Electronic Supplementary Material (ESI) for Dalton Transactions.

Supporting Information

Ultraviolet-C persistent luminescence from $Lu_2SiO_5:Pr^{3+}$ persistent phosphor for solar-blind optical tagging

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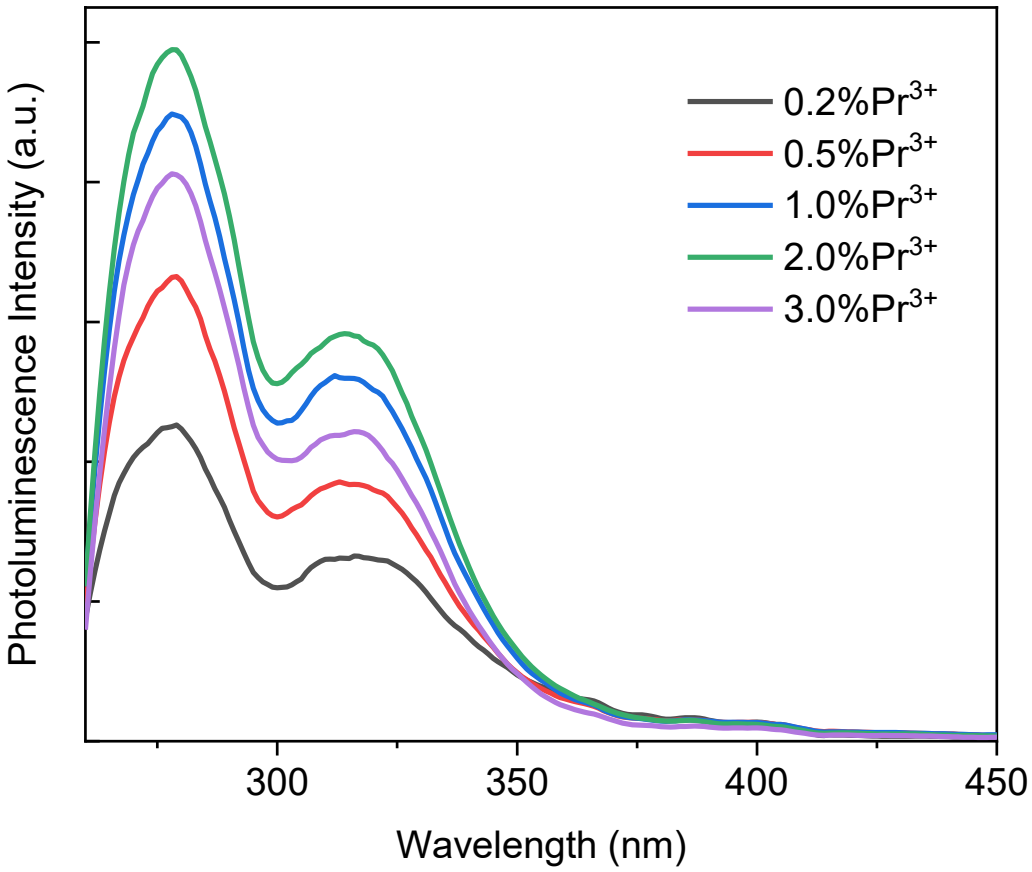

Fig. S1. Photoluminescence emission spectra of $Lu_{2-x}SiO_5$:x%Pr^{3+} (x= 0.2, 0.5, 1, 2, 3). The spectra are obtained under 248 nm light excitation.

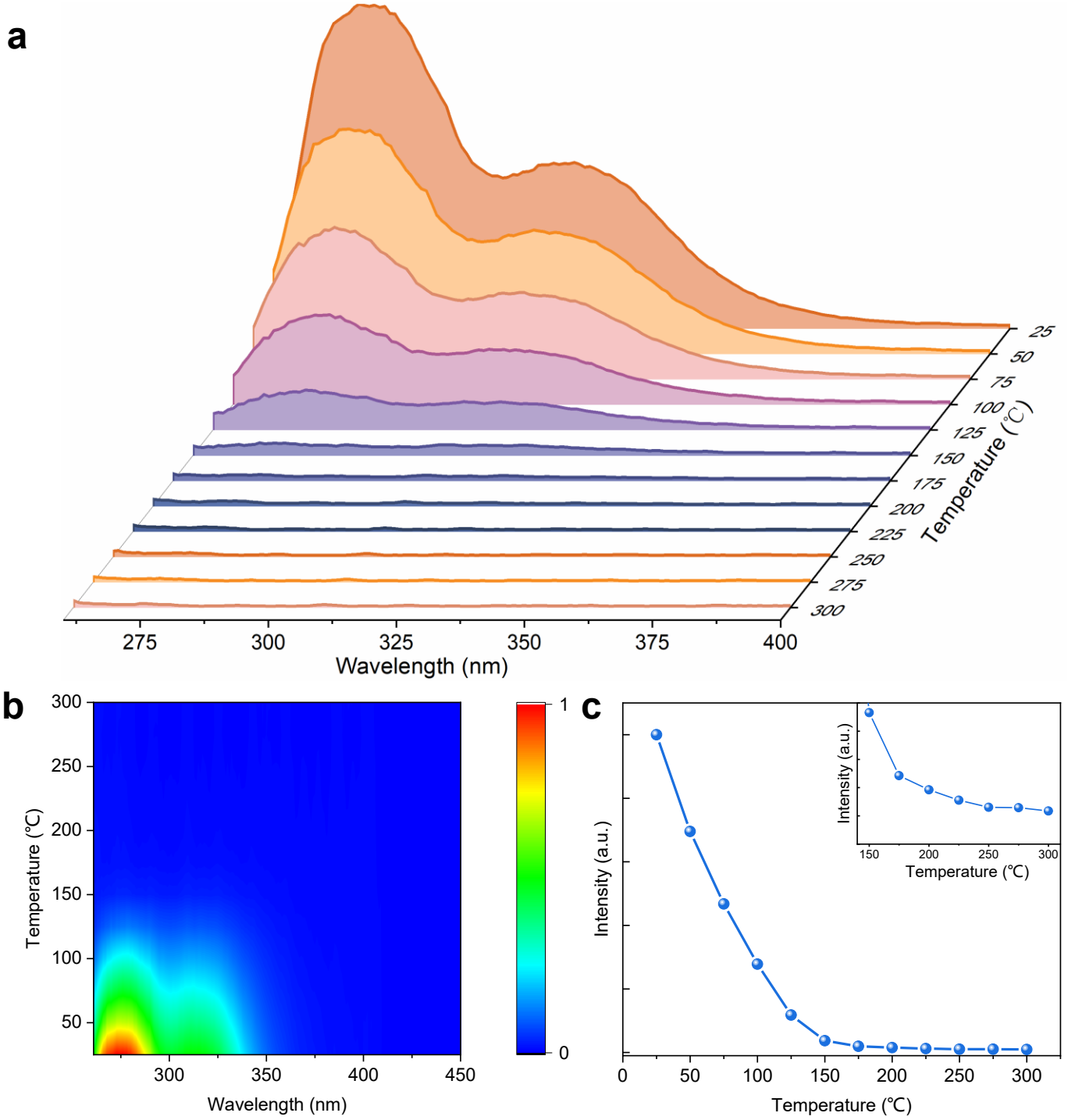

Fig. S2. (a) Temperature-depended emission spectra of $Lu_2SiO_5:Pr^{3+}$. (b) 2D color maps of temperature-dependent emission spectra of $Lu_2SiO_5:Pr^{3+}$ phosphors. (c) Normalized emission intensities monitored at 280 nm as a function of temperature.

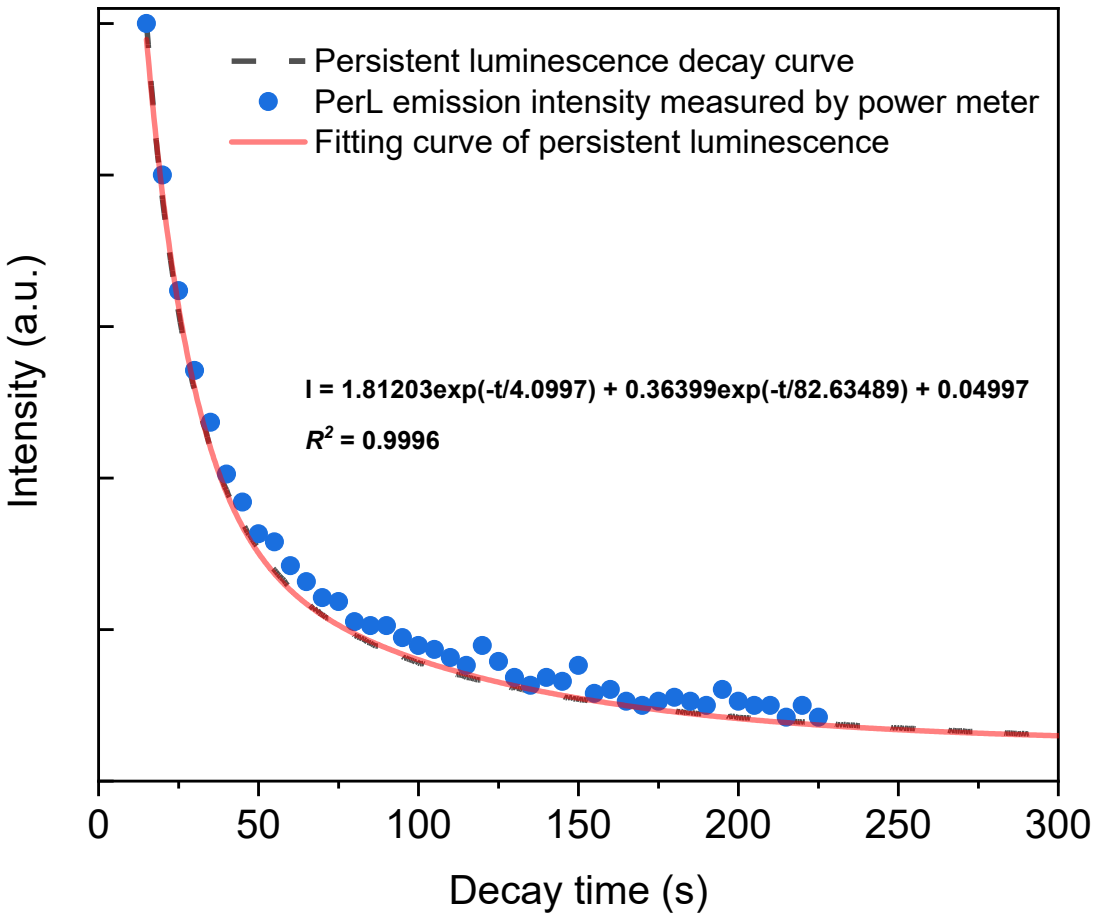

Fig. S3. Persistent luminescence decay curve (grey dash curve) monitored at 270 nm. The decay curve was normalized at the 15 s decay instant. The measured persistent luminescence intensity was also normalized at the 15 s decay instant and the red line is the fitting curve of persistent luminescence intensity.

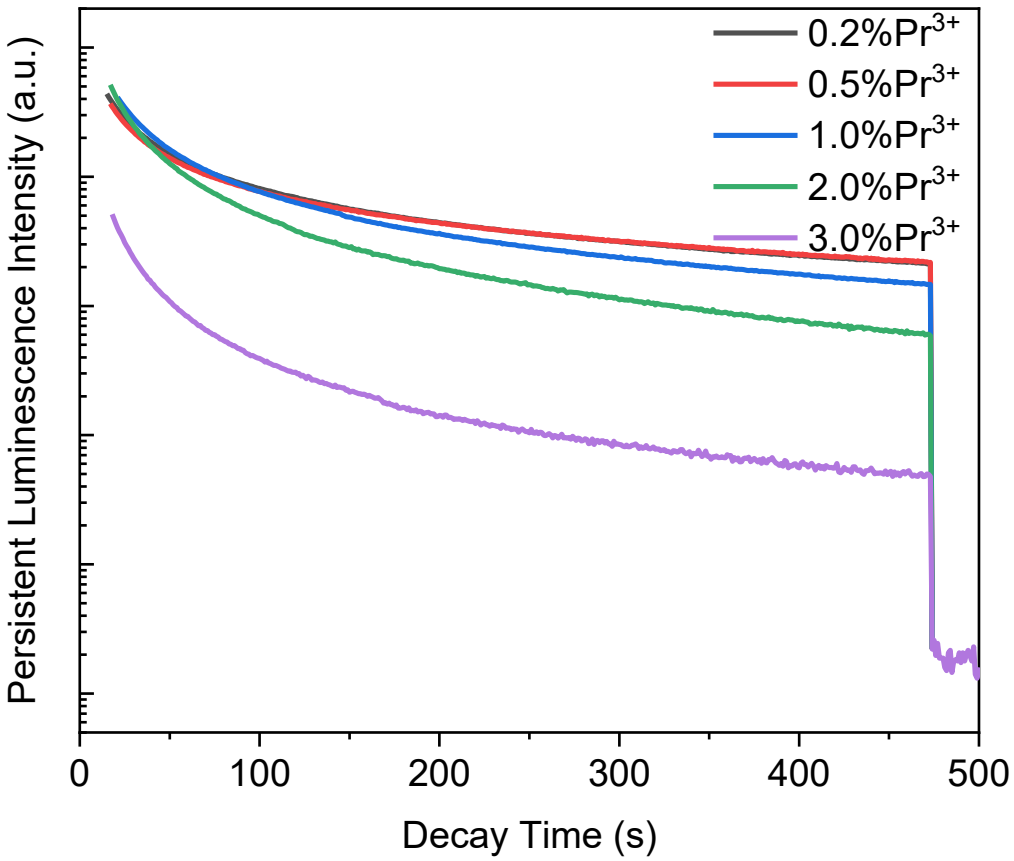

Fig. S4. Persistent luminescence decay curves of $Lu_{2-x}SiO_5$:x%Pr^{3+} (x= 0.2, 0.5, 1, 2, 3) phosphors monitored at 270 nm at room temperature. The samples were irradiated by a 254 nm UV-lamp for 10 min.

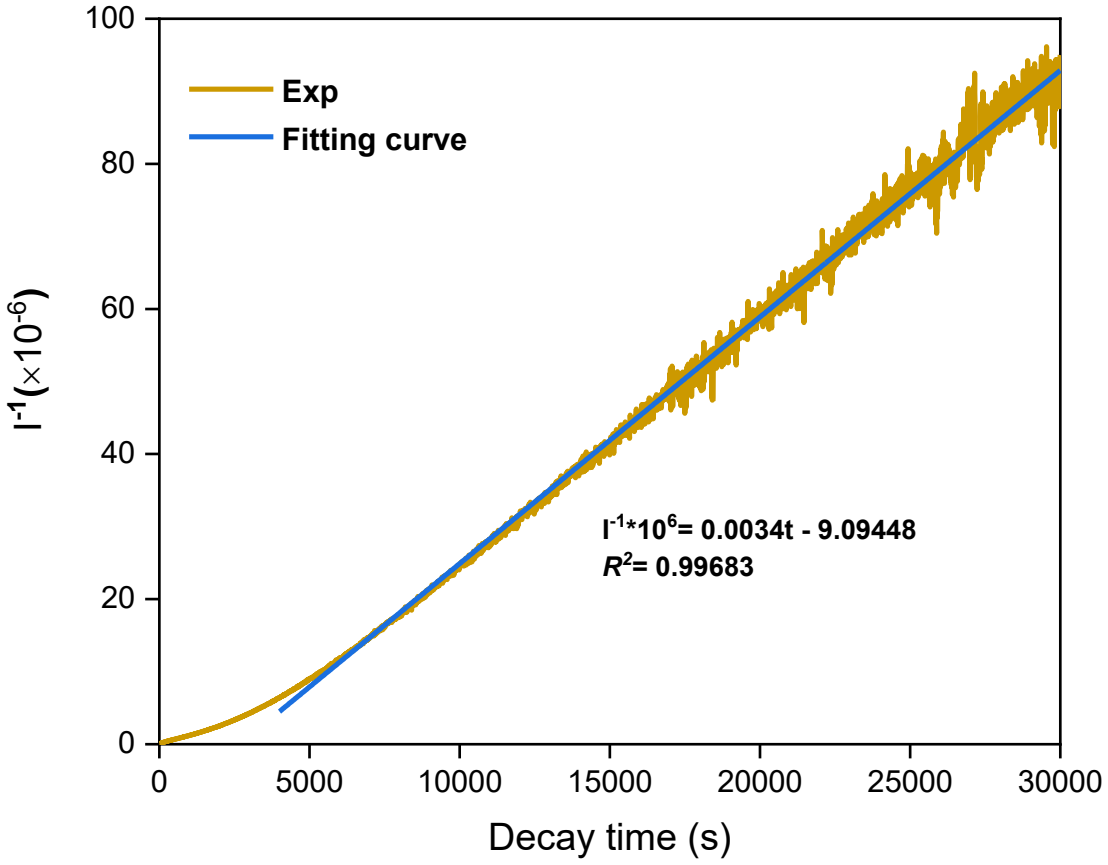

Fig. S5. The relationship of persistent luminescence intensity (I^{-1}) as a function of decay time (t).

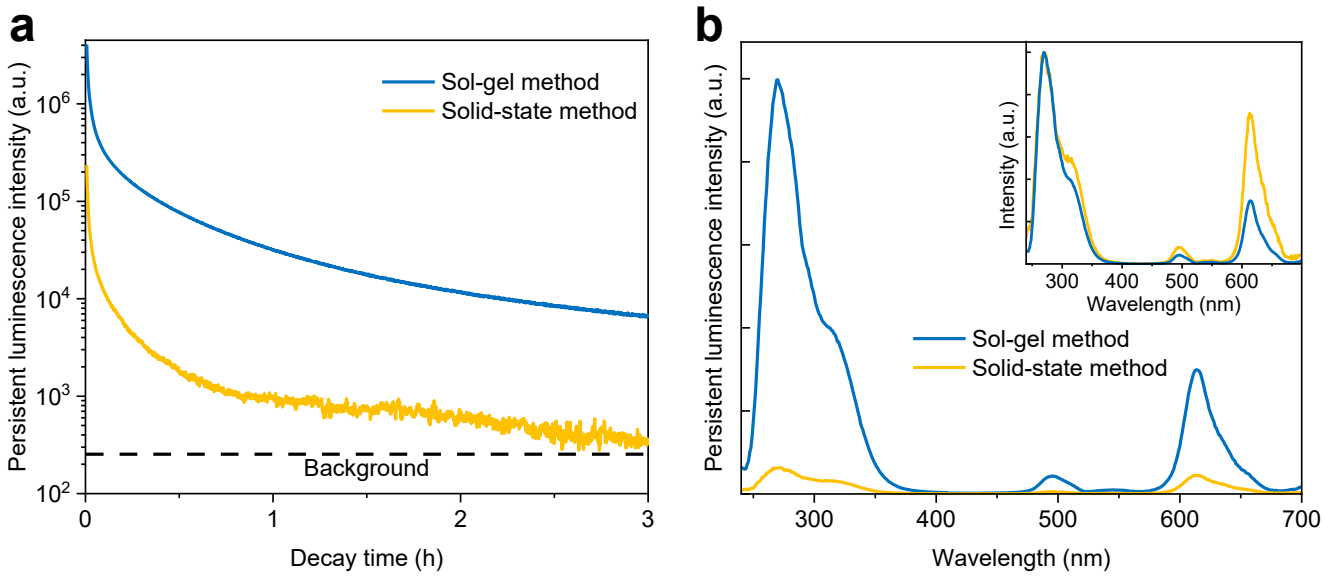

Fig. S6. Comparison of persistent luminescence properties of $Lu_2SiO_5:Pr^{3+}$ prepared by sol-gel method and high-temperature solid-state reaction method. (a) Persistent luminescence decay curves of $Lu2SiO_5:Pr^{3+}$ prepared with different methods. The curves were monitored at 270 nm after the sample pre-irradiated by a 254 nm UV lamp for 15 min. (b) Persistent luminescence emission spectra of $Lu_2SiO_5:Pr^{3+}$ prepared with different methods. The emission spectra were measured after 1 min decay after the stoppage of 254 nm UV lamp irradiation for 5 min. The inset shows the normalized persistent luminescence emission spectra of $Lu_2SiO_5:Pr^{3+}$ prepared with different methods.

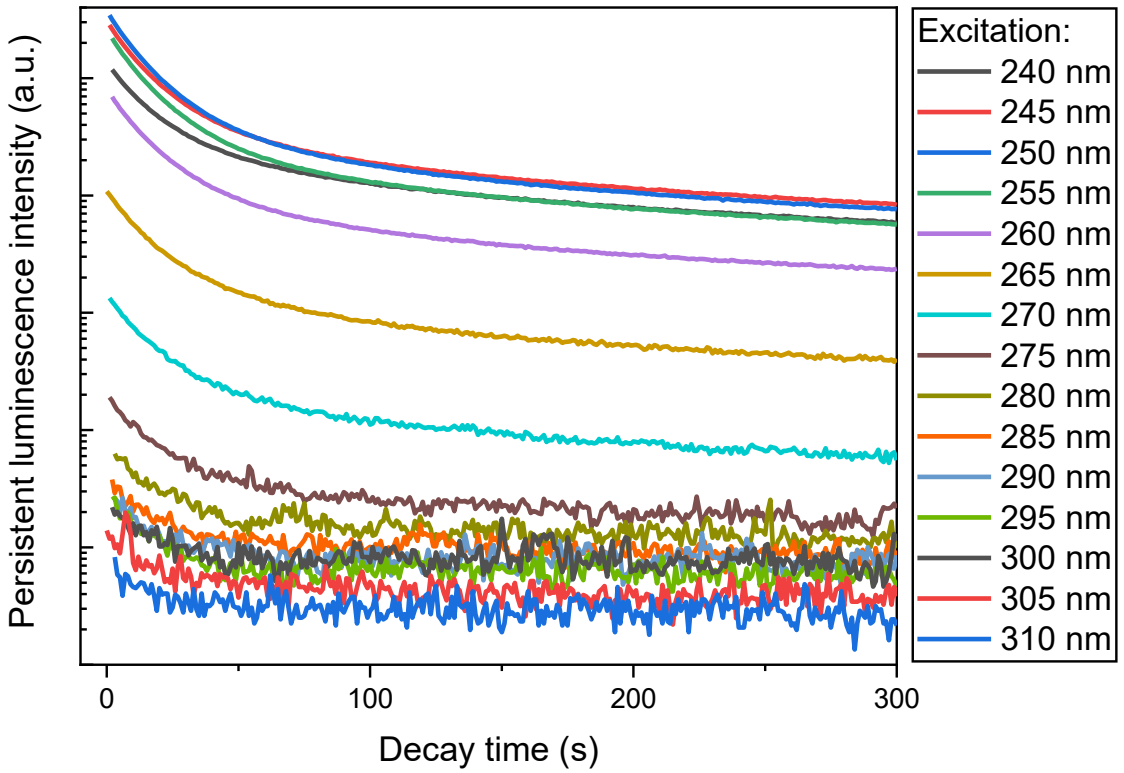

Fig. S7. Room temperature persistent luminescence decay curves of $Lu_2SiO_5:Pr^{3+}$ phosphor irradiated by monochromatic light between 240-310 nm for 5 min. The monitoring wavelength is 270 nm. The persistent luminescence intensity at 30 s decay after the stoppage of the irradiation (I_{30s}) was used to plot the persistent luminescence intensity as a function of excitation wavelength, as shown in Fig. 4b.

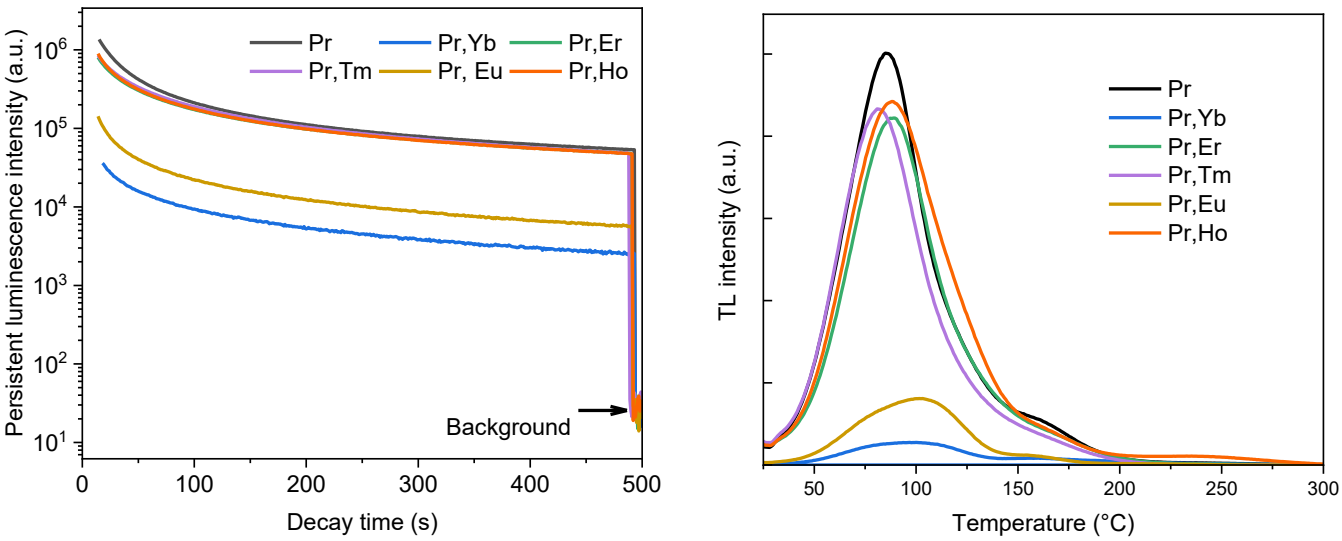

Fig. S8. (a) Persistent luminescence decay curves of $Lu_2SiO_5:Pr^{3+}$ and $Lu_2SiO_5:Pr^{3+},RE^{3+}$ (RE=Yb, Er, Tm, Eu, and Ho) samples. (b) TL curves of $Lu_2SiO_5:Pr^{3+}$ and $Lu_2SiO_5:Pr^{3+},RE^{3+}$ (RE=Yb, Er, Tm, Eu, and Ho) samples. The curves were measured at 1 min after the stoppage of 254 nm UV lamp irradiation.

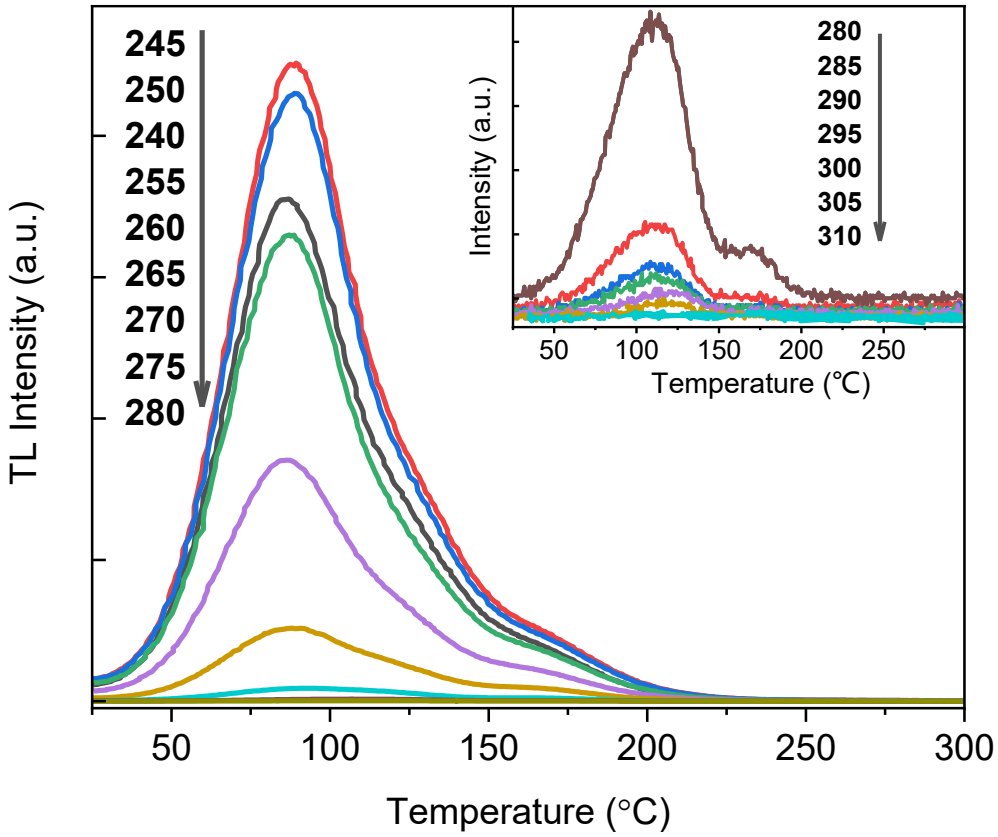

Fig. S9. TL curves with an excitation wavelength from 240 to 310 nm of $Lu_2SiO_5:Pr^{3+}$ phosphor. The sample was pre-irradiated for 10 min at each measured wavelength using a xenon arc lamp.

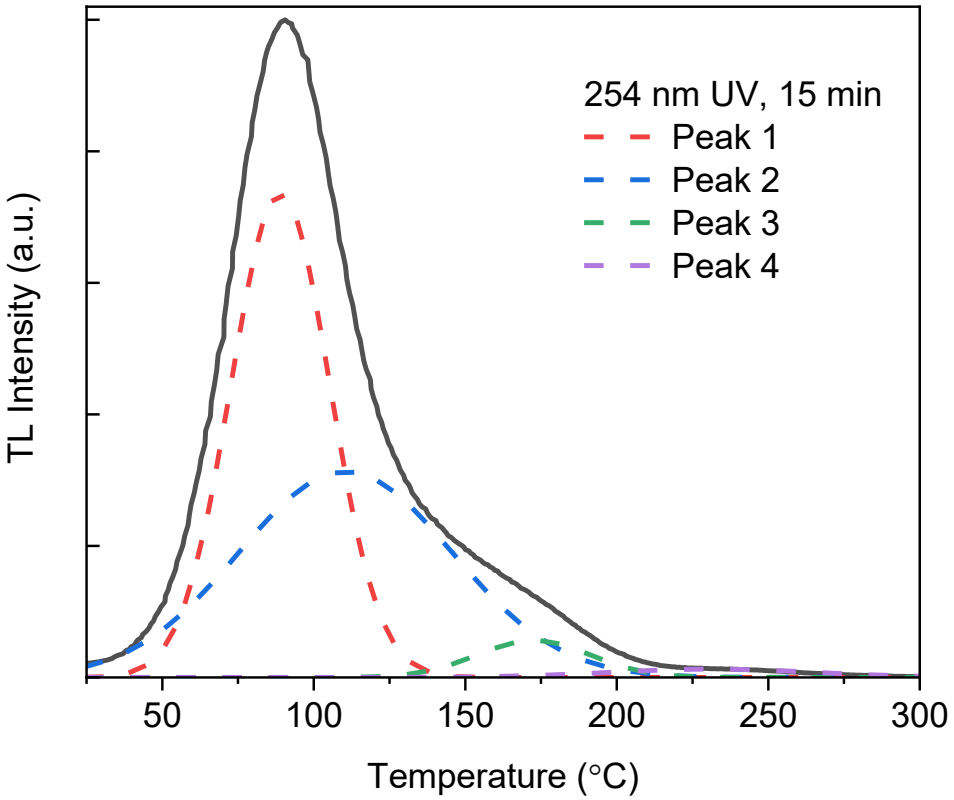

Fig. S10. TL curve of $Lu_2SiO_5:Pr^{3+}$ phosphor at 60 s short decay and the Gaussian fitting results. The sample was pre-irradiated by a 254 nm UV lamp for 15 min.

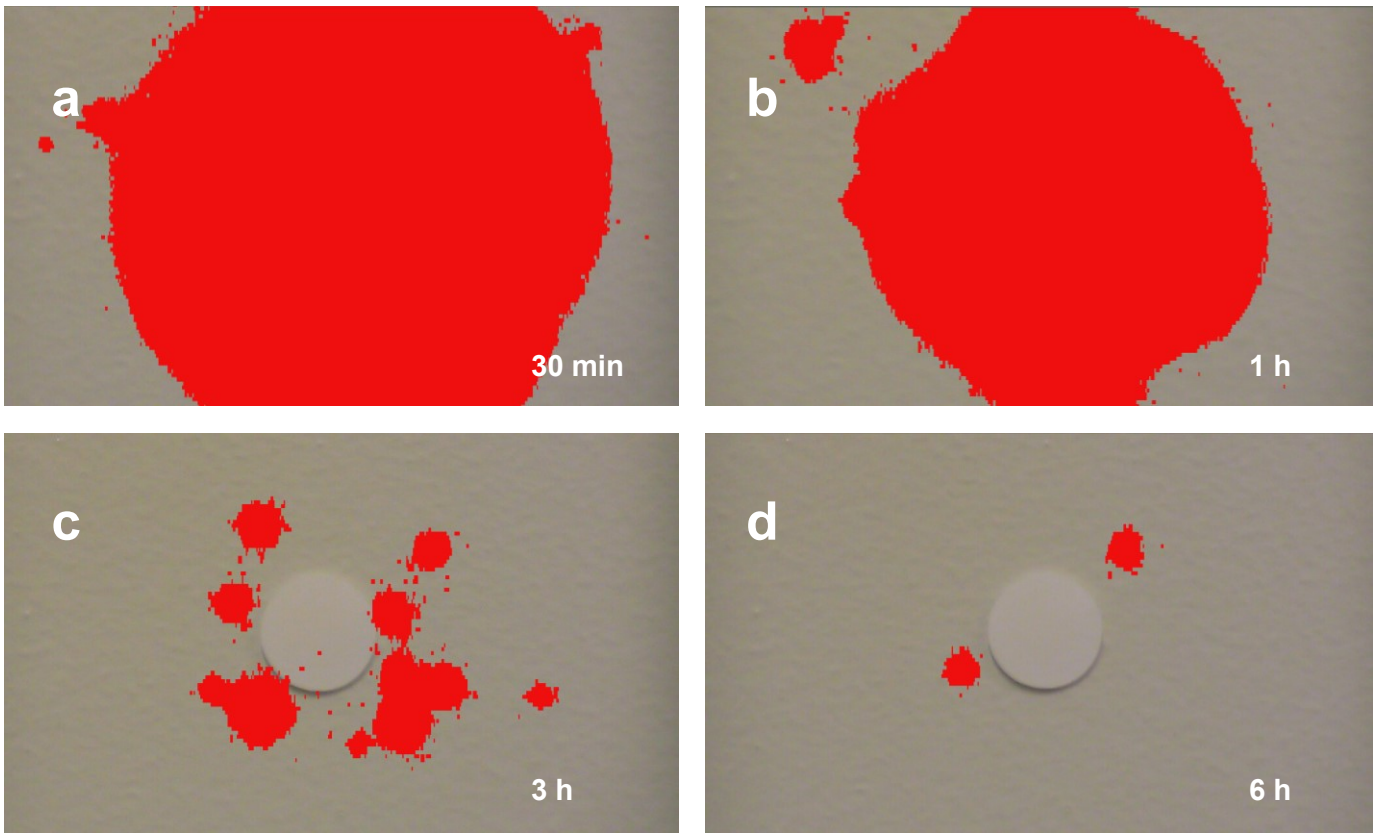

Fig. S11. UVC images of $Lu_2SiO_5:Pr^{3+}$ persistent phosphor disc taken in indoor-lighting environment from 30 min to 6 h. The detected UVC emission is denoted by red pattern, whose area is proportional to the emission intensity. The sample was pre-irradiated by a 254 nm lamp for 10 min.

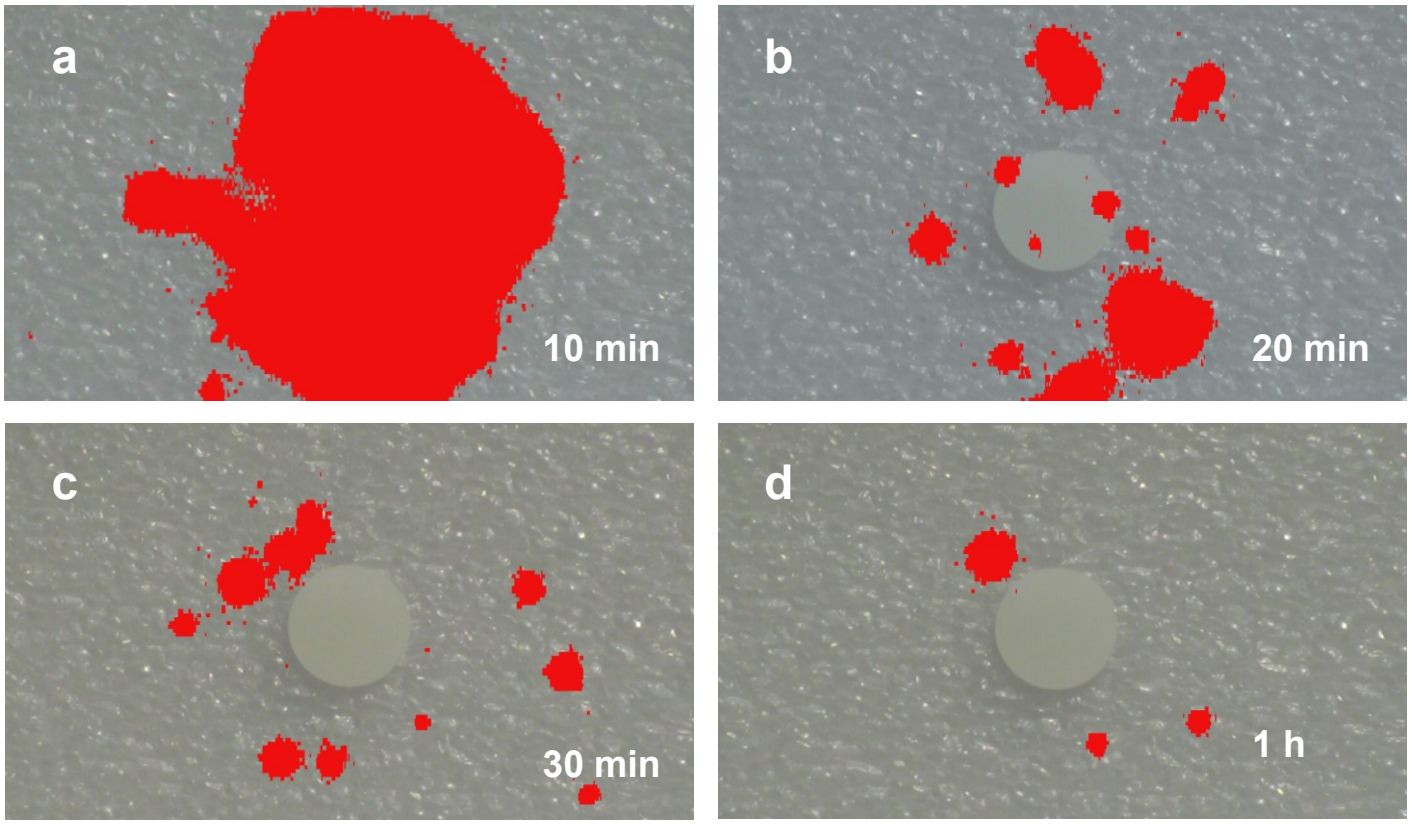

Fig. S12. UVC images of $Lu_2SiO_5:Pr^{3+}$ persistent phosphor in direct sunlight from 10 min to 1 h. The detected UVC emission is denoted by red pattern, whose area is proportional to the emission intensity. The sample was pre-irradiated by a 254 nm lamp for 10 min.

Sample	Lu_2SiO_5:0.5%Pr^{3+}
Space group	C12/c1
a (Å)	14.2539(7)
b (Å)	6.6431(8)
c (Å)	10.2564(8)
V ($Å^3$)	822.113(3)
α= γ (°)	90
β (°)	122.1681(8)
Density (g/cm^3)	7.1948(7)
Rp and Rwp	5.256% and 7.454%

Table S1. Rietveld refinement parameters of Lu_2SiO_5:Pr^{3+} phosphor.

Decay time (s)	Intensity (pW)
5	304.74
10	180.23
15	130.70
20	104.56
25	84.611
30	70.853
35	61.910
40	54.343
45	48.152
50	42.649
55	41.274
60	37.146

Table S2. Persistent luminescence power intensities of $Lu_2SiO_5:Pr^{3+}$ phosphor measured by a Newport UV power meter.