

## Supporting Information

# Well-fabricated Ru@C material derived from Ru/Zn-MOF derived with high activity and stability in hydrogenated of 4-chloronitrobenzene

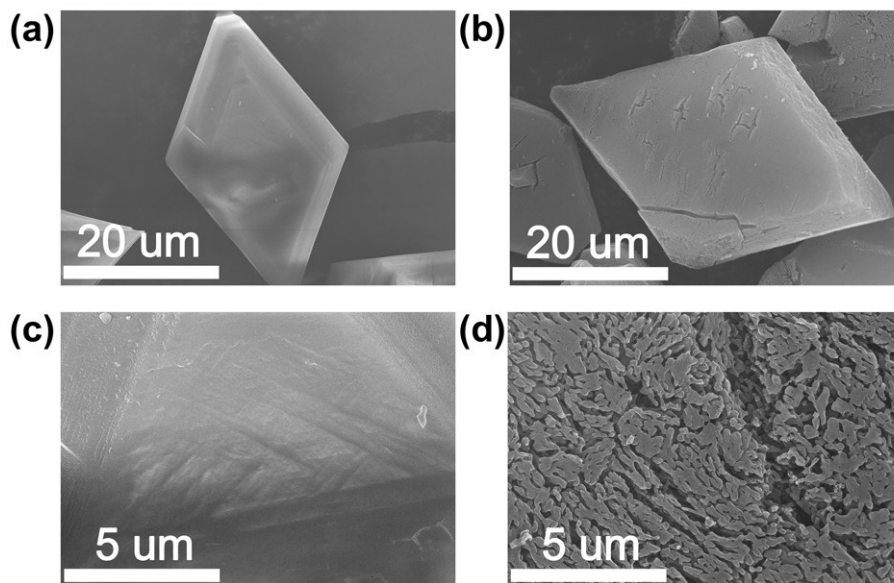
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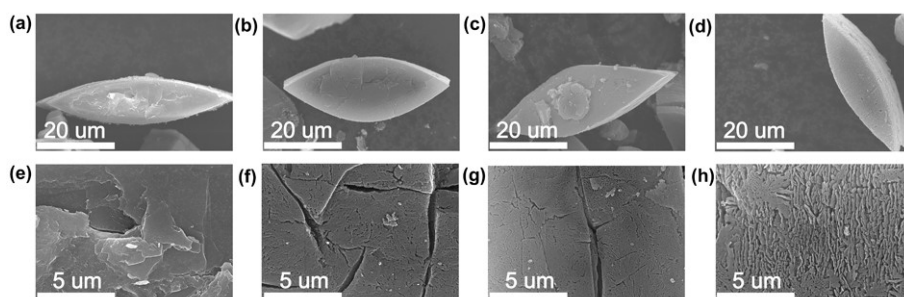
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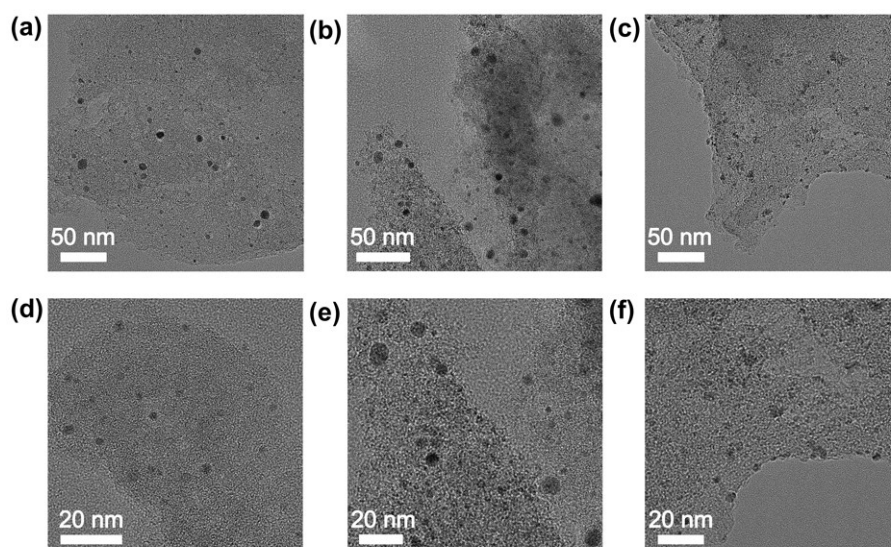
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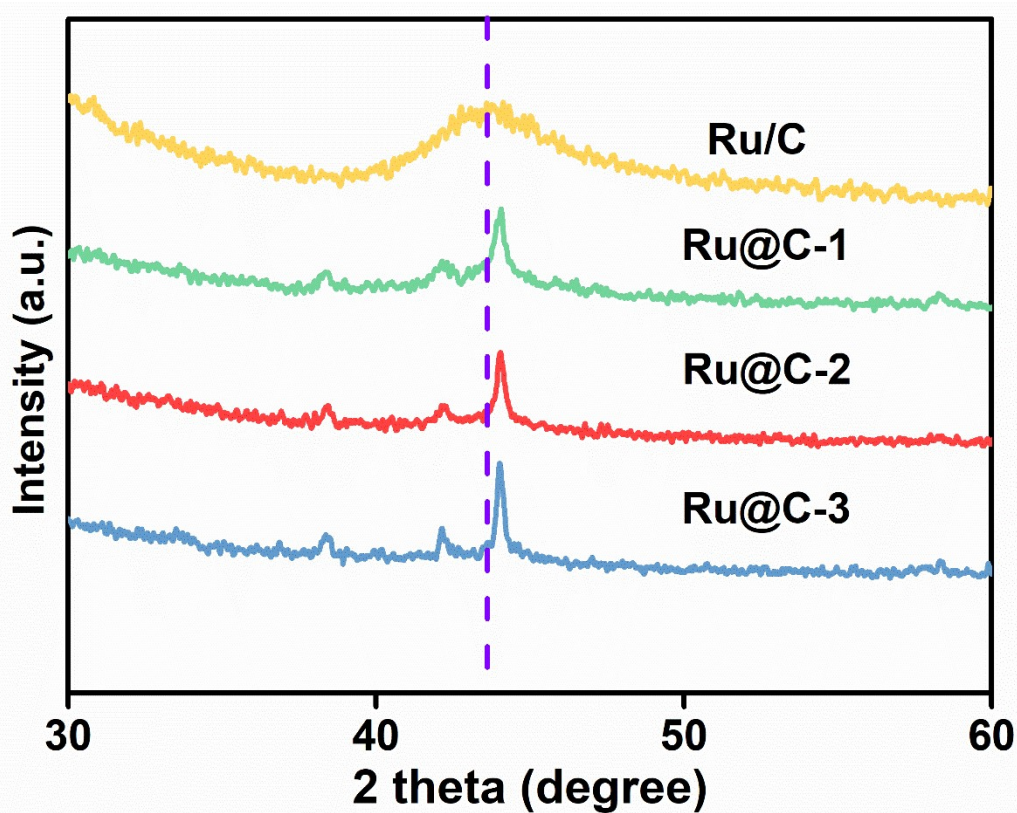
**Fig. S1** SEM images of (a, c) Zn-MOF, (b, d) and C.



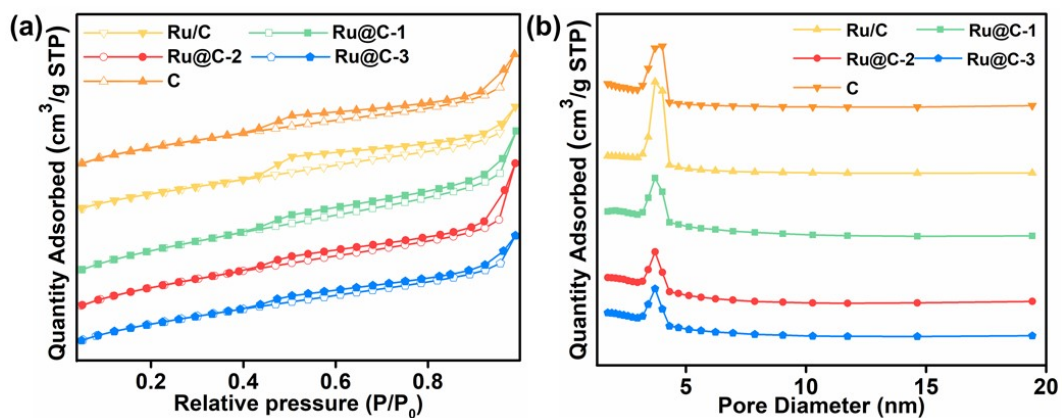
**Fig. S2** SEM images of (a, e) Ru/Zn-MOF, (b, f) Ru@C-1, (c, g) Ru@C-2 (d, h) and Ru@C-3.



**Fig. S3** TEM images of (a, d) Ru@C-1 (b, e) Ru@C-3 (c, f) Ru/C.



**Fig. S4** XRD patterns of Ru/C, Ru@C-1, Ru@C-2 and Ru@C-3 in the angular range ( $2\theta$ ) from 30 to 60°.



**Fig. S5** (a) N<sub>2</sub> adsorption-desorption isotherms analysis showing catalysts possess a mesoporous structure. (b) BJH pore size distribution verifies the mesoporous characteristics of the samples.

**Table S1** Specific surface area and pore structure results of a series of catalysts.

Catalyst	BET (m <sup>2</sup> /g)	Vp (cm <sup>3</sup> /g)
C	1155.5	0.97
Ru@C-1	1108.7	1.06
Ru@C-2	1057.4	1.07
Ru@C-3	1010.4	0.88
Ru/C	1008.9	0.87

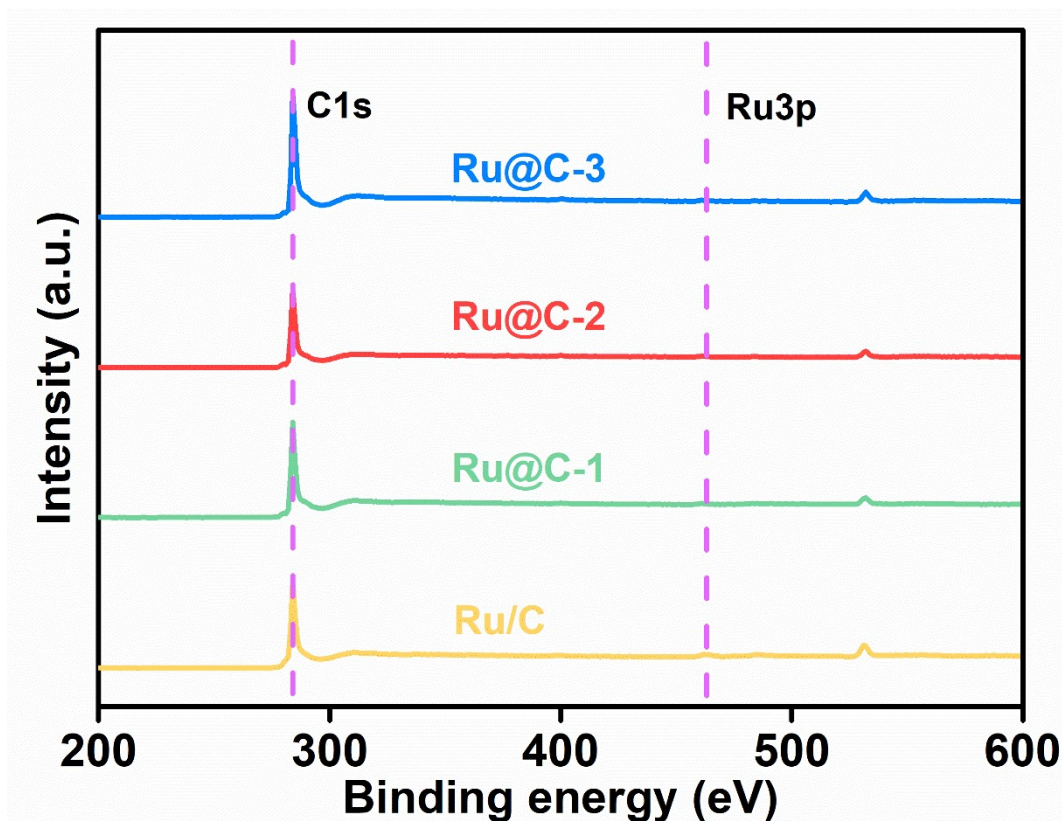
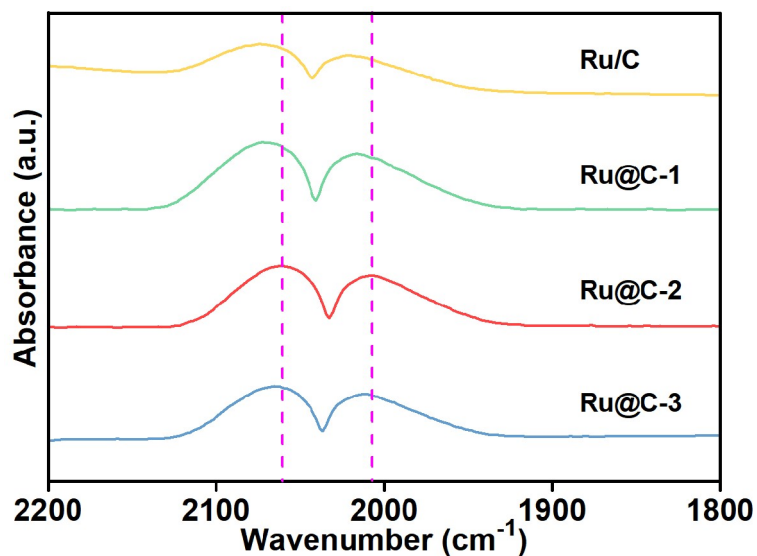


Fig. S6 XPS high-resolution spectra the surface compositions of catalysts.

**Table S2** Element analysis results of the samples with different content of XPS.

Sample	Ru (wt%) <sup>a</sup>	C (wt%) <sup>a</sup>	Ru (wt%) <sup>b</sup>
Ru/C	5.03	94.97	4.92
Ru@C-1	1.40	98.60	1.48
Ru@C-2	1.78	98.22	1.75
Ru@C-3	3.50	96.50	3.39

<sup>a</sup>The element content of XPS. <sup>b</sup>The element content of ICP.



**Fig. S7** In situ DRIFT spectra of CO adsorption on Ru@C-1, Ru@C-2, Ru@C-3 and Ru/C.

**Table S3** Comparison of Catalytic Performance of Different Catalysts for the Hydrogenation of 4-CNB

Catalyst	$W_{\text{cat}}$ (g)	$n_{\text{p-CNB}}$ (mmol)	T (°C)	Pressure (bar)	Time (min)	Conv. (%)	Sel. (%)	References
<b>0.5PdCo-red</b>	0.01	3.3	100	40	180	100.0	98.0	1
<b>Ru/CN</b>	0.01	2	80	20	90	100.0	100.0	2
<b>Pd-Ni-B/C</b>	0.05	3.2	110	30	240	98.6	94.6	3
<b>Ru@CNT</b>	0.01	2.4	100	20	180	90.0	99.7	4
<b>PtCu/CNT</b>	0.01	4	120	15	325	99.9	99.1	5
<b>Ru5/NPC (NB)</b>	0.01	1	140	15	150	98.0	98.0	6
<b>Ru-Fe<sub>3</sub>O<sub>4</sub>/FLG</b>	0.1	2.5	60	30	180	100.0	94.0	7
<b>Ru/RGO</b>	0.005	1	60	30	120	100.0	96.0	8
<b>Ru@C-2</b>	0.01	0.5	60	10	60	99.9	99.9	this work

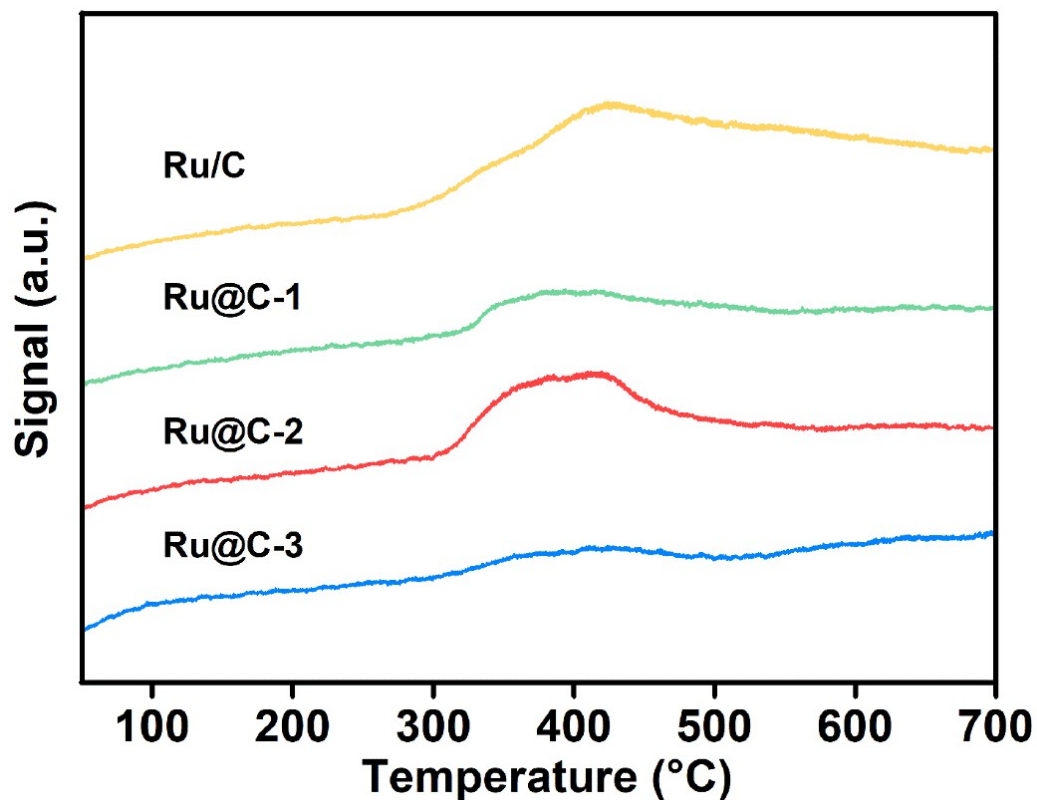


Fig. S8 H<sub>2</sub>-TPD profiles of Ru/C, Ru@C-1, Ru@C-2 and Ru@C-3.

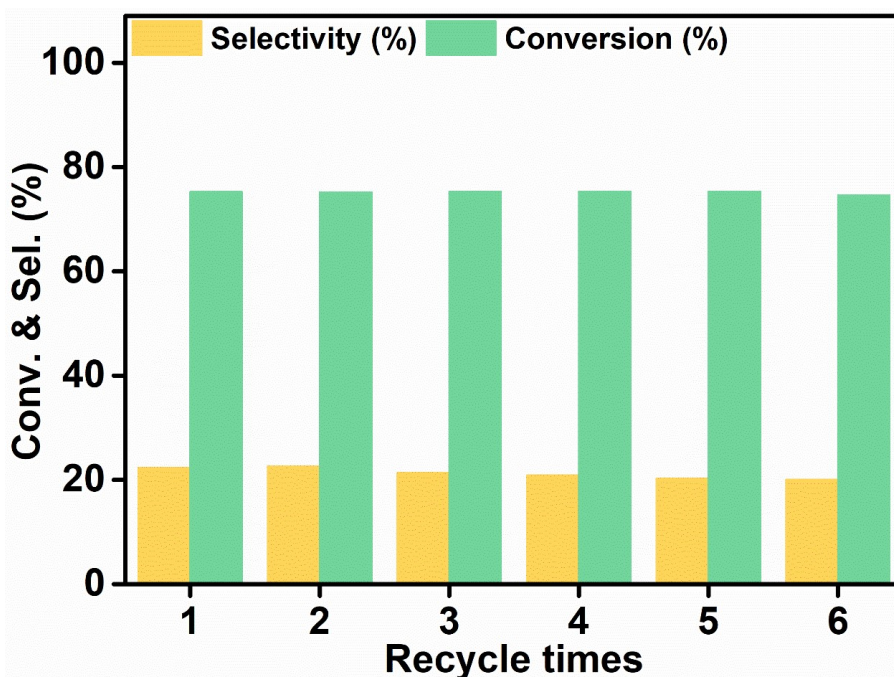
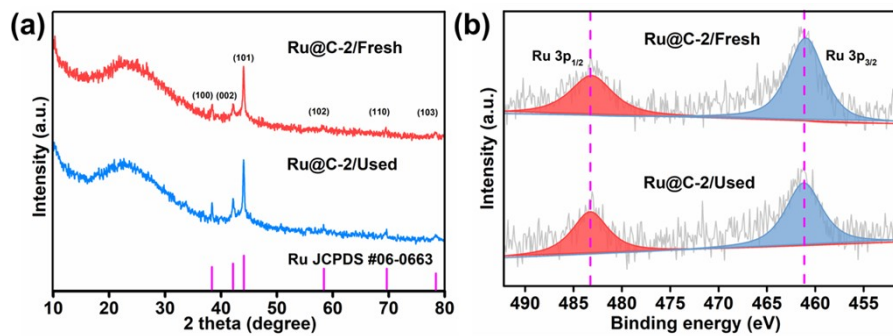
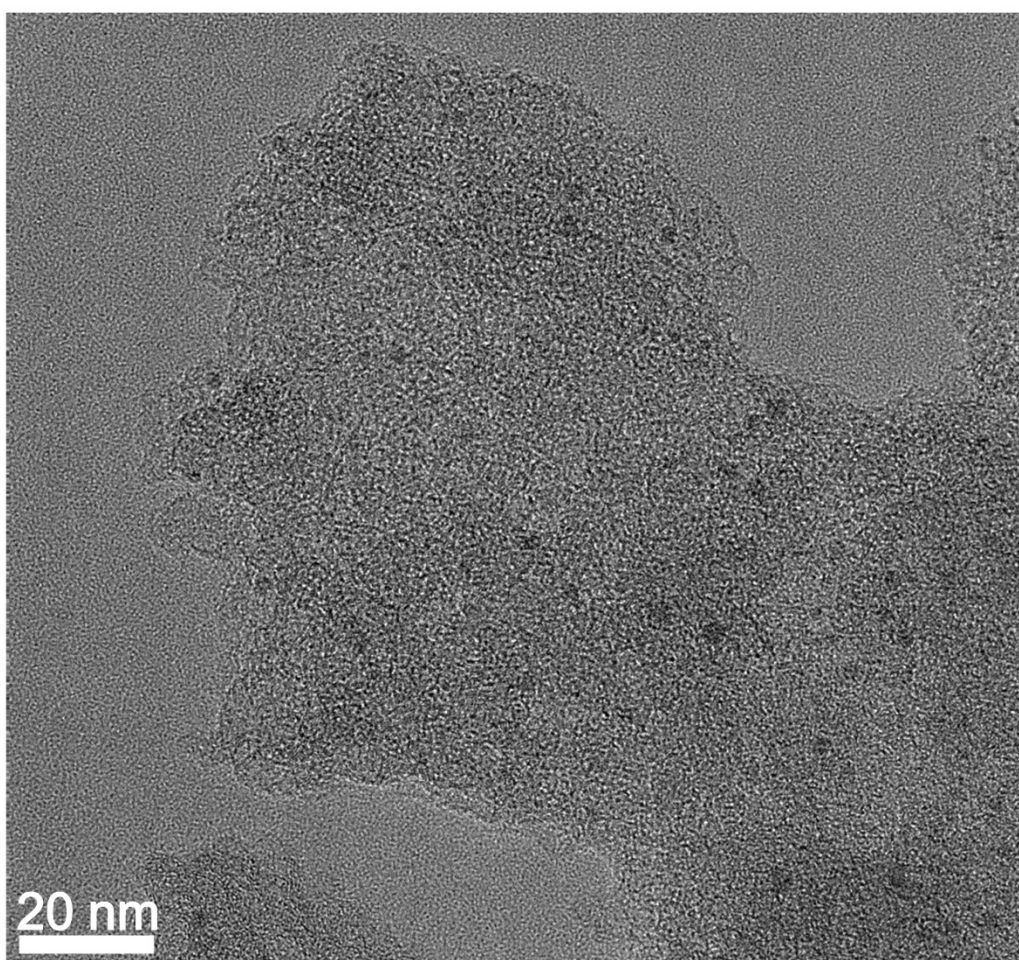


Fig. S9 Reusable of Ru@C-2 catalyst in the hydrogenation of 4-CNB to 4-CAN. Reaction conditions: catalyst, 10 mg; 4-CNB 79 mg, solvent, ethanol (1 ml); temperature, 20 °C; hydrogen pressure, 1 MPa, time, 60min.



**Fig. S10** (a) XRD and (b) XPS spectra of new catalysts and catalysts reused.



**Fig. S11** TEM images of Ru@C-2 reused.



## REFERENCES

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