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

Supporting information

Broadband Near-Infrared Emission of $La_3Ga_5GeO_{14}:Tb^{3+}$, Cr^{3+} Phosphors: Energy Transfer, Persistent Luminescence and Application in NIR Light-Emitting Diodes

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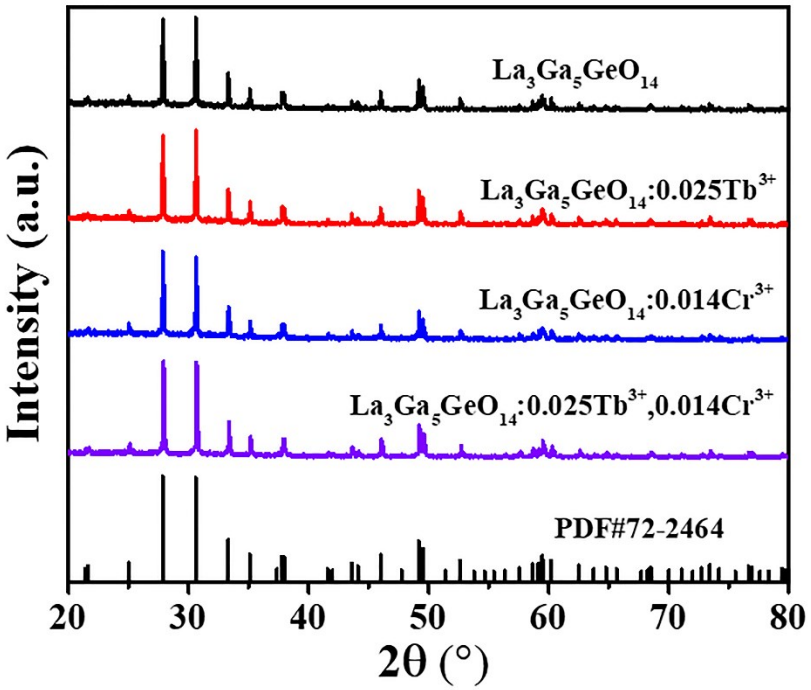

Fig. S1 XRD patterns of as-prepared $La_3Ga_5GeO_{14}$, $La_{2.975}Ga_5GeO_{14}:0.025Tb^{3+}$, $La_3Ga_{4.986}GeO_{14}:0.014Cr^{3+}$, $La_{2.975}Ga_{4.986}GeO_{14}:0.025Tb^{3+}$, $0.014Cr^{3+}$.

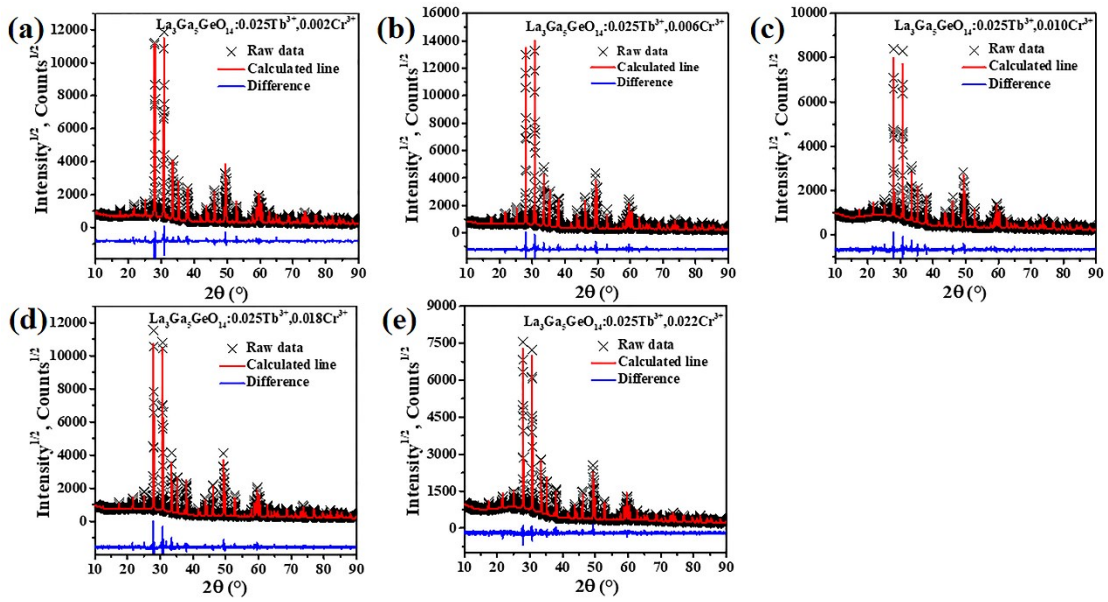

Fig. S2 Rietveld refinement of powder XRD patterns of $La_{2.975}Ga_{5-y}GeO_{14}$:0.025$Tb^{3+}$, $y$$Cr^{3+}$: (a) y = 0.002, (b) y = 0.006, (c) y = 0.010, (d) y = 0.018, (e) y = 0.022.

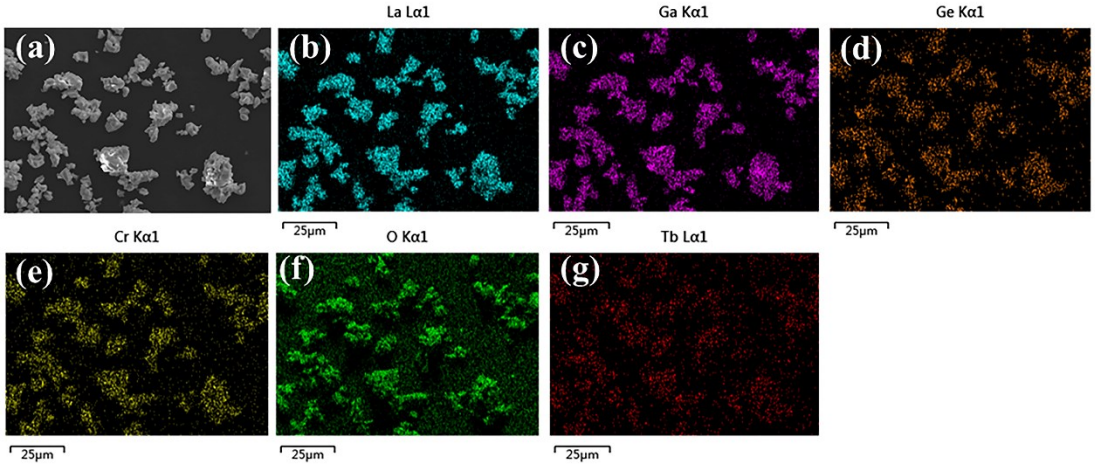

Fig. S3 EDS elemental mapping images of the $La_{2.975}Ga_{4.986}GeO_{14}$:0.025$Tb^{3+}$, 0.014$Cr^{3+}$ sample.

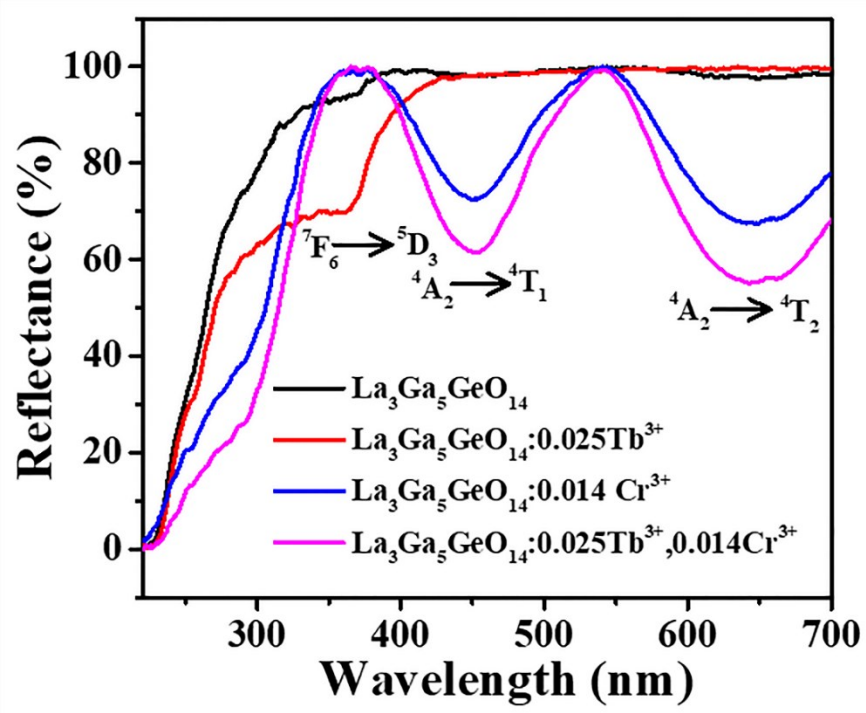

Fig. S4 Diffuse reflectance spectra synthesized of $La_3Ga_5GeO_{14}$, $La_{2.975}Ga_5GeO_{14}$: 0.025Tb^{3+}, $La_3Ga_{4.986}GeO_{14}$:0.014Cr^{3+} and $La_{2.975}Ga_{4.986}GeO_{14}$:0.025$Tb^{3+}$,0.014$Cr^{3+}$.

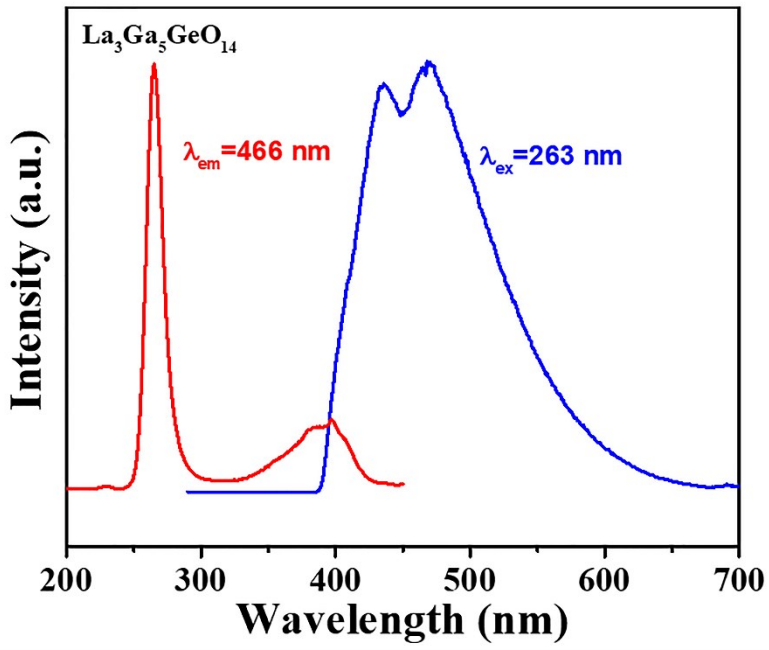

Fig. S5 Excitation (red curve, monitored emission at 466 nm) and emission (blue curve, excitation at 263 nm) spectra of the $La_3Ga_5GeO_{14}$ phosphor.

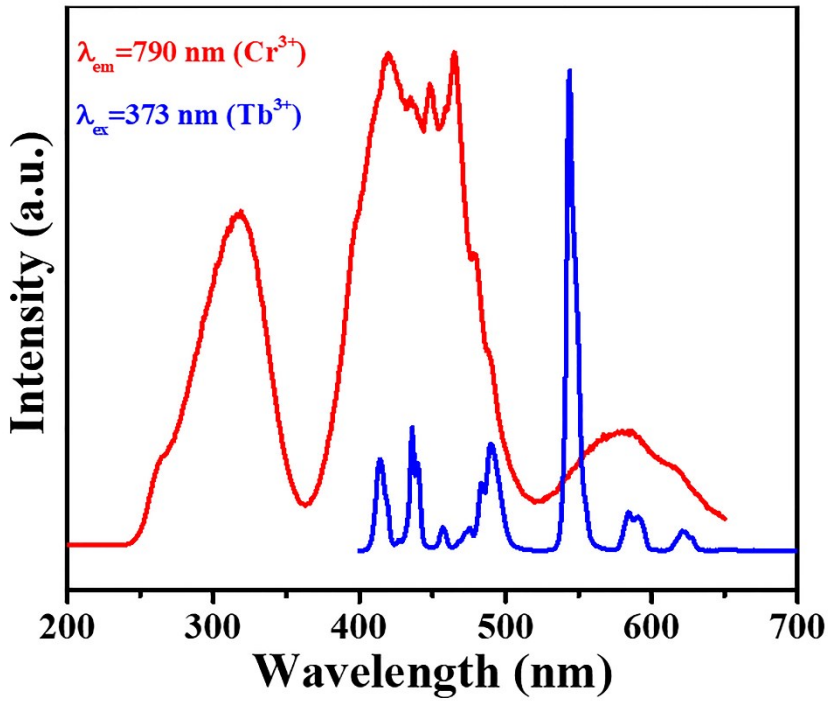

Fig. S6 Overlapping of the emission (blue curve) spectrum of $La_{2.975}Ga_5GeO_{14}$: $0.025Tb^{3+}$ and the excitation (red curve) spectra of $La_3Ga_{4.986}GeO_{14}$:$0.014Cr^{3+}$.

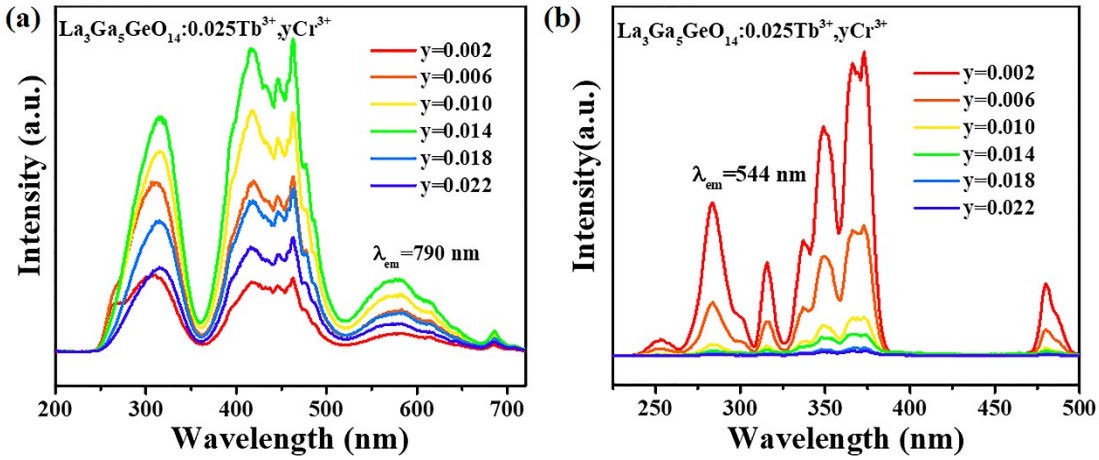

Fig. S7 Excitation spectra of $La_{2.975}Ga_{4.986}GeO_{14}$:$0.025Tb^{3+}$, $0.014Cr^{3+}$ phosphors under (a) 790 nm and (b) 544 nm monitoring.

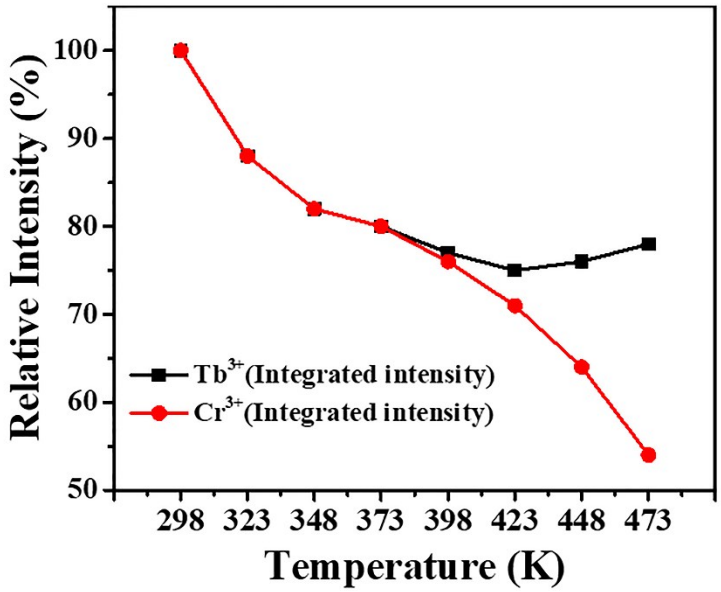

Fig. S8 Temperature - dependent relative integrated intensities of Tb^{3+}(400-600 nm) and Cr^{3+}(600-1000 nm).

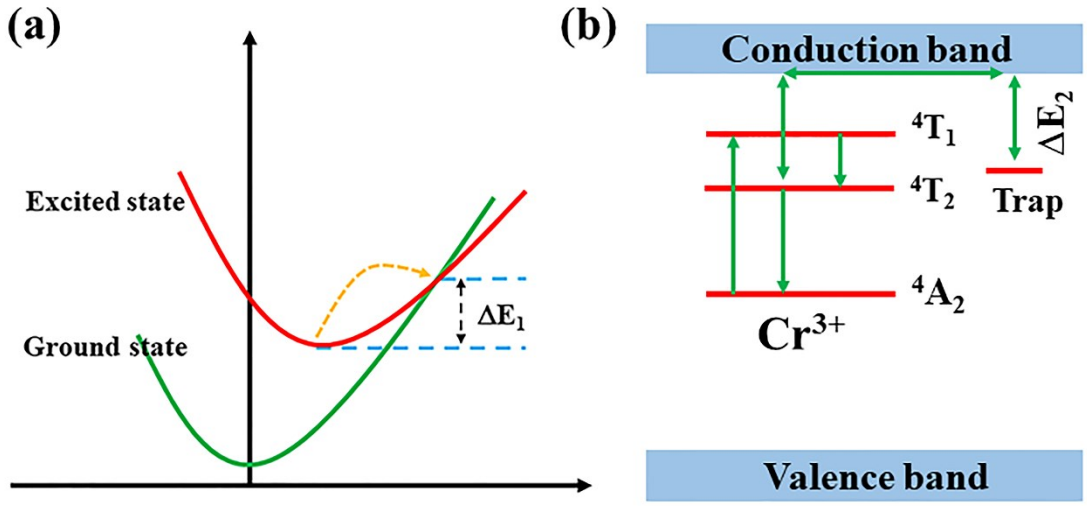

Fig. S9 (a) Configurational coordinate diagram and (b) activation energy of the thermal ionization process of as-phosphor.

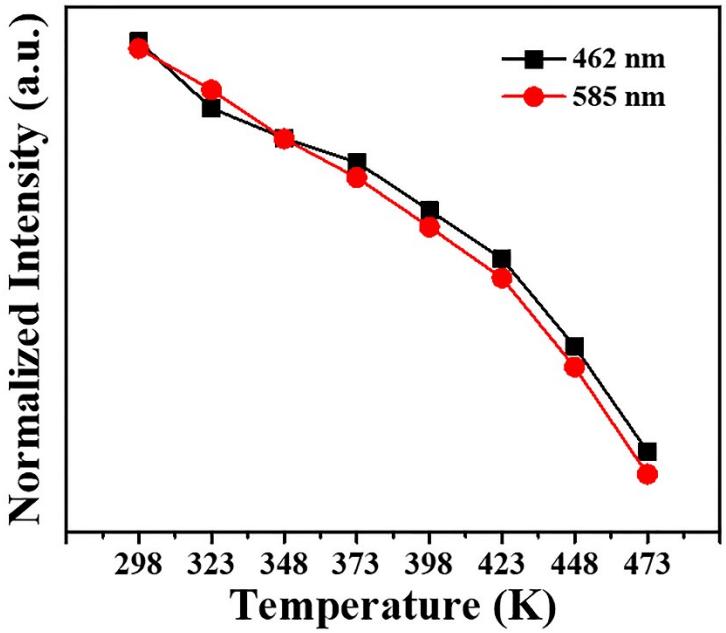

Fig. S10 Temperature dependent intensities of $La_{2.975}Ga_{4.986}GeO_{14}$:0.025$Tb^{3+}$, 0.014$Cr^{3+}$ when excited at 462 and 585 nm, respectively.

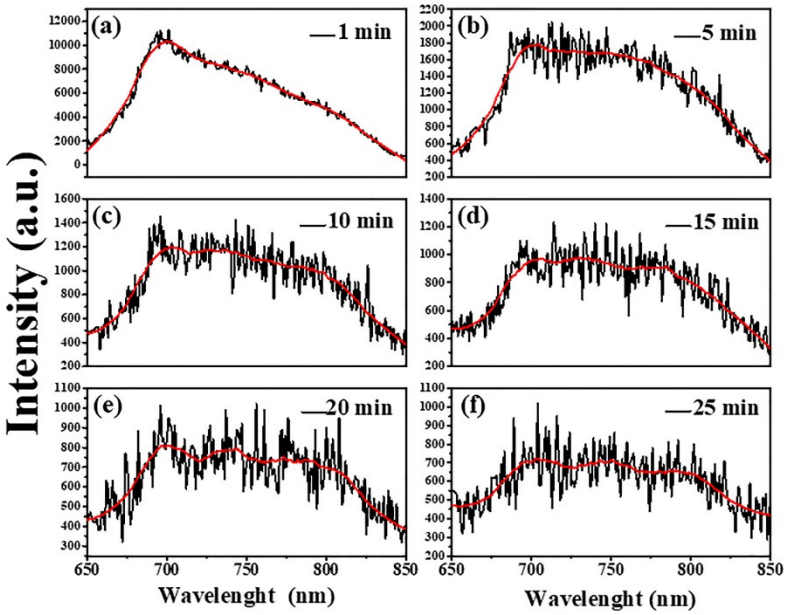

Fig. S11 The $La_{2.975}Ga_{4.986}GeO_{14}$:0.025$Tb^{3+}$,0.014$Cr^{3+}$ long persistent luminescence spectrum was measured between 1 min and 25 min after 10 min of pre-irradiation under a 254 nm UV lamp, with an interval of 5 min.

Table S1 Properties of NIR-LEDs prepared using $La_{2.975}Ga_{4.986}GeO_{14}$:0.025$Tb^{3+}$, 0.014$Cr^{3+}$ phosphor (weight ratio of 100%).

Current (mA)	Voltage (V)	Input power (mW)	Optical power (mW)
20	2.65	52.73	0.6489
40	2.71	108.2	1.22
60	2.75	164.8	1.695
80	2.79	223.2	2.093
100	2.83	283	2.413
120	2.87	343.7	2.699
140	2.90	405.9	2.923
160	2.93	469.2	3.108