

Supporting Information

A Highly Efficient and Thermally Stable Green Phosphor $\text{Lu}_2\text{SrAl}_4\text{SiO}_{12}:\text{Ce}^{3+}$ for Full-spectrum White LEDs

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1.1 Experimental details

1.2 Materials synthesis

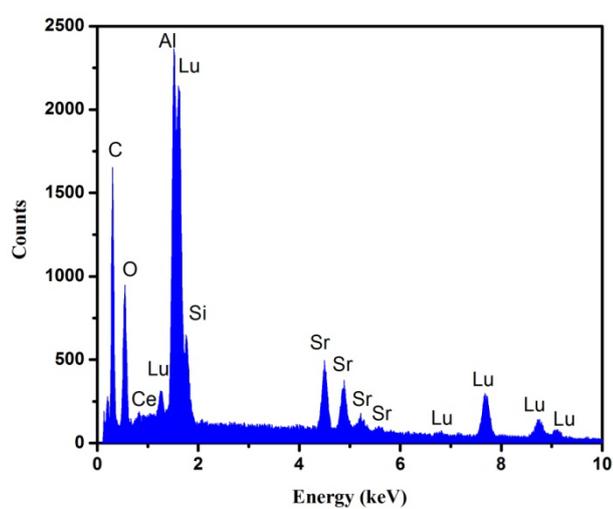
The samples, $\text{Lu}_2\text{SrAl}_4\text{SiO}_{12}:\text{Ce}^{3+}$ (LSAS: Ce^{3+}), was prepared by the traditional high-temperature solid-state reaction. The starting materials SrCO_3 (G.R.), Lu_2O_3 (99.99%), Al_2O_3 (G.R.) and CeO_2 (99.99%) were weighted stoichiometrically according to the composition of $\text{Lu}_{2(1-x)}\text{SrAl}_4\text{SiO}_{12}:x\text{Ce}^{3+}$ ($x = 1\%$, 4% , 6% , 8% and 10%). The raw materials were mixed thoroughly in an agate mortar, and then placed in an alumina crucible. These crucible were put into the tube furnace and sintered at $1400\text{ }^\circ\text{C}$ for three hours in a reducing atmosphere of $5\% \text{H}_2+95\% \text{N}_2$, and then cooled down at the rate of $5\text{ }^\circ\text{C}/\text{min}$. Finally, all the samples were ground into powders for the following characterization.

1.3 Characterization

The element composition was analyzed by an energy-dispersive spectrometer coupled to a field emission scanning electron microscopy (FESEM, Hitachi, S-4800). The crystal structure was identified by X-ray power diffraction (XRD) on a Bruker D8 Focus diffractometer with $\text{Cu K}\alpha$ radiation ($\lambda=1.54056\text{ \AA}$) operated at 40 kV and 40 mA . The XRD data were collected with step size of 0.02° and count time of $2\text{ s}/\text{step}$ in the 2θ range from 10° to 90° . Structure refinement was conducted by the Rietveld method using the FullProf program. The photoluminescence (PL) and photoluminescence excitation (PLE) spectra were measured by Hitachi F-7000 spectrometer equipped with a 150 W xenon lamp under a working voltage of 700 V . The electroluminescence spectra, color rendering index, correlated color temperature (CCT) and luminous efficiency of the fabricated pc-WLEDs were obtained from an integrated test system (EVERFINE, China) including photoelectric characteristic testing system, high precision fast spectral radiometer (HAAS-2000), dc stabilized current power supply and a rotating integral ball. PL quantum efficiency (QE) was measured directly by the absolute PL quantum yield measurement system using a spectralon-coated integrating sphere (FL980, Edinburg Instruments, UK). The temperature-dependent PL spectra were obtained by the measurement system containing using a heating stage (Linkam THMS-600) and a QEPro high performance spectrometer (Ocean Optics) which gives the time-integrated intensities.

Table S1. Rietveld refinement of LSAS:6%Ce³⁺

Temperature/K	300 K
Space group	<i>Ia</i>$\bar{3}$<i>d</i>
Lattice parameters	
<i>a</i> /Å	11.91417
<i>b</i> /Å	11.91417
<i>c</i> /Å	11.91417
<i>V</i> /Å ³	1691.187
R_p (%)	5.77
R_{wp} (%)	10.36
χ²	4.84

**Fig. S1 EDS spectrum of LSAS:6%Ce³⁺****Table S2. The result of EDS analysis of LSAS:6%Ce³⁺**

Element	wt%	at%
Sr	12.32	06.50
Lu	46.34	12.24
Al	16.26	27.85
Si	06.61	10.86
O	14.25	41.17
Ce	04.22	01.39

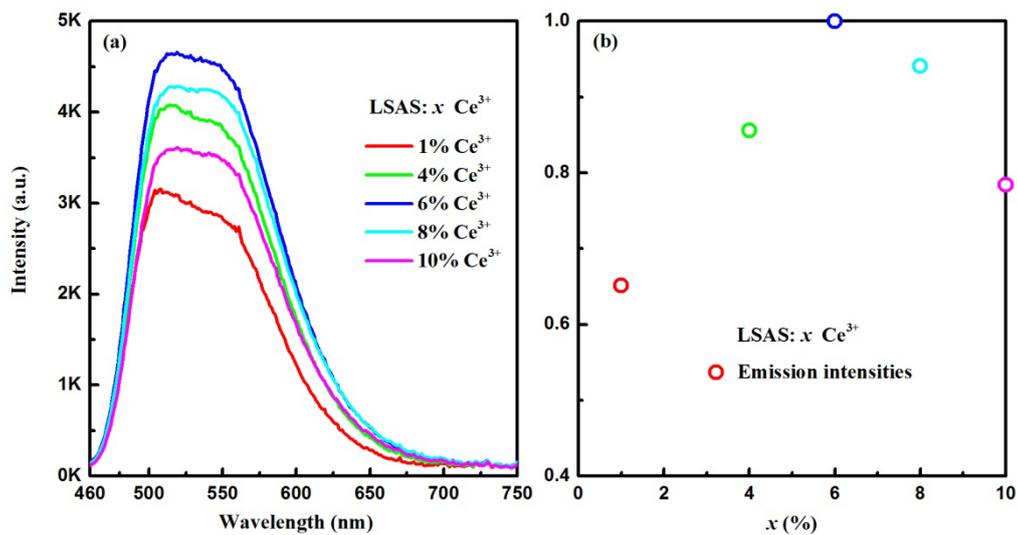


Fig. S2 PL spectra (a), and the dependence of PL intensities on Ce³⁺ concentration for LSAS: x Ce³⁺ (x=1%, 4%, 6%, 8% and 10%) under 448 nm excitation (b).

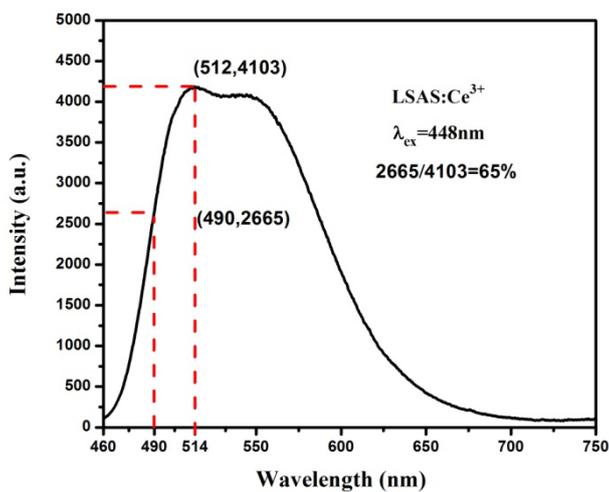


Fig. S3 The ratio of PL intensity at 490 nm to 514 nm under 448 nm excitation for LSAS:Ce³⁺

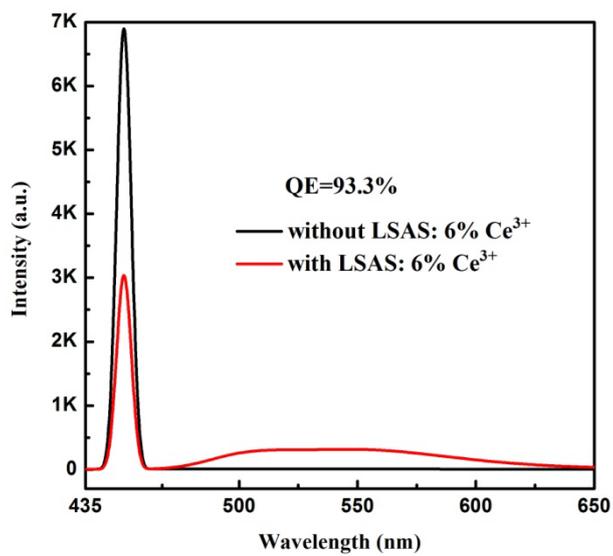


Fig. S4 Emission spectra inside the integrating sphere without and with the LSAS:6%Ce³⁺ phosphor upon 448 nm excitation.