Supporting Information

Ru Nanospheres in Water Drops for Enhanced Catalytic Performances in Selective Hydrogenation

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Experimental section

Preparation of Ru(0) catalyst

19.46 g $RuCl_3 \cdot 3H_2O$ was dissolved in 200 mL of H_2O with agitation. 11.12 g NaOH was dissolved in 200 mL of H_2O and then added to the above stirred solution instantaneously and the resulting mixture was agitated for an additional 30 min. The black precipitate was then transferred into a 1 L Hastelloy autoclave. Hydrogen was introduced into the autoclave to raise the total internal pressure of 5 MPa and operated at 150 °C, 800 rpm for 3 h. When the reaction mixture was cooled, the catalyst was washed with deionized water until Cl^- was undetectable, and then the desired Ru catalysts were obtained.

Table S1. Textural properties and crystallite size of three catalysts.

Sample	S_{BET} (m^2 g^{-1})	V_{Pore} (cm^3 g^{-1})	D_{Pore}	d_M[a]
			nm	
Ru bulk	13	0.02	6.7	4.2
Ru network	15	0.03	8.9	4.3
Ru NSs	20	0.05	9.2	4.0
Ru(0)[S1]	88	0.18	4.1	4.1

[a] Measured by Scherrer equation.

Table S2. The variety of Ru catalysts for benzene-selective hydrogenation.

Catalysts	Benzene conv. (%)	CHE select. (%)	Y_{max} (%)	Reference
Ru/La_2O_3	40	25	14	[1]
Ru-[bmim]BF_4	49.5	34.1	17.0	[2]
Ru/BEN	59.7	44.9	26.8	[3]
Ru/Al_2O_3	40	13	-	[4]
Ru/ZnO-$La(OH)_3$	48.0	50.3	29.2	[5]
Ru/ZnO-$Mg(OH)_2$	49.8	35.2	17.5	[5]
Ru/SiO_2	64.9	33.1	21.5	[6]
Ru/ZrO_2-GLY	65	43	28	[7]
Ru/ZrO_2-EG	58	41	24	[7]
Ru/ZrO_2-PDO	84	37	31	[7]
Ru-Cd/BEN	57.4	43.1	24.8	[8]
Ru-Cu/ZnO	37.2	18.3	34.8	[9]
Ru NSs	50.0	61.9	37.5	This work

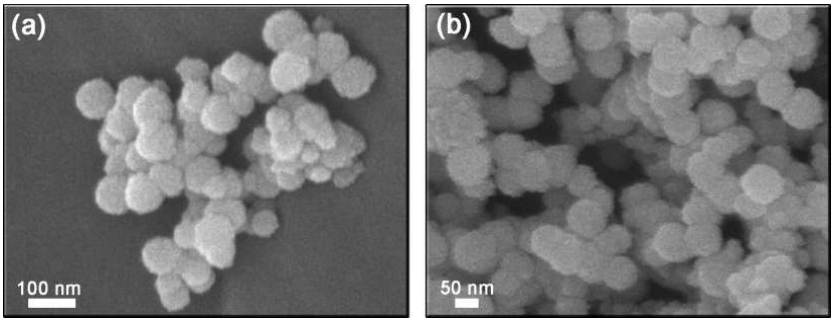

Figure S1. (a, b) FESEM images of Ru NSs.

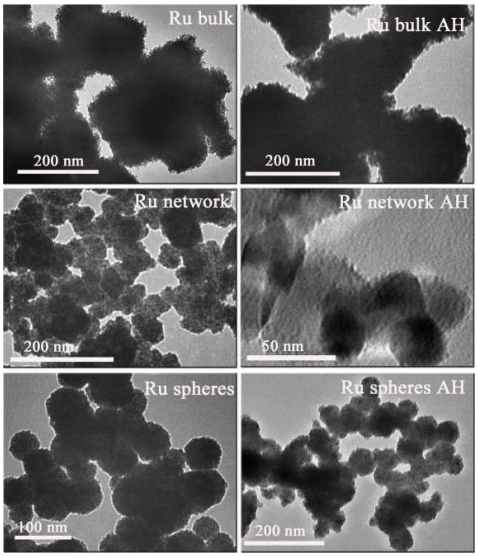

Figure S2. TEM images of three different morphology catalysts before and after hydrogenation (AH).

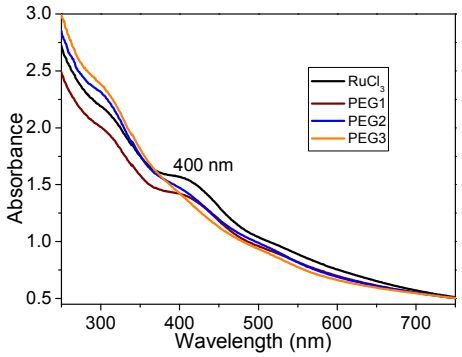

Figure S3. UV-Vis spectra of Ru^{3+} with different amount of PEG_{10000}.
PEG1: $n(Ru^{3+}):n(PEG)=2.44:1$
PEG2: $n(Ru^{3+}):n(PEG)=1.22:1$

PEG3: n(Ru^{3+}):n(PEG)=0.61:1

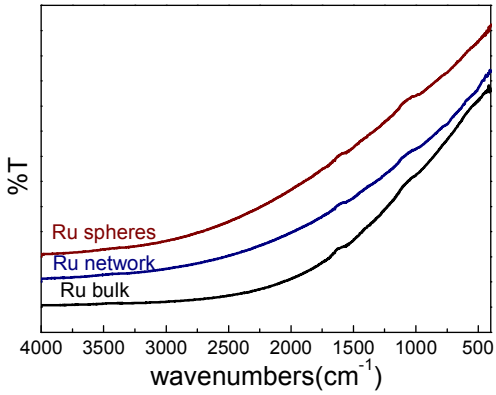

Figure S4. FT-IR spectra of three different morphology catalysts. Ru bulk (0.547 mg) in KBr (124.5 mg); Ru network (0.542 mg) in KBr (124.7) mg; Ru spheres(0.548 mg) in KBr (126.3 mg).

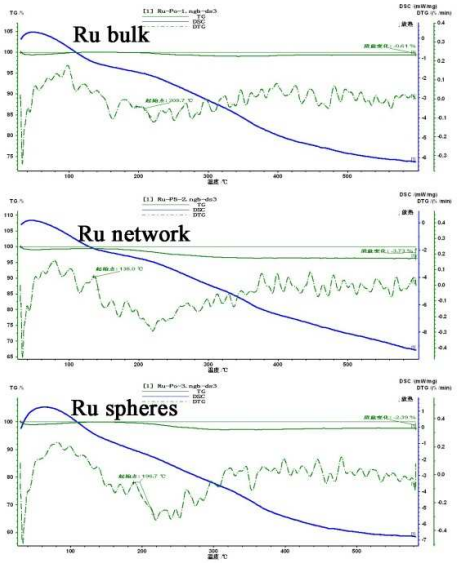

Figure S5. TG and DSC curves of three different morphology catalysts measured in Ar atmosphere.

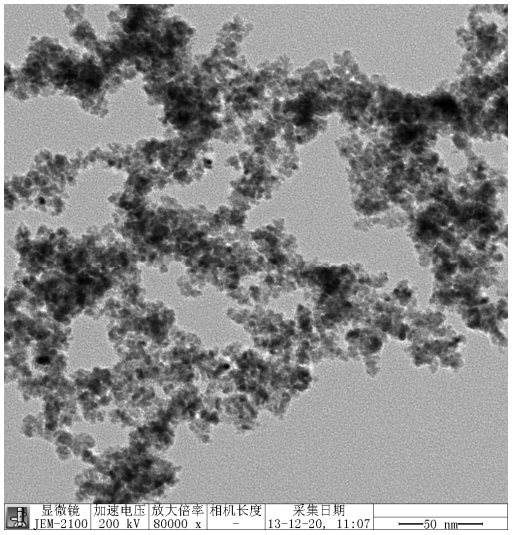

Figure S6. TEM image of Ru(0) prepared by coprecipitation.

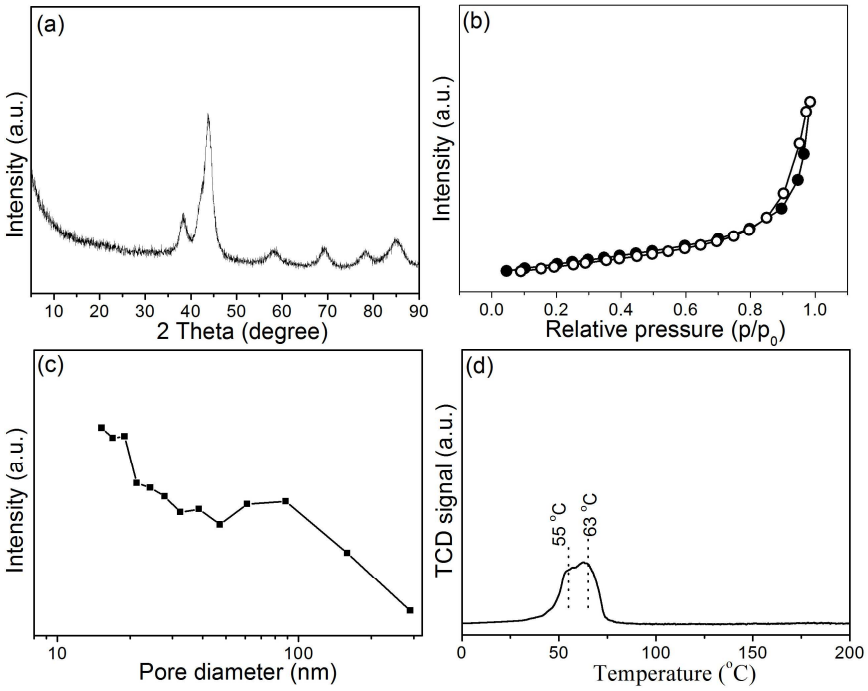

Figure S7. (a) XRD patterns, (b) N_2 adsorption (close symbol)-desorption (open symbol) isotherms, (c) pore size distribution curves, and (d) H_2-TPR profiles of Ru(0) catalysts.

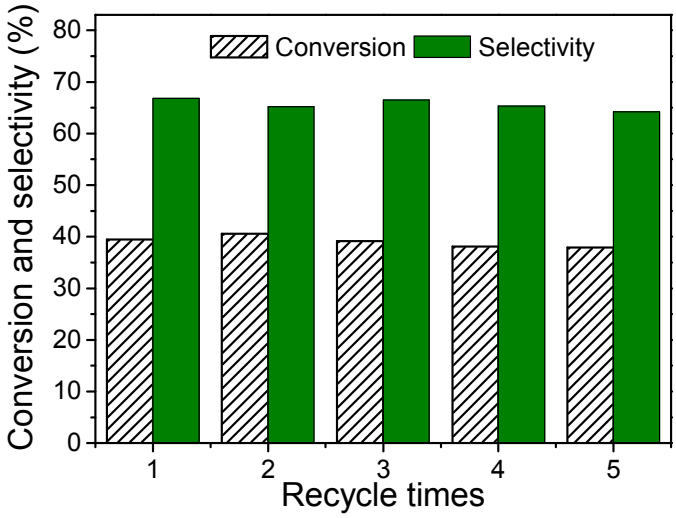

Figure S8. Reusability of Ru NSs for benzene-selective hydrogenation towards benzene conversion and CHE selectivity (sampling at 25 min).

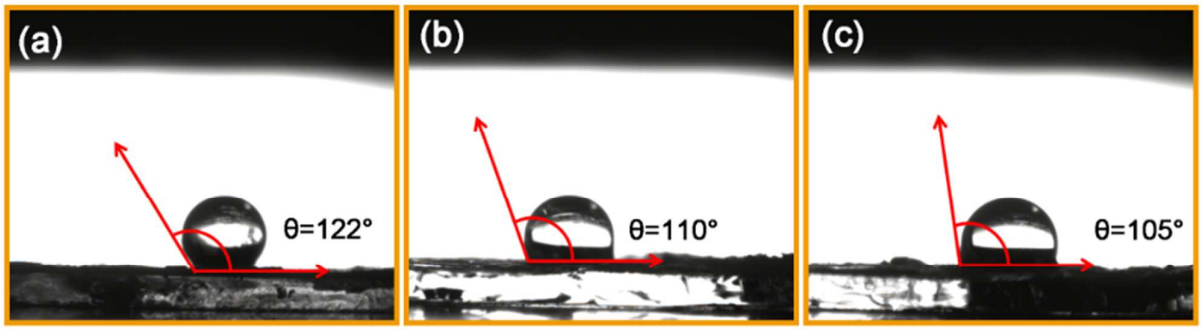

Figure S9. The water contact angle test for the (a) Ru bulk, (b) Ru network, and (c) Ru NSs.

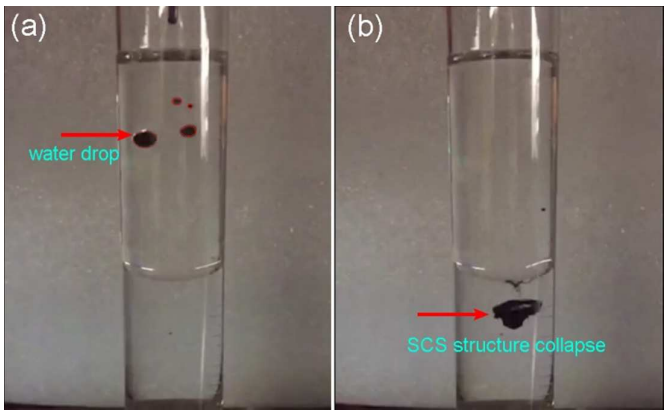

Figure S10. illustration of (a) the catalyst particles locating in water drops in benzene phase and (b) the SCS structure collapsing in water phase.

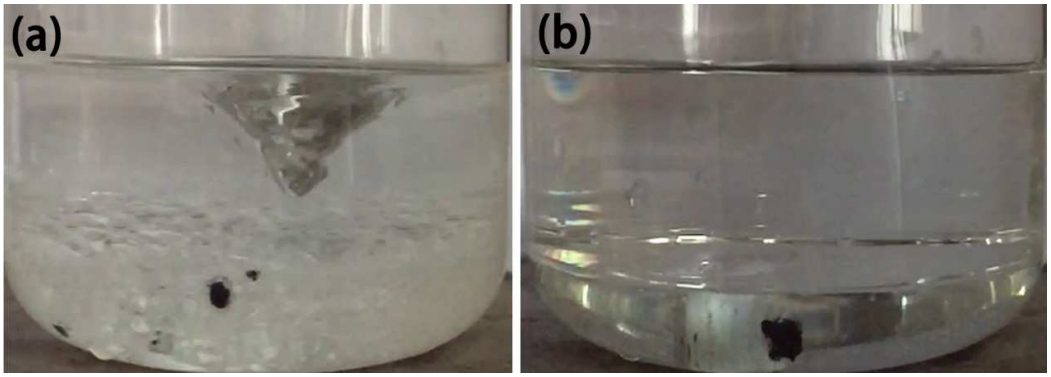

Figure S11. Illustration of the Ru SCS structure (a) under stirring and (b) stop stirring.

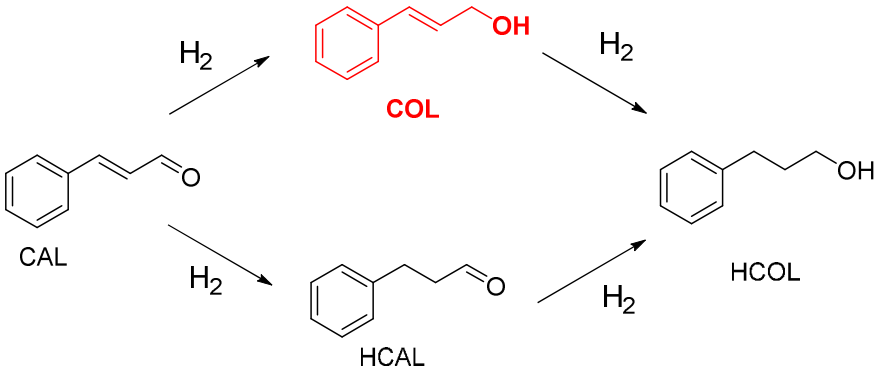

Figure S12. Hydrogenation of cinnamaldehyde (CAL) (cinnamyl alcohol (COL) is the preferred product)

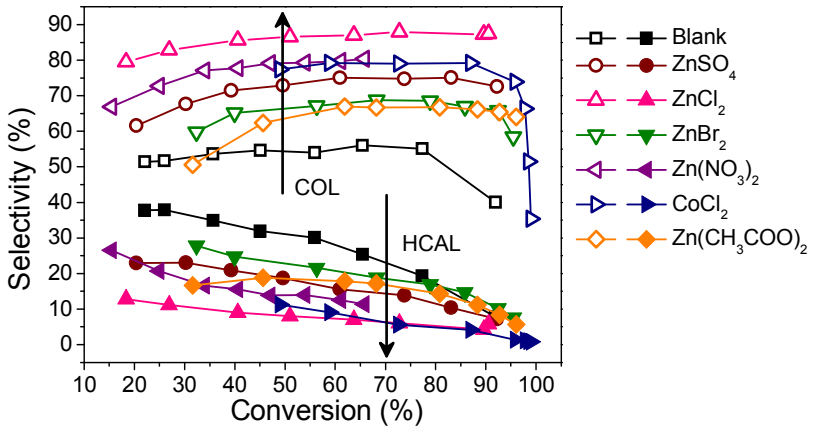

Figure S13. The selectivity of COL and HCAL as a function of CAL conversion in the presence of variety of electrolyte solutions. Reaction condition: 0.2 g of catalyst, 48 mL of H_2O, 12 mL of CAL, C_{salt} = 0.5 mol L^{-1}, temperature of 70 °C, H_2 pressure of 5.0 MPa, and stirring rate of 800 rpm

References

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