Supporting Information

Bimetallic CuRu/Al$_2$O$_3$ catalyst for highly selective hydrogenation of furfural to furfuryl alcohol

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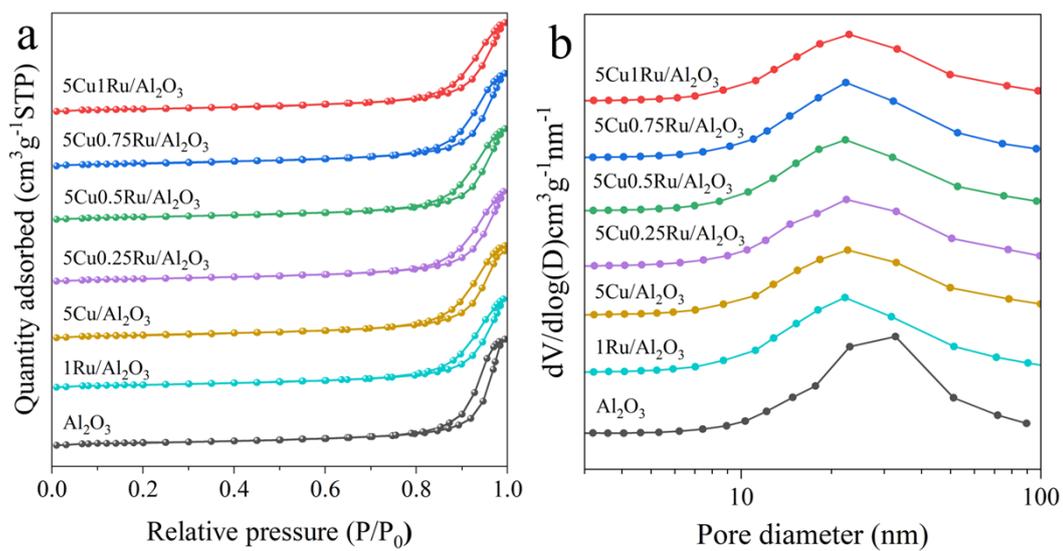
Fig. S1 N$_2$ physisorption isotherms (**a**) and pore size distribution plots (**b**) of Al$_2$O$_3$ support and the supported catalysts.
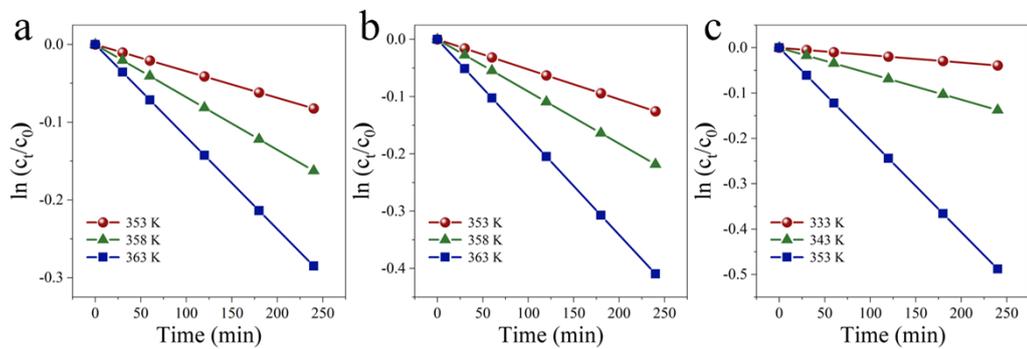
Fig. S2 Relationship between $\ln(c_t/c_0)$ and reaction time at various reaction temperatures of (a) 5Cu/Al$_2$O$_3$, (b) 1Ru/Al$_2$O$_3$, and (c) 5Cu1Ru/Al$_2$O$_3$.

Table S1 Effect of stirring rate on the hydrogenation of FAL over 5Cu1Ru/Al$_2$O$_3$ catalyst.

Entry	Stirring rate (rpm)	FAL conv. (%)	FA sel. (%)
1	400	86.5	99.5
2	600	98.6	99.9
3	800	99.9	99.9
4	1000	99.9	99.9

Reaction conditions: catalyst (0.1 g), furfural (0.5 g), isopropanol (30 mL), time (4 h), H$_2$ pressure (1 MPa).

Table S2 Calculation data of apparent activation energy for $5Cu/Al_2O_3$ in the selective hydrogenation of FAL.

T (K)	Conv. (%)	k (min^{-1})	lnk (min^{-1})	1/T (K^{-1})	1000/T (K^{-1})	Ea (kJ/mol)
353	7.9	0.0003429	−7.978072	0.002833	2.833	
358	15.0	0.0006772	−7.297603	0.002793	2.793	132.5
363	22.6	0.0011876	−6.735838	0.002755	2.755	

Reaction conditions: catalyst (0.1 g), furfural (0.5 g), isopropanol (30 mL), time (4 h), H_2 pressure (1 MPa).

Table S3 Calculation data of apparent activation energy for $1Ru/Al_2O_3$ in the selective hydrogenation of FAL.

T (K)	Conv. (%)	k (min^{-1})	lnk (min^{-1})	1/T (K^{-1})	1000/T (K^{-1})	Ea (kJ/mol)
353	11.8	0.000523	−7.555929	0.002833	2.833	
358	19.6	0.000909	−7.003165	0.002793	2.793	125.9
363	33.6	0.001706	−6.373604	0.002755	2.755	

Reaction conditions: catalyst (0.1 g), furfural (0.5 g), isopropanol (30 mL), time (4 h), H_2 pressure (1 MPa).

Table S4 Calculation data of apparent activation energy for $5Cu1Ru/Al_2O_3$ in the selective hydrogenation of FAL.

T (K)	Conv. (%)	k (min^{-1})	lnk (min^{-1})	1/T (K^{-1})	1000/T (K^{-1})	Ea (kJ/mol)
333	3.8	0.0001634	-8.719309	0.003003	3.003	
343	12.8	0.0005723	-7.463204	0.002915	2.915	118.4
353	38.7	0.0020334	-6.190444	0.002833	2.833	
363	99.9	0.0287823	-3.555384	0.002755	2.755	

Reaction conditions: catalyst (0.1 g), furfural (0.5 g), isopropanol (30 mL), time (4 h), H_2 pressure (1 MPa).

Table S5 Comparison of Catalytic Performance for Selective Hydrogenation of FAL to FA Using Different Catalysts.

Catalyst	Reaction Conditions	Conv.(%)	Sel.(%)	Ref.
Pd-CuO$_x$	120 °C, 1.0 MPa H$_2$, 4 h	100	100	[1]
Cu$_3$Ni$_1$/SiO$_2$	60 °C, 2.0 MPa H$_2$, 3 h	99.9	99.9	[2]
(tH$_2$)Ru$_x$Co$_{100}$	120 °C, 1.0 MPa H$_2$, 4 h	100	98	[3]
CuFe700	200 °C, 2 h	96.1	93.2	[4]
PtFe$_{0.6}$-TiO$_2$	40 °C, 2.0 MPa H$_2$, 4 h	99	99	[5]
Pd-Au/Cp-butyl	50 °C, 0.5 MPa H$_2$, 5 h	75	74	[6]
CuCoAlO$_x$	90 °C, 2.0 MPa H$_2$, 5 h	99	98	[7]
Pt-(SnO$_2$)$_{0.3}$/Al$_2$O$_3$	100 °C, 1.0 MPa H$_2$, 3 h	99.7	98.5	[8]
Cu@Mg/γ-Al$_2$O$_3$	170 °C, 2.0 MPa H$_2$, 3 h	99	94	[9]
2.5%CuO/MCM-41	210 °C, 0.1 MPa H$_2$, 20 h	92.5	88	[10]
NiCoCuZnFe/C-800	90 °C, 3.0 MPa H$_2$, 9 h	87.3	100	[11]
Cu$_2$Ni$_1$AlO$_y$	120 °C, 1.6 MPa H$_2$, 1.5 h	98	99	[12]
Cu$_2$Zn/SiO$_2$-IS	120 °C, 2.5 MPa H$_2$, 4 h	81.9	94.8	[13]
Cu/t-ZrO$_2$-300	120 °C, 2 MPa H$_2$, 4 h	100	100	[14]
5Cu1Ru/Al$_2$O$_3$	90 °C, 1 MPa H$_2$, 4 h	99.9	99.9	This work

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