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

Supporting Information

Enabling narrowband cyan photoluminescence and long-lasting ultraviolet-A persistent luminescence in Bi^{3+} single-doped $Sr_3Sc_2Ge_3O_{12}$ phosphor by selective site occupation

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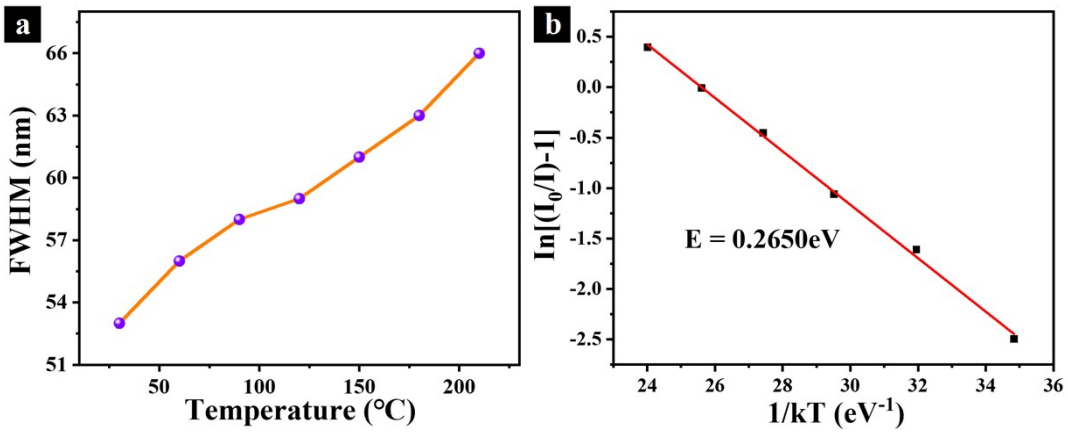

Fig. S1. (a) The FWHM values $Sr_3Sc_2Ge_3O_{12}$:15%Bi^{3+} phosphor under different temperatures. (b) The plot of $\ln[(I_0/I)^{-1}]$ versus $1/kT$.

The activation energy ΔE can be obtained using the following equation:

$$I_T = \frac{I_0}{1 + c\exp(-\frac{\Delta E}{kT})} \quad (1)$$

where T represents the temperature, k is the Boltzmann constant (8.629×10^{-5}Ev/k), c is a constant, I_0 and I_T are the initial PL intensity of the samples at room temperature and different temperatures, respectively. The Plot of $\ln[I_0/I-1]$ versus 1/kT is given in Fig. S1. On the basis of Eq. 1, ΔE values of $Sr_3Sc_2Ge_3O_{12}$:15%Bi^{3+} sample was calculated to be 0.2650 eV.

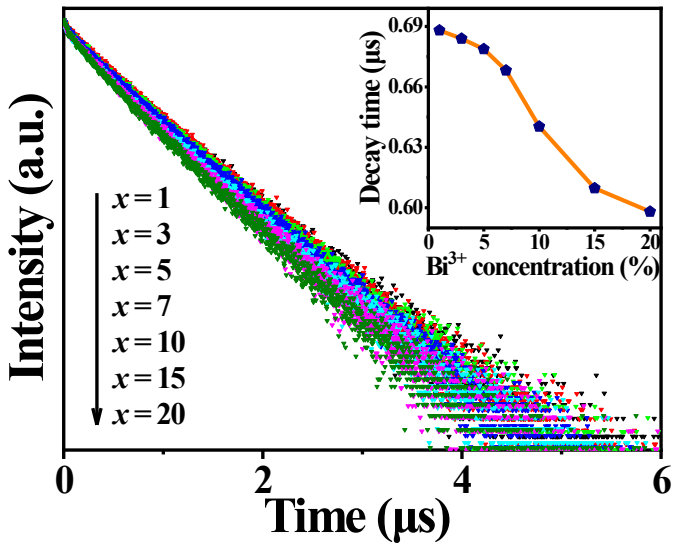

Fig. S2. The fluorescence decay curves of $Sr_3Sc_2Ge_3O_{12}:Bi^{3+}$ phosphors under different Bi^{3+} contents by monitoring 487 nm emission upon 375-nm-laser excitation.

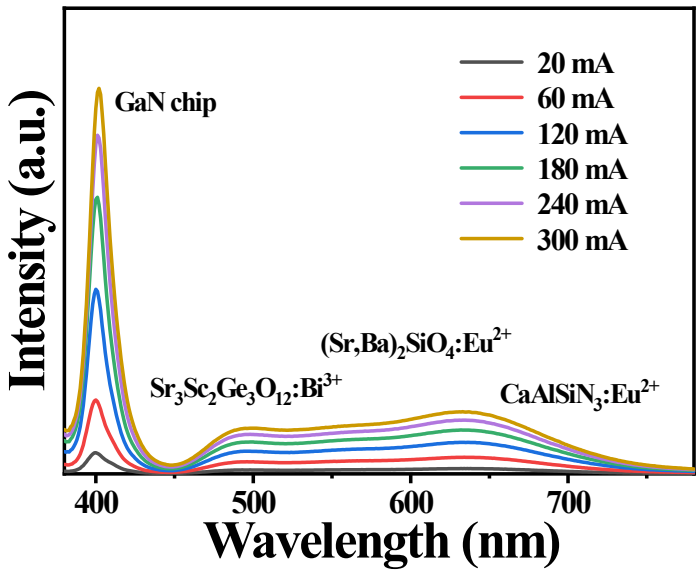

Fig. S3. Emission spectra of the LED fabricated with $Sr_3Sc_2Ge_3O_{12}:Bi^{3+}$, yellow phosphor $(Sr,Ba)_2SiO_4:Eu^{2+}$ and red phosphor $CaAlSiN_3:Eu^{2+}$ on a near-UV LED chip (λ = 395 nm) under different currents.

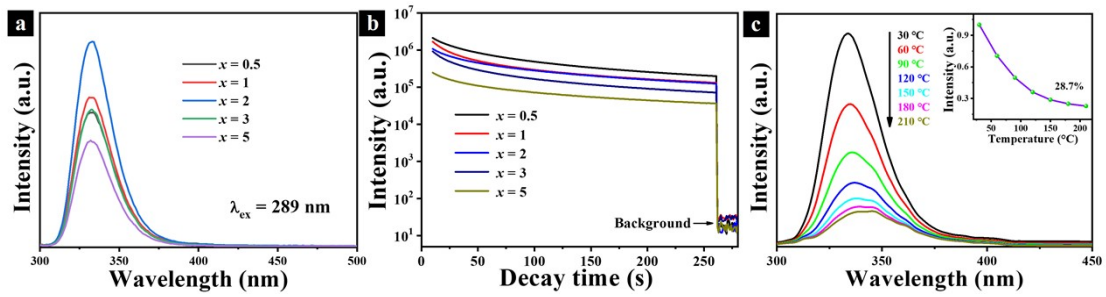

Fig. S4. (a) Emission spectra of $Sr_3Sc_2Ge_3O_{12}$:x%Bi^{3+} (x = 0.5, 1, 2, 3 and 5) phosphors under the excitation of 289 nm. (b) Persistent luminescence decay curves of $Sr_3Sc_2Ge_3O_{12}$:x%Bi^{3+} samples monitored at 333 nm after irradiation by a 254 nm UV lamp for 10 min. (c) The temperature dependent emission spectra of $Sr_3Sc_2Ge_3O_{12}$:0.5%Bi^{3+} phosphor. Inset: the temperature dependence of relative intensity.

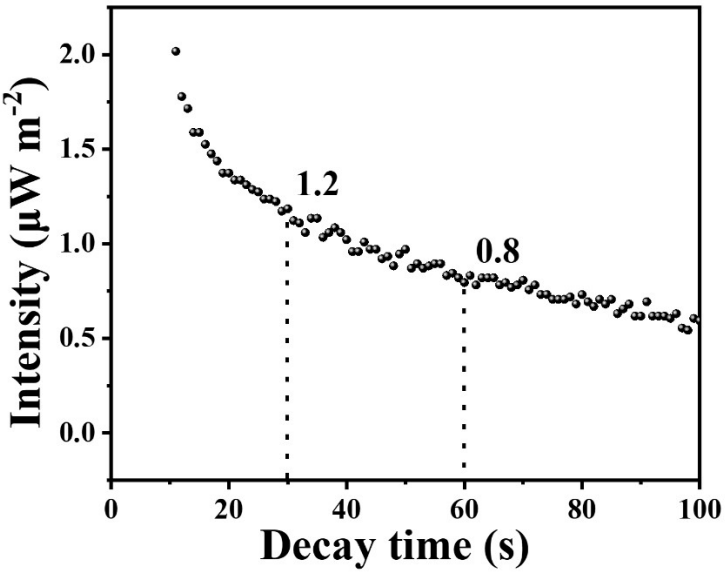

Fig. S5. The luminescence power intensity of $Sr_3Sc_2Ge_3O_{12}$:0.5%Bi^{3+} phosphor monitored at 333 nm.

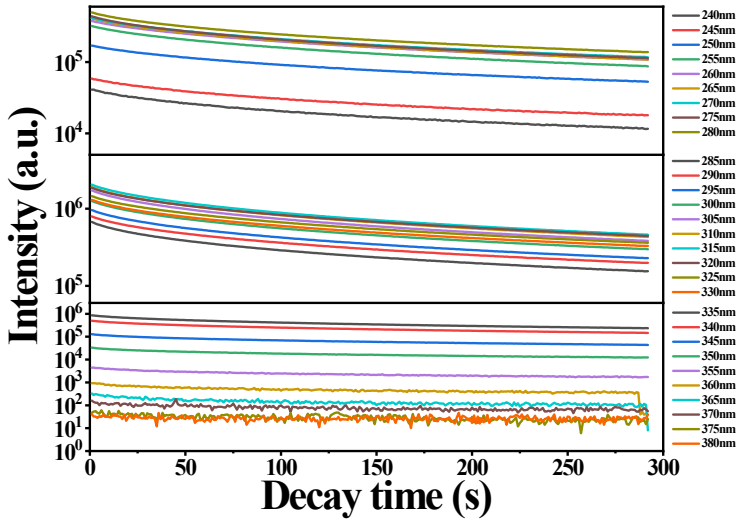

Fig. S6. Persistent luminescence decay curves of $Sr_3Sc_2Ge_3O_{12}$:0.5%Bi^{3+} phosphor irradiated by 240–380 nm lights for 5 min. The monitoring wavelength is 333 nm.

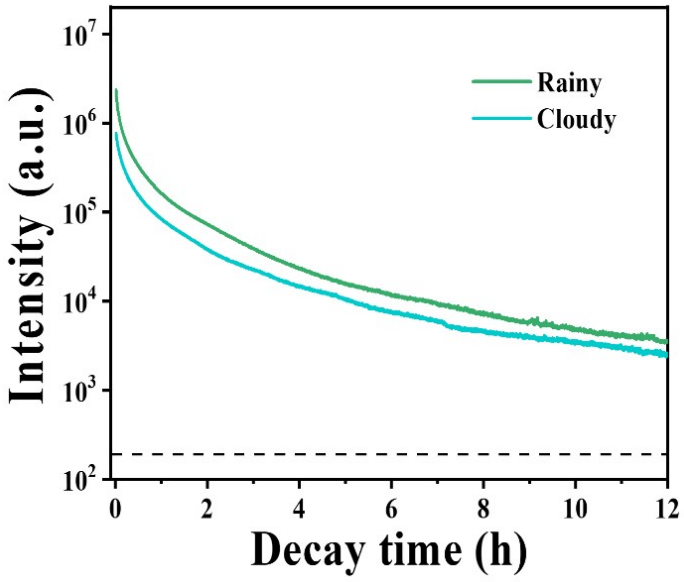

Fig. S7. UVA persistent luminescence decay curves after irradiation with direct sunlight for 30 min under different weather conditions.

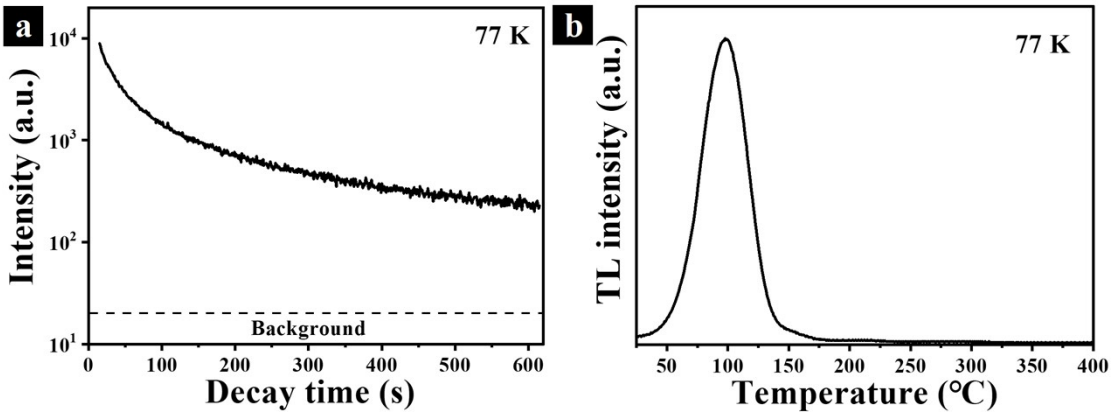

Fig. S8. (a) Persistent luminescence decay curve of $Sr_3Sc_2Ge_3O_{12}:Bi^{3+}$ phosphor irradiated by 310 nm light for 10 min at 77 K. The monitoring wavelength is 333 nm. (b) TL spectra of $Sr_3Sc_2Ge_3O_{12}:Bi^{3+}$ phosphor obtained by illuminating with 310 nm light for 10 min at 77 K.

Table S1 Rrefined structural parameters and cell parameter values of $Sr_3Sc_2Ge_3O_{12}$:Bi^{3+} from the Rietveld refinement.

Formula	$Sr_3Sc_2Ge_3O_{12}$			
Crystal system	Cubic			
Space group	*Ia-3d* (230)			
Cell parameters	$a = b = c = 12.786148$ Å			
	Alpha = 90	Beta = 90	Gamma = 90	
Cell volume	$V = 2090.351$ Å^3			
Z	8			
Reliability factors	$R_p = 6.41\%$, $R_{wp} = 9.76\%$ and $\chi^2 = 4.074$			
Atom	x/a	y/b	z/c	Ui/Ue*100
Sr1	0.125000	0.000000	0.250000	0.00
Sc1	0.00000	0.000000	0.000000	-1.60
Ge1	0.375000	0.000000	0.250000	0.36
O1	0.963273	0.052963	0.142525	2.35

Table S2 Chromaticity parameters of the fabricated white LED under different diving currents.

Current (mA)	CIE coordinates (x, y)	CCT (K)	CRI
20	0.4024, 0.4046	3672	95.9
60	0.4017, 0.4020	3667	96.1
120	0.3971, 0.3931	3703	95.9
180	0.3917, 0.3857	3775	95.3
240	0.3880, 0.3806	3828	94.8
300	0.3851, 0.3763	3870	94.3