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

Supporting Information

Sunlight-activated Yellow long persistent luminescence from Nb-doped $Sr_3SiO_5:Eu^{2+}$ for warm-color mark applications

Zhizhen Wang†, Zhen Song†, Lixin Ning‡,* Quanlin Liu†,*

†The Beijing Municipal Key Laboratory of New Energy Materials and Technologies, School of Materials Sciences and Engineering, University of Science and Technology Beijing, Beijing 100083, China

‡Anhui Key Laboratory of Optoelectric Materials Science and Technology, Key Laboratory of Functional Molecular Solids, Ministry of Education, Anhui Normal University, Wuhu 241000, P.R. China

Table S1. Main parameters of persistent luminescent materials having relatively good performance.

Host material	Dopants	Persistent emission wavelength (nm)	Persistent duration time (h)	Reference
$CaAl_2O_4$	Eu^{2+},Nd^{3+}	440	□5	S1
$Sr_3MgSi_2O_8$	Eu^{2+},Dy^{3+}	460	□10	S1
$Sr_2MgSi_2O_7$	Eu^{2+},Dy^{3+}	470	□10	S1
$Sr_4Al_{14}O_{25}$	Eu^{2+},Dy^{3+}	490	> 20	S1
$SrAl_2O_4$	Eu^{2+},Dy^{3+}	520	□30	S1
$Y_3Al_2Ga_3O_{12}$	Ce^{3+},Yb^{3+}	520	□100	S2
$Ca_2Al_2SiO_7$	Ce^{3+} >> Mn^{2+}	550	□10	S3
$CaGa_2S_4$	Eu^{2+},Ho^{3+}	555	□0.5	S1
$CdSiO_3$	Mn^{2+}	575	□1	S4
Y_2O_2S	Ti^{3+}/defects	594	> 5	S4
$Ca_2Si_5N_8$	Eu^{2+},Tm^{3+}	620	□1	S3
(Ca,Sr)$AlSiN_3$	Eu^{2+}	628	□2	S5
CaS	Eu^{2+},Tm^{3+}	650	□1	S3
$MgSiO_3$	Eu^{2+}>> Mn^{2+}	665	~ 4	S3

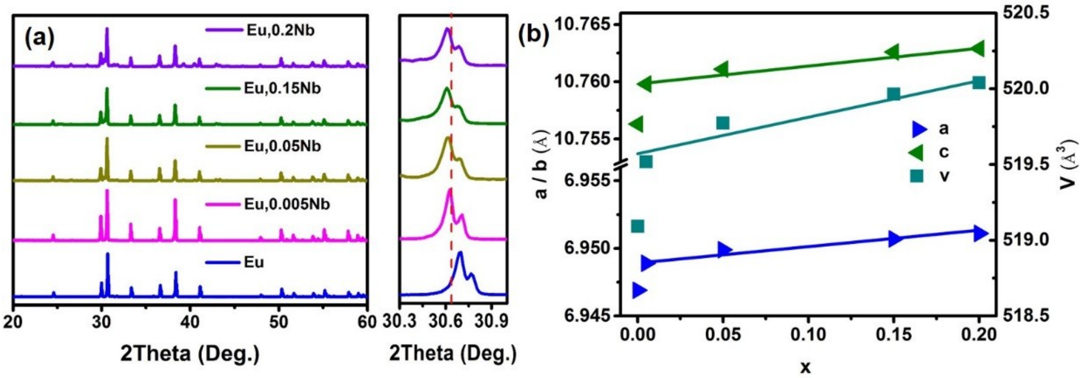


Figure S1. a) XRD patterns of $Sr_3(Si_{1-x}Nb_x)O_5$:Eu^{2+} (x = 0 – 0.2) samples. All the samples are pure Sr_3SiO_5 phases. b) Dependence of the lattice parameters and unit cells volume on x value. Cell parameters have a linear increase trend except x = 0 sample.

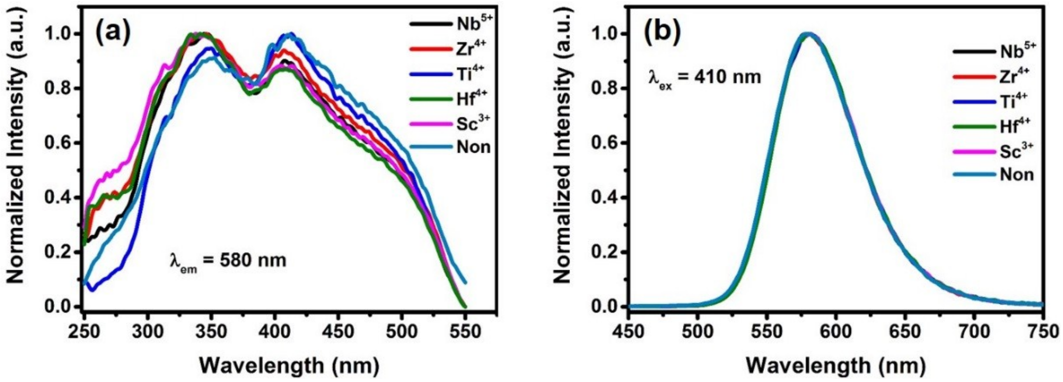


Figure S2. a) PLE spectrums of Sr_3SiO_5:Eu^{2+} and Sr_3SiO_5:Eu^{2+}, TM phosphors measured under 580 nm emission wavelength at room temperature. b) PL spectrums of all the phosphors measured under 410 nm excitation wavelength.

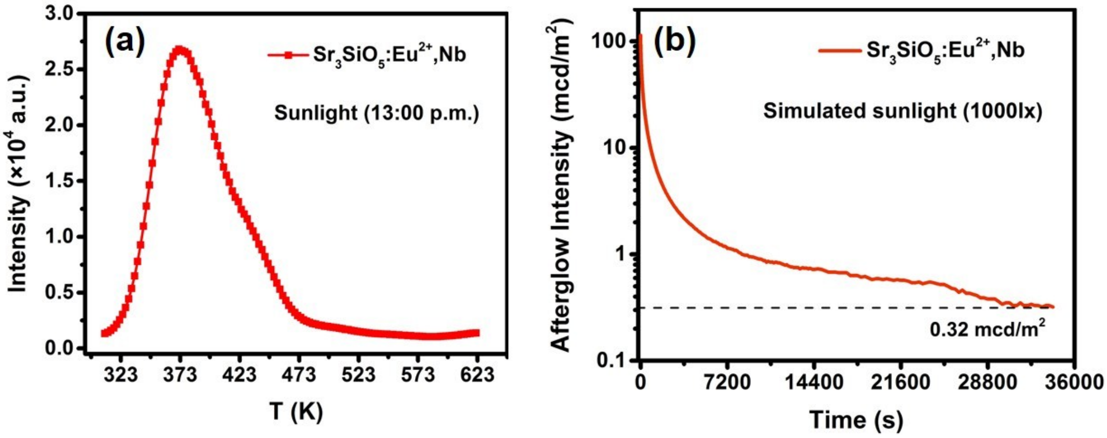


Figure S3. a) TL glow curve of Sr_3SiO_5:Eu^{2+}, Nb sample after 10 minutes charging by sunlight. b) Persistent luminescence decay curve of Sr_3SiO_5:Eu^{2+}, Nb after 10 minutes simulated sunlight (1000 lx) radiation.

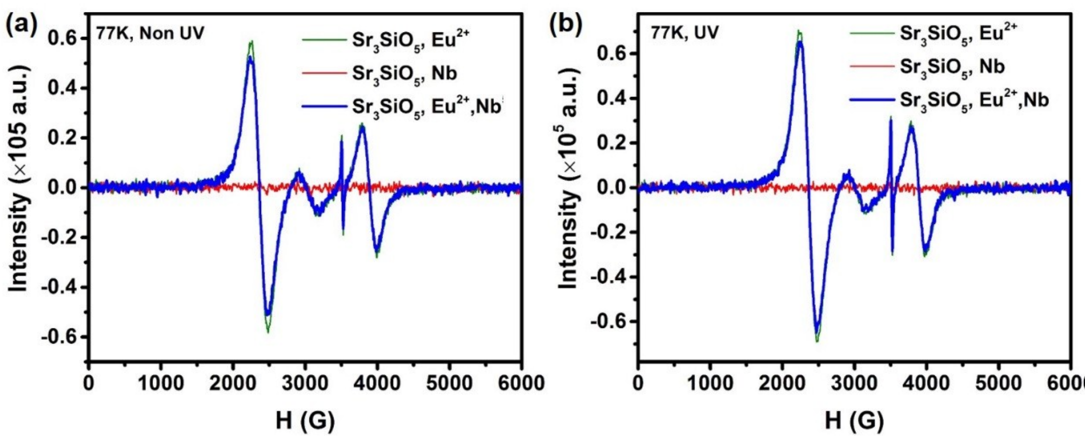
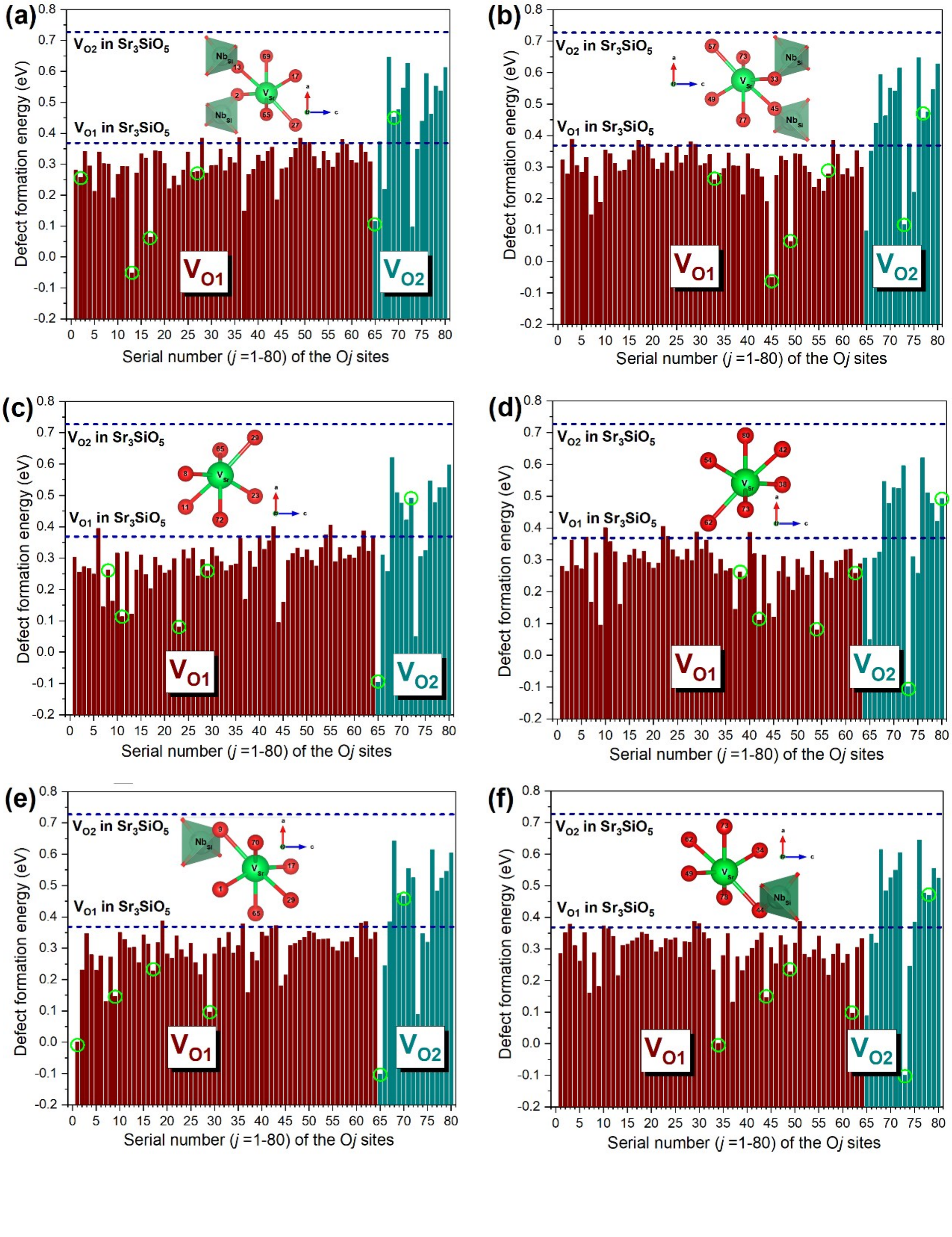


Figure S4. Low temperature (77 K) EPR spectra of Sr_3SiO_5:Eu^{2+} (green line), and Sr_3SiO_5, Nb (red line) and Sr_3SiO_5:Eu^{2+}, Nb (blue line). a) Non UV. b) after 100 s UV radiation. Sharp signal at about 3520 G (g = 2.002) corresponding to oxygen vacancies.



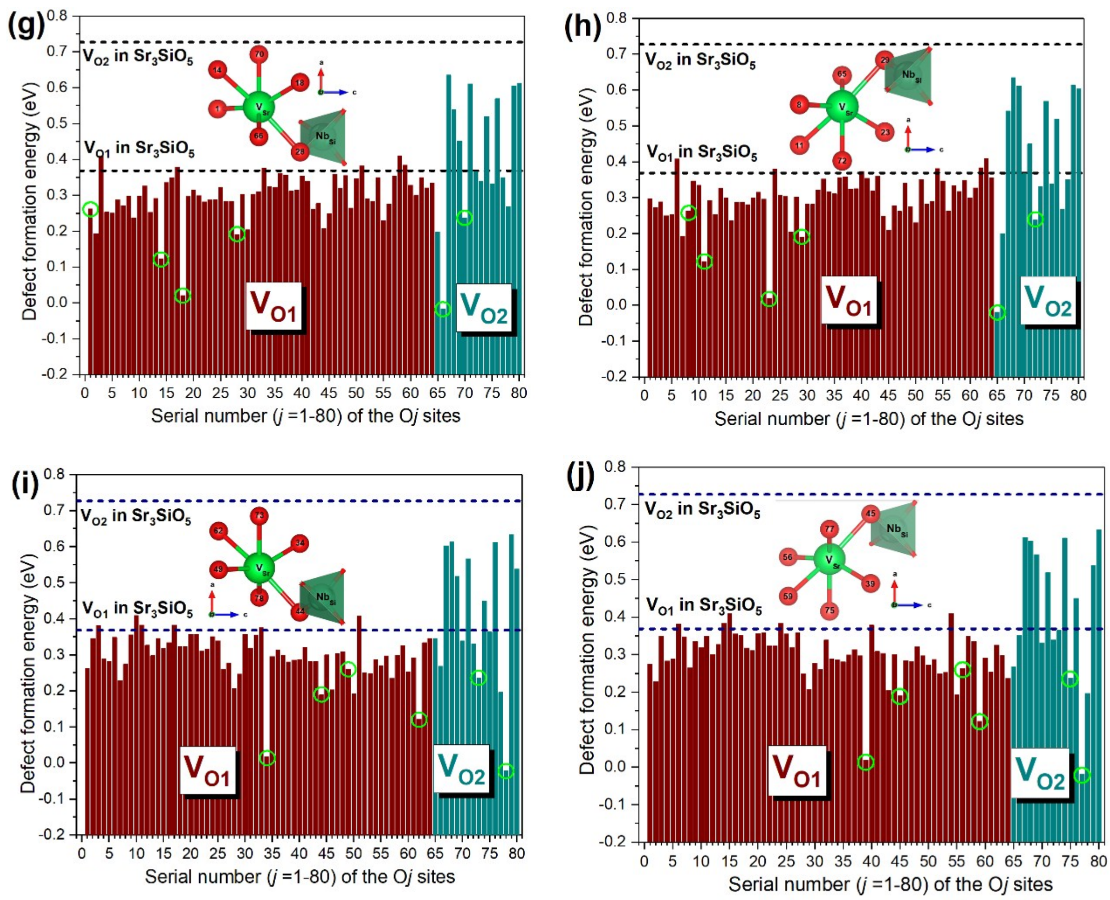


Figure S5. Calculated defect formation energies for oxygen vacancies in Sr_3SiO_5 with incorporation of the ten most probable $2Nb_{Si}$–V_{Sr} configurations (a–h, in order of decreasing occurrence probability). The horizontal dash lines indicate the formation energies of the two symmetrically distinct oxygen vacancies (V_{O1} and V_{O2}) in undoped Sr_3SiO_5 for comparison. The green cycles denote the defect formation energies of oxygen vacancies in the coordination polyhedron of V_{Sr} (as shown pictorially in the inset).

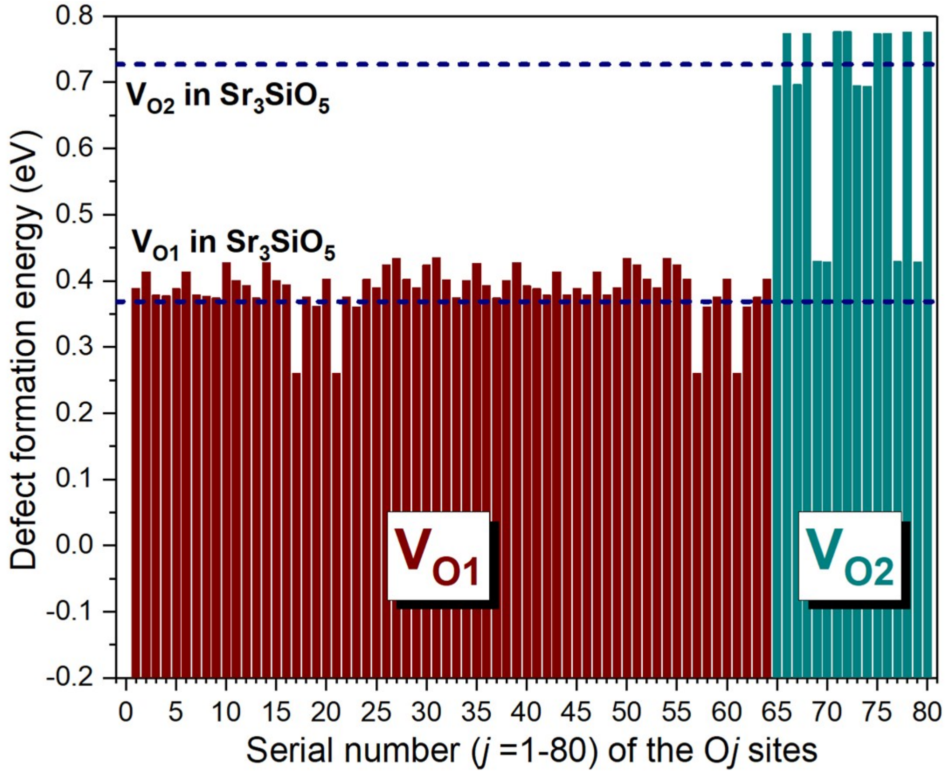


Figure S6. Calculated defect formation energies for oxygen vacancies in Nb_{Si} singly doped Sr_3SiO_5. The horizontal dash lines indicate the formation energies of the two symmetrically distinct oxygen vacancies (V_{O1} and V_{O2}) in undoped Sr_3SiO_5 for comparison.

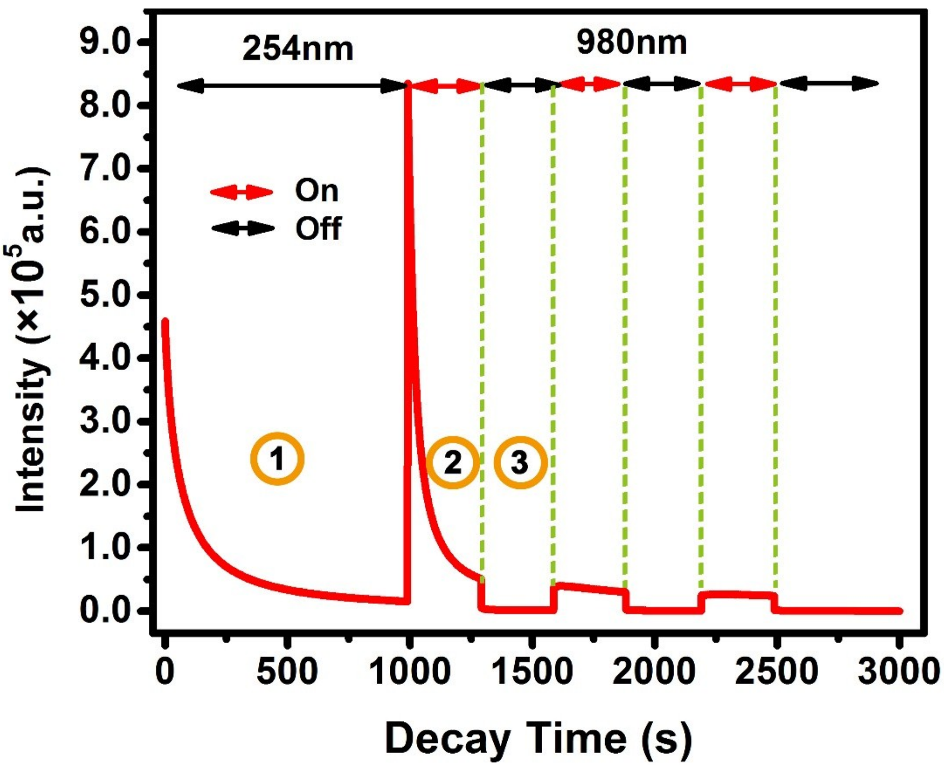


Figure S7. Persistent luminescence decay curve of the Sr_3SiO_5:Eu^{2+}, Nb phosphor with 980 nm NIR photostimulation at room temperature. The red two-way arrow denoted as "On" present the 980 nm NIR light is on, and the black two-way arrow denoted as "Off" present the 980 nm NIR light is off. In the red curve, the NIR photo-stimulation from 1000 s to 2500 s is a pulsed type with repeating NIR on and off for each 300 s. Inset digital photographs of the sample were taken at ① 500 s, ② 1050 s and ③ 1350 s, respectively. This NIR photo-stimulation offers a way to read out information, which shows a potentiality on information storage-readout application.

References

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