Supporting Information

High Eu^{3+} concentration quenching in Y_3TaO_7 solid solution for Orange-reddish emission in photonics

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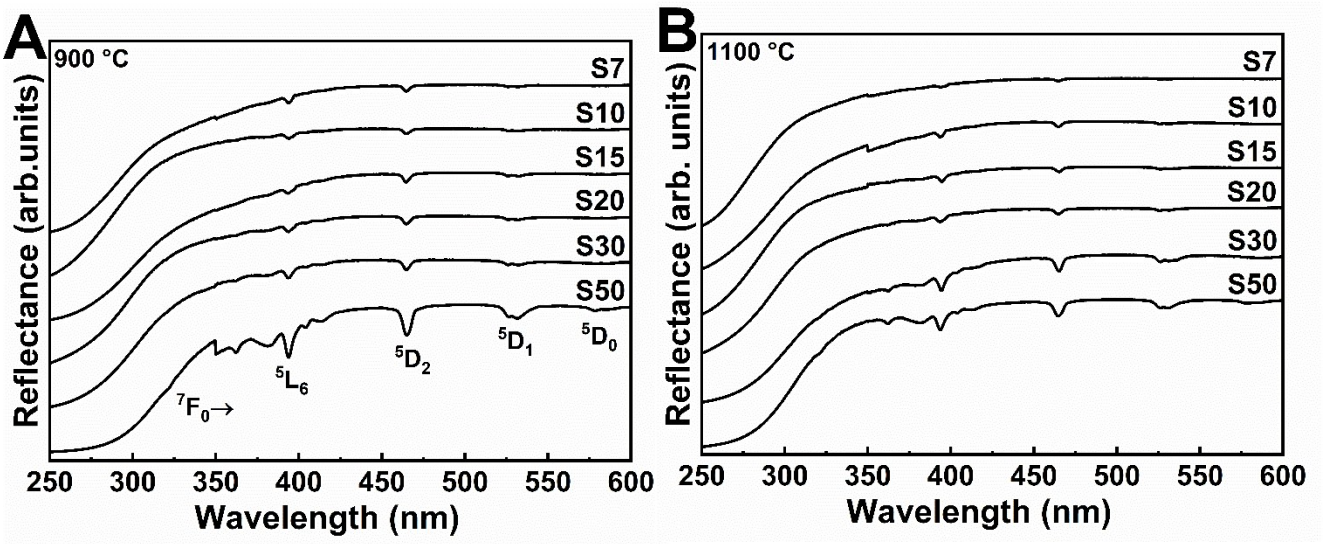

Figure S1. DRS spectra of Eu^{3+}-doped Y_3TaO_7 annealed at (A) 900 °C and (B) 1100 °C.

1. Structural and vibrational properties

Figures S23 and S2B present the DRS spectra of samples S7–S50 annealed at 900 or 1100 °C. Absorption bands emerge at 394, 465, 530, and 580 nm, which can be assigned to Eu^{3+} f-f transitions from the ground states $^7F_{0,1}$ to the $^5L_6$, $^5D_2$, $^5D_1$, and $^5D_0$

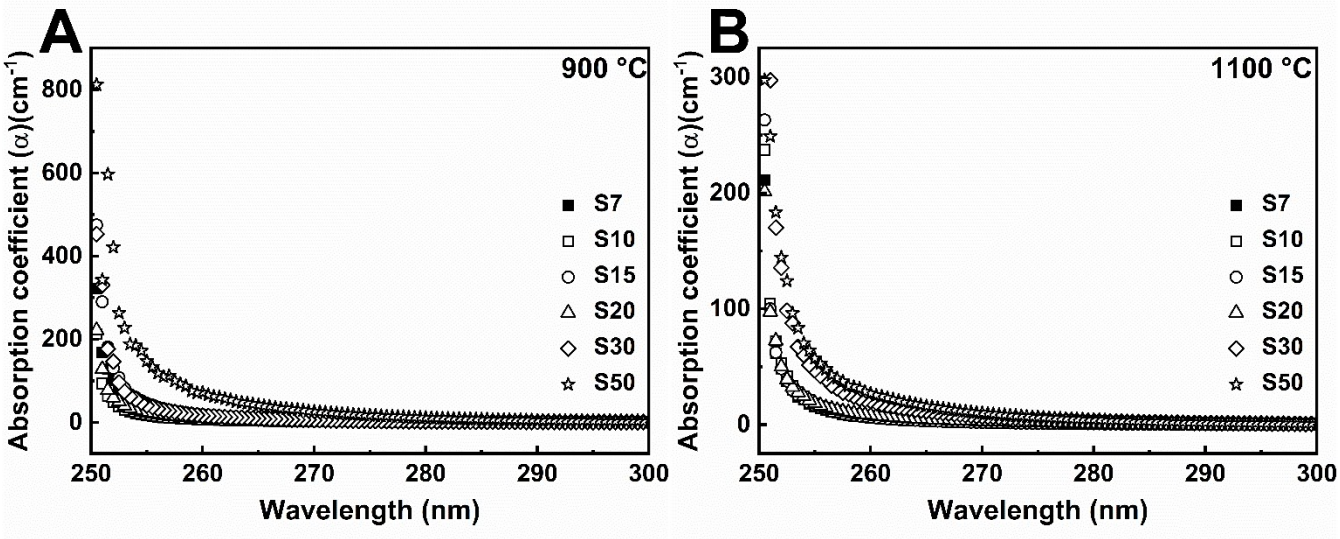

Figure S2. Absorption coefficient (α) as a function of the wavelength of Eu^{3+}-doped Y_3TaO_7 samples annealed at (A) 900 °C and (B) 1100 °C.

excited states, respectively.

Figures 3A and 3C present the absorption coefficient (α) of calculated by Kubelka-Munk equation [1] for samples S7–S50 annealed at 900 or 1100 °C from the reflectance data.

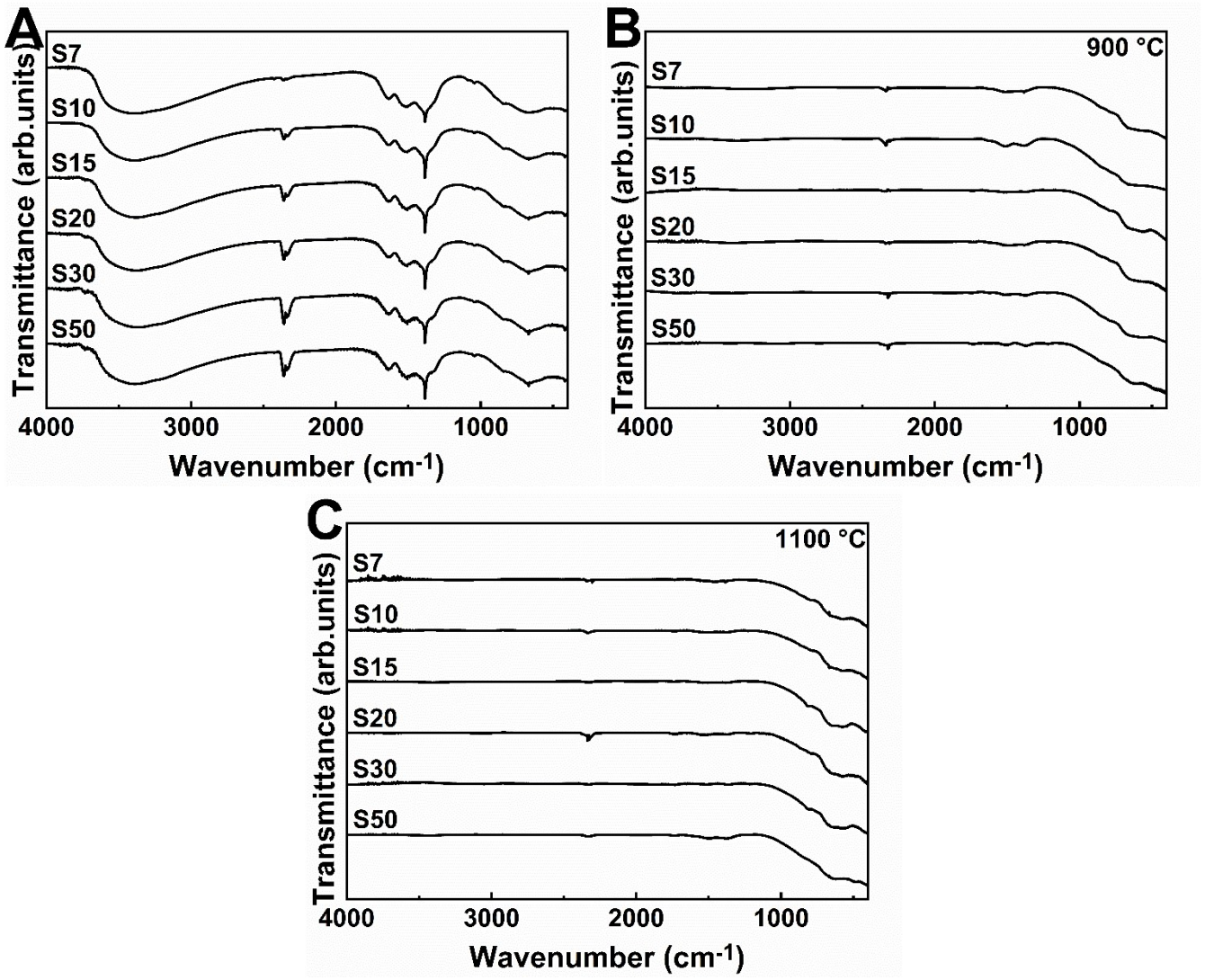

Figure S3. FTIR spectra of pure and Eu^{3+}-doped Y_3TaO_7 samples (A) without annealing or annealed at (B) 900 or (C) 1100 °C.

We analyzed Eu^{3+}-doped Y_3TaO_7 samples without annealing and annealed at 900 or 1100 °C by FTIR (Figures 4A, 4B, and 4C). The non-annealed samples present a broad band centered at about 3400 cm^{-1}, assigned to OH and CH stretching vibrations. The bands at 1640, 1520, and 1380 cm^{-1} are attributed to H-OH angular deformation, C-H deformation, and carbonate group ν_3 vibrational modes, respectively, of water and organic residues [2,3]. For the annealed samples, the spectra indicate full removal of water and

organic substances, which could decrease luminescence and quantum emission efficiency by the non-radiative process through excited-state deactivation. Samples S7–S50 annealed at 900 and 1100 °C have quite similar spectra. The bands around 820 cm^{-1}, from 660 to 620 cm^{-1}, and at 440 cm^{-1} correspond to Ta-O-Ta and Ta-O vibration [4,5], and the bands below 520 cm^{-1} are characteristic of Y-O vibration [6] can be seen in Figures 4B and 4C. We highlight that Y_3TaO_7 has relatively low phonon energy.

2. Luminescent properties

Table S1. Ratios between the intensities of the $^5D_0 \rightarrow {}^7F_2$ and $^5D_0 \rightarrow {}^7F_1$ transitions for different Eu^{3+} concentrations and annealing temperatures for Eu^{3+}-doped Y_3TaO_7 samples under different excitation wavelengths.

Annealing temperatures	**Samples**	$\frac{I(^5D_0 \rightarrow {}^7F_2)}{I(^5D_0 \rightarrow {}^7F_1)}$		
		CTB	**394.0 nm**	**464.0 nm**
900 °C	S7	4.3 ± 0.3	4.4 ± 0.3	4.6 ± 0.3
	S10	4.6 ± 0.4	4.5 ± 0.3	4.7 ± 0.3
	S15	4.2 ± 0.3	4.3 ± 0.3	4.4 ± 0.4
	S20	4.3 ± 0.3	4.3 ± 0.3	4.3 ± 0.4
	S30	4.3 ± 0.3	4.4 ± 0.4	4.5 ± 0.4
	S50	5.2 ± 0.7	5.5 ± 0.9	5.9 ± 0.9
1100 °C	S7	3.1 ± 0.2	3.4 ± 0.3	3.6 ± 0.4
	S10	3.3 ± 0.2	3.6 ± 0.3	3.7 ± 0.3
	S15	3.2 ± 0.2	3.9 ± 0.3	3.5 ± 0.2
	S20	3.0 ± 0.2	3.1 ± 0.2	3.1 ± 0.2
	S30	3.3 ± 0.2	4.0 ± 0.7	3.6 ± 0.2
	S50	3.9 ± 0.4	4.1 ± 0.5	4.5 ± 0.7

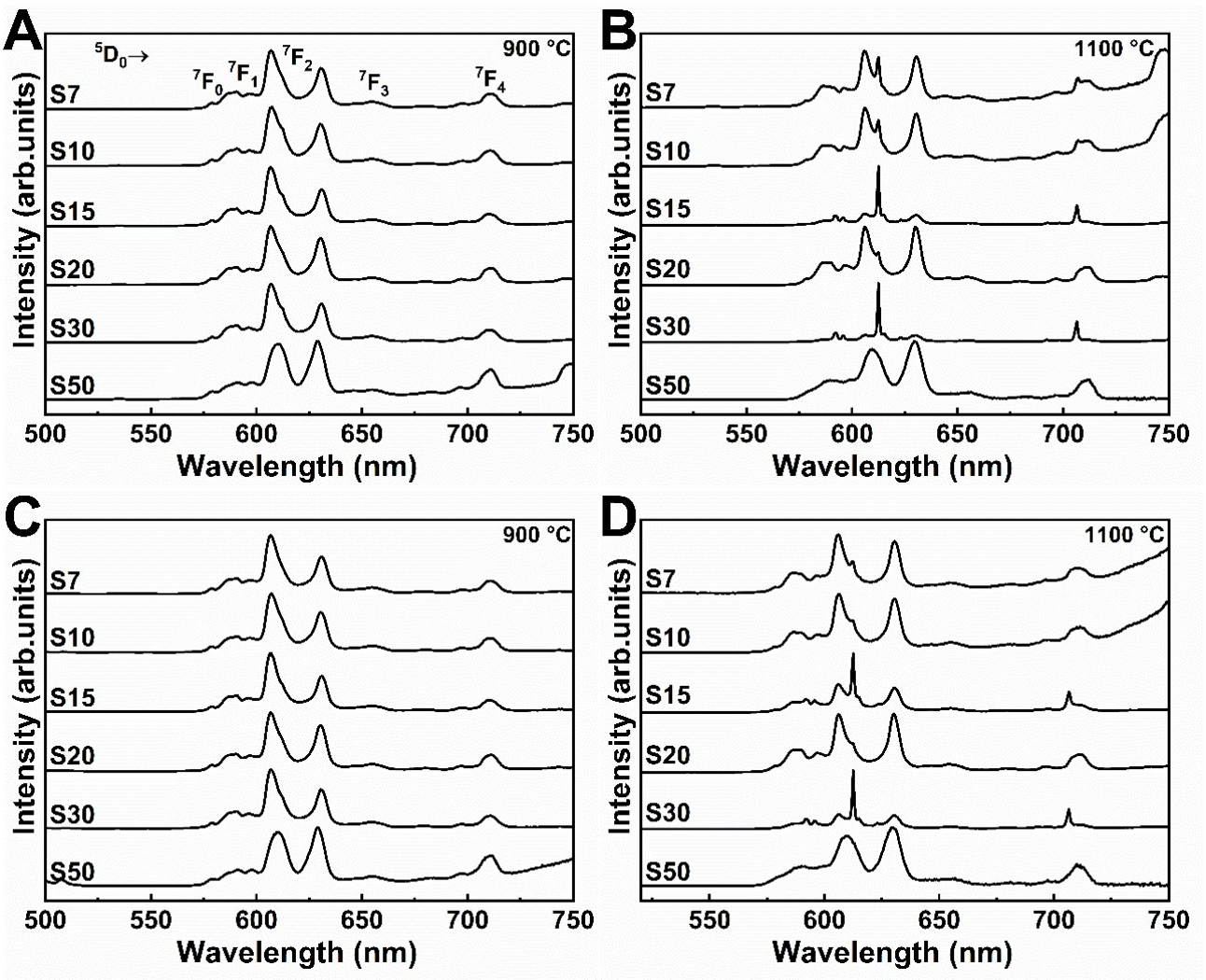

Figure S4. Emission spectra under excitation at (A) and (B) 394 nm and (C) and (D) 464 nm of Eu^{3+}-doped Y_3TaO_7 samples annealed at 900 or 1100 °C as indicated.

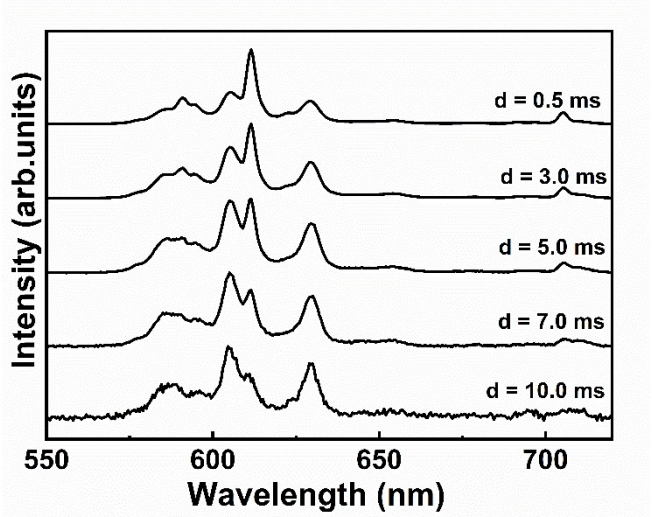

Figure S5. Time-resolved emission spectra under excitation at 393.0 nm of sample S15 annealed at 1100 °C.

Figure S5 shows the time-resolved emission spectra of the same sample under 392.5 nm excitation and the delay times were 0, 1, 5, and 10 ms. Since the lifetime of Eu^{3+} excited state in $YTaO_4$ (Table 3) is lower than the lifetime of Eu^{3+} in Y_3TaO_7 (Table 2), it is possible to observe that the intensity of the single peak at 611.5 nm diminishes with the increase of the delay time. However, the emission decay curves of $^5D_0$ excited state of Eu^{3+} distributed into Y_3TaO_7 exhibited a single exponential behavior. Thus, it was not possible to distinguish different symmetry sites with the increase of the delay, only to

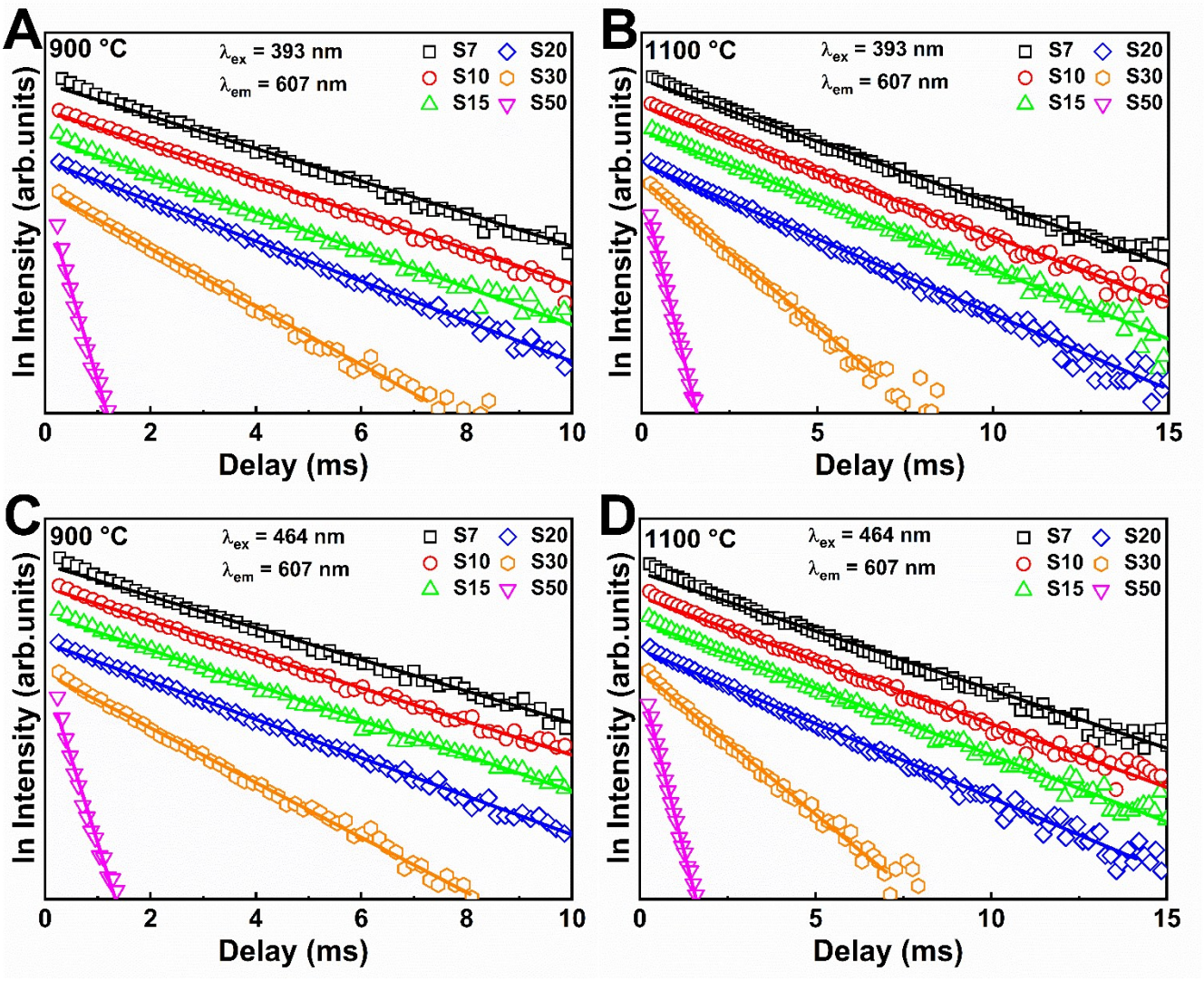

Figure S6. PL decay curves for the Eu^{3+} $^5D_0$ excited state under excitation at (A, B) 393 nm and (C, D) 464 nm of Eu^{3+}-doped Y_3TaO_7 samples annealed at 900 or 1100 °C. with fixed emission at 607 nm

observe a similar spectral profile with the broad spectra of Figure 4.

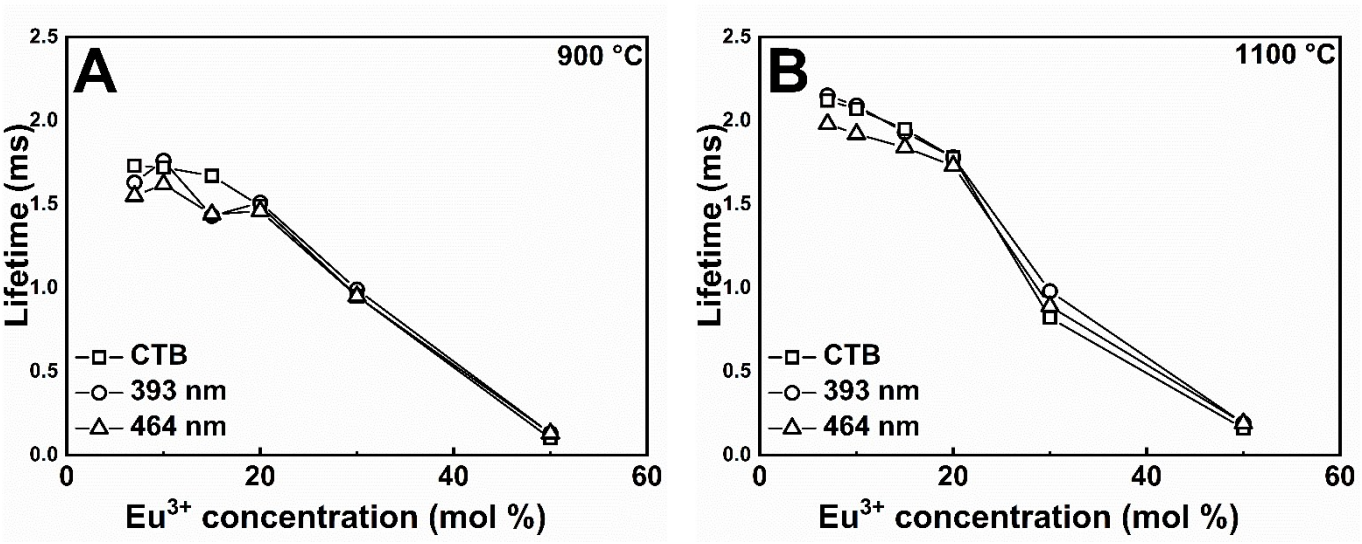

Figure S7. Lifetime ($\tau_{1/e}$) values as a function of Eu^{3+} concentration of Y_3TaO_7 samples annealed at (A) 900 or (B) 1100 °C. The lines are visual guides.

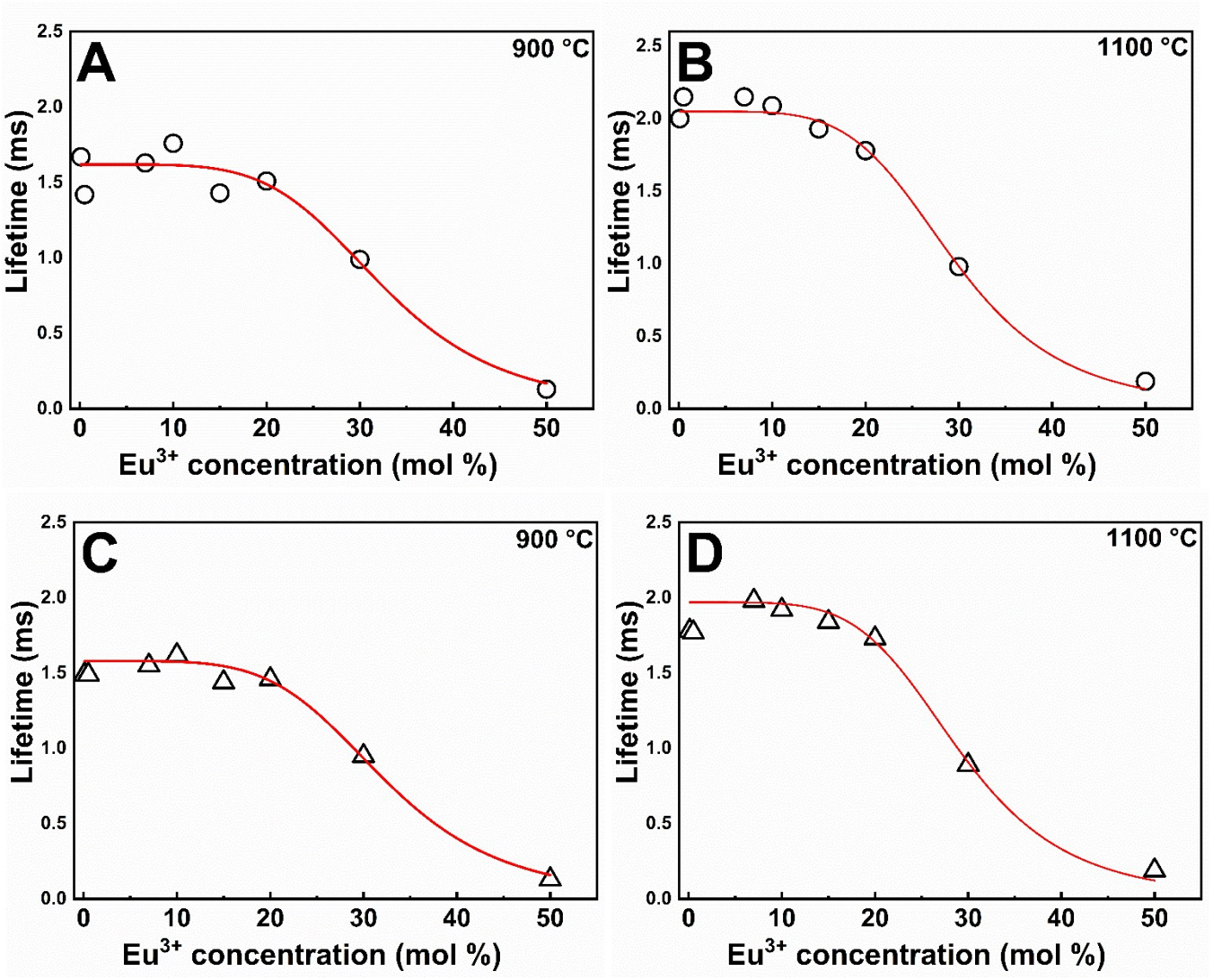

Figure S8. Lifetime values (τ_{obs}) as a function of Eu^{3+} concentration (from 0.1 [30] up to 50 mol %) under (A, B) 393.0 nm and (C, D) 464.0 nm, with fixed emission at 607.0 nm of yttrium tantalate samples annealed at 900 or 1100 °C. The lines are visual guides.

References

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