Electronic supplementary information

Tunable concentration/excitation-dependent deep-red and white light emission in a single-phase Eu^{2+}-activated Sc-based oxide phosphors for blue/UV-LEDs

Shuai Huang,[a,b] Mengmeng Shang,* [a] Minliang Deng,[a] Yu Yan,[a] Peipei Dang[c] and Jun Lin* [c]

[a]*Key Laboratory for Liquid-Solid Structural Evolution and Processing of Materials Ministry of Education, School of Material Science and Engineering, Shandong University, 17923 Jingshi Road, Jinan 250061, P. R. China. E-mail: mmshang@sdu.edu.cn*

[b]*Address College of Materials Science and Engineering, Nanchang University, Nanchang 330031, P. R. China*

[c]*State Key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun 130022, P. R. China. E-mail:* jlin@ciac.ac.cn

Table S1. The values of n and r for four different substitutable sites

Cation	Polyhedron	n	r	n*r
Sr	$Sr1O_6$	6	1.18	7.08
	$Sr2O_9$	9	1.31	11.79
	$Sr3O_{12}$	12	1.44	17.28
Sc	ScO_6	6	0.745	4.47

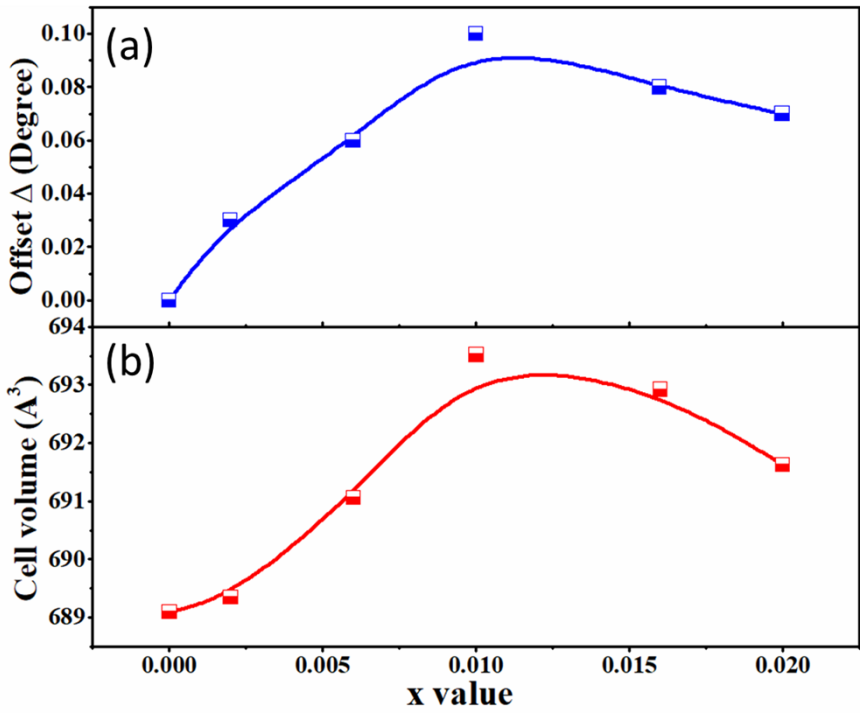

Fig. S1 Dependence of the offset (Δ) and cell volume (V) on the x value.

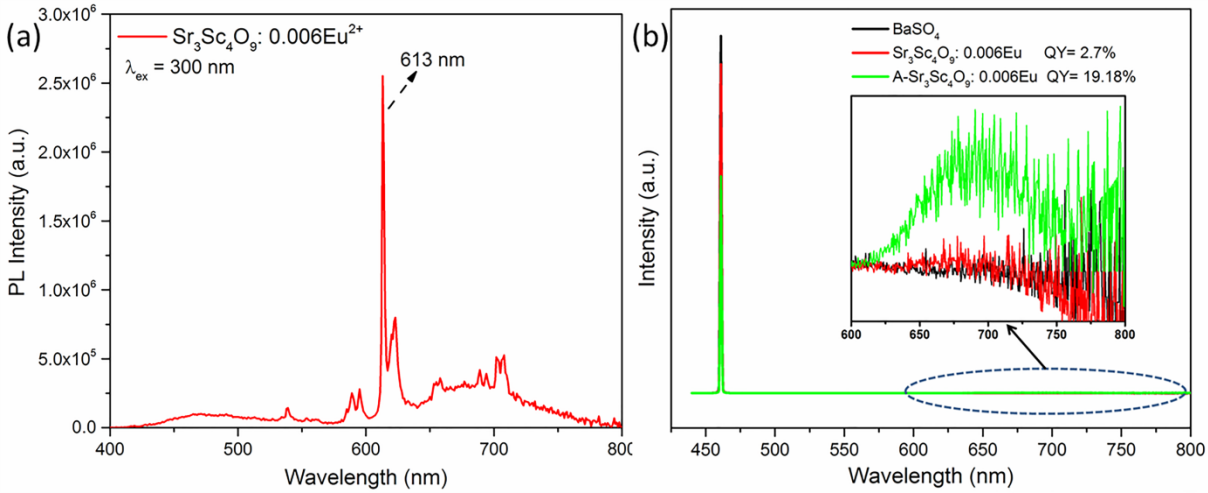

Fig. S2 (a) PL spectra of $Sr_3Sc_4O_9$: 0.06Eu sample upon 300nm excitation. (b) Quantum efficiency spectra of $Sr_3Sc_4O_9$:0.006Eu and A-$Sr_3Sc_4O_9$:0.006Eu.

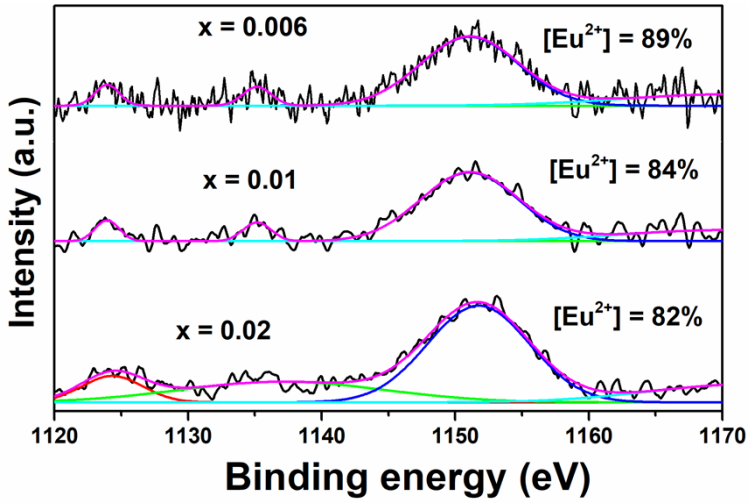

Fig. S3 The normalized Eu-3d XPS spectra of $Sr_3Sc_4O_9$:xEu (x = 0.006, 0.01, 0.02).

The high-resolution XPS spectra at the Eu 3d of $Sr_3Sc_4O_9$:xEu (x = 0.006, 0.01 and 0.02) phosphors were applied to compare the ratio changing of Eu^{2+} and Eu^{3+}. The shapes and binding energies are in good agreement with the characteristic binding peaks of Eu^{3+} $3d_{5/2}$ (1135 eV) and Eu^{2+} $3d_{3/2}$ (1155 eV) and $3d_{5/2}$ (1126 eV), indicating that Eu^{3+} and Eu^{2+} coexist. A semiquantitative analysis of the integrated peak area can provide the concentration ratio of Eu^{2+}/Eu^{3+}. The concentrations of Eu^{2+} ion for $Sr_3Sc_4O_9$:xEu (x = 0.006, 0.01 and 0.02) phosphors are calculated to be 89%, 84% and 82%, respectively.

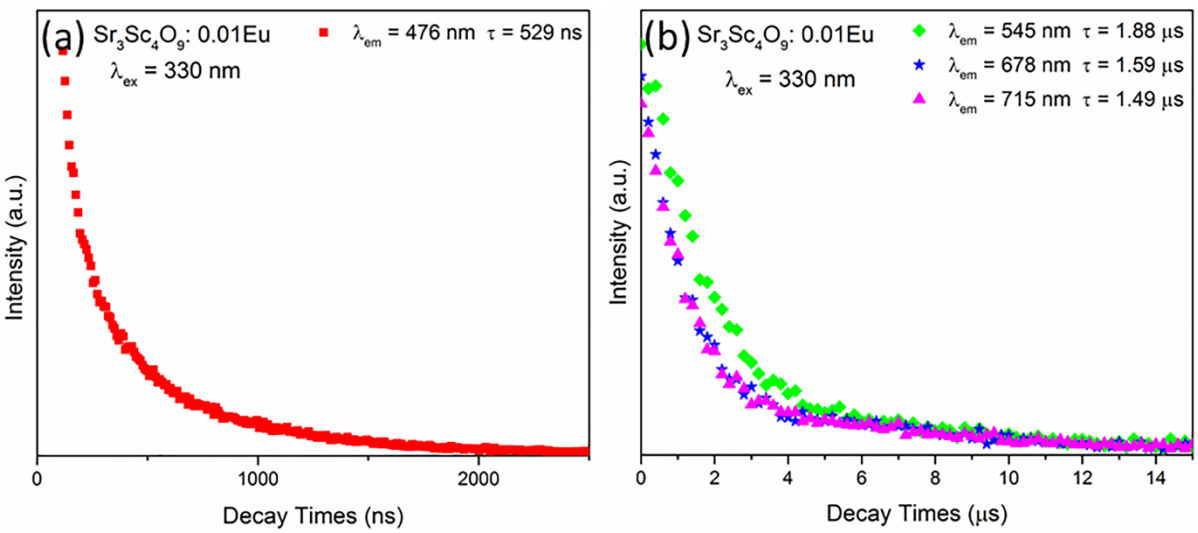

Fig. S4 The decay curves of $Sr_3Sc_4O_9$: 0.01Eu at different monitoring wavelengths.

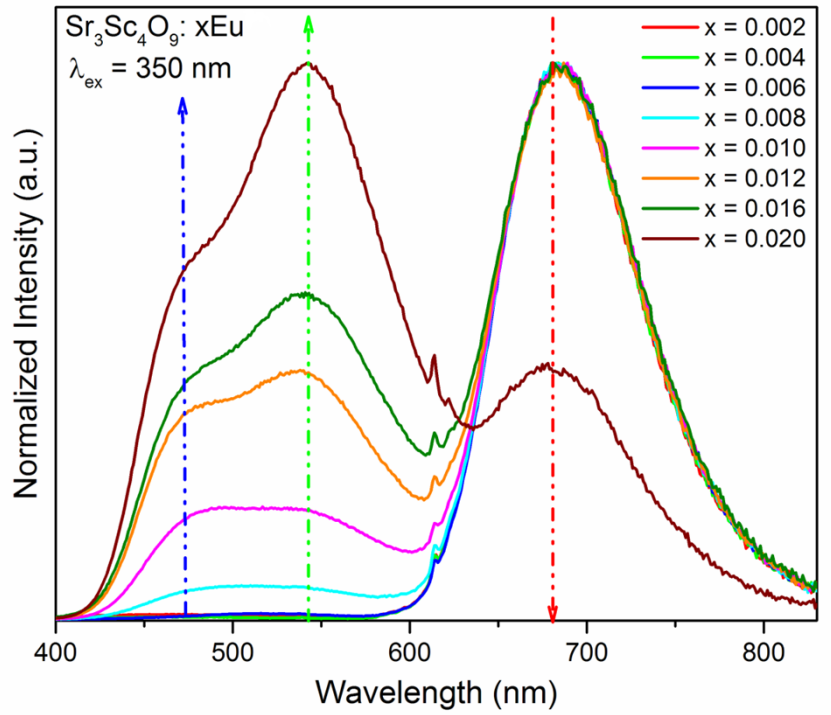

Fig. S5 Normalized PL spectra of $Sr_3Sc_4O_9$: xEu samples upon 350nm excitation.

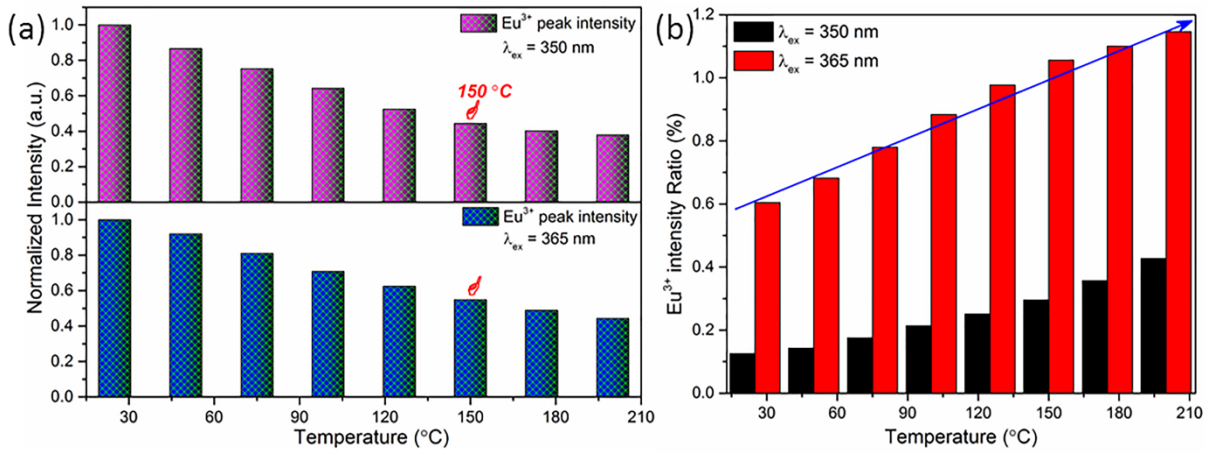

Fig. S6 Eu^{3+} peak intensities (a) and Eu^{3+} intensities ratio to the integrated PL intensities (b) of $Sr_3Sc_4O_9$: 0.01Eu as a function of temperature.

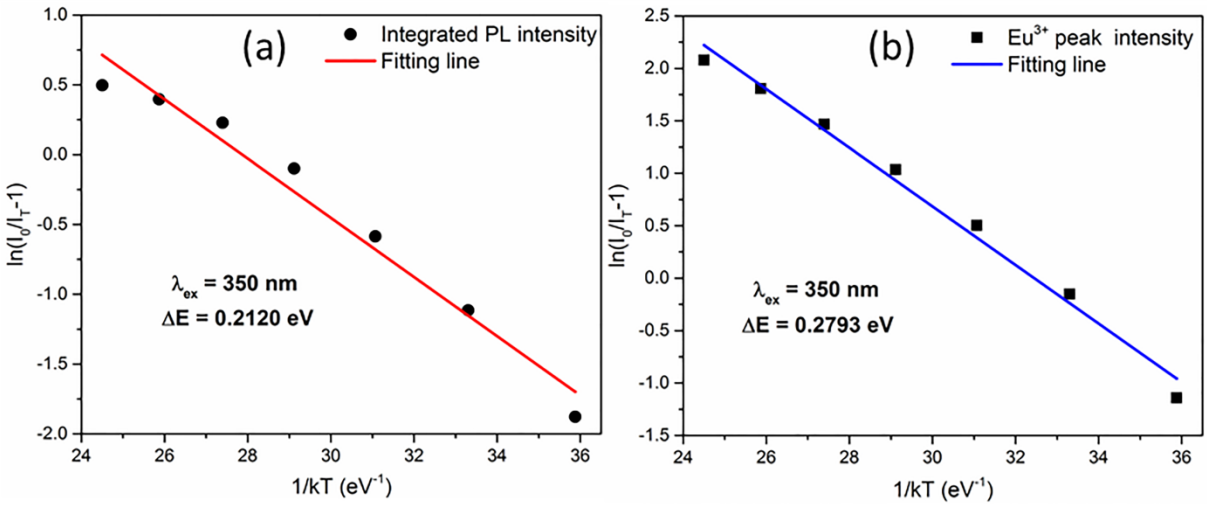

Fig. S7 The plot of $\ln[I_0/I(T) - 1]$ vs. 1/T for Eu^{2+} (a) and Eu^{3+} (b) emission in $Sr_3Sc_4O_9$ host.

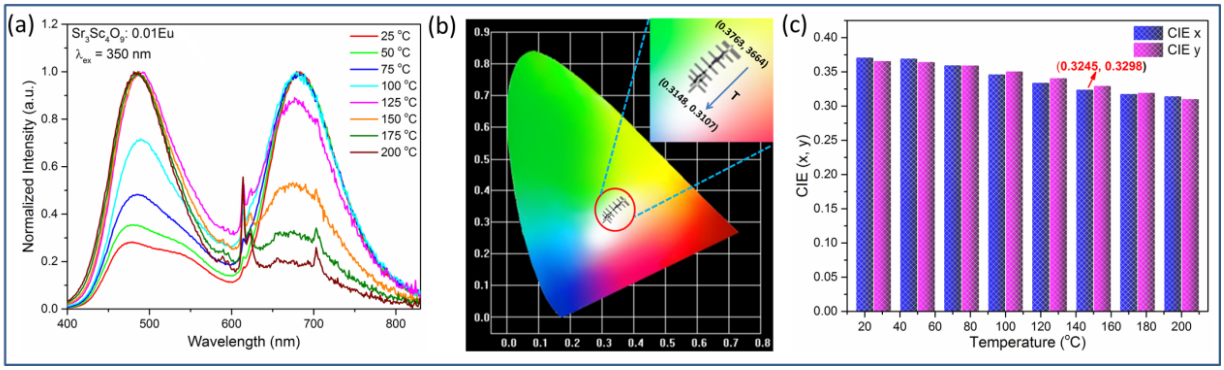

Fig. S8 The spectral profile (a), CIE coordinates diagram (b) and CIE coordinates (c) of $Sr_3Sc_4O_9$: 0.01Eu sample (upon 350 nm excitation) as a function of temperature.