Supporting information:

Time- resolved and photoluminescence spectroscopy of θ-Al_2O_3 nanowires for promising fast optical sensor applications

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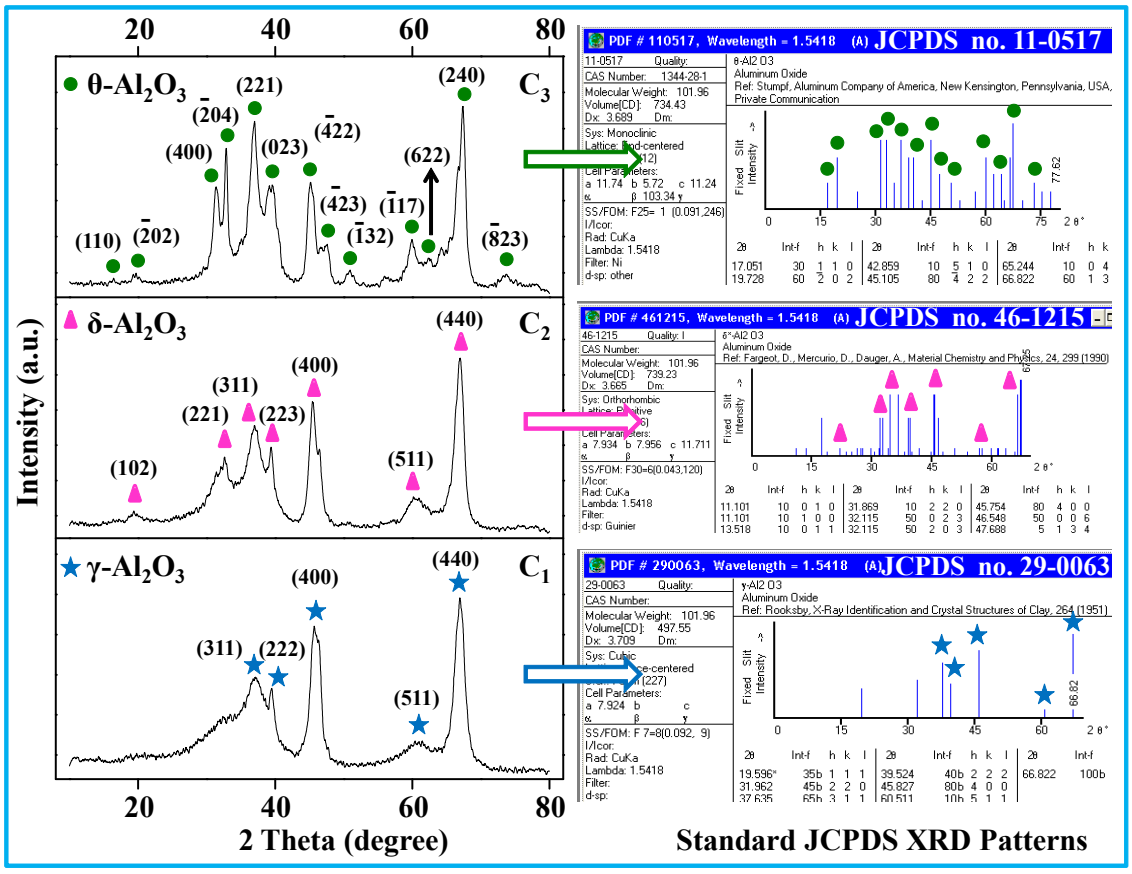

Fig. S1 Exhibits the comparative studies between standard JCPDS cards for γ-, δ-, and θ-Al_2O_3 with XRD patterns of our synthesized γ-, δ-, and θ-Al_2O_3 nanowires. It is evident from comparative study; we achieved the pure individual phase of γ-, δ-, and θ-Al_2O_3 nanowires at 500, 800 and 1000 °C, respectively. No any impurity peaks were detected.

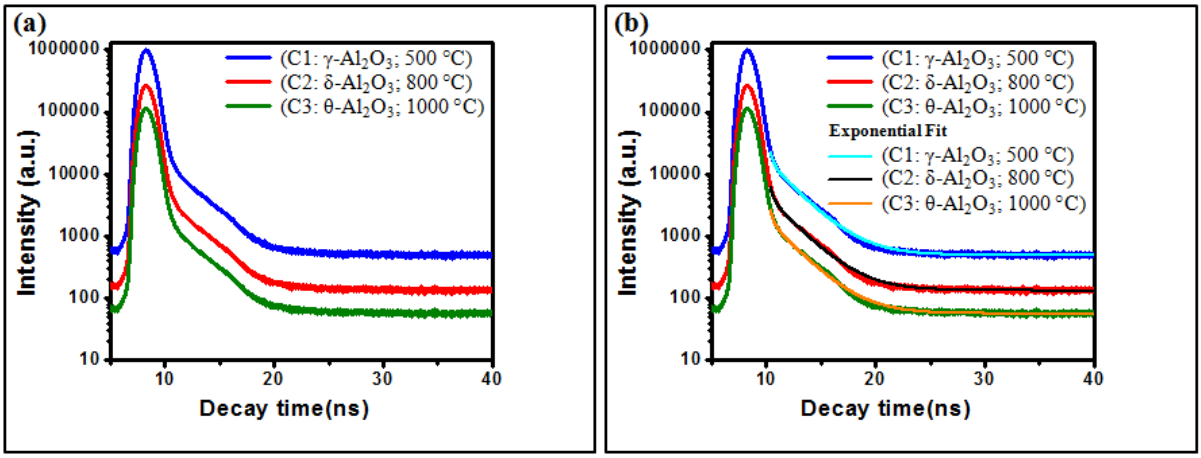

Fig. S2 (a) The time-resolved PL decay profiles of γ-, δ-, and θ-Al_2O_3 nanowires recoded at room temperature at 397 nm emission with a laser diode of 371 nm excitation wavelength. It can be easily notice that the decay time decreases as defect density decreases in γ-, δ-, and θ-Al_2O_3 nanowires, **(b)** Exhibits the exponential fit of the spectra observed for time-resolved PL decay profiles of γ-, δ-, and θ-Al_2O_3 nanowires.

The obtained TRPL results reveal the decay time increases in order to; γ-phase > δ-phase > θ-phase of Al_2O_3 nanowires, which can be easily seen in Table S1.

Table S1. The average decay time (τ_{av}) and the parameters generated by the exponential fitting of γ-, δ-, and θ-Al_2O_3 nanowires.

S. No.	**Sample details**	**λ_{ex} (nm)**	**λ_{em} (nm)**	**Decay components**		**Weighing parameters**			**good ness-of-fit (χ^2)**	**Average decay time (τ_{av})**
				τ_1 (ns)	**(τ_2) (ns)**	**A**	**A_1**	**A_2**		
01.	C1: γ-Al_2O_3, 500 °C	371	397	0.461	7.623	21.24	0.11	0.89	2.87	7.57
02.	C2: δ-Al_2O_3, 800 °C	371	397	0.371	5.62	11.25	0.25	0.75	2.68	5.51
03.	C3: θ-Al_2O_3, 1000 °C	371	397	0.265	2.387	491.44	0.07	0.93	4.12	2.23

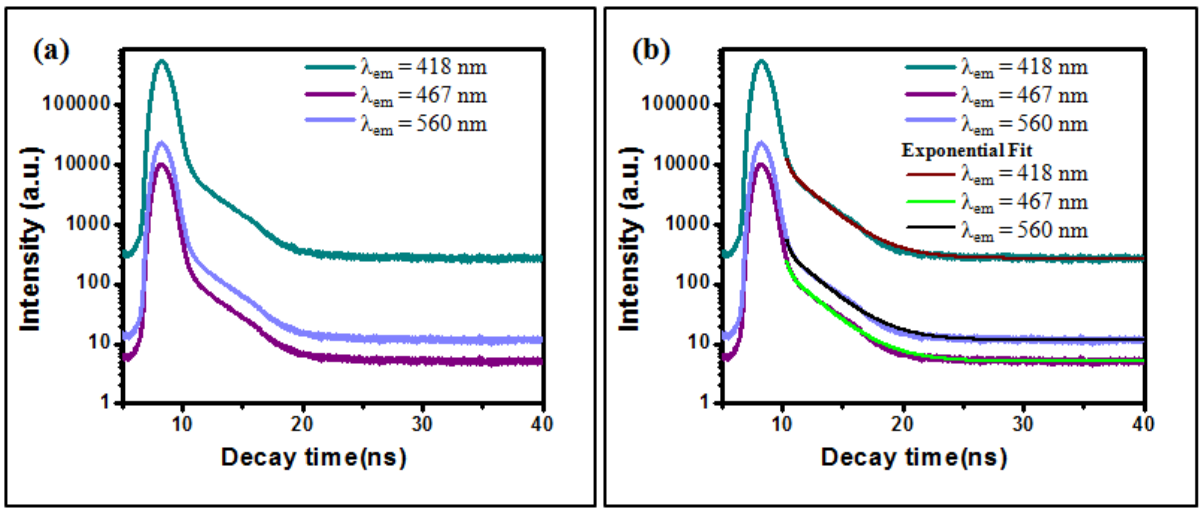

Fig. S3 (a) The time-resolved PL decay profiles of θ-Al_2O_3 nanowires recoded at room temperature at different emission wavelengths 418, 467 and 560 nm with a laser diode of 371 nm fixed excitation wavelength. **(b)** Exhibits the exponential fit of the spectra observed for time-resolved PL decay profiles at different emission wavelengths of θ-Al_2O_3 nanowires.

The TRPL decay profiles of θ-Al_2O_3 nanowires at different emission wavelengths have shown in Fig. S2. The obtained results are interesting and clearly demonstrating the average decay time decreases as per PL emission peak intensity decreases (Fig. 3c in the main manuscript), as it was expected for TRPL decay time. After exponential fit, the generated parameters are shown in Table S2.

Table S2. The average decay time (τ_{av}) and the parameters generated by the exponential fitting θ-Al_2O_3 nanowires at different emission wavelengths at fixed excitation.

S. No.	**Sample details**	**λ_{ex} (nm)**	**λ_{em} (nm)**	**Decay components**		**Weighing parameters**			**good ness-of-fit (χ^2)**	**Average decay time (τ_{av})**
				τ_1 (ns)	**(τ_2) (ns)**	**A**	**A_1**	**A_2**		
01.	C3: θ-Al_2O_3, 1000 °C	371	418	0.210	2.135	37	0.37	0.63	3.90	2.03
02.	C3: θ-Al_2O_3, 1000 °C	371	467	0.101	1.423	48.26	0.22	0.78	4.37	1.39

03.	C3: θ-Al_2O_3, 1000 °C	371	560	0.0515	0.9816	17.21	0.05	0.95	3.68	0.97

where $\lambda_{ex\ and}$ λ_{em} represents the wavelengths of excitation and emission, respectively.

The TRPL results have good consistency with obtained our PL results.