Supporting Information

A polymorphic SrGa$_2$O$_4$:Eu^{2+} red phosphor for warm illumination and operando visualization of H$_2$O$_2$ catalytic reaction

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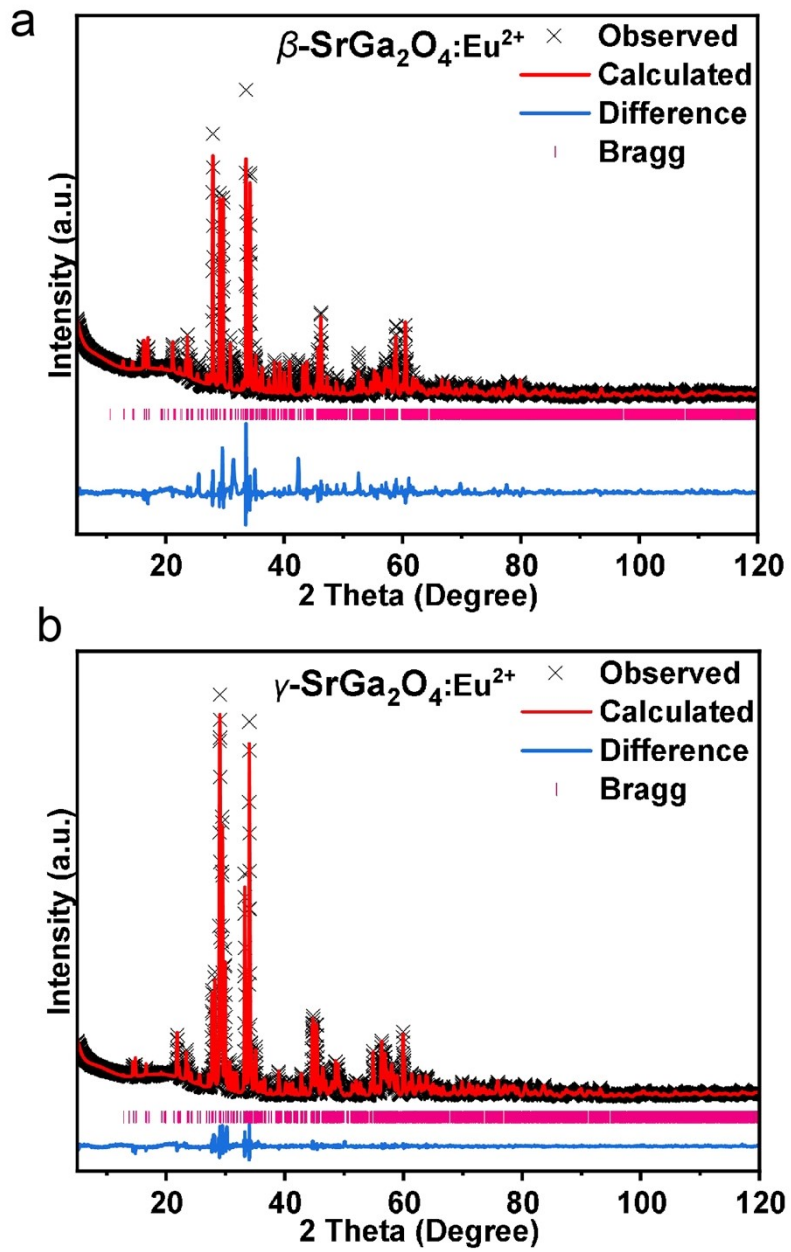
Figure S1 XRD refinements on the (a) β-SrGa$_2$O$_4$:Eu^{2+} synthesized at 1000 ^{o}C and (b) γ-SrGa$_2$O$_4$:Eu^{2+} synthesized at 1200 ^{o}C

Table S1 The refined structure parameters of β-SrGa$_2$O$_4$:Eu^{2+} and γ-SrGa$_2$O$_4$:Eu^{2+} red phosphor

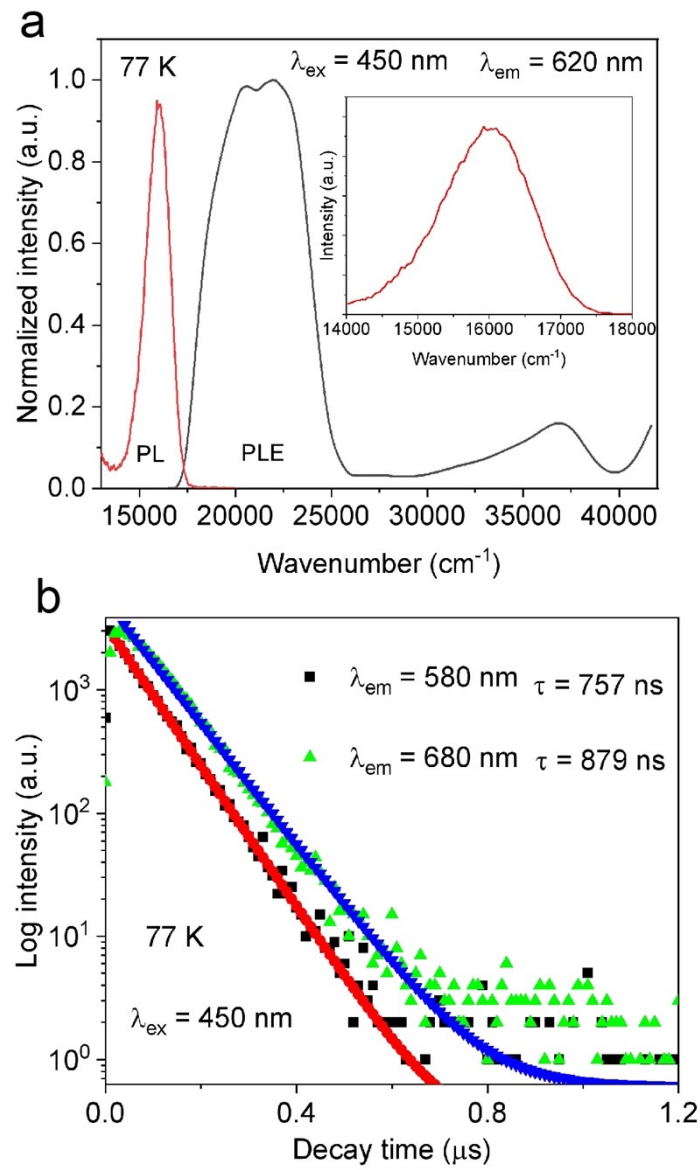| Sample	Space group	Cell parameters(Å,°), Cell volume(Å^3)	R$_p$(%), R$_{wp}$(%)
γ-SrGa$_2$O$_4$:Eu^{2+}	P21/n	$a = 8.10924$	
		$b = 10.75332$	
		$c = 9.04985$	5.60
		$V = 788.872717$	3.94
		$\alpha = \gamma = 90$	
		$\beta = 91.5413$	
β-SrGa$_2$O$_4$:Eu^{2+}	P21/c	$a = 8.38204$	
		$b = 8.99710$	
		$c = 10.68064$	12.76
		$V = 803.597830$	7.87
		$\alpha = \gamma = 90$	
		$\beta = 93.9076$	

Figure S2 (a) PLE and PL spectra of β-SrGa$_2$O$_4$:Eu^{2+} phosphor measured at temperature 77 K, the inset gives the enlarge view of the PL spectra. (b) low temperature PL decay curves of β-SrGa$_2$O$_4$:Eu^{2+} phosphor by monitoring 580 nm and 680 nm emission
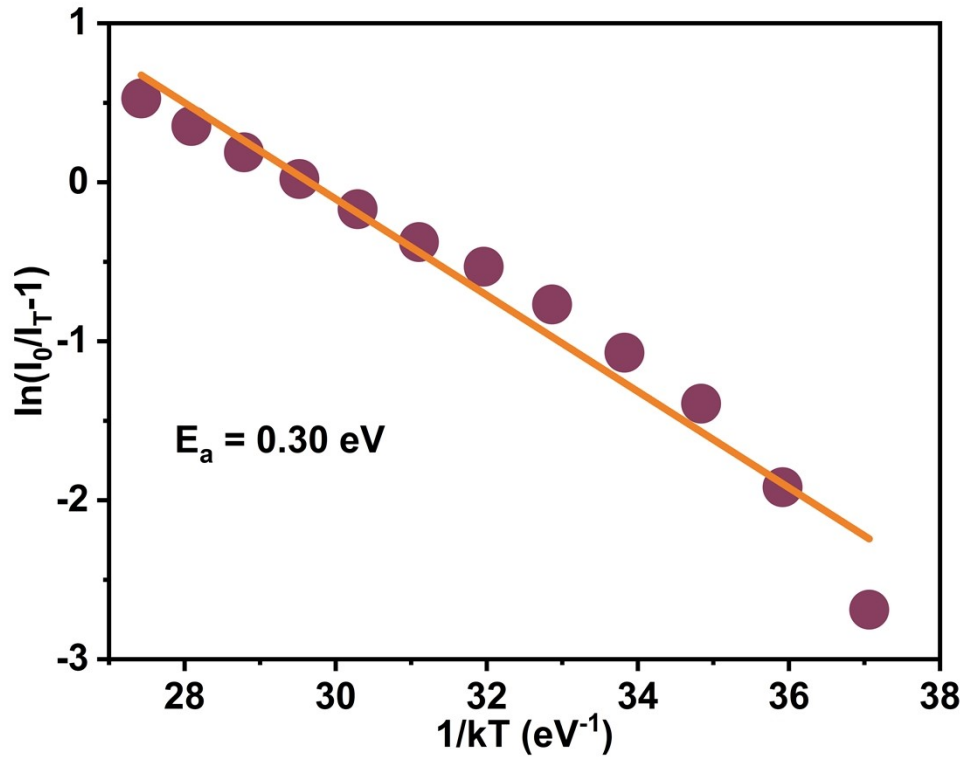
Figure S3 The fitted activation energy for the thermal quenching of β-SrGa$_2$O$_4$:Eu^{2+} red phosphor.

The activation energy ΔE_a for the thermal quenching of the Eu^{2+} emission was calculated by the following Arrhenius equation:

$$I_T / I_0 = \frac{1}{1 + A\exp\left(-\dfrac{\Delta E_a}{kT}\right)}$$

Where I_0 is the initial intensity, I_T is the intensity at given temperature T, A is constant, and k is the Boltzmann constant (8.62×10^{-5} eV/K). The thermal activation energy ΔE_a for the β-SrGa$_2$O$_4$:Eu^{2+} red phosphor was calculated to be 0.30 eV.
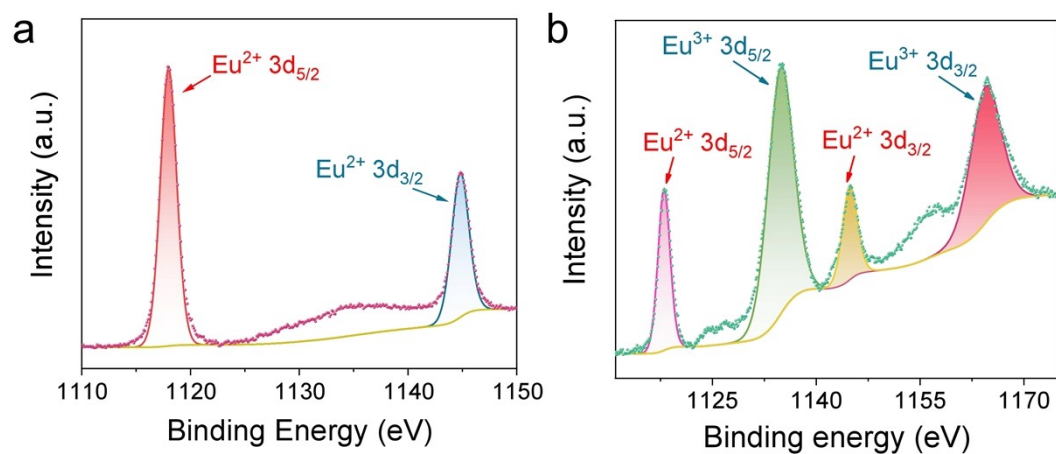
Figure S4 High-resolution Eu 3d XPS spectra of (a) β-SrGa$_2$O$_4$:Eu^{2+} phosphor, and (b) the compound collected after immersing β-SrGa$_2$O$_4$:Eu^{2+} phosphor in MnO$_2$@H$_2$O$_2$ solution for 3h.