

Electronic Supplementary Information

Thermal annealing effects on $\text{La}_2\text{Hf}_2\text{O}_7:\text{Eu}^{3+}$ nanoparticles: A curious case study of structural evolution and site-specific photo- and radio-luminescence

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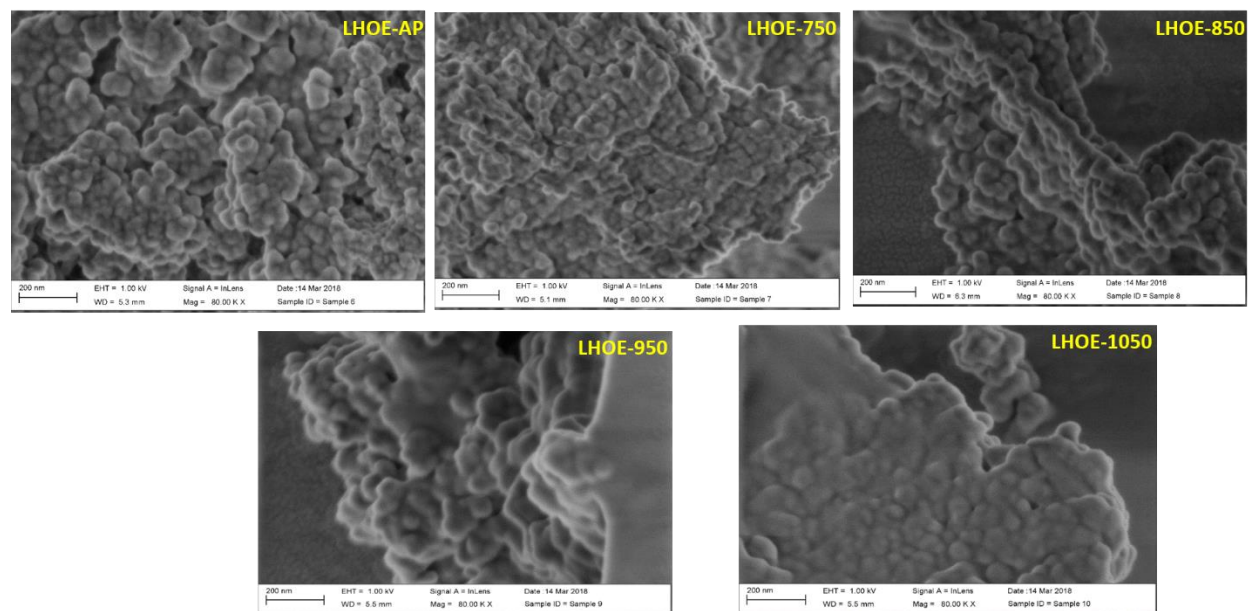


Figure S1. SEM images of the $\text{La}_2\text{Hf}_2\text{O}_7:\text{Eu}^{3+}$ NPs annealed at various temperatures.

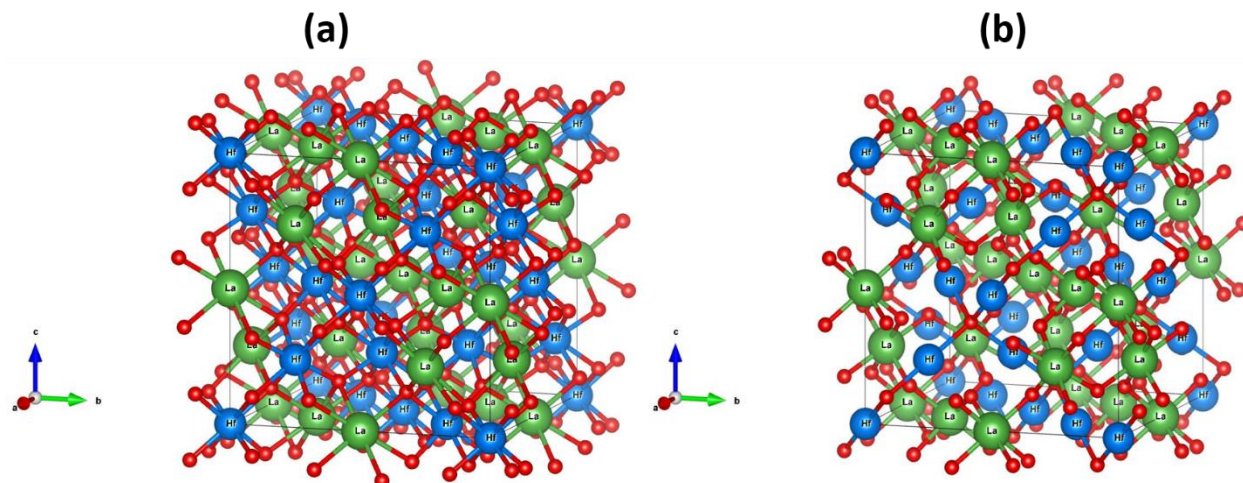


Figure S2. (a) Crystal Structure of (a) the undoped $\text{La}_2\text{Hf}_2\text{O}_7$ and (b) 5% Eu^{3+} doped $\text{La}_2\text{Hf}_2\text{O}_7$ NPs synthesized at 650°C .

Table S1. Rietveld analysis parameters from the XRD patterns of the $\text{La}_2\text{Hf}_2\text{O}_7$ NPs

Molecular formula	$\text{La}_2\text{Hf}_2\text{O}_7\text{-AP}$	$\text{La}_2\text{Hf}_2\text{O}_7:\text{Eu}^{3+}\text{-AP}$
Space Group	Fm-3m (No 227)	Fm-3m (No 227)
Crystal System	Cubic	Cubic
Point Group	m-3m	m-3m
Bravais lattice	F	F
Unit cell parameters		
$a = b = c$ (Å)	10.773(1)	10.765(1)
$\alpha = \beta = \gamma$	90°	90°
Cell Volume	$1250.323(25) \text{ \AA}^3$	$1247.748(25) \text{ \AA}^3$
Density	7.935 g/cc	7.951 g/cc
Bragg Factor	1.81	12.36
RF factor	1.80	2.23
Chi-square	1.25	1.22
Rp	10.9	12.6
Rwp	11.3	12.7
Re	10.1	11.5

Table S2. Structure parameters obtained from Rietveld Refinement of the XRD pattern of the $\text{La}_2\text{Hf}_2\text{O}_7$ NPs

	x	y	z	Occ.	B	Site	Symm.
La	0.50000	0.50000	0.50000	1.000	1.000	16d	-3m
O	0.34300	0.12500	0.12500	1.000	1.000	48f	2mm
Hf	0.00000	0.00000	0.00000	1.000	1.000	16c	-3m
O'	0.12500	0.12500	0.12500	1.000	1.000	8a	-43m

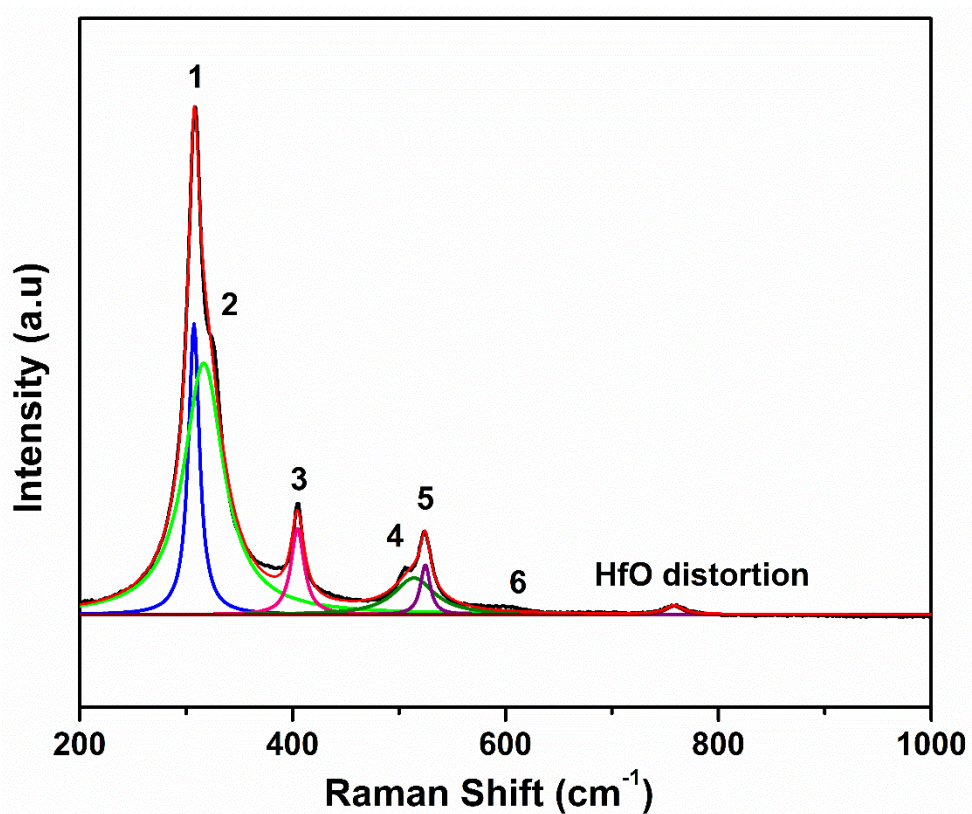


Figure S3. Gaussian deconvoluted Raman bands of the LHOE-1050 NPs with ideal pyrochlore structure.

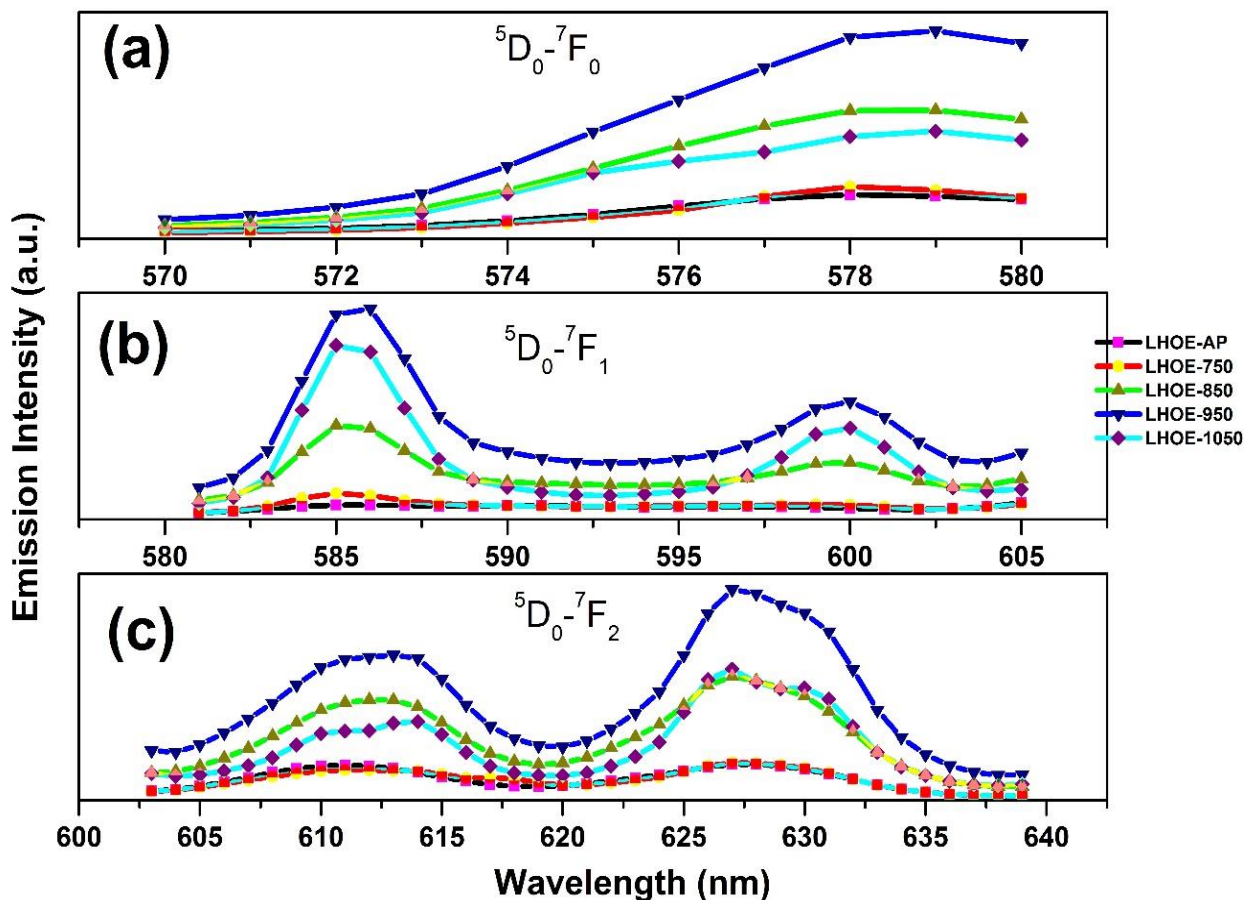


Figure S4. Stark splitting pattern of various transitions of the $\text{La}_2\text{Hf}_2\text{O}_7:\text{Eu}^{3+}$ NPs annealed at various temperatures.

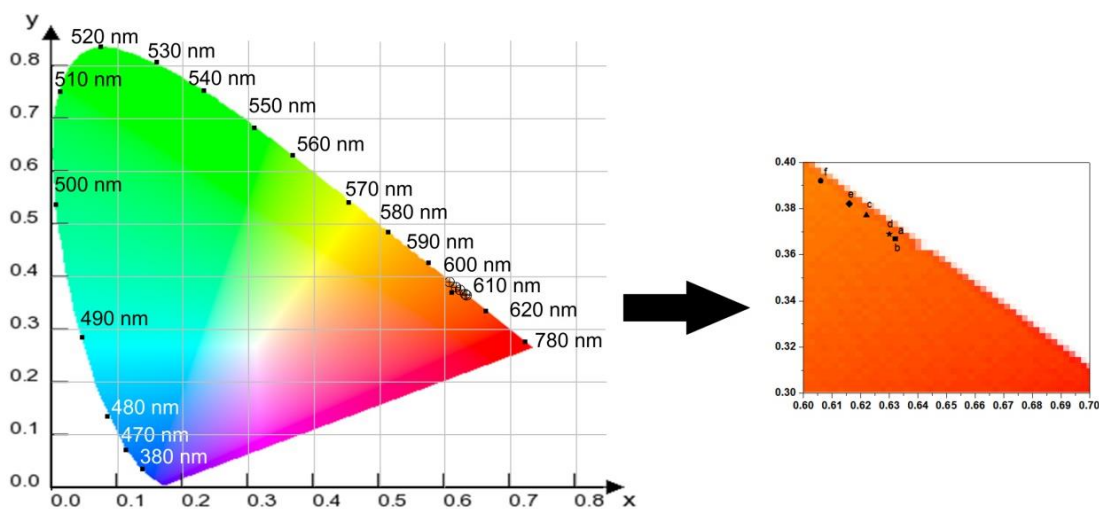


Figure S5. CIE chromaticity diagram coordinates of the $\text{La}_2\text{Hf}_2\text{O}_7:\text{Eu}^{3+}$ NPs (950°C annealed) at various excitation wavelength. Right panel presents a detailed view of these coordinates in the red-end wavelengths.

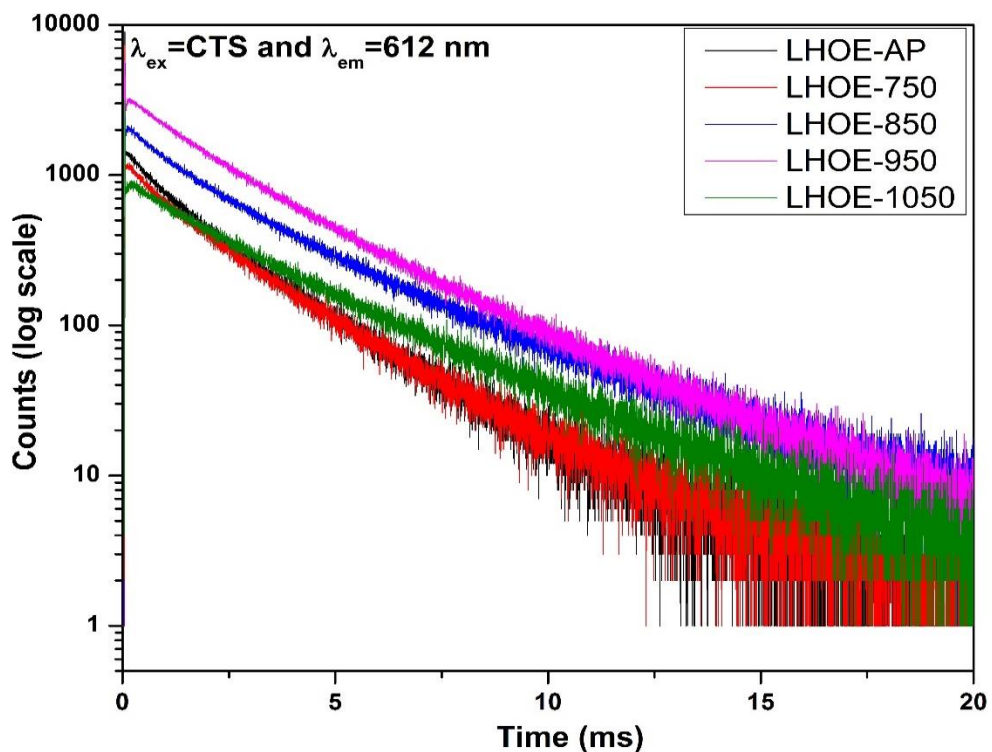


Figure S6. Luminescence lifetime of the $\text{La}_2\text{Hf}_2\text{O}_7:\text{Eu}^{3+}$ NPs as a function of annealing temperature.

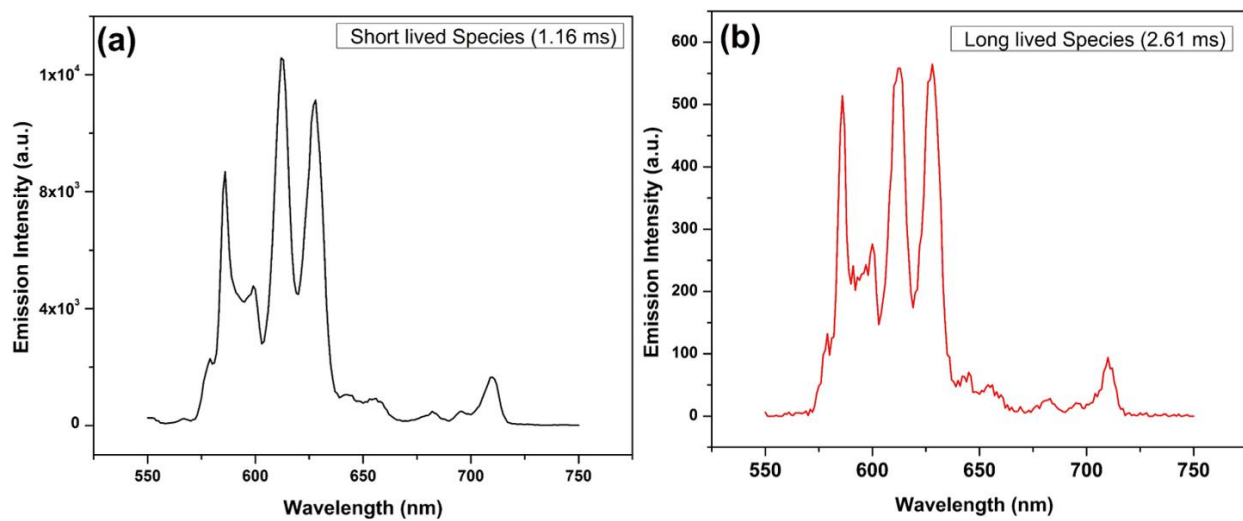


Figure S7. Time resolved emission spectra of the short and long-lived europium ions in the $\text{La}_2\text{Hf}_2\text{O}_7:\text{Eu}^{3+}$ NPs.