.00
BMPO:0.18Eu	5.6052	8.5005	12.6237	90.00	90.06	90.00
BMPO:0.20Eu	5.5866	8.5016	12.6101	90.00	90.01	90.00

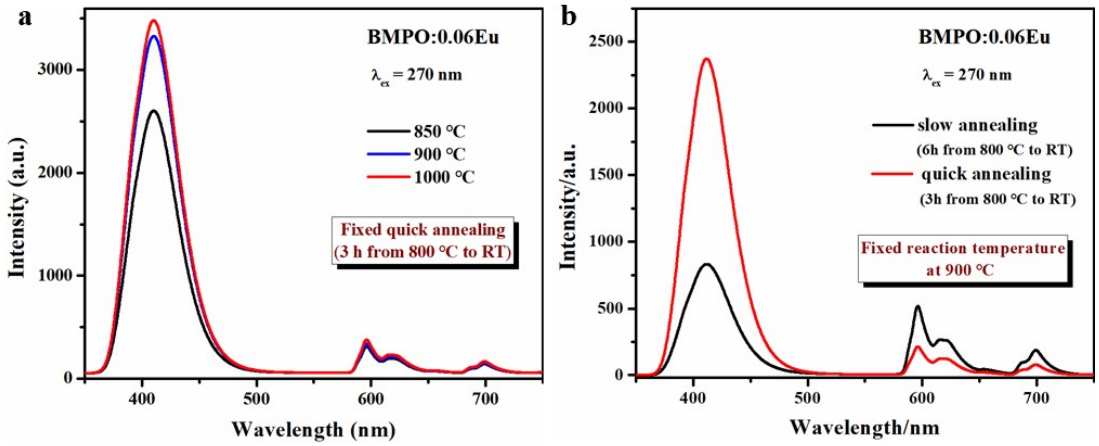

Figure S2. Comparison of the PL spectra of BMPO:0.06Eu synthesized at different temperatures (a) and with different annealing treatments (b).

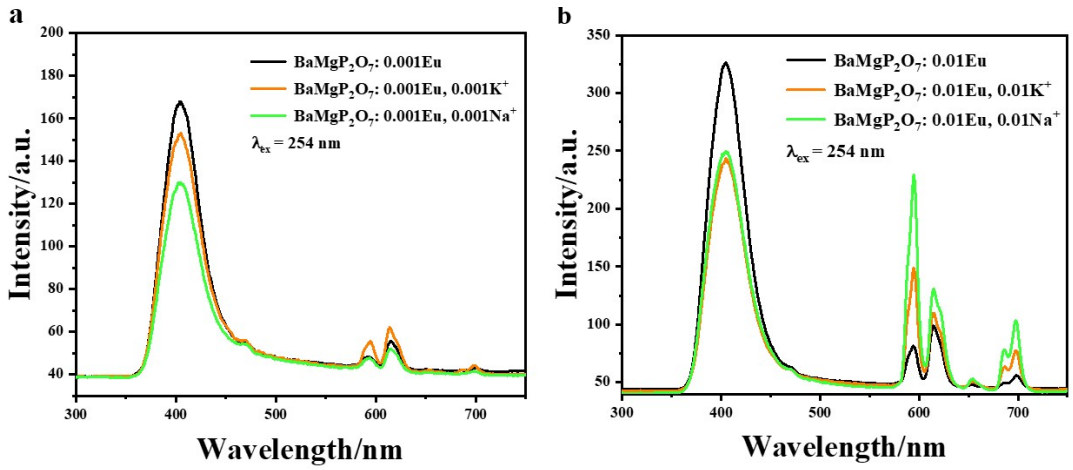

Figure S3. Comparison of PL spectra of $Ba_{1-2x}MgP_2O_7$:xEu,xK$^+$/Na$^+$ (x = 0.001, 0.01) with or without Na$^+$/K$^+$ addition.

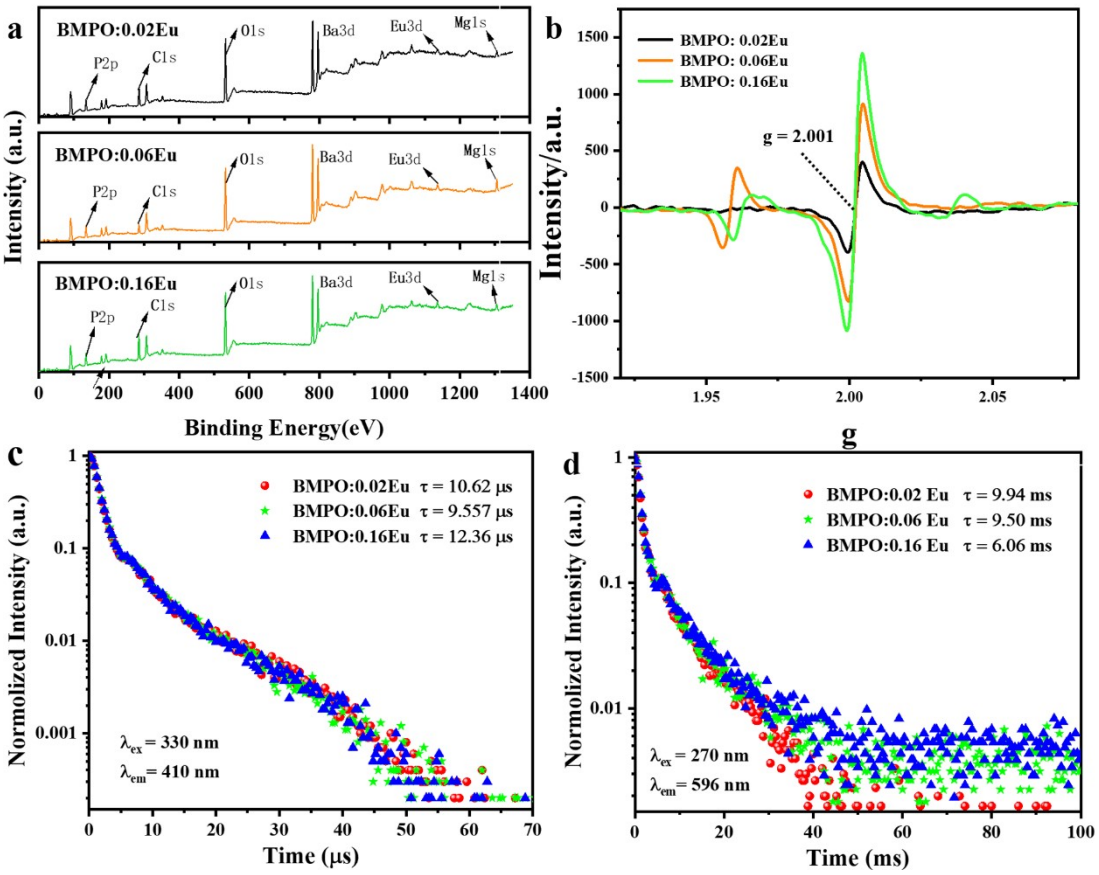

Figure S4. BMPO:xEu (x = 0.02, 0.06, 0.16): Full XPS spectra (a); EPR spectra (b); Luminescence decay curves of monitored at 410 nm (c) and 596 nm (d), respectively.

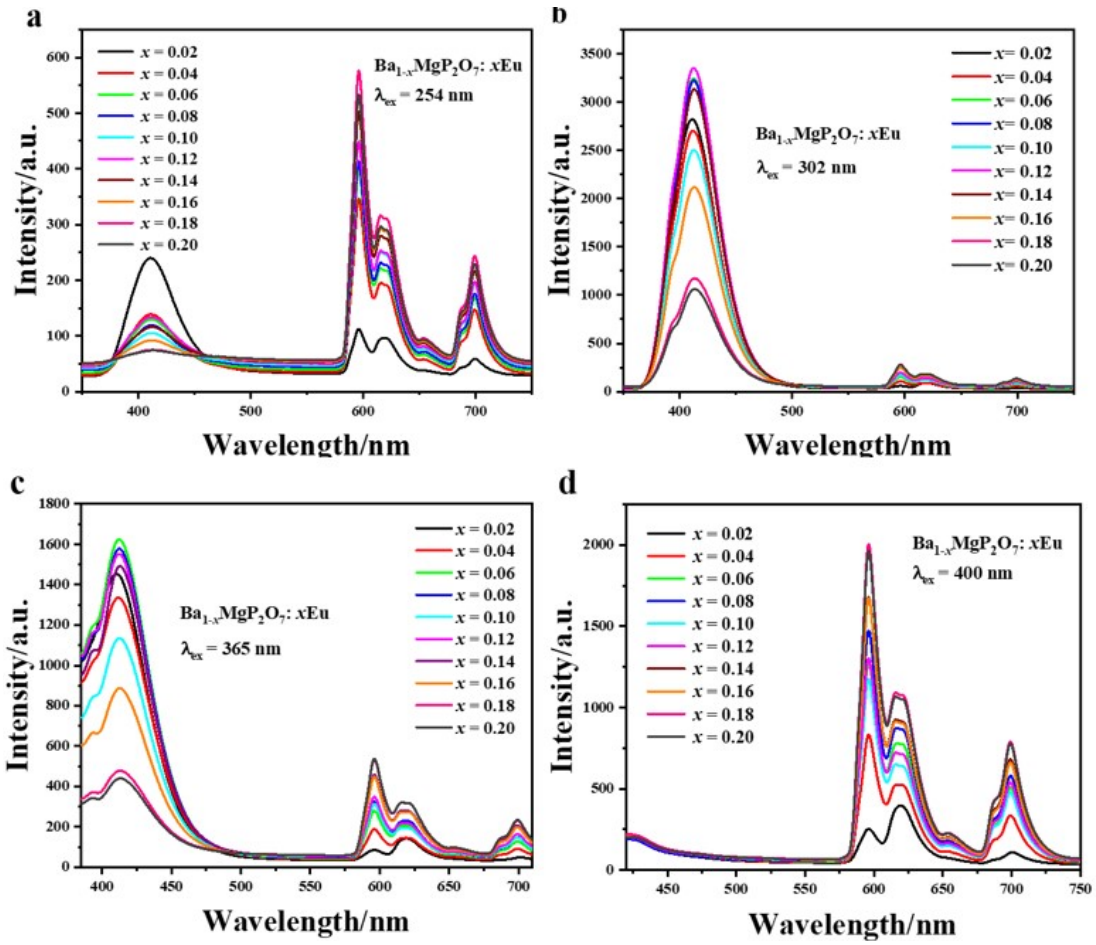

Figure S5. PL spectra of BMPO:*x*Eu (*x* = 0.02–0.20) under excitation of 254 (a), 302 (b), 330 (c), and 400 (d) nm, respectively.

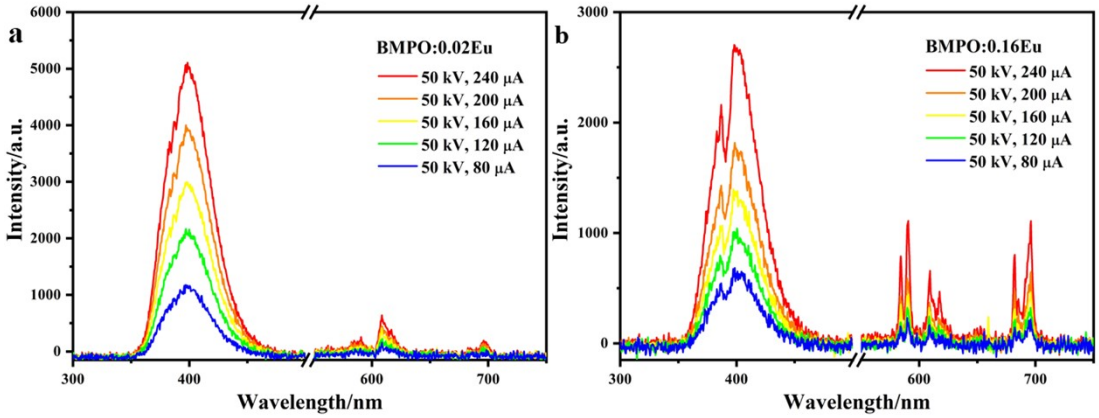

Figure S6. X-ray stimulated spectra of BMPO:0.02Eu (a) and BMPO:0.16Eu(b).

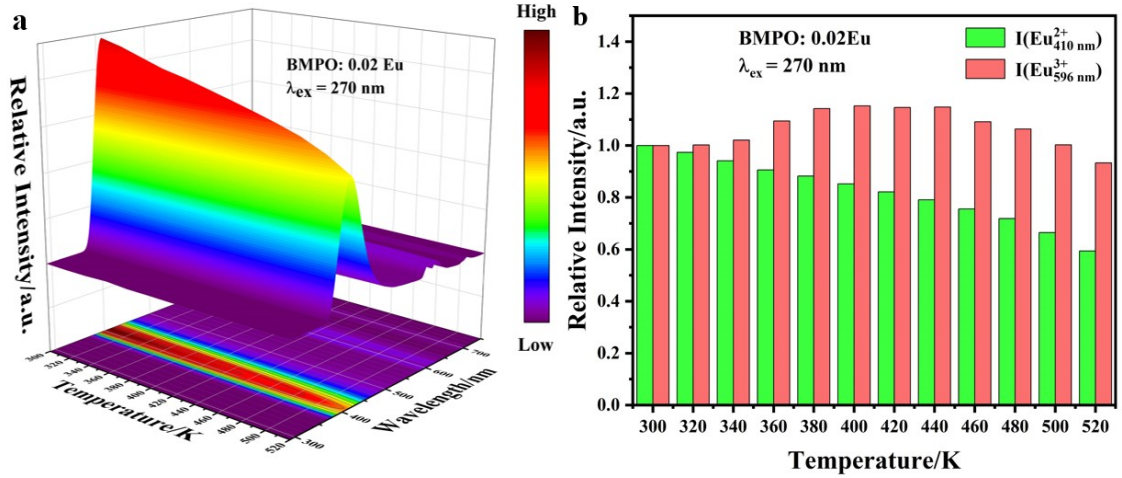

Figure S7. Temperature-dependent (300-520 K) PL spectra of dual-emitting BMPO:0.02$Eu^{2+/3+}$; (b) The emission intensities of Eu^{2+} at 410 nm and Eu^{3+} at 596 nm versus recording temperature, respectively.

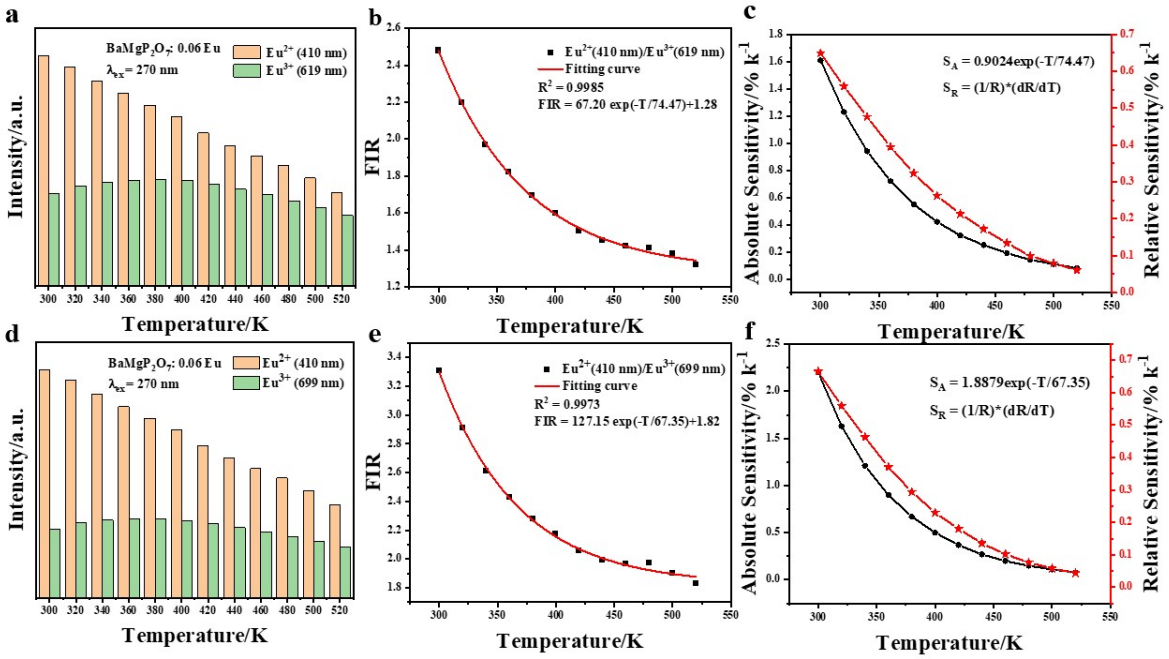

Figure S8. Temperature dependent FIR(Eu^{2+}/Eu^{3+})-related information in BMPO:0.06Eu referring Eu^{3+} at 619 nm (a-c) and at 699 nm (d-f).

Table S2. Optical thermometric properties of several Eu-based materials

Materials	Temperature	S_a (K^{-1})	S_r (%K^{-1})	Ref.
$Ca_2Al_2SiO_7:Eu^{2+}/Eu^{3+}$	303-443 K	0.024	2.46	18
$Ca_9Mg_{1.5}(PO_4)_7:Eu^{2+}/Eu^{3+}$	293-473 K	0.064	1.192	16
$SrAl_2Si_2O_8:Eu^{2+}/Eu^{3+}$	303-583 K	0.056	0.3	13
$Ca_2Na_2La_6(SiO_4)_4(PO_4)_2O:Eu^{2+}/Eu^{3+}$	298-473	-	2.82	15
$LaAlO_3:Eu^{2+}/Eu^{3+}$	293-473	0.014	1.193	17
BMPO:Eu^{2+}/Eu^{3+}	300-520	0.0094	0.66	This Work