

Supporting Information

Low-Temperature Photothermal Catalytic Oxidation of Toluene on a Core/Shell $\text{SiO}_2@\text{Pt}@\text{ZrO}_2$ Nanostructure

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S1 Characterization of the samples

Table S1 BET Surface area, average pore size, and pore volume of samples

Sample	Pt (wt%)	Surface area (m ² /g)	pore size (nm)	pore volume (cm ³ /g)
SZ	0	152.29	1.123	0.57
SPZ-1	0.05	150.61	1.245	0.48
SPZ -2	0.1	149.17	1.138	0.32
SPZ -3	0.3	134.25	1.136	0.41
SPZ 4	0.5	131.58	1.086	0.56

Table S2 XPS data and correlation analysis for the as-prepared catalysts

Catalysts	Binding energy(eV)				Surface atom ratio ^a	
	Pt 4f _{5/2}	Pt 4f _{7/2}	Zr 3d _{3/2}	Zr3d _{5/2}	O _{II} (O _I)	O _{II} /O _I
SZ	-	-	184.1	181.8	532.3(530.1)	2.02
SPZ	74.07	70.87	184.3	182.1	532.3(530.1)	2.1

Calculated from the corresponding areas of fitted peaks done by XPSPEAK 4.1 with Shirley background.

Table S3 The values of photocurrent intensity for the as-prepared catalysts

Catalysts	30 °C	45 °C	60 °C	75 °C
SZ	2.8×10 ⁻⁸	-	-	-
SPZ	8.5×10 ⁻⁸	9.19×10 ⁻⁸	9.19×10 ⁻⁸	9.19×10 ⁻⁸

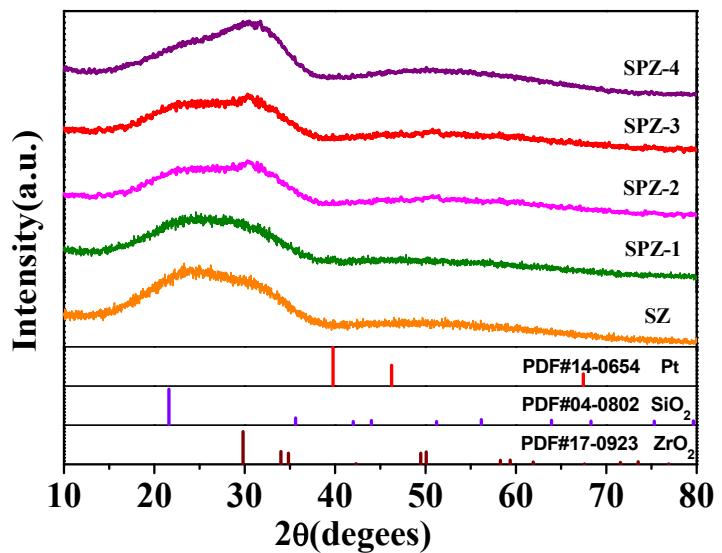


Figure S1. XRD patterns for the as-prepared catalysts

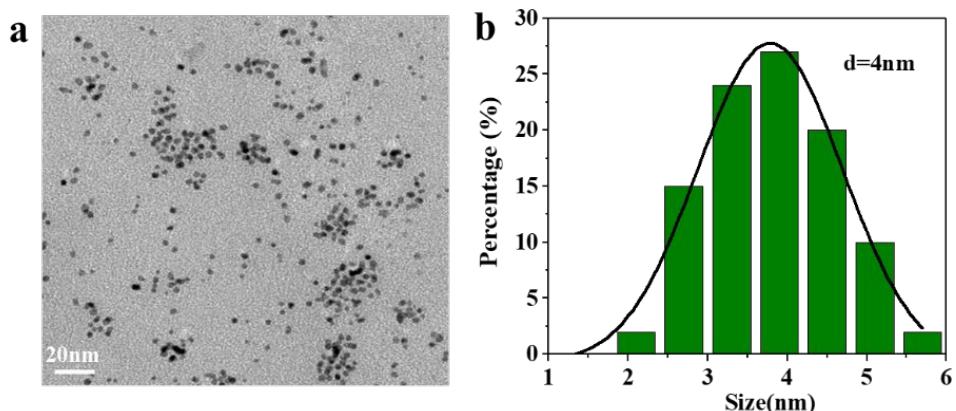


Figure S2. TEM images of Pt nanoparticles and size distributions of the Pt particles.

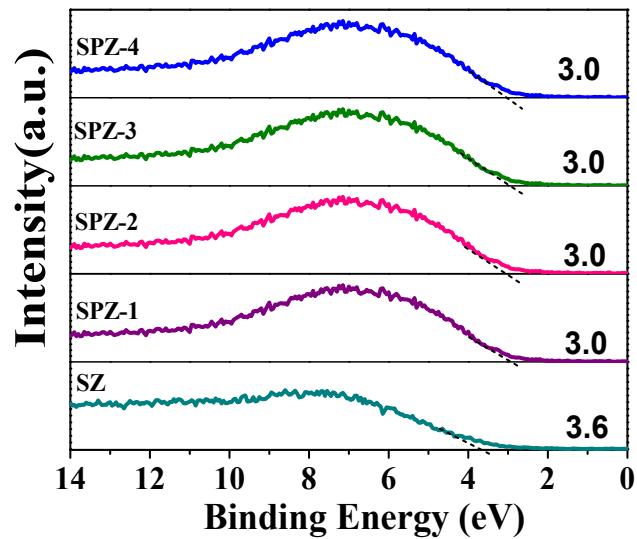


Figure S3. XPS valence band spectra for the as-prepared catalysts

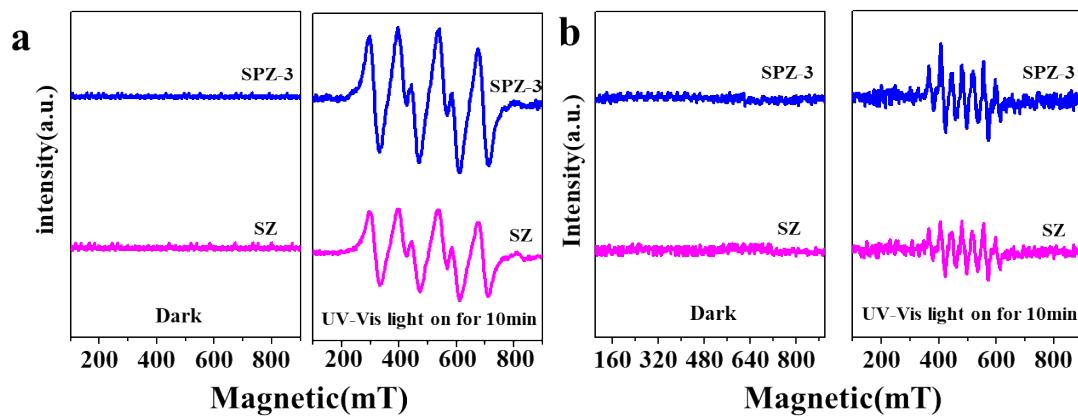


Figure S4. (a)DMPO-•OH and (b) DMPO-•O₂⁻ EPR spectra adducts under UV-visible light ($\lambda>300\text{nm}$) in the suspension of SPZ-3 and SZ NPs.

S2 Performance evaluation

Table S4 Regressed reaction rate constants(k) and R^2 values of the photo-thermalcatalytic toluene oxidation at various temperature

Samples	30°C		60°C		90°C		120°C		150°C	
	$k(10^{-3}\text{min}^{-1})$	R^2								
SPZ	0.002	0.996	0.0036	0.992	0.009	0.981	0.012	0.980	0.048	0.993
SPZ(dark)	-	-	0.00133	0.982	0.00313	0.985	0.0064	0.990	0.0175	0.997

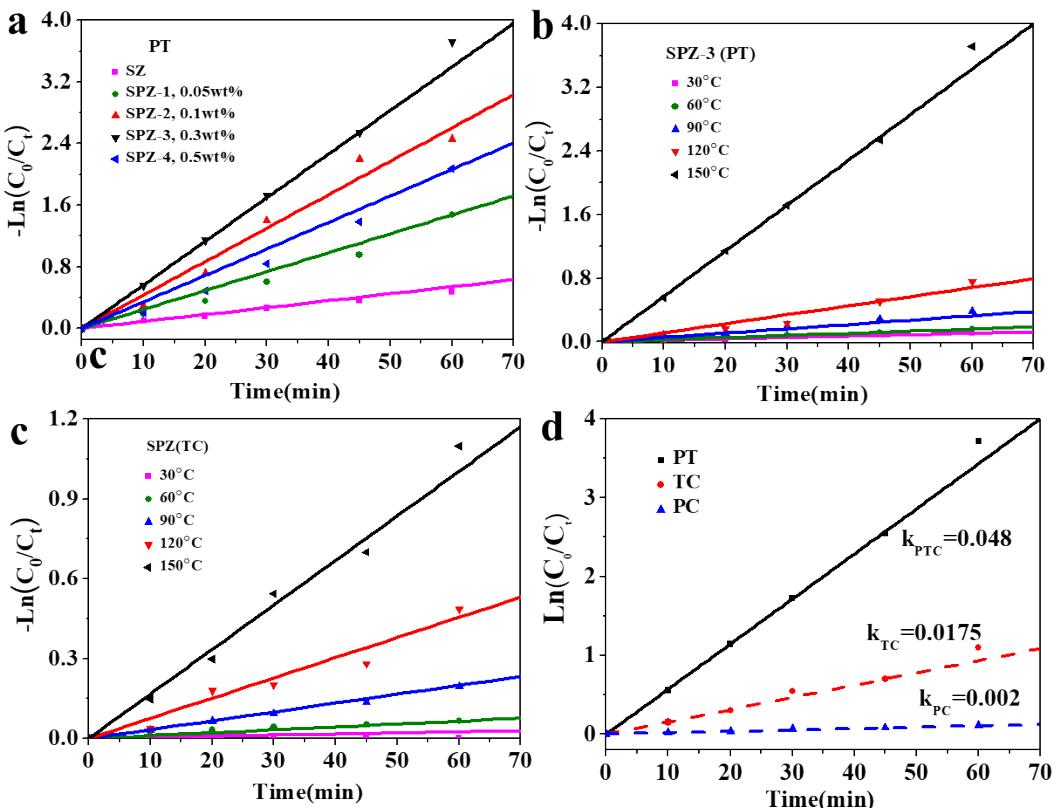


Figure S5. $\ln(C_0/C)$ versus reaction time t plots of (a) PT (Photothermal) oxidation of toluene for one hour with various Pt loading over the as-prepared catalysts, (b) PT (Photothermal) oxidation of toluene over SPZ-3 at various temperature; (c) TC (Thermo-catalytic) oxidation of toluene over SPZ-3 at various temperature;(d) different conditions(UV-visible light photocatalytic at 30 °C (PC), Thermo-catalytic at 150°C(TC), Photothermal catalytic at 150 °C (PT)) oxidation of toluene over SPZ-3.

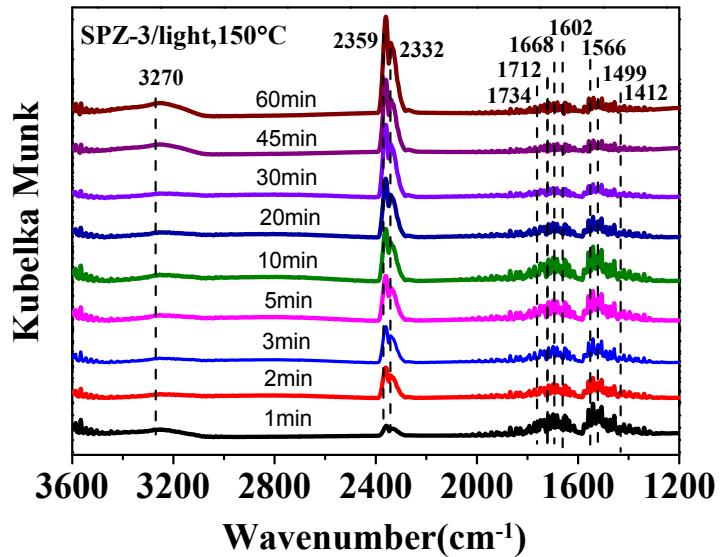


Figure S6. In situ DRIFTS spectra of adsorbed species over SPZ-3 composite in a toluene/21% O₂/N₂ feed gas upon heating at various times under UV-Vis light($\lambda>300\text{nm}$) illumination .

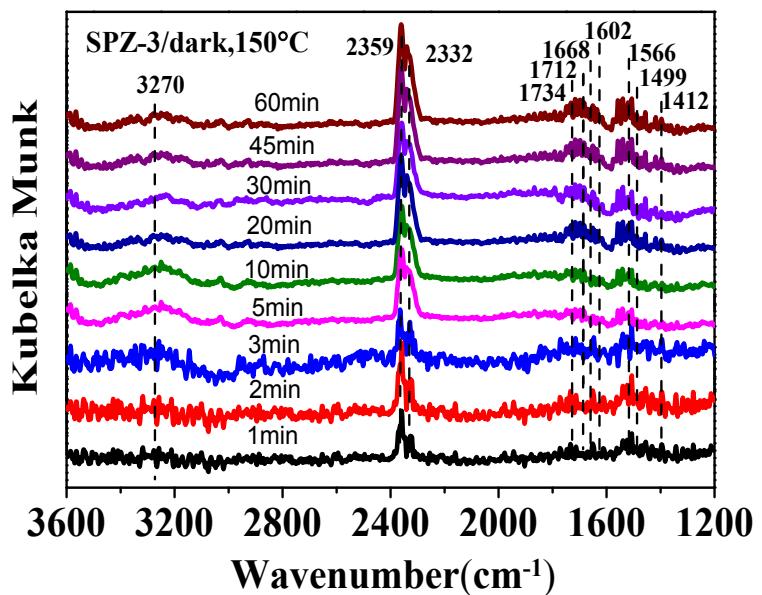


Figure S7. In situ DRIFTS spectra of adsorbed species over SPZ-3 composite in a toluene/21% O₂/N₂ feed gas upon heating at various times in the dark.