

Supporting Information

**Efficient and controllable photoluminescence in novel solid
solution phosphors $\text{Ca}_{1-x}\text{Sr}_x\text{Hf}_4(\text{PO}_4)_6:\text{Eu}^{2+}$ with high
thermal stability for white light emitting diodes**

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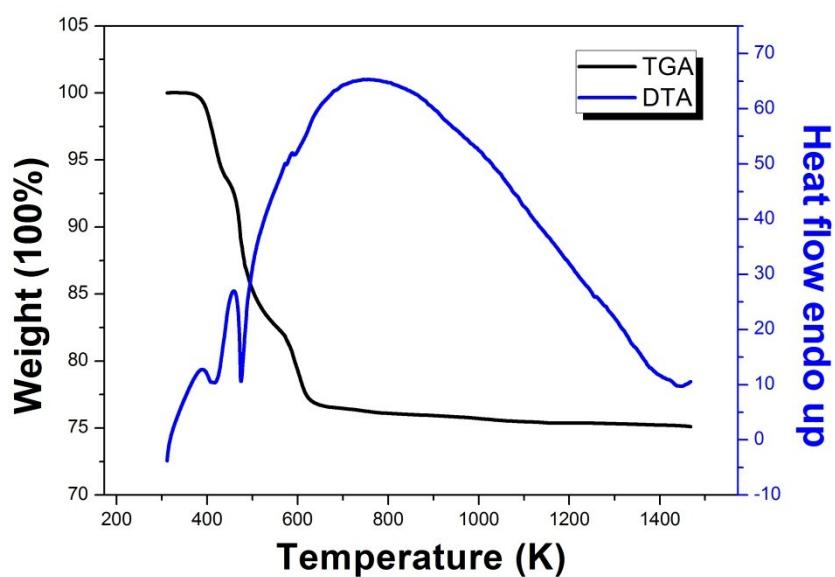


Figure S1 TG-DTA curves as-prepared $\text{SrHf}_4(\text{PO}_4)_6$ sample.

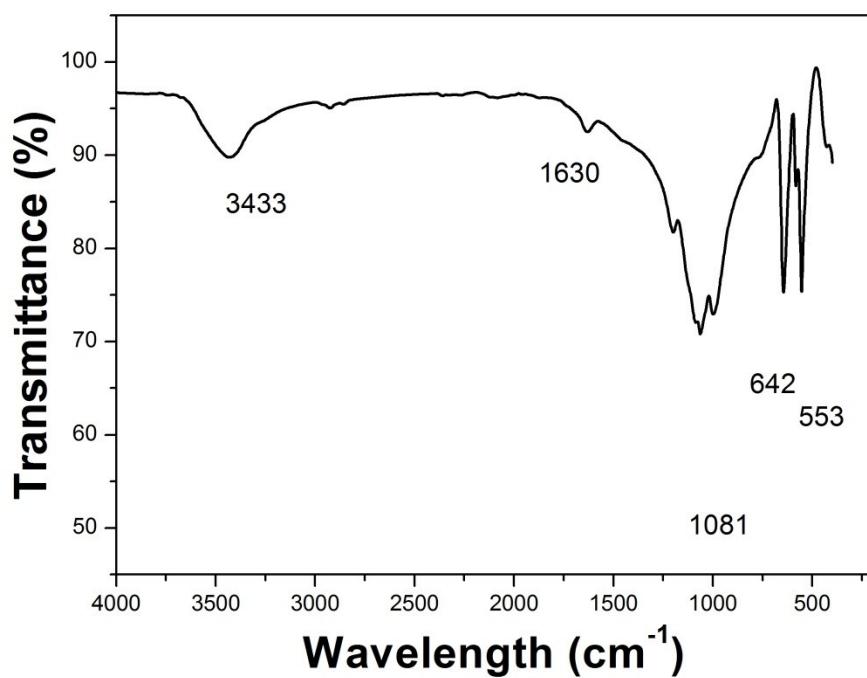


Figure S2 FTIR spectrum of as-prepared $\text{SrHf}_4(\text{PO}_4)_6$ sample.

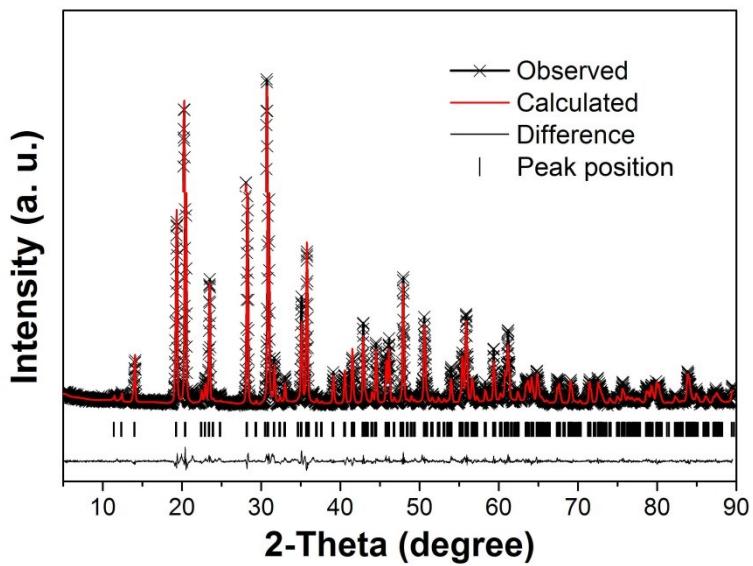


Figure S3 Power XRD patterns for Rietveld structure analysis of the selected $\text{SrHf}_4(\text{PO}_4)_6$ sample by using GSAS program.

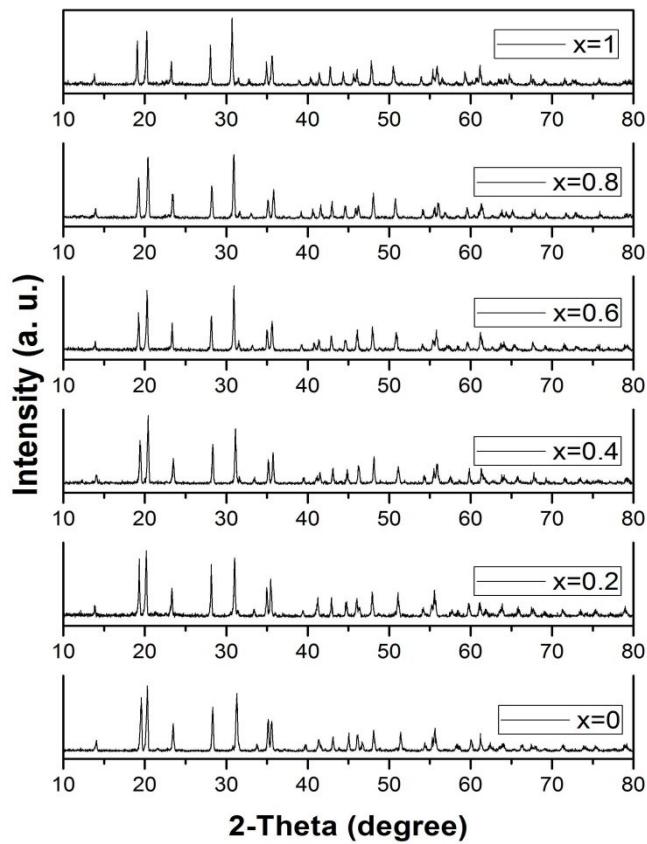


Figure S4 The XRD patterns of $\text{Ca}_{1-x}\text{Sr}_x\text{Hf}_4(\text{PO}_4)_6$ ($0 \leq x \leq 1$) solid solution compounds.

Table S1 Refinement results of the atomic coordinates and thermal parameters of $\text{SrHf}_4(\text{PO}_4)_6$

Atom	Wyck.	x/a	y/b	z/c	Occupancy	U_{iso}
Sr	3b	0	0	0.5000	1.0000	0.0286
Hf1	6c	0	0	0.1469	1.0000	0.0010
Hf2	6c	0	0	0.6480	1.0000	0.0215
P	18f	0.28310	1.00226	0.26053	1.0000	0.0026
O1	18f	0.13565	0.91192	0.19361	1.0000	0.0009
O2	18f	0.05260	0.77749	0.69334	1.0000	0.0037
O3	18f	0.20570	0.03385	0.08580	1.0000	0.0039
O4	18f	0.78676	0.76079	0.57840	1.0000	0.0924

Table S2 The effective ionic radii of Ca^{2+} , Hf^{4+} , P^{5+} and Eu^{2+} ions with different coordination numbers (CN)

Ionic	Ca^{2+} (\AA)	Sr^{2+} (\AA)	Hf^{4+} (\AA)	P^{5+} (\AA)	Eu^{2+} (\AA)
Ionic radii	1.00 (CN=6)	1.00 (CN=6)	0.71 (CN=6)	0.38 (CN=4)	1.17 (CN=6)

Table S3 The refinement results of the selective interatomic distances of Sr-O, Hf-O and P-O in $\text{SrHf}_4(\text{PO}_4)_6$

Center atom	Ligand atom	Count	Distance
Sr	O4	6x	2.6954
Hf1	O1	3x	2.0197
	O3	3x	2.1909
Hf2	O2	3x	2.4448
	O4	3x	2.5601
P1	O1	1x	1.9219
	O2	1x	1.1766
	O3	1x	2.2774
	O4	1x	1.2397

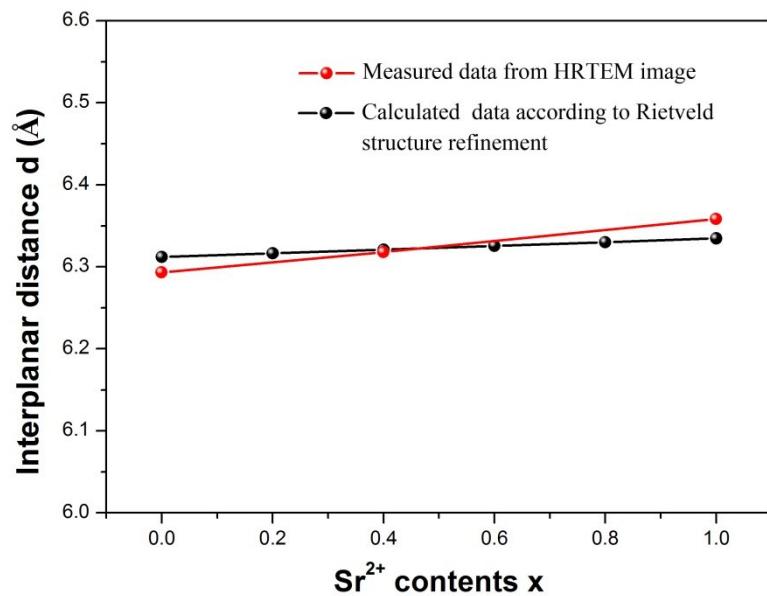


Figure S5 The measured and calculated interplanar distance d of (0,1,2) lattice plane with different Sr^{2+} doping contents.

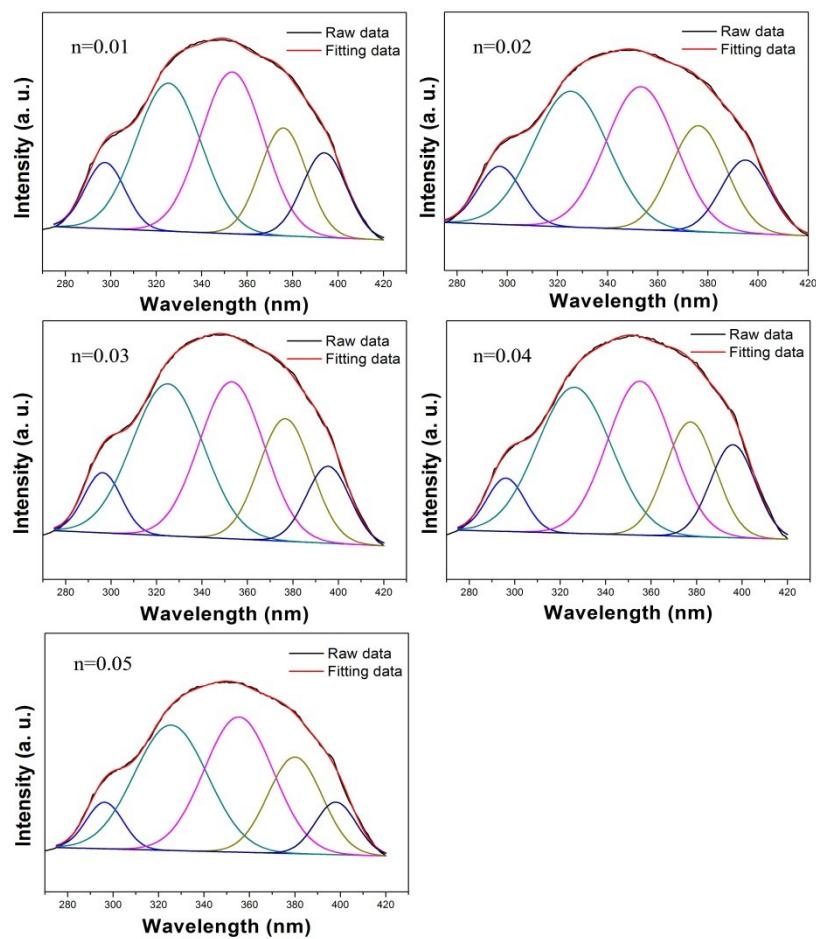


Figure S6 The Guass fitting of the PL excitation spectra of $\text{SrHf}_4(\text{PO}_4)_6:n\text{Eu}^{2+}$ ($0.01 \leq n \leq 0.05$)

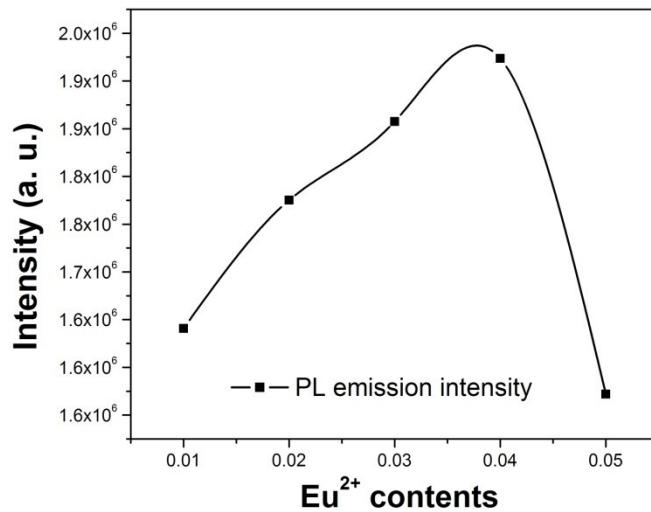


Figure S7 The contents dependent PL emission intensity of SrHf₄(PO₄)₆:nEu²⁺ (0.01≤n≤0.05)

$$\text{color purity} = \frac{\sqrt{(x_s - x_i)^2 + (y_s - y_i)^2}}{\sqrt{(x_d - x_i)^2 + (y_d - y_i)^2}} \times 100\% \quad \text{Eq. S1}$$

The dominant wavelength and color purity as compared to the 1931 CIE Standard Source C [illuminant C = 0.3101, 0.3162)] were determined from the PL emission spectrum in Fig. 5. The dominant wavelength of a color is the single mono-chromatic wavelength of the spectrum whose chromaticity is on the same straight line as the sample point (x_s , y_s) and the illuminant point (x_i , y_i).