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

Supporting Information

Luminescence color tuning and energy transfer properties in $(Sr,Ba)_2LaGaO_5:Bi^{3+},Eu^{3+}$ solid solution phosphors: realization of single-phased white emission for WLEDs

Dongjie Liu,[a,b] Peipei Dang,[a,b] Xiaohan Yun,[c] Guogang Li,[,c] Hongzhou Lian,[a] and Jun Lin*[,a,b,d]*

[a]*State Key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun 130022, P. R. China. E-mail: jlin@ciac.ac.cn*

[b]*University of Science and Technology of China, Hefei, 230026, P. R. China*

[c]*Engineering Research Center of Nano-Geomaterials of Ministry of Education, Faculty of Materials Science and Chemistry, China University of Geosciences, 388 Lumo Road, Wuhan 430074, P. R. China. E-mail: ggli@cug.edu.cn*

[d]*School of Applied Physics and Materials, Wuyi University, Jiangmen, Guangdong 529020, P. R. China*.

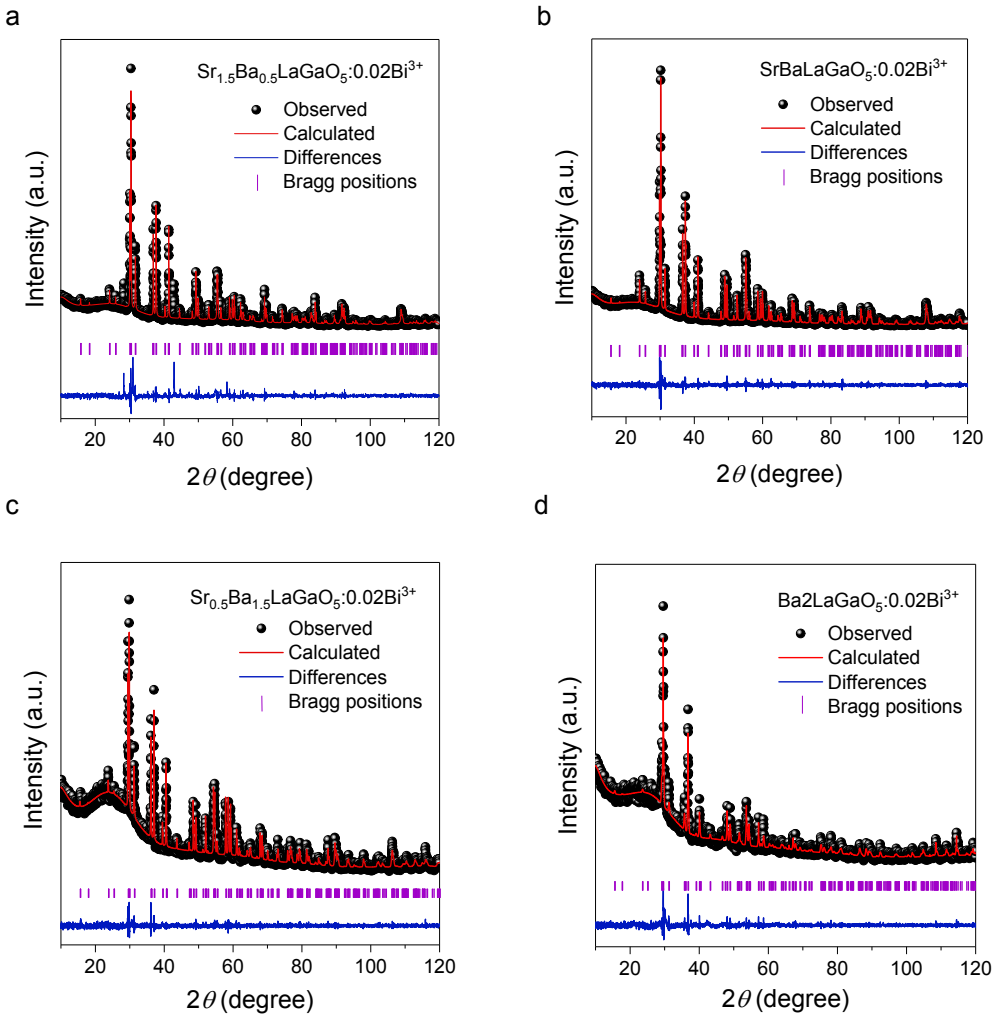

Fig. S1 Data (black dots) and fitted (red line) powder XRD patterns as well as the difference profile (blue line) for Rietveld analysis of (a) $Sr_{1.5}Ba_{0.5}LaGaO_5$:0.02Bi^{3+}, (b) $Sr_{1.0}Ba_{1.0}LaGaO_5$:0.02Bi^{3+} (c) $Sr_{0.5}Ba_{0.5}LaGaO_5$:0.02Bi^{3+} and (d) Ba_2LaGaO_5:0.02Bi^{3+} samples. The short vertical lines show the positions of Bragg reflections of the fitted patterns.

Table S1. Final refined structure parameters of $Sr_{2-y}Ba_yLaGaO_5$:0.02Bi^{3+} (y = 0-2.0) samples derived from the GSAS refinement of XRD data.

Samples	Atom	Site	X	Y	Z	Frac.	Uiso
	La	8*h*	0.181000	0.680950	0	0.5000	0.95
	Sr1	8*h*	0.179903	0.679853	0	0.4423	0.28
y = 0	Sr2	4*a*	0	0	1/4	0.9886	0.96
	Ga	4*b*	0	1/2	1/4	1.0085	-0.04
	O1	4*c*	0	0	0	0.7891	0.38
	O2	16*l*	0.143713	0.643743	0.652630	0.6550	1.29
	La	8*h*	0.181000	0.680950	0	0.9137	2.61
	Sr1	8*h*	0.161753	0.661703	0	0.0556	-9.00
y = 0.5	Sr2	4*a*	0	0	1/4	1.3210	1.31
	Ga	4*b*	0	1/2	1/4	1.1656	0.01
	O1	4*c*	0	0	0	0.6679	-0.17
	O2	16*l*	0.141937	0.641967	0.651225	0.8466	-2.66
	La	8*h*	0.182216	0.682166	0	0.5000	3.97
	Sr1	8*h*	0.179329	0.679279	0	-1.5874	1.70
y = 1.0	Sr2	4*a*	0	0	1/4	-0.8854	-0.27
	Ga	4*b*	0	1/2	1/4	-0.6582	0.61
	O1	4*c*	0	0	0	-0.5006	-1.06
	O2	16*l*	0.130770	0.630800	0.632946	-0.6150	-0.43
	La	8*h*	0.179141	0.679091	0	-1.7957	1.70
	Sr1	8*h*	0.170738	0.670688	0	-0.7466	1.70
y = 1.5	Sr2	4*a*	0	0	1/4	-3.5629	1.27
	Ga	4*b*	0	1/2	1/4	-2.6559	2.80
	O1	4*c*	0	0	0	-3.6257	10.19
	O2	16*l*	0.158934	0.658964	0.645074	-1.9722	0.81

	La	8*h*	0.182817	.682817	0	0.4919	1.41
	Sr1	8*h*	0.187240	0.687240	0	0.5891	1.93
	Sr2	4*a*	0	0	1/4	1.0294	-0.15
y = 2.0	Ga	4*b*	0	1/2	1/4	0.9710	6.16
	O1	4*c*	0	0	0	2.1976	80.00
	O2	16*l*	0.135301	0.635301	0.645999	1.1343	8.22

Table S2. Main bond distance of $Sr_{2-y}Ba_yLaGaO_5$:0.02Bi^{3+} (y = 0-2.0) samples.

Samples	Bond distance (Å)					
	La-O1	2.54182(3)	Sr1-O1	2.54470(3)	Sr2-O1	2.81962(6)
	La-O1	2.54135(3)	Sr1-O1	2.54423(3)	Sr2-O1	2.81962(6)
	La-O2	2.84476(3)	Sr1-O2	2.83807(3)	Sr2-O2	2.87958(3)
	La-O2	2.43195(3)	Sr1-O2	2.43955(3)	Sr2-O2	2.87958(3)
	La-O2	2.84470(3)	Sr1-O2	2.83801(3)	Sr2-O2	2.87958(3)
y = 0	La-O2	2.84470(3)	Sr1-O2	2.83801(3)	Sr2-O2	2.87958(3)
	La-O2	2.84476(3)	Sr1-O2	2.83807(3)	Sr2-O2	2.87958(3)
	La-O2	2.43195(3)	Sr1-O2	2.43955(3)	Sr2-O2	2.87958(3)
					Sr2-O2	2.87958(3)
					Sr2-O2	2.87958(3)
	Average	2.66575	Average	2.66502	Average	2.86760
	La-O1	2.53957(3)	Sr1-O1	2.59608(3)	Sr2-O1	2.84108(9)
	La-O1	2.53910(3)	Sr1-O1	2.59562(3)	Sr2-O1	2.84108(9)
	La-O2	2.83285(4)	Sr1-O2	2.71897(4)	Sr2-O2	2.89309(3)
	La-O2	2.44116(4)	Sr1-O2	2.57841(4)	Sr2-O2	2.89309(3)
	La-O2	2.83280(4)	Sr1-O2	2.71889(4)	Sr2-O2	2.89309(3)
y = 0.5	La-O2	2.83280(4)	Sr1-O2	2.71889(4)	Sr2-O2	2.89309(3)
	La-O2	2.83285(4)	Sr1-O2	2.71897(4)	Sr2-O2	2.89309(3)
	La-O2	2.44116(4)	Sr1-O2	2.57841(4)	Sr2-O2	2.89309(3)
					Sr2-O2	2.89309(3)
					Sr2-O2	2.89309(3)
	Average	2.66154	Average	2.65303	Average	2.88269

	La-O1	2.55274(4)	Sr1-O1	2.56033(4)	Sr2-O1	2.85719(7)
	La-O1	2.55227(4)	Sr1-O1	2.55986(4)	Sr2-O1	2.85719(7)
	La-O2	2.68192(3)	Sr1-O2	2.66296(3)	Sr2-O2	3.03937(4)
	La-O2	2.38851(3)	Sr1-O2	2.41053(3)	Sr2-O2	3.03937(4)
	La-O2	2.68188(3)	Sr1-O2	2.66292(3)	Sr2-O2	3.03937(4)
y = 1.0	La-O2	2.68188(3)	Sr1-O2	2.66292(3)	Sr2-O2	3.03937(4)
	La-O2	2.68192(3)	Sr1-O2	2.66296(3)	Sr2-O2	3.03937(4)
	La-O2	2.38851(3)	Sr1-O2	2.41053(3)	Sr2-O2	3.03937(4)
					Sr2-O2	3.03937(4)
					Sr2-O2	3.03937(4)
	Average	2.57620	Average	2.57413	Average	3.00293
	La-O1	2.59185(7)	Sr1-O1	2.61595(7)	Sr2-O1	2.87014(13)
	La-O1	2.59137(7)	Sr1-O1	2.61548(7)	Sr2-O1	2.87014(13)
	La-O2	2.91177(7)	Sr1-O2	2.86112(7)	Sr2-O2	2.91404(7)
	La-O2	2.31998(6)	Sr1-O2	2.37908(6)	Sr2-O2	2.91404(7)
	La-O2	2.91168(7)	Sr1-O2	2.86103(7)	Sr2-O2	2.91404(7)
y = 1.5	La-O2	2.91168(7)	Sr1-O2	2.86103(7)	Sr2-O2	2.91404(7)
	La-O2	2.91177(7)	Sr1-O2	2.86112(7)	Sr2-O2	2.91404(7)
	La-O2	2.31998(6)	Sr1-O2	2.37908(6)	Sr2-O2	2.91404(7)
					Sr2-O2	2.91404(7)
					Sr2-O2	2.91404(7)
	Average	2.68376	Average	2.67924	Average	2.90526

	La-O1	2.61403(24)	Sr1-O1	2.60279(24)	Sr2-O1	2.87760(4)
	La-O1	2.61403(24)	Sr1-O1	2.60279(24)	Sr2-O1	2.87760(4)
	La-O2	2.84582(21)	Sr1-O2	2.87499(21)	Sr2-O2	3.02447(24)
	La-O2	2.48943(19)	Sr1-O2	2.45666(19)	Sr2-O2	3.02447(24)
	La-O2	2.84582(21)	Sr1-O2	2.87499(21)	Sr2-O2	3.02447(24)
y = 2.0	La-O2	2.84582(21)	Sr1-O2	2.87499(21)	Sr2-O2	3.02447(24)
	La-O2	2.84582(21)	Sr1-O2	2.87499(21)	Sr2-O2	3.02447(24)
	La-O2	2.48943(19)	Sr1-O2	2.45666(19)	Sr2-O2	3.02447(24)
					Sr2-O2	3.02447(24)
					Sr2-O2	3.02447(24)
	Average	2.69878	Average	2.70236	Average	2.99510

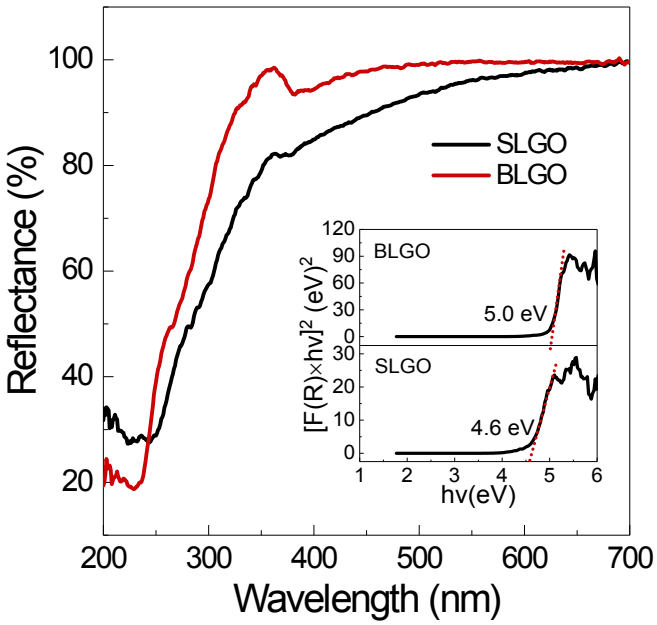

Fig. S2 Diffuse reflectance spectra of the Sr_2LaGaO_5 and Ba_2LaGaO_5 hosts. The inset depicts the band gap energy of the Sr_2LaGaO_5 and Ba_2LaGaO_5 hosts.

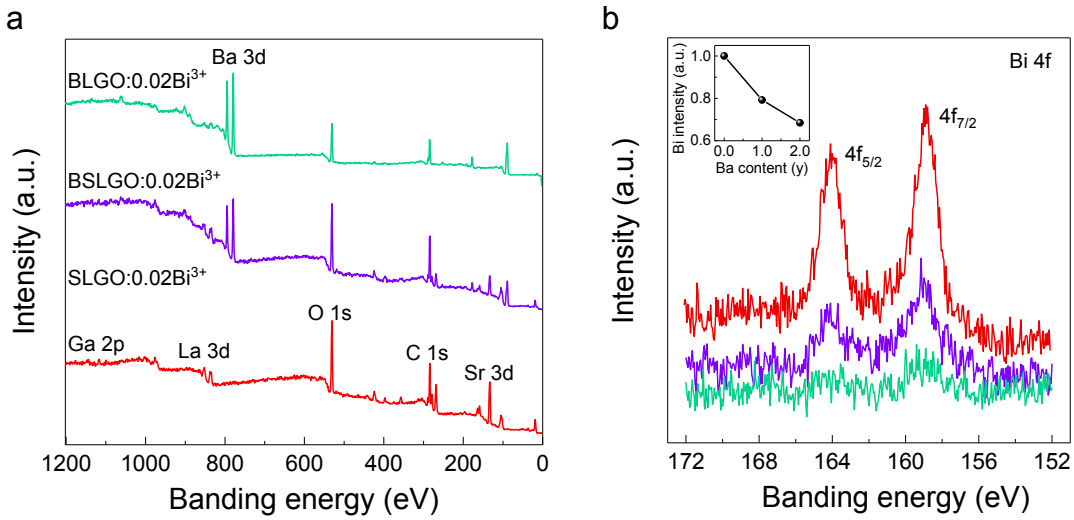

Fig. S3 (a) The XPS spectra and (b) enlarged peaks of Bi^{3+} in $Sr_{2-y}Ba_yLaGaO_5$:0.02Bi^{3+} (y = 0 (red line), y = 1.0 (blue line), y = 2.0 (green line)). The inset in (b) shows the integrated intensity of Bi^{3+} peaks in $Sr_{2-y}Ba_yLaGaO_5$:0.02Bi^{3+} (y = 0, 1.0, 2.0) samples with various Ba^{2+} content.

Table S3. The IQYs of $Sr_{2-y}Ba_yLaGaO_5:0.02Bi^{3+}$ (y = 0-2.0) samples.

y	IQY
0	47.3%
0.5	31.4%
1.0	24.9%
1.5	16.7%
2.0	14.7%

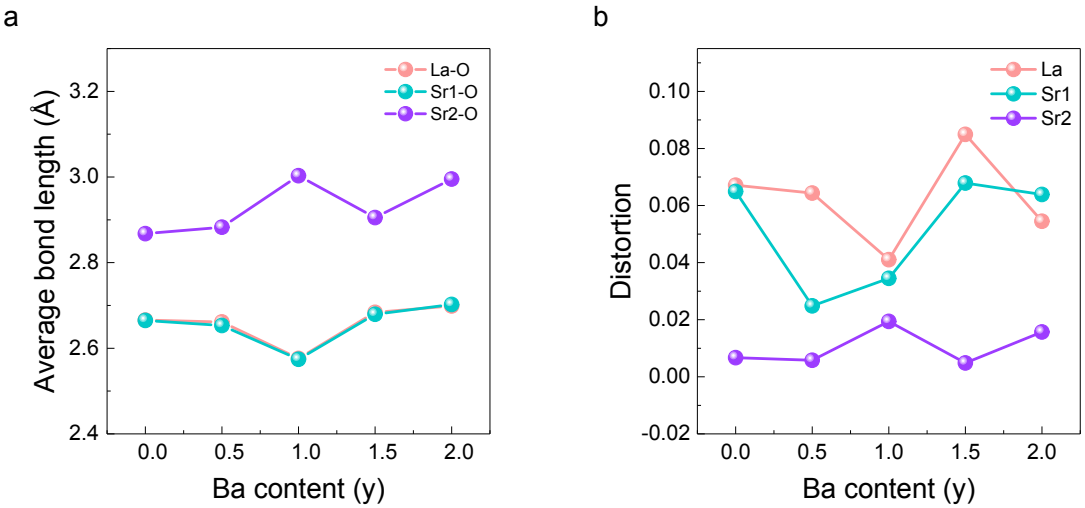

Fig. S4 (a) Average bond length of La-O, Sr1-O and Sr2-O in $Sr_{2-y}Ba_yLaGaO_5$:0.02Bi^{3+} (y = 0-2.0). (b) Distortion of La, Sr1 and Sr2 sites in $Sr_{2-y}Ba_yLaGaO_5$:0.02Bi^{3+} (y = 0-2.0)

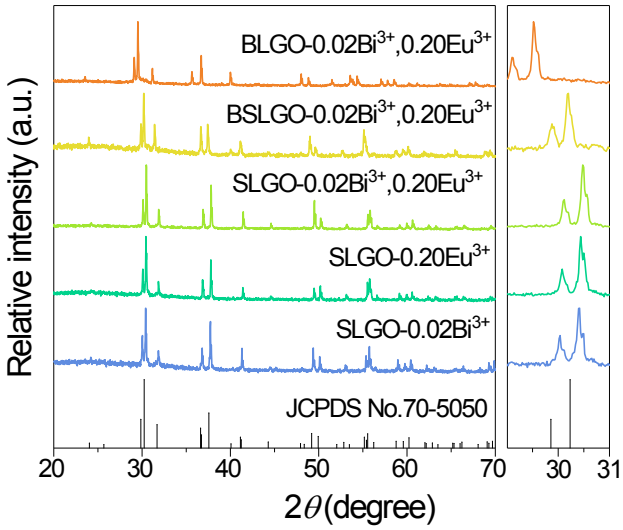

Fig. S5 XRD patterns of $Sr_{2-y}Ba_yLaGaO_5$:xBi^{3+}, zEu^{3+} (x = 0, 0.02; y = 0, 1.0, 2.0; z = 0, 0.20) samples.

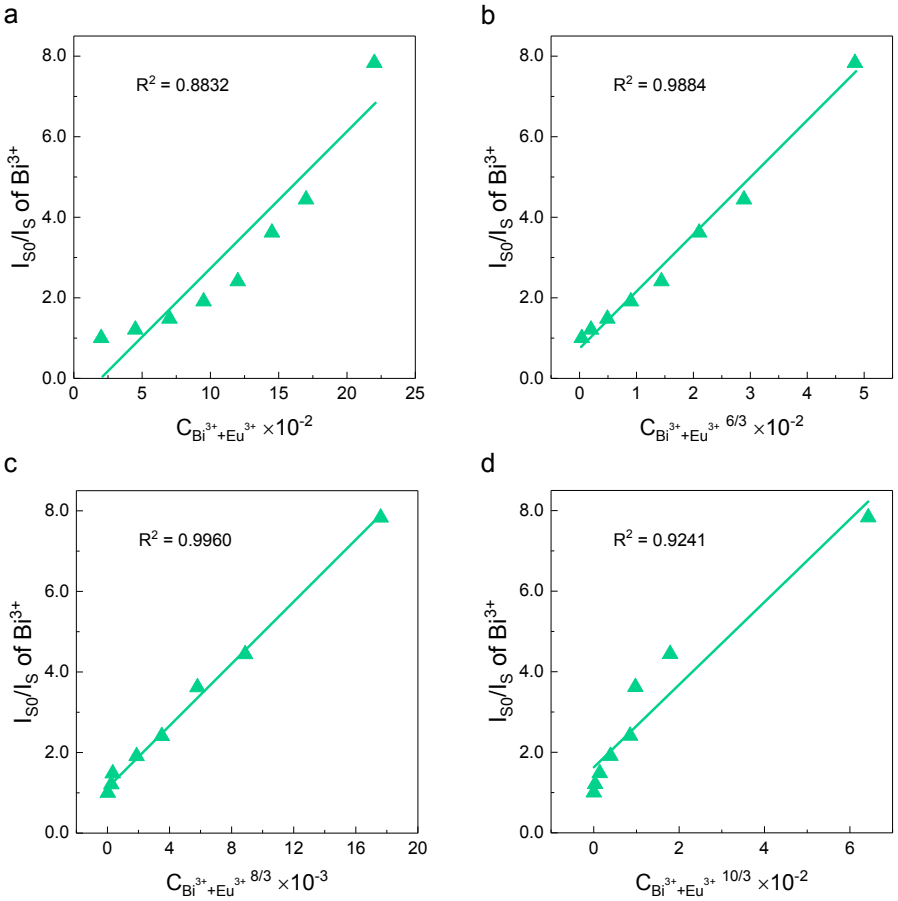

Fig. S6 Dependence of I_{S0}/I_S of Bi^{3+} on (a) C, (b) $C^{6/3}$, (c) $C^{8/3}$, and (d) $C^{10/3}$ in Sr_2LaGaO_5:0.02Bi^{3+}, zEu^{3+} (z = 0-0.20) system.

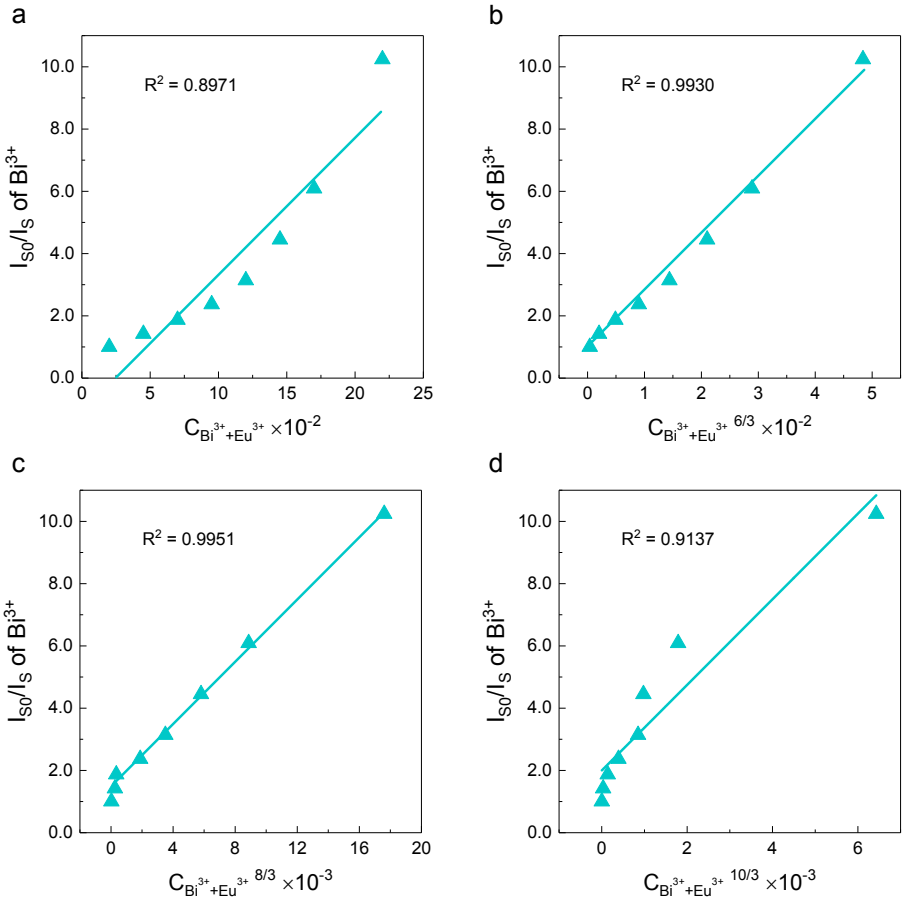

Fig. S7 Dependence of I_{S0}/I_S of Bi^{3+} on (a) *C*, (b) $C^{6/3}$, (c) $C^{8/3}$, and (d) $C^{10/3}$ in $SrBaLaGaO_5$:0.02Bi^{3+}, *z*Eu^{3+} (*z* = 0-0.20) system.

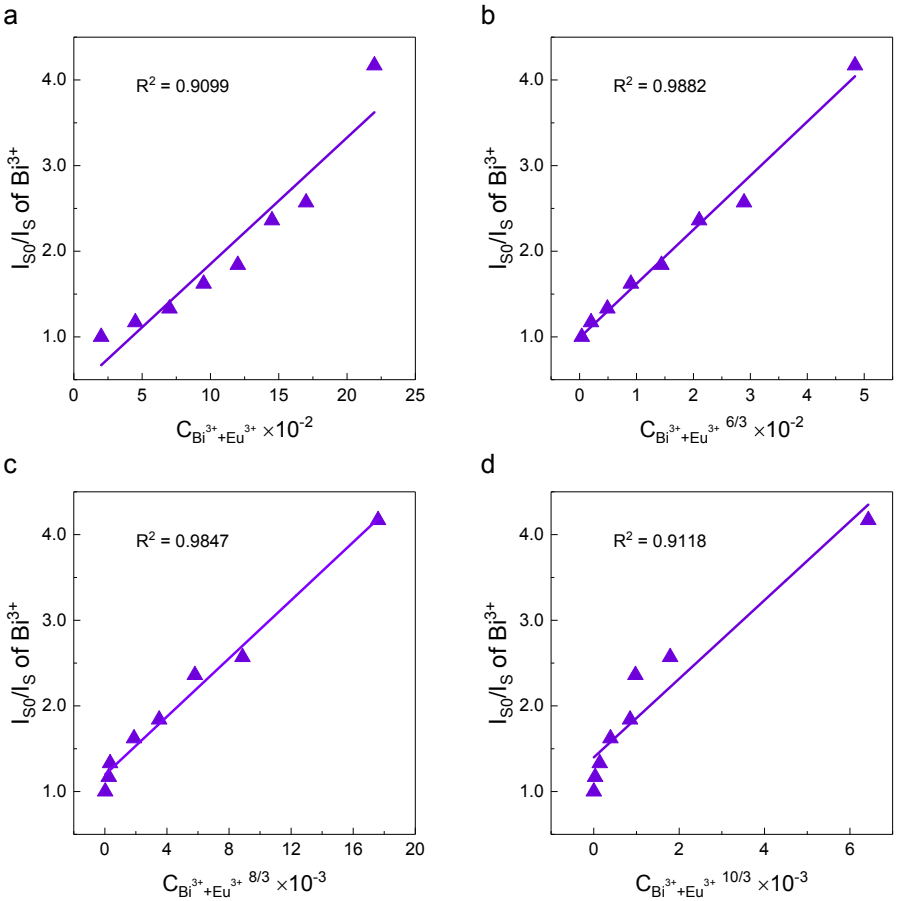

Fig. S8 Dependence of I_{S0}/I_S of Bi^{3+} on (a) *C*, (b) $C^{6/3}$, (c) $C^{8/3}$, and (d) $C^{10/3}$ in Ba_2LaGaO_5:0.02Bi^{3+}, *z*Eu^{3+} (*z* = 0-0.20) system.

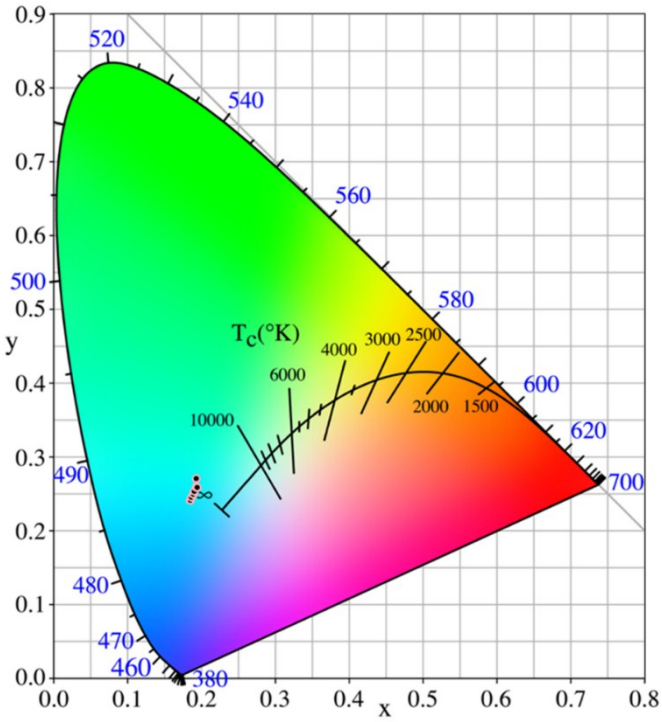

Fig. S9 The CIE chromaticity coordinates diagram of Sr_2LaGaO_5:0.02Bi^{3+} phosphor at different temperatures.