

**Supplementary Information for**

**Thermally Stable Pt-Mesoporous Silica Core-Shell Nanocatalysts  
for High Temperature Reactions**

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## **Experimental Details**

### *1. Synthesis of TTAB-capped Pt nanoparticles*

For the synthesis of Pt nanoparticles, 5 mL of aqueous 10 mM  $K_2PtCl_4$  (Aldrich, 99.9%) and 12.5 mL of 400 mM TTAB (Aldrich, 99%) were mixed with 29.5 mL of deionized water (DI) in a 100-mL round bottom flask at room temperature. The mixture was stirred at room temperature for 10 min and was heated at 50 °C for 10 min. To the clear solution, 3 mL of 500 mM ice-cooled  $NaBH_4$  (Aldrich, 98%) solution was injected through the septum using a syringe. The gas evolved inside the flask was released by inserting a needle through the septum for 20 min. The needle was then removed and the solution was kept at 50 °C for 15 h. The product was centrifuged at 3000 rpm for 30 min. The supernatant solution was separated and centrifuged again at 14000 rpm for 15 min, twice. The Pt nanoparticle colloids were collected and re-dispersed in 5 mL of deionized water by sonication for further use.

### *2. Fabrication of Langmuir-Blodgett films of Pt and Pt@SiO<sub>2</sub> nanoparticles*

Colloidal Pt or Pt@SiO<sub>2</sub> nanoparticle solutions were dispersed on the surface of DI subphase on a LB trough (type 611, NIMA Technology) at room temperature. The surface pressure was monitored with a Wilhelmy plate and adjusted to zero before spreading the nanoparticles. The resulting surface layer was compressed by a mobile barrier at a rate of 20 cm<sup>2</sup> min<sup>-1</sup>. The nanoparticles were deposited by lifting up the silicon substrates (which had been immersed in water subphase before the nanoparticles were dispersed) at a surface pressure of ~12 mN m<sup>-1</sup>.

### *3. Measurement of ethylene hydrogenation*

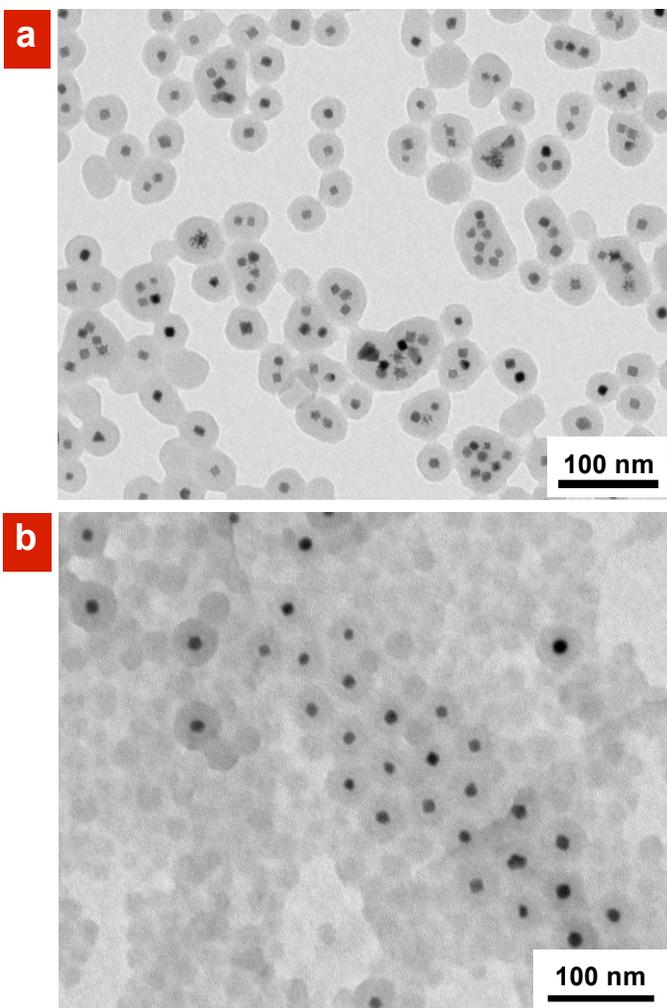
The ethylene hydrogenation was conducted in a plug flow reactor made of Pyrex. Reactants and products were detected by gas chromatography (Hewlett-Packard 5890 Series II). Rate measurement for ethylene hydrogenation was conducted at differential conditions (all conversions < 10%).

Catalyst	$E_a$ (kcal mol <sup>-1</sup> )	TOF (s <sup>-1</sup> ) <sup>a</sup>	Reference
Pt(111)	10.8	9.3	(1)
Pt nanoparticle array	10.2	14.3	(2)
0.5 % Pt/SiO <sub>2</sub>	8.9	17.5	(3)
0.04 % Pt/SiO <sub>2</sub>	8.6	4.4	(4)
~ 1 % Pt/SBA-15 by capillary inclusion	7	~ 0.7	(5)
~ 1 % Pt/SBA-15 by nanoencapsulation	10~12	~ 3.5	(6)
14% Pt@CoO	5.0	0.29	(7)
Pt@mSiO <sub>2</sub>	8.1	6.9	This Work

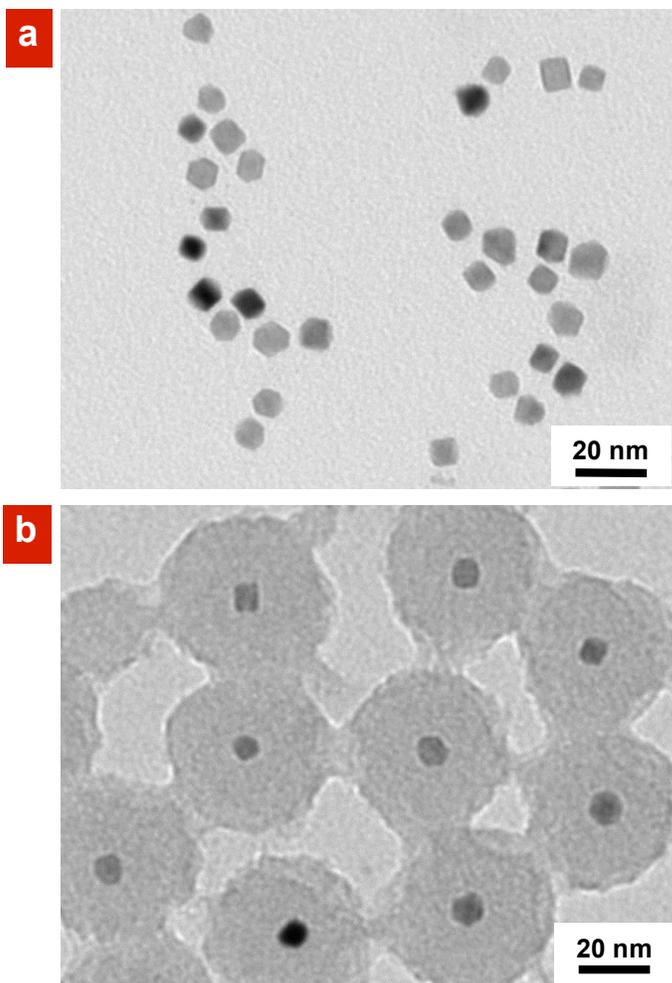
<sup>a</sup> Reaction conditions were 10 Torr C<sub>2</sub>H<sub>4</sub>, 100 Torr H<sub>2</sub>, and 298 K.

### References for Table S1

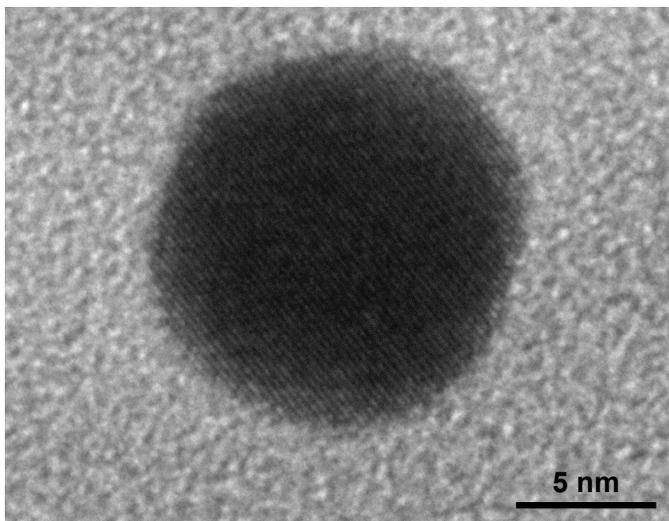
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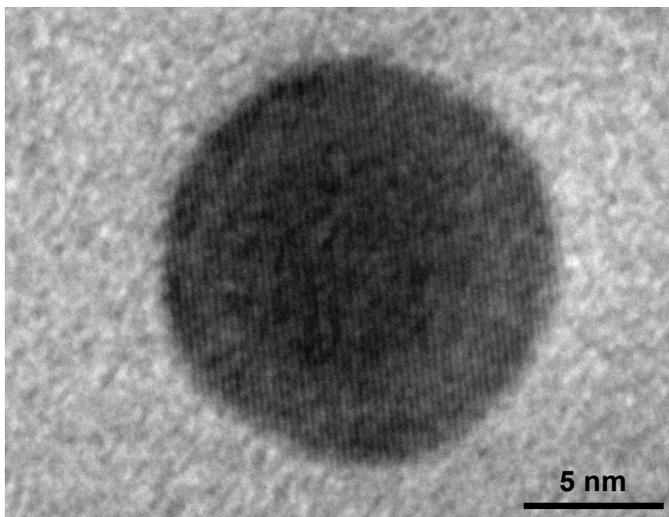
**Figure S1.** Pt@SiO<sub>2</sub> core-shell nanoparticles synthesized under (a) lower and (b) higher concentrations of TEOS, compared to the Pt@SiO<sub>2</sub> nanoparticles synthesized under the optimum TEOS concentration where each Pt particle is encaged within a silica shell.



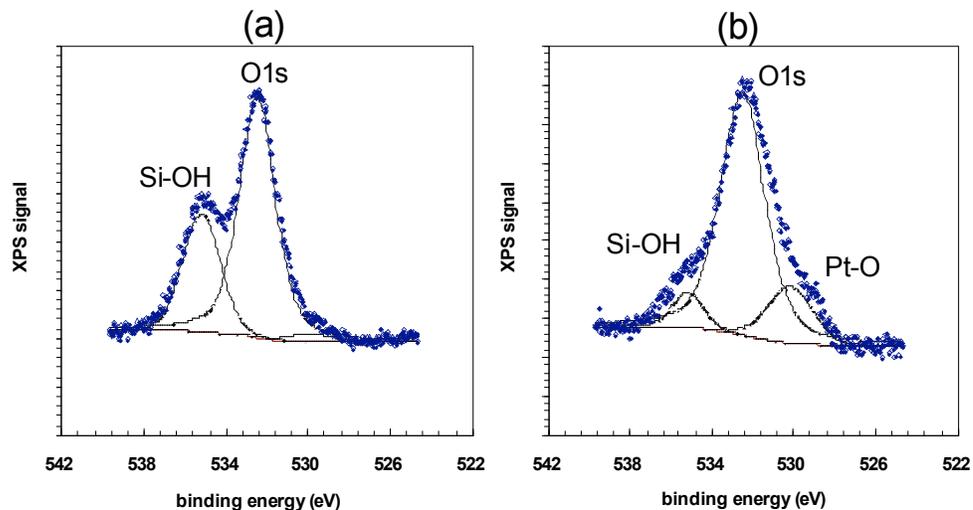
**Figure S2.** TEM images of (a) 8.5 nm Pt and (b) corresponding Pt@SiO<sub>2</sub> core-shell nanoparticles. The shell thickness of these nanoparticles was found to be ~ 18 nm, similar to that of core-shell nanoparticles with 14 nm Pt core.



**Figure S3.** High resolution TEM image Pt core in Pt@mSiO<sub>2</sub> core-shell nanoparticle after calcination at 350 °C.



**Figure S4.** High resolution TEM image Pt core in Pt@mSiO<sub>2</sub> core-shell nanoparticle after calcination and subsequent CO oxidation.



**Figure S5.** XPS plots of Pt@SiO<sub>2</sub> core-shell nanoparticles (a) before and (b) after calcination and CO oxidation. The Pt@SiO<sub>2</sub> nanoparticles were deposited on a silicon wafer using the Langmuir-Blodgett (LB) technique. The maximum temperature for CO oxidation was 340 °C. The binding energy for XPS measurements was calibrated with the C1s peak (285 eV). O1s is presumably attributed to the SiO<sub>2</sub> oxygen. The as-synthesized sample exhibits two peaks of hydroxides and atomic oxygen. After calcination, the hydroxide peak decreased and a small peak, that is attributed to Pt-O, appeared, suggesting that Pt core is partially oxidized during the catalytic reactions.