

Complete Hydrogenation of Aromatic Compounds by Platinum Nanowire Catalysts

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General Experimental Procedures and Characterizations


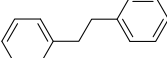
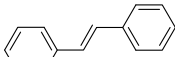
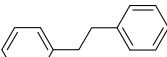
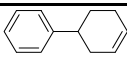
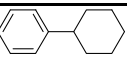
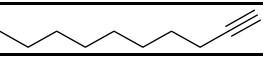
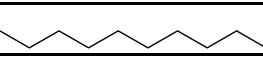




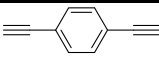
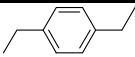
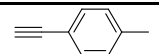
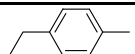
Synthesis of Pt nanowires: Ultrathin Pt nanowires were achieved by acidic etching of FePt nanowires, which was synthesized according to the procedure described by S. H. Sun *et al.*¹ FePt nanowires were firstly treated by air bubbling at 100 °C, and HCl/methanol solution was added into the above solution. The solution was heated and stirred, the resultant precipitates were obtained following 10 minutes of centrifugation (3000 rpm). The dark solid was washed with methanol for at least two times and stored in hexane.

Typical procedure for catalytic hydrogenation of alkenes and alkynes: Catalyst testing was carried out in a sealed tube. Pt nanowires in hexane were added and the hexane was evacuated by pressure reducing. Alkenes (alkynes), *n*-dodecane and the solvents were added in the reaction tube and then sealed. The reaction tube was thrice evacuated and flushed with hydrogen and took place at a certain temperature under hydrogen atmosphere. Resulting product mixtures were analyzed by GC (VARIAN CP-3800 GC, HP-5 capillary column, FID detector) and GC-MS (VARIAN 450-GC & VARIAN 240-GC) equipped with a CP8944 capillary column (30 m × 0.25 mm) and a FID detector.

Typical procedure for catalytic hydrogenation of aromatics: Catalyst testing was carried out in a pressure vessel. Pt nanowires in hexane were added and the hexane was evacuated by pressure reducing. Aromatics, *n*-dodecane and the solvents were added in the pressure vessel and then sealed. The pressure vessel was first thrice evacuated with Ar and then thrice evacuated with H₂. The pressure vessel was flushed with hydrogen and took place at a certain temperature under hydrogen atmosphere. Resulting product mixtures were analyzed by GC (VARIAN CP-3800 GC, HP-5 capillary column, FID detector) and GC-MS (VARIAN 450-GC & VARIAN 240-GC) equipped with a CP8944 capillary column (30 m × 0.25 mm) and a FID detector.

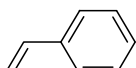
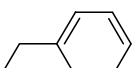
1 C. Wang, Y. L. Hou, J. Kim and S. H. Sun, *Angew. Chem. Int. Ed.*, 2007, **46**, 6333.

Table S1. Hydrogenation of alkene and alkyne compounds.^a

Entry	Substrate	Product	Additive	t (min)	Yield (%)
1			-	60	100
2			Et ₃ N	60	85.3
3			KOH	60	42.1
4			HOAc	60	100
5			HCl	60	100
6			-	5	69.7
7			-	10	84.1
8			-	20	95.1
9			-	30	98.2
10			-	40	99.2
11			-	60	99.0
12			-	60	100
13			-	60	100
14			-	90	31.0
15			-	120	100
16			-	120	100

^a Reaction conditions: Pt nanowires (0.005 mmol), alkene or alkyne compound (1.0 mmol), CH₃OH (2 mL), 40 °C, 1 atm initial hydrogen pressure. Yields were determined by gas chromatography (GC) and GC-MS.

Table S2. Hydrogenation of styrene.^a

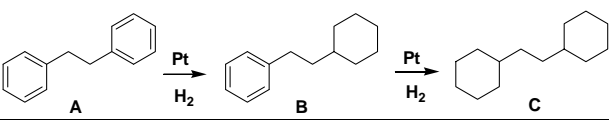
Entry	Substrate	Product	t (min)	Yield	TOF(h ⁻¹)
1			5	8.4	2016
2			10	11.7	1404
3			20	20.4	1224
4			40	37.4	1122
5			60	62.9	1258
6			90	100	1333
7 ^b			10	100	12000

^a Reaction conditions: Pt nanowires (0.005 mmol), styrene (10 mmol), CH₃OH (20 mL), 40 °C, 1 atm initial hydrogen pressure; ^b4 atm initial hydrogen pressure; Yields were determined by gas chromatography (GC) and GC-MS.

Table S3. Compare the catalytic activity of Pt NWs with the literature values.

Entry	Catalyst	Reaction condition	TOF (h ⁻¹)	Literature
1	Pt NWs	4atm, 40°C	12000	Our work
2	Pt NWs	1atm, 40°C	1333	Our work
3	Pt@{walls}SiO ₂	35bar, rt	19800	<i>J. Catal.</i> 2011, 284 , 184-193
4	Industrial Pt/Al ₂ O ₃	35bar, rt	9000	<i>J. Catal.</i> 2011, 284 , 184-193
5	Pt/H ₃ Si(n-C ₈ H ₁₇)	30bar, 23°C	129600	<i>Angew. Chem., Int. Ed.</i> 2011, 50 , 5170-5173
6	Pt/HDA	13.8bar, 80°C	36000	<i>Chem. Commun.</i> 2002, 3002
7	Pd-PEG	1bar, rt	60	<i>J. Catal.</i> 2011, doi:10.1016/j.jcat.2011.11.001
8	Re(I)/Boron Lewis Acid	10bar, 90°C	1455	<i>J. Am. Chem. Soc.</i> 2010, 132 , 18233-18247

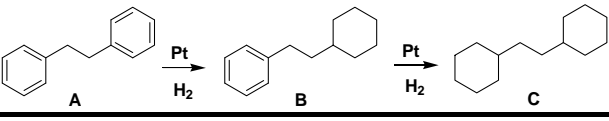
Table S4. Hydrogenation of 1,2-diphenylethane.^a



Entry	Solvent	Time (h)	T (°C)	Conv.	Select.(%)	
					B	C
1	CH ₃ OH	25	40	85.5	63.2	36.8
2	CH ₃ CH ₂ OH	25	60	100	28.5	71.5
3	(CH ₃) ₂ CHOH	25	60	100	13.6	86.4
4	HOAc /H ₂ O	25	70	26.1	75.7	24.3
5	HOAc	25	60	95.5	33.0	67.0
6	HOAc	25	70	100	0.6	99.4

^a Reaction conditions: Pt nanowires (0.005 mmol), 1,2-diphenylethane (1.0 mmol), solvent (2 mL), Lewis acid (0.25 mmol) and hydrogen pressure (1 MPa); The conversion and selectivity were determined by gas chromatography (GC).

Table S4. Hydrogenation of 1,2-diphenylethane using different catalysts.^a



Entry	Catalyst	Conversion (%)	Selectivity (%)	
			B	C
1	Pt NWs	100	0.6	99.4
2	Pt NRs	100	38.7	61.3
3	Pt NPs	86.4	52.1	47.9
4	Pt/Al ₂ O ₃	100	47.5	52.5

^aReaction condition: Catalyst (0.005mmol), 1,2-diphenylethane (1.0 mmol), acetic acid (2 mL), AlCl₃ (0.25 mmol) and hydrogen pressure (1 MPa) at 40°C for 25 hours.

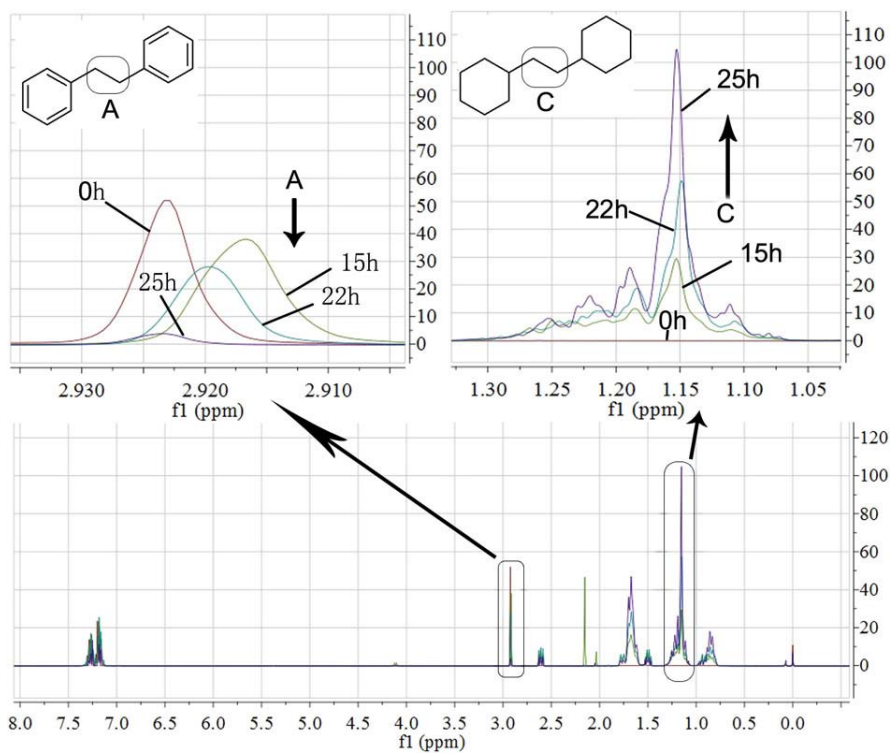


Figure S1. Time-dependent ^1H NMR analysis of 1,2-diphenylethane hydrogenation.