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

Supporting Information

Design of efficient color-tunable long persistent luminescence phosphor $BaGa_2O_4:Pr^{3+}$ and its performance enhancement via trap-induced strategy

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Table S1 Test conditions of PSL decay curves and thermoluminescence (TL) glow curves

Conditions	PSL decay curves	Thermoluminescence (TL) glow curves
Pre-treatment	Keep at 400℃ for 3min in dark room.	Keep at 400℃ for 3min in dark room.
Mass of samples	Filling the sample tank(~2g)	0.005g
Testing temperature	Room temperature (20℃)	From room temperature to 400℃ via programed heating (1℃/s).
Irradiation wavelength	254nm	254nm
Power of UV light	24W	24W
Irradiation distance	5cm above the samples.	5cm above the samples.
Pre-irradiation times	180s	180s
Delay times	5s	5s

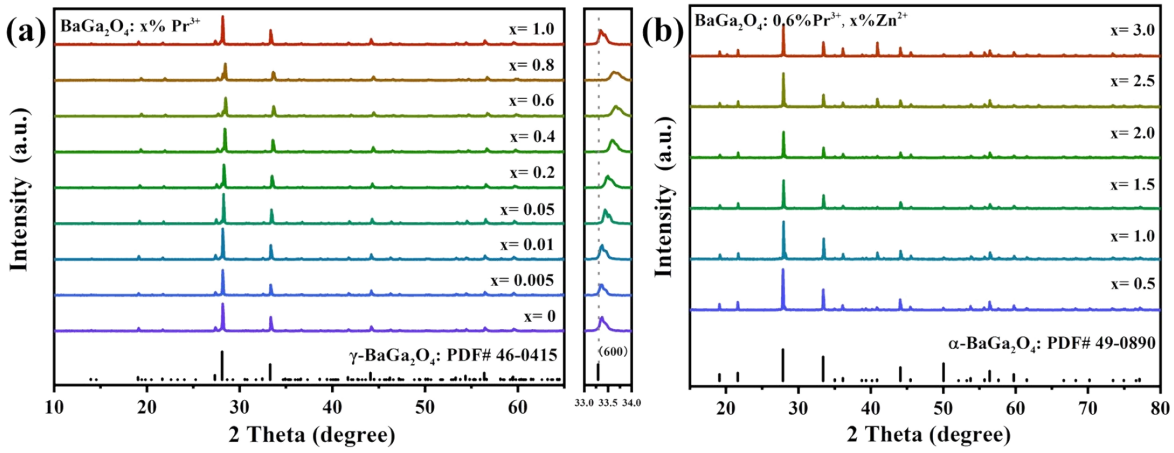

Fig. S1 (a) XRD patterns of BGO: x% Pr^{3+}. Inset is the peak shifting between 33°-34° corresponding to (600) crystallography plane. (b) XRD patterns of BGO: 0.6% Pr^{3+}, x% Zn^{2+}.

Table S2 Cell parameters and refinement results of BGO: 0.6% Pr^{3+} and BGO: 0.6% Pr^{3+}, 2.0% Zn^{2+}

Formula	BGO: 0.6% Pr^{3+}	BGO: 0.6% Pr^{3+}, 2.0% Zn^{2+}
Crystal system	Hexagonal	Hexagonal
Space group	$P6_3$	$P6_322$
a= b (Å)	18.63(3)	5.34(3)
c (Å)	8.66(3)	8.81(3)
α=β(°)	90	90
γ (°)	120	120
R_{wp}	0.1144	0.1333
Rp	0.0863	0.1084
χ^2	1.805	1.636

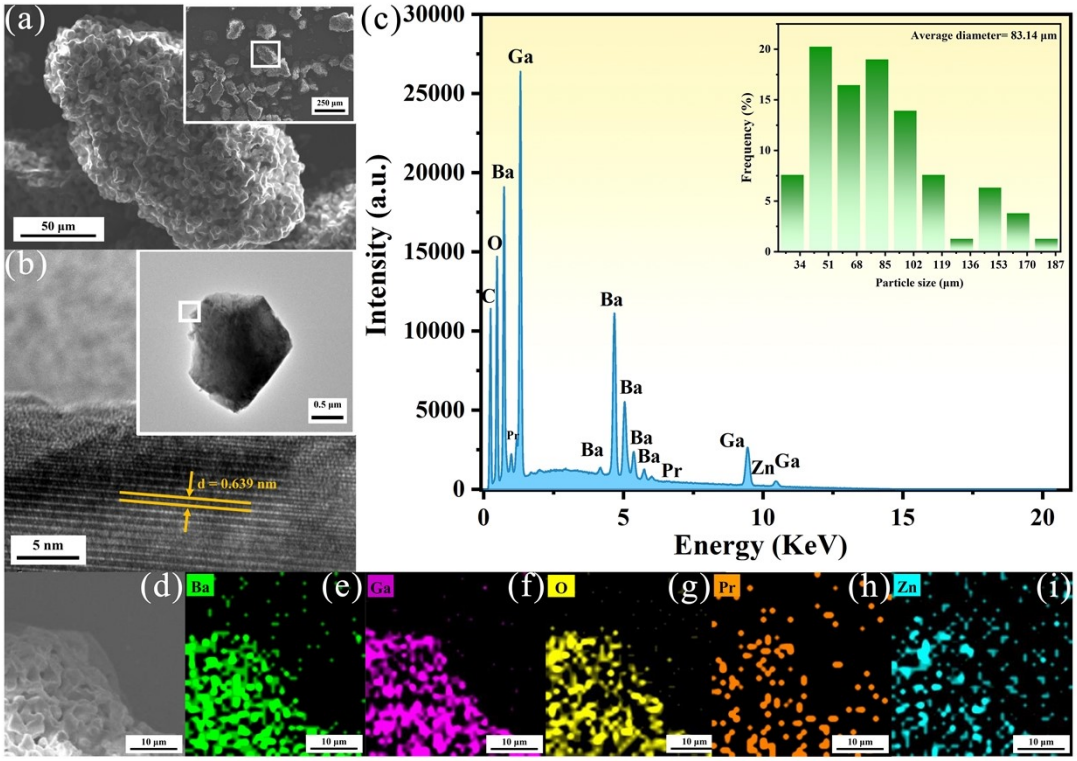

Fig. S2 (a) SEM images of BGO: 0.6% Pr^{3+}. (b) HRTEM image of BGO: 0.6% Pr^{3+}. Inset is the morphology under TEM mode. (c) EDX spectrum of BGO: 0.6% Pr^{3+}, 2.0% Zn^{2+}. Inset is the particle size distribution of BGO: 0.6% Pr^{3+}, 2.0% Zn^{2+}. (d)-(i) Mapping-scan of BGO: 0.6% Pr^{3+}, 2.0% Zn^{2+}.

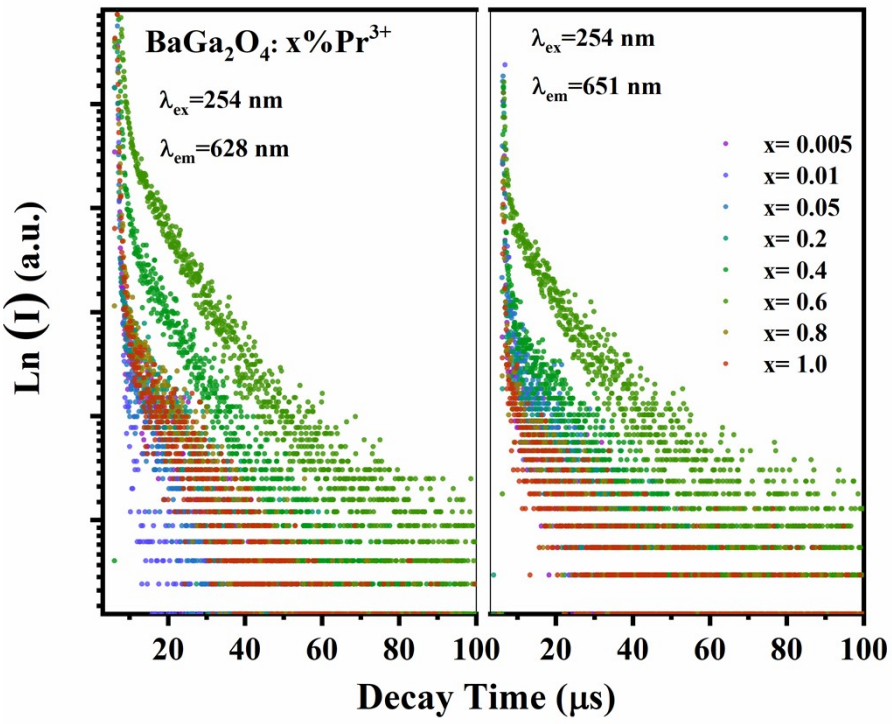

Fig. S3 The decay curves of BGO: x% Pr^{3+} under 254nm excitation.

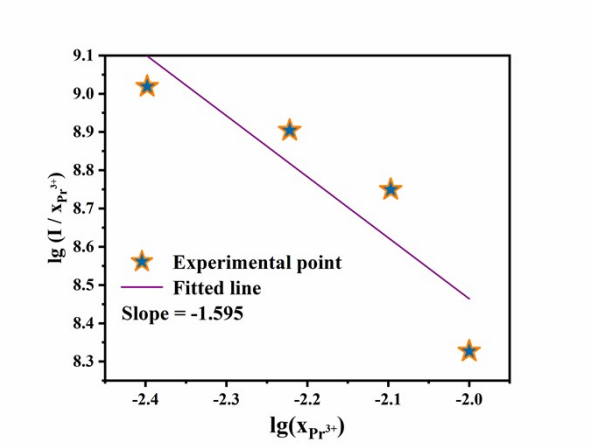

Fig. S4 Fitted line of $lg(I/x_{Pr}^{3+})$ VS. $lg(x_{Pr}^{3+})$ for $BaGa_2O_4$: x%Pr^{3+} phosphors.

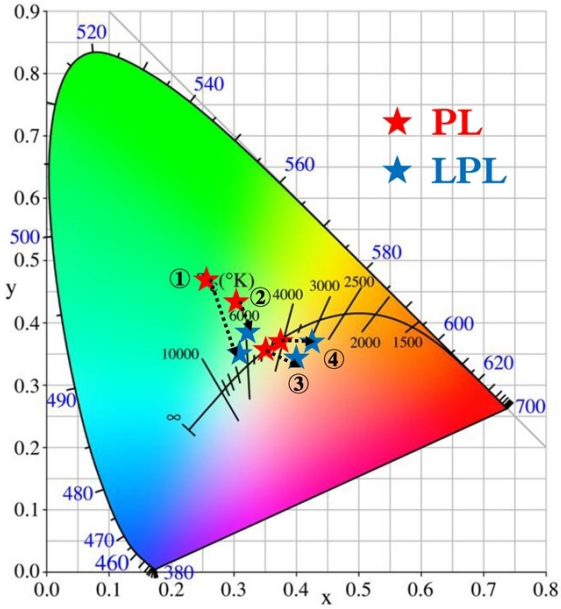

Fig. S5 CIE chromaticity coordination of BGO: x% Pr^{3+} (①: x=0.005, ②: x=0.01, ③: x=0.2, ④: x=0.6)

Table S3 CIE chromaticity coordinate calculation of BGO: x% Pr^{3+}

Samples	PL		LPL	
	CIE x	CIE y	CIE x	CIE y
①: x=0.005	0.259	0.4689	0.3099	0.354
②: x=0.01	0.3072	0.4304	0.323	0.3785
③: x=0.2	0.3547	0.3566	0.4003	0.3468
④: x=0.6	0.3738	0.3647	0.425	0.3662

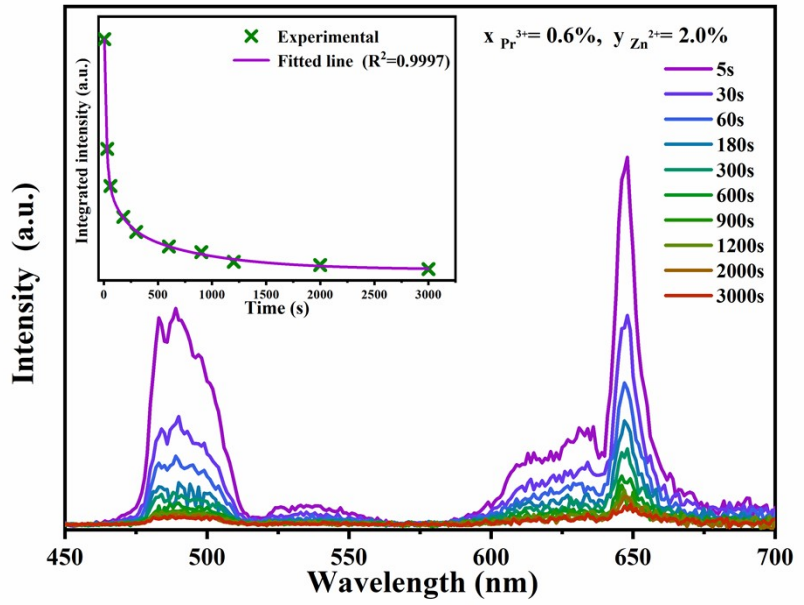

Fig. S6 LPL spectra of BGO: 0.6 % Pr^{3+}, 2.0%Zn^{2+}. Inset is the fitted duration curve.

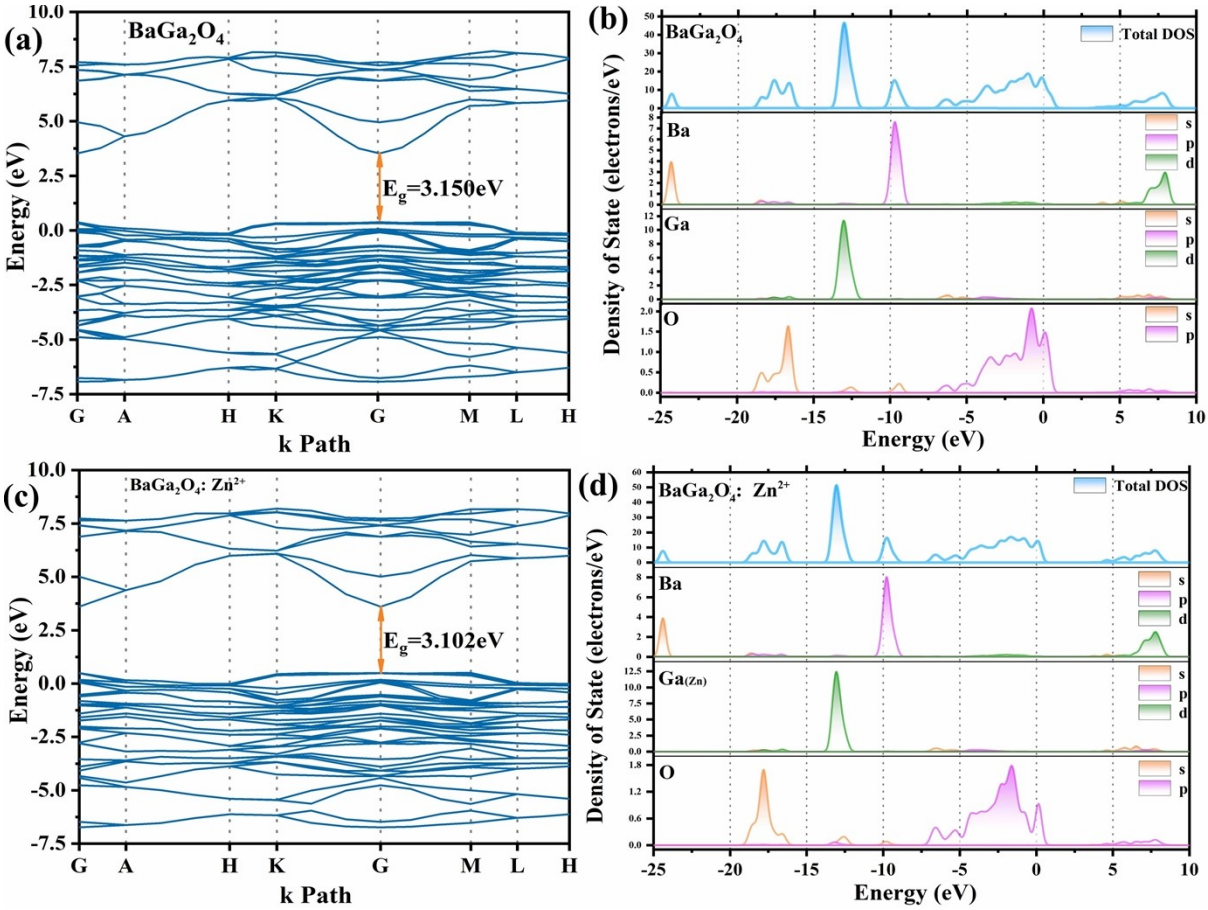

Fig. S7 Band structure: (a) BGO host, (c) Single Zn^{2+} doped sample, and density of states: (b) BGO host, (d) Single Zn^{2+} doped sample.

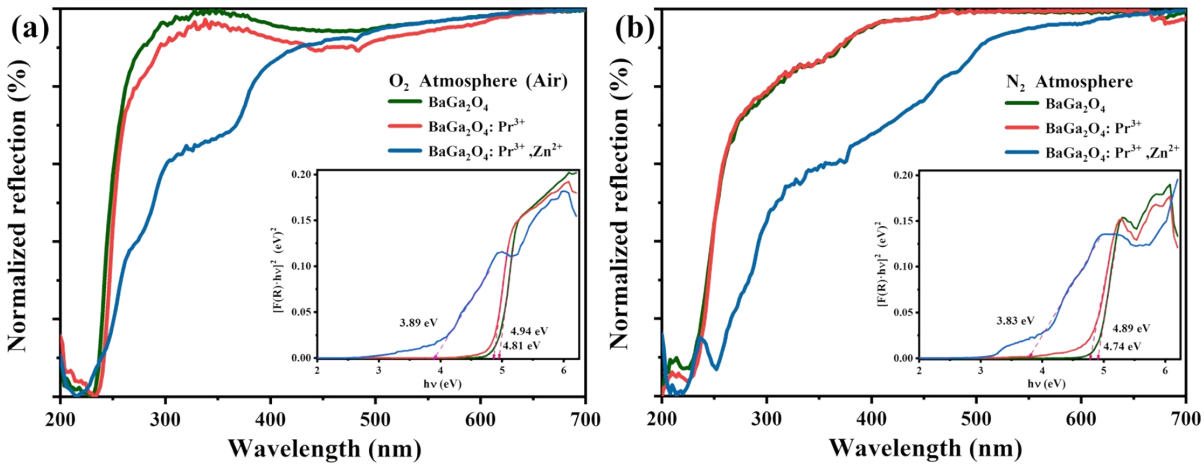

Fig. S8 The DRS spectra of BGO: x% Pr^{3+}, y% Zn^{2+} sintered under different atmosphere: (a) Air sintered, (b) N_2 sintered. The inset shows the Straight-line extrapolation under Kubelka-Munk formula of BGO.

Kubelka-Munk formula and Tauc equation are used to calculate the direct optical band gap of the materials based on the diffuse spectral experimental value [1] [2].

$$F_{(R)} = (1-R)^2/2R \qquad (1)$$

$$[F_{(R)} \cdot h\nu]^n = \alpha (h\nu - E_g) \qquad (2)$$

where, R is the relative reflectance of the thick sample determined by the white reference material ($BaSO_4$), α is the instrument parameter, n is the parameter to measure the band gap property of the material (direct band structure, $n = 2$), E_g refers to the direct optical band gap of the materials, υ is the frequency; h is the Planck constant (6.62618×10^{-34}Js), and c is the velocity of light (2.99792×10^{8}ms^{-1}).

Reference

1. H. Ji, L. Wang, M. S. Molokeev, N. Hirosaki, R. Xie, Z. Huang, Z. Xia, O. M. ten Kate, L. Liu and V. V. Atuchin, *Journal of Materials Chemistry C*, 2016, **4**, 6855-6863.
2. K. Li, M. Xu, J. Fan, M. Shang, H. Lian and J. Lin, *Journal of Materials Chemistry C*, 2015, **3**, 11618-11628.