

Highly selective one-step hydrogenation of nitrobenzene to cyclohexylamine over the supported 10%Ni/carbon catalysts doped with 3%Rh

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Table S1. BET surface areas and pore volumes of different materials.

Catalyst	Surface area (m ² /g)	Total pore volume (cm ³ /g)
CSC	681.6	0.32
1%Ni/CSC	679.5	0.32
3%Ni/CSC	679.2	0.32
5%Ni/CSC	678.1	0.31
7%Ni/CSC	676.5	0.31
10%Ni/CSC	675.4	0.30
15%Ni/CSC	673.8	0.29
3%Rh/CSC	678.9	0.31
3%Rh-10%Ni/CSC	676.2	0.31
AC	768.2	0.46
10%Ni/AC	712.5	0.42
G	515.2	0.25
10%Ni/G	508.5	0.23

Table S2 Catalytic activity of Rh-M/CSC composite catalysts.^a

Catalyst	T (°C)	Conversion (mol%)	Selectivity (%)		
			AN	CHA	Others
3%Rh-10%Ni/CSC	140	100	0	91.6	8.4
10%Cu/CSC	200	100	97.8	2.2	0
3%Rh-10%Cu/CSC	140	100	40.0	52.9	7.1
10%Co/CSC	200	100	98.8	1.2	0
3%Rh-10%Co/CSC	140	100	50.0	41.1	8.9
10%Fe/CSC	200	100	100	0	0
3%Rh-10%Fe/CSC	140	100	72.8	25.3	1.9
10%Mo/CSC	200	100	100	0	0
3%Rh-10%Mo/CSC	140	100	62.1	34.6	3.3

^a Reaction conditions: Catalyst, 100 mg; NB, 1 g; LiOH, 40 mg; solvent, THF 9 g; pressure, 3.5 MPa H₂; time, 6 h.

Table S3 Effect of basic additives on the hydrogenation of NB.^a

Carrier	Additive	Conversion (mol%)	Selectivity (%)		
			AN	CHA	Others
	no	100	0	53.3	46.7
	LiOH	100	0	91.6	8.4
3%Rh-10%Ni/CSC	NaNH ₂	100	32.5	67.5	0
	K ₂ CO ₃	100	35.6	64.4	0
	NaHCO ₃	100	4.8	60.8	34.4

^a Conditions: NB, 1 g; additive, 40 mg; solvent, THF 9 g; pressure, 3.5 MPa H₂; temperature, 140 °C; time, 6 h.

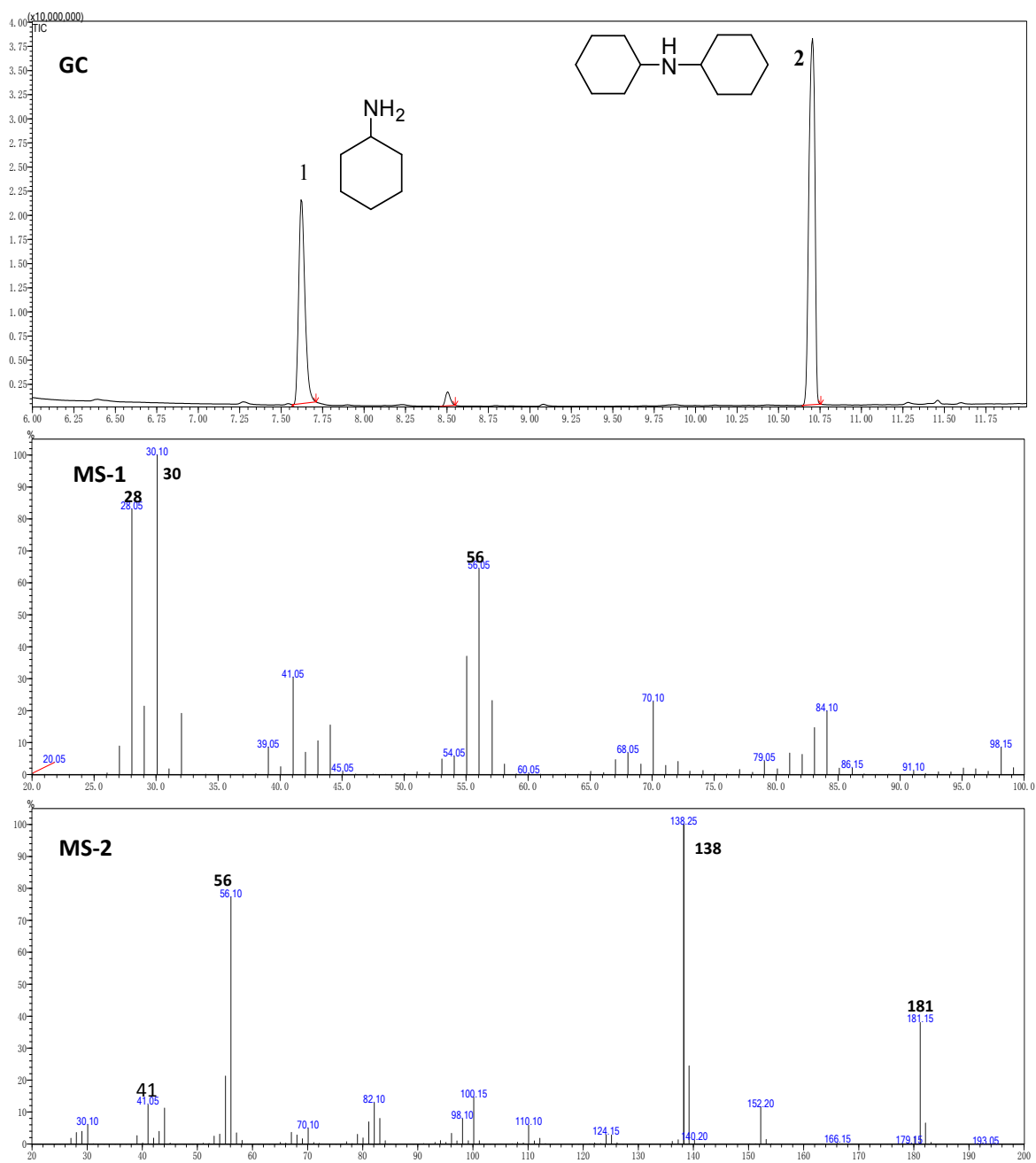


Fig. S1 The GC-MS images of the hydrogenation products

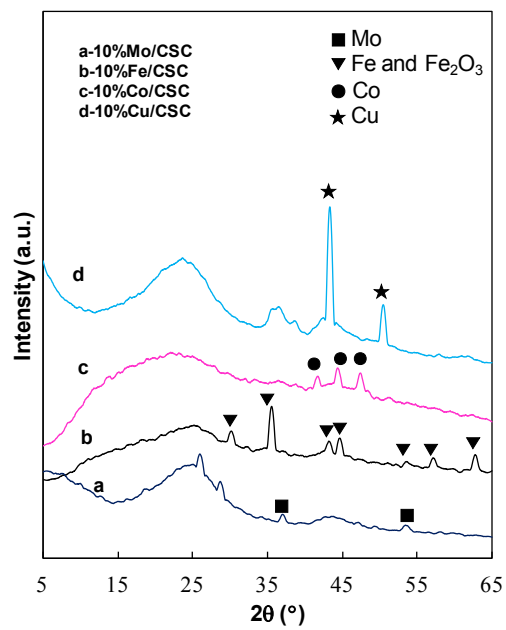


Fig. S2. XRD patterns of CSC supported other metal catalysts.

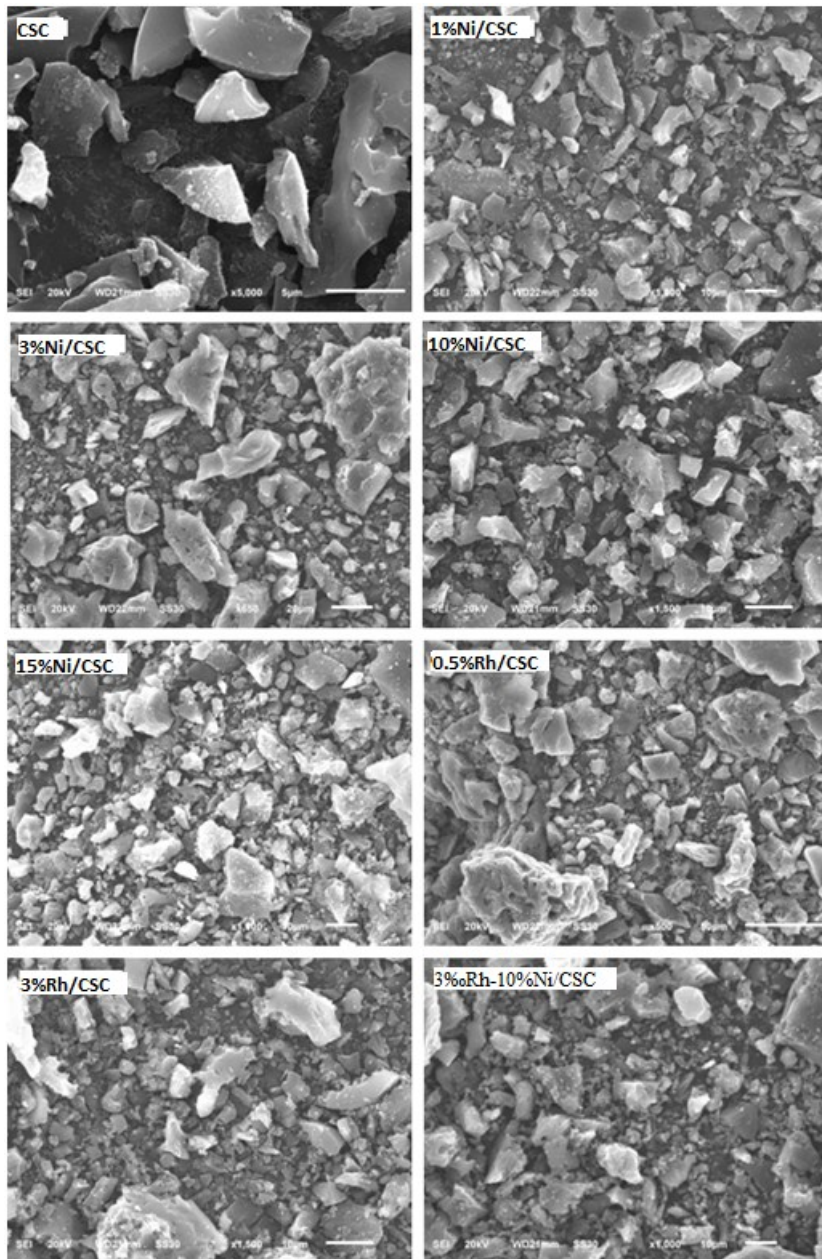


Fig. S3. SEM images of CSC supported Ni or Rh catalysts.

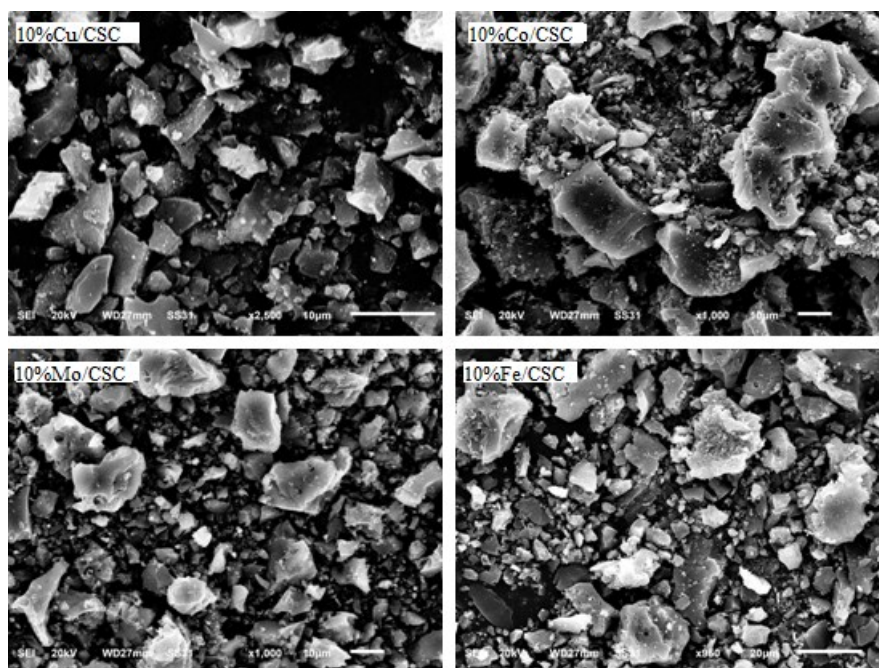


Fig. S4. SEM images of CSC supported other metal catalysts.

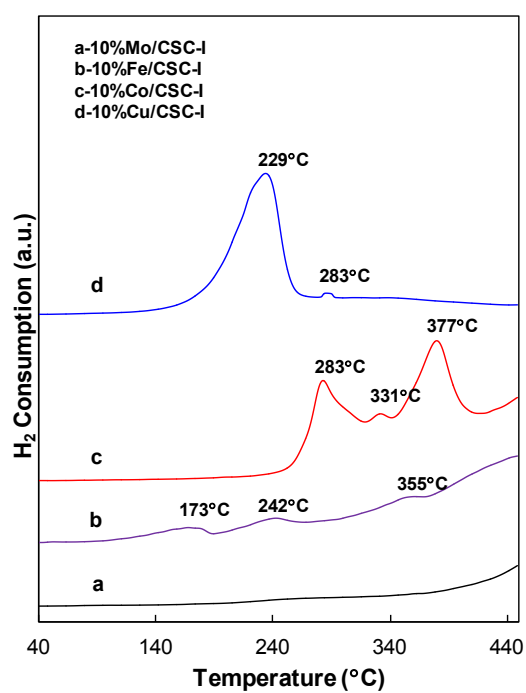


Fig. S5. Effect of other metals on H₂-TPR profiles of 10%M/CSC.

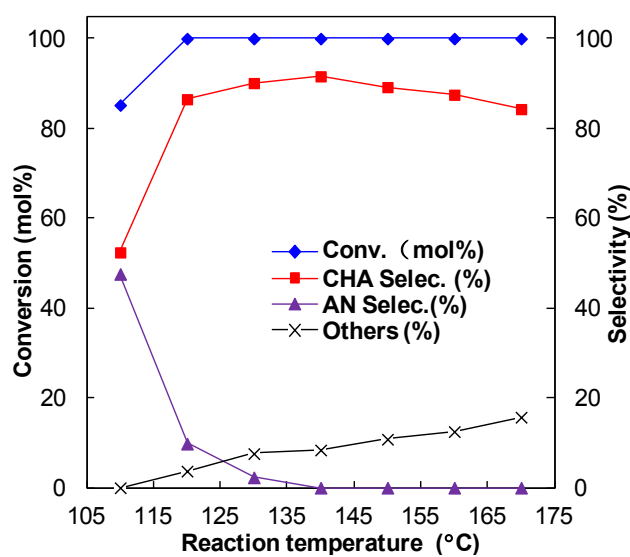


Fig. S6 Effect of reaction temperature on the hydrogenation (Conditions: catalyst, 3%Rh-10%Ni/CSC 100 mg; NB, 1 g; LiOH, 40 mg; solvent, THF 9 g; pressure, 3.5 MPa H₂; time, 6 h).

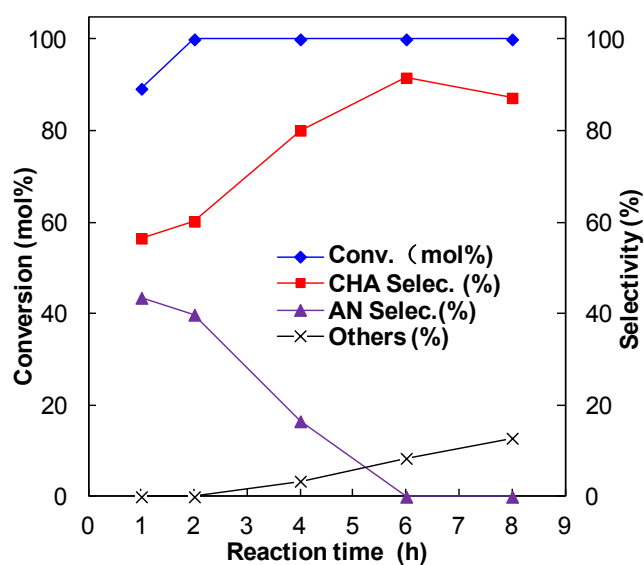


Fig. S7 Effect of reaction time on the hydrogenation (Conditions: catalyst, 3%Rh-10%Ni/CSC 100 mg; NB, 1 g; LiOH, 40 mg; solvent, THF 9 g; pressure, 3.5 MPa H₂; temperature, 140 °C).

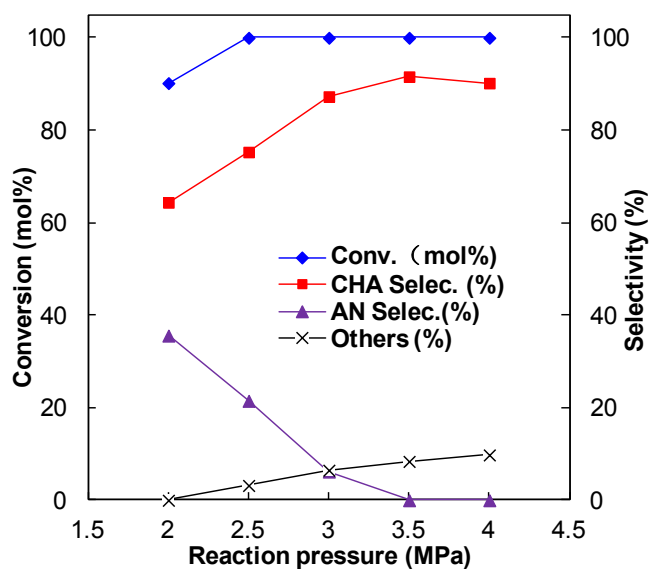


Fig. S8 Effect of H₂ pressure on the hydrogenation (Conditions: catalyst, 3%Rh-10%Ni/CSC 100 mg; NB, 1g; LiOH, 40 mg; solvent, THF 9 g; temperature, 140 °C; time, 6 h).

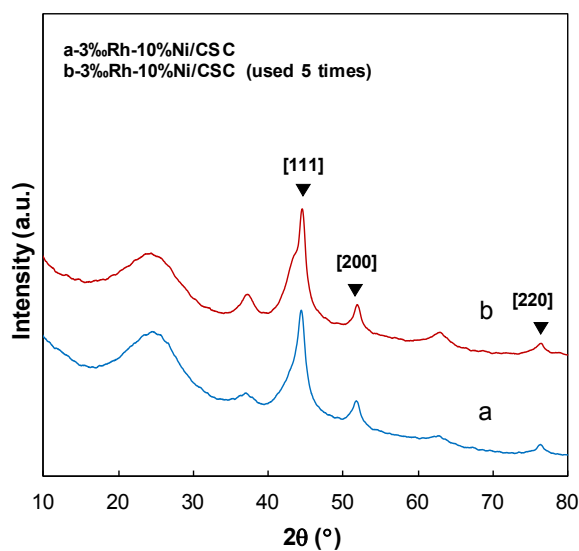


Fig. S9 XRD patterns of 3%Rh-10%Ni/CSC (fresh and reused 5 times) catalysts.

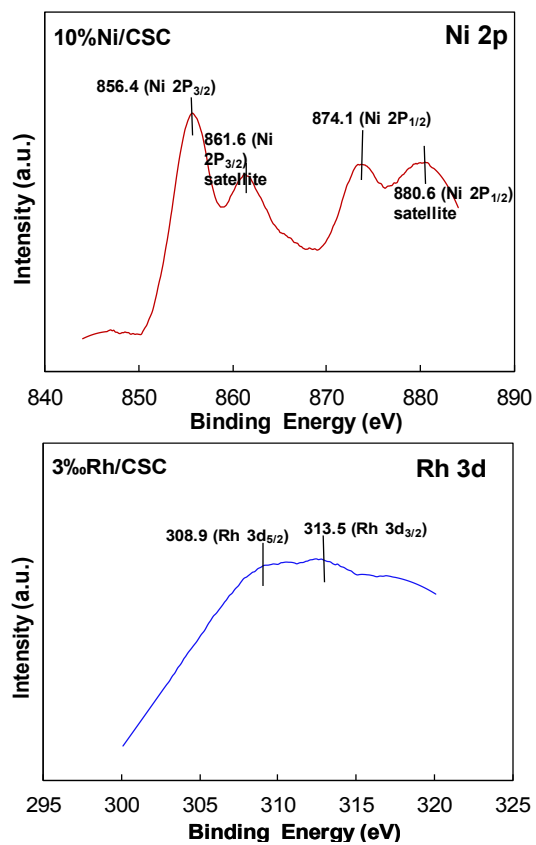


Fig. S10 XPS spectra of 3%Rh-10%Ni/CSC (reused 5 times) catalyst.

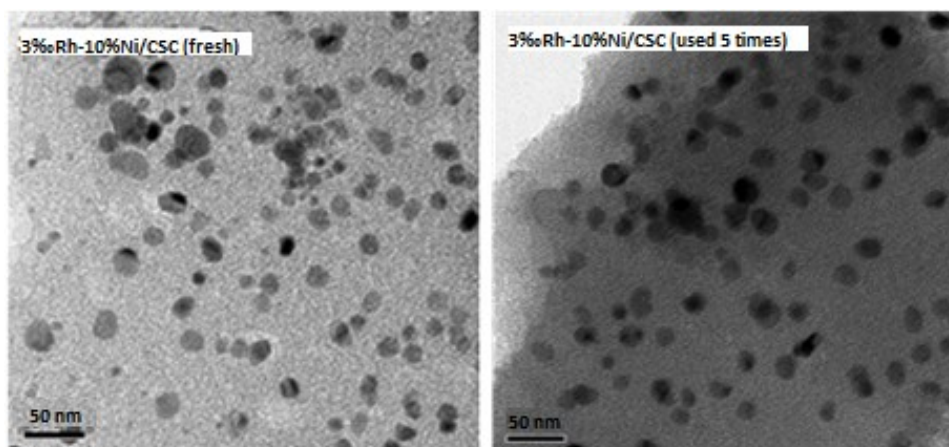


Fig. S11 TEM images of 3%Rh-10%Ni/CSC (fresh and reused 5 times) catalysts.