Supporting Information

Time-dependent dynamic multicolor afterglow of simple $LiGa_5O_8:Eu^{3+}/Tb^{3+}$ particles for advanced anticounterfeiting and encryption

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Computational Methods

Spin-polarized calculations are performed using the Vienna Ab initio Simulation Package (VASP) and the project augmented wave potential. The functional of Perdew-Burke-Ernzerhof is used to calculate the exchange energy. The plane wave cutoff energy is set at 400 eV, the convergence criterion for the total energy is set at 10^{-5} eV, and the force acting on each atom is set at 0.02 eV/Å. Brillouin zone sampling is performed using the Gamma-center scheme with a k mesh of 3×3×3. HSE06 functionals are used to calculate the band of the $LiGa_5O_8$.

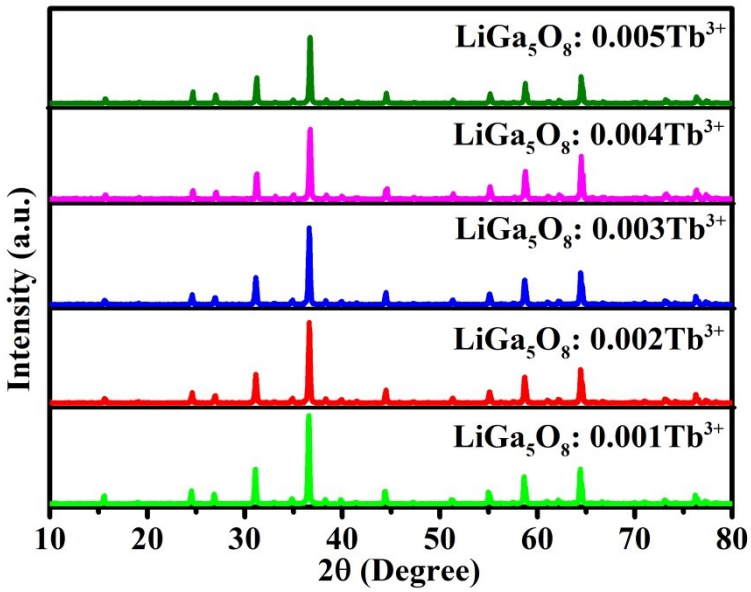

Fig. S1. XRD patterns of the $LiGa_5O_8:Tb^{3+}$ phosphors.

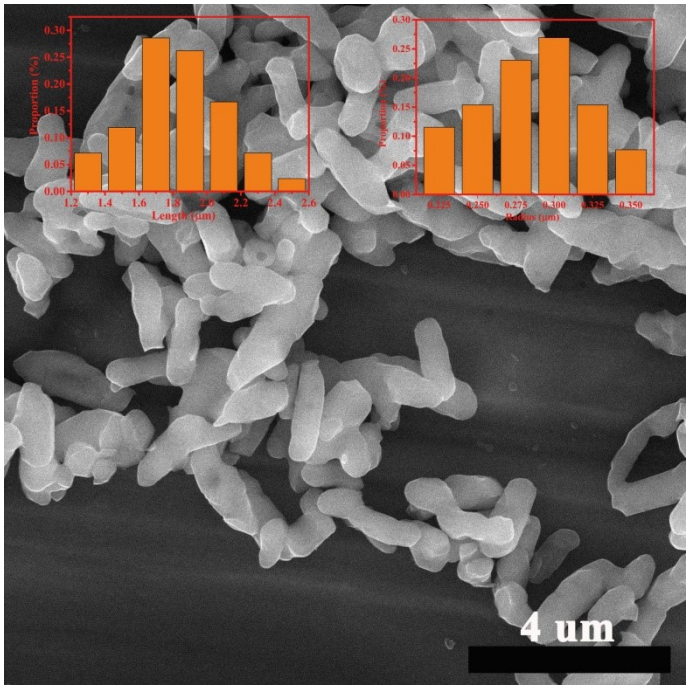

Fig. S2. SEM image of the $LiGa_5O_8:Eu^{3+}$ phosphors. The insets show the bar charts of the size distribution.

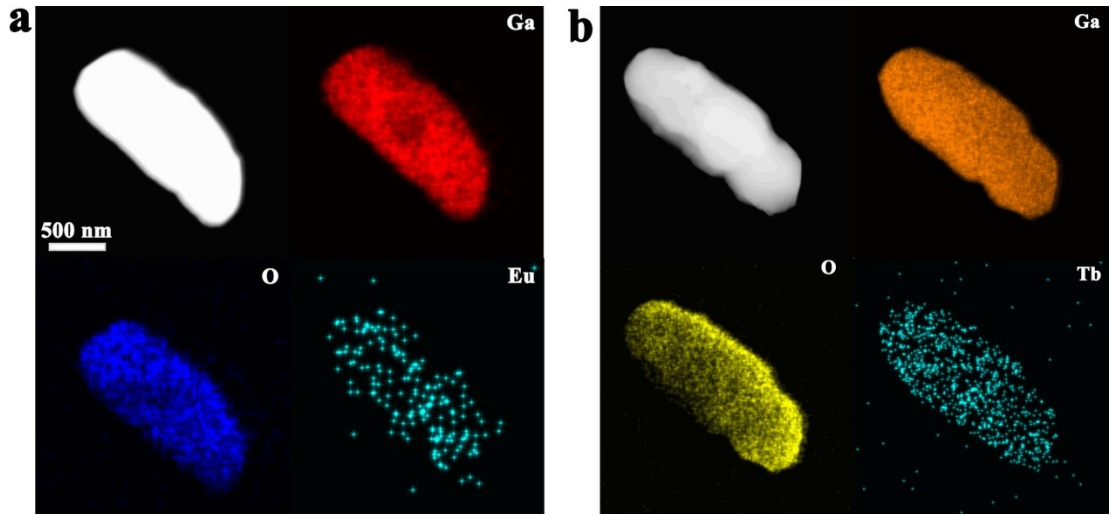

Fig. S3. Elemental distribution maps of the $LiGa_5O_8$:0.003Eu^{3+} phosphors and the $LiGa_5O_8$:0.003Tb^{3+} phosphors.

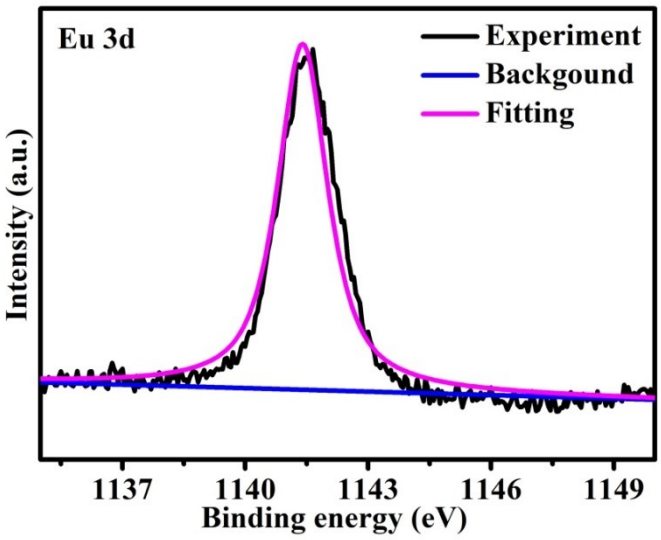

Fig. S4. High-resolution XPS spectra of Eu 3d.

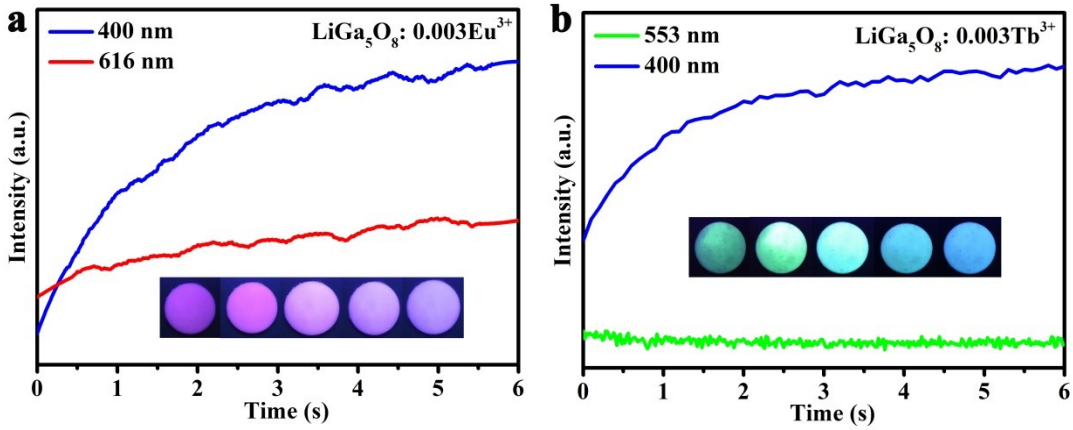

Fig. S5. The emission intensity in the period from 0 s to 6 s.

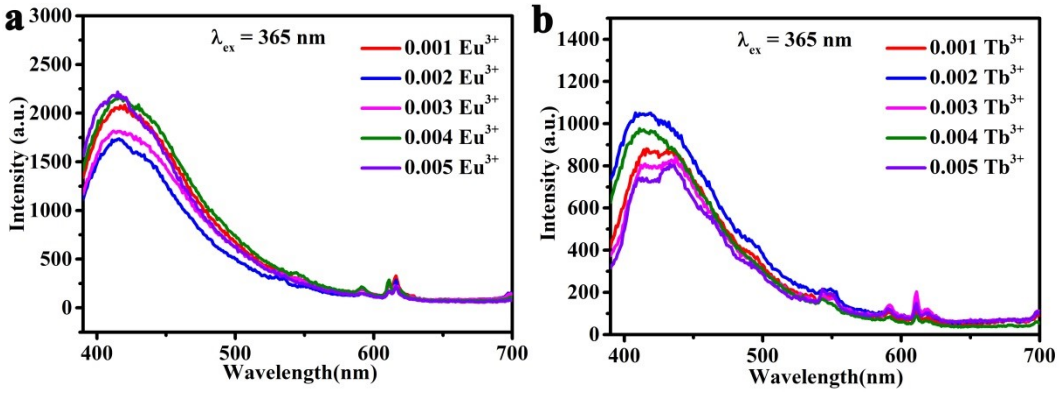

Fig. S6. PL spectra of $LiGa_5O_8$:xEu^{3+} phosphors and $LiGa_5O_8$:xTb^{3+} phosphors (x = 0.001-0.005).

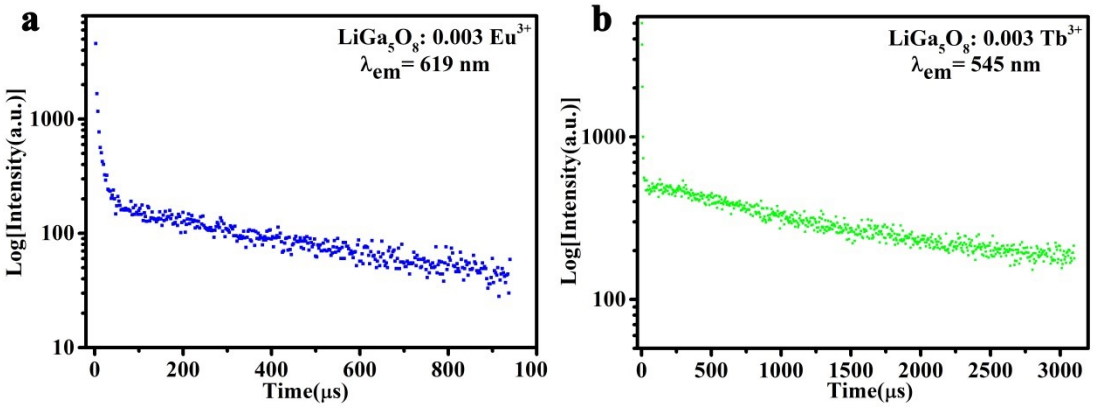

Fig. S7. Fluorescence decay curves of $LiGa_5O_8$:0.003Eu^{3+} phosphors and $LiGa_5O_8$:0.003Tb^{3+} phosphors at 254 nm excitation.

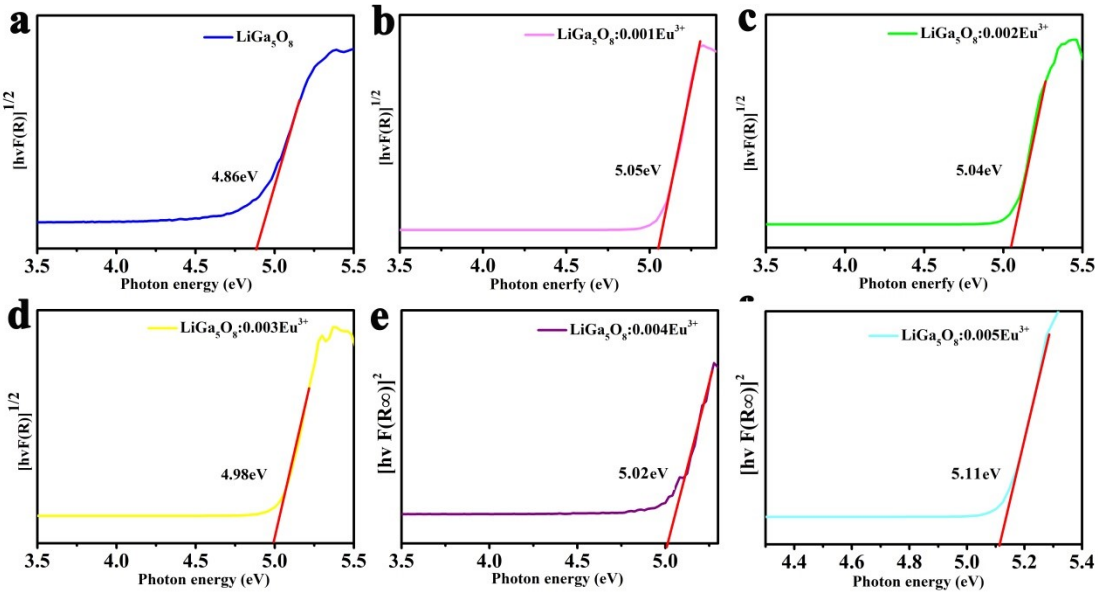

Fig. S8. DR spectra of $LiGa_5O_8:xEu^{3+}$ (x = 0, 0.001, 0.002, 0.003, 0.004, 0.005) phosphors.

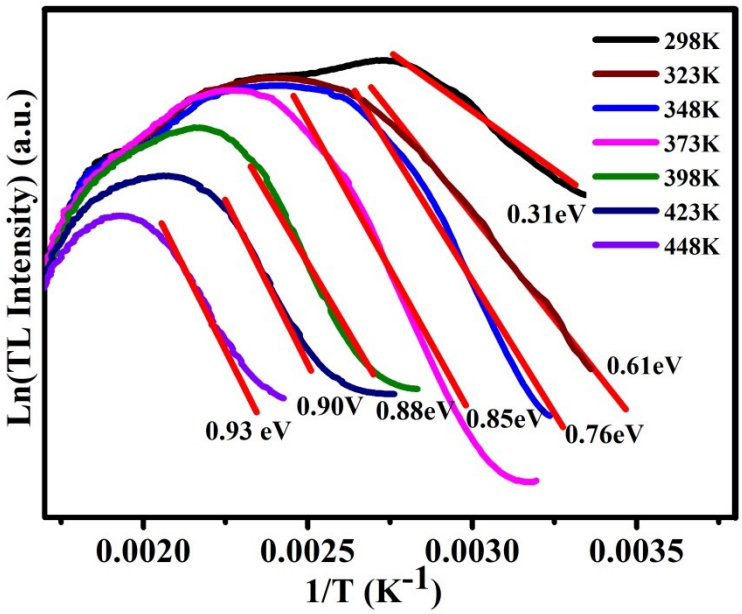

Fig. S9. TL curves analyzed by the initial rising method for trap depth evaluation.

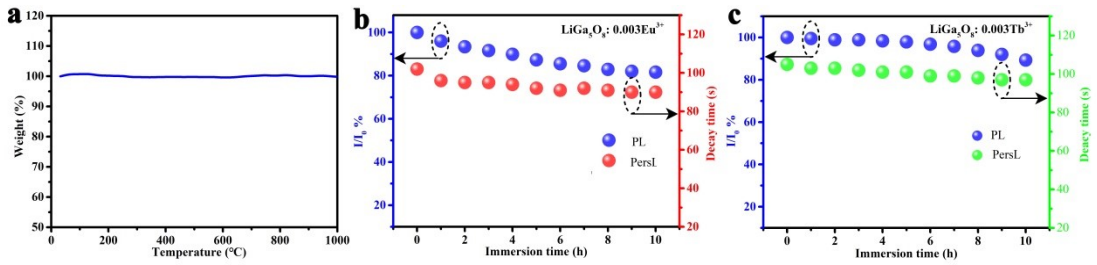

Fig. S10. (a) Thermogravimetric analysis (TGA) data of $LiGa_5O_8$:0.003Eu^{3+} under inert atmosphere. (b) Water resistance tests of the $LiGa_5O_8$:Eu^{3+} after being placed in tap water for different time. (c)Water resistance tests of the $LiGa_5O_8$: Tb^{3+} after being placed in tap water for different time.

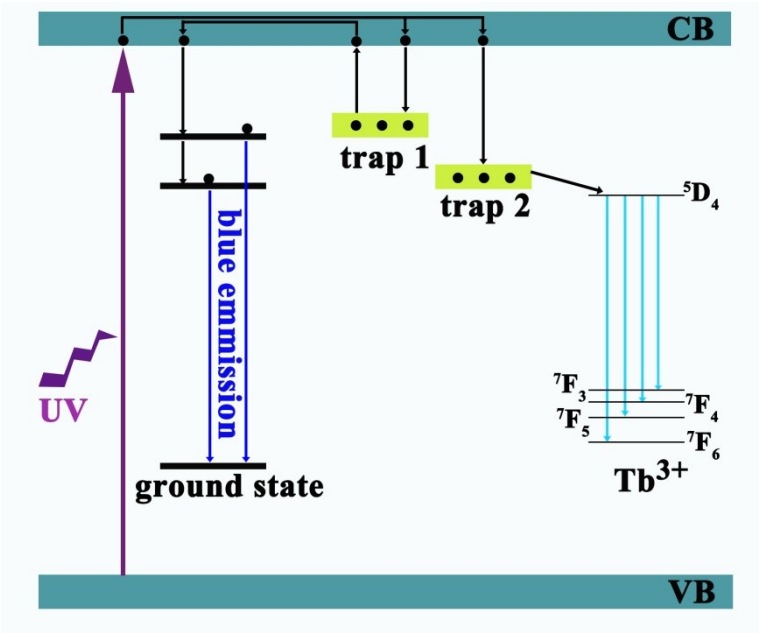

Fig. S11. Energy diagram proposed a plausible afterglow mechanism

Table S1. The refined crystallographic data of $LiGa_5O_8$.

Formula	$LiGa_5O_8$
Crystal system	Cubic
Space group	P4332 (212)
Lattice parameters	
a(Å)	8.2130
b(Å)	8.2130
c(Å)	8.2130
α°=β°=γ°	90
Cell volume($Å^3$)	553.78
T/K	297
Diffractometer	Rigaku D/Max-2400
Radiation/Å	Cu-Ka (λ= 1.5405)
Absorption correction	multi-scan
2θ range°/	10-70
Z	8
Calculated Density	5.3227 g/cm^3
R_{wp}	9.83%
R_p	7.10%

Table S2. Trap parameters and properties based on thermoluminescence peak fitting of $LiGa_5O_8:0.003Eu^{3+}$ phosphors.

Samples	Fitting	E (eV)	b	s (s^{-1})	n_0 (cm^{-3})
$LiGa_5O_8:0.003Eu^{3+}$	TL1	0.45	1.13	6.492×10^4	7.713×10^6
	TL2	0.69	1.99	1.044×10^7	6.775×10^6
	TL3	0.72	1.31	2.902×10^6	3.272×10^6
	TL4	0.74	1.35	3.483×10^5	2.848×10^6