Supplementary Information

Engineering Metal-Support Interactions of Ceria Supported Cobalt Catalysts for Durable Hydrogenation of Levulinic Acid to γ-Valerolactone

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Table S1. Results of BET surface areas.

	BET surface Area (m^2/g)	Pore volume (cm^3/g)	Pore Size (nm)
CeO_2	2.9	0.014	19.2
0.5CoCe	5.7	0.020	14.2
1CoCe	4.6	0.017	14.8
5CoCe	3.7	0.020	21.8

Table S2 The percentage of cobalt species calculated from Co 2p XPS.

Sample	Co^0 (%)	Co^{2+} (%)	Co^{3+} (%)	Ce^{3+} (%)	Ov (%)
0.5CoCe	5.0	61.3	33.7	25.7	27.3
1CoCe	6.0	69.0	25.0	28.7	29.7
5CoCe	7.6	55.7	36.7	27.3	20.7
CeO_2				18.7	19.8

Table S3. Co loadings and H_2 consumption from H_2 TPR profiles.

	[a]Co loadings (wt%)	[b]Total H_2 consumption of each catalyst (mmol/g)	H_2 consumption per Co (mmol/g)
0.5CoCe	0.50	0.15	30.0
1CoCe	0.89	0.40	43.0
5CoCe	5.06	0.62	12.0

[a]Co loadings are determined by ICP.

[b]Total H_2 consumption is calculated based on the area from 100 °C to 450 °C in the TPR profiles.

Table S4. LA hydrogenation by bare CeO_2.

Conversion (%)	EL selectivity (%)	GVL selectivity (%)
3.8	100	0

Reaction conditions: catalyst 50 mg, LA 4.3 mmol, 180℃, 3 MPa H_2, 20 min.

Table S5. Recently reported non-precious catalysts for LA to GVL.

Sample	Reaction conditions	TOF（mol/mol$_{Co}$/h）	Ref.
30%Ni/O-clay450N	140°C, 3 MPa H_2, 1,4-Dioxane	1.73	[1]
Cu/NC300@NMSSs	140°C, 3 MPa H_2, methanol	11.51	[2]
Cu/NC@SBA-15−1.0	140°C, 3 MPa H_2, methanol	5.42	[3]
Co NPs/SAs-NC@HNC-1	180°C, 4.5 MPa H_2, H_2O	731	[4]
1CoCe	140°C, 3 MPa H_2, EtOH	21.8	This work
1CoCe	180°C, 3 MPa H_2, EtOH	194.6	This work

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[2] F. Lan, H. Zhang, C. Zhao, Y. Shu, Q. Guan, W. Li, Copper clusters encapsulated in carbonaceous mesoporous silica nanospheres for the valorization of biomass-derived molecules, ACS Catal. 12 (2022) 5711-5725.

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[4] S. Shao, Z. Ding, C. Shang, S. Zhang, Y. Ke, G. Zhu, Yang, Yolk-shell Co catalysts with controlled nanoparticle/single-atom ratio for aqueous levulinic acid hydrogenation to γ-valerolactone, Chem. Eng. J. 450 (2022) 138153.

Table S6. Co loadings of fresh and spent for cobalt catalysts.

	Fresh (wt%)	Spent (wt%)
0.5CoCe	0.50	0.28
1CoCe	0.89	0.88
5CoCe	5.06	2.27

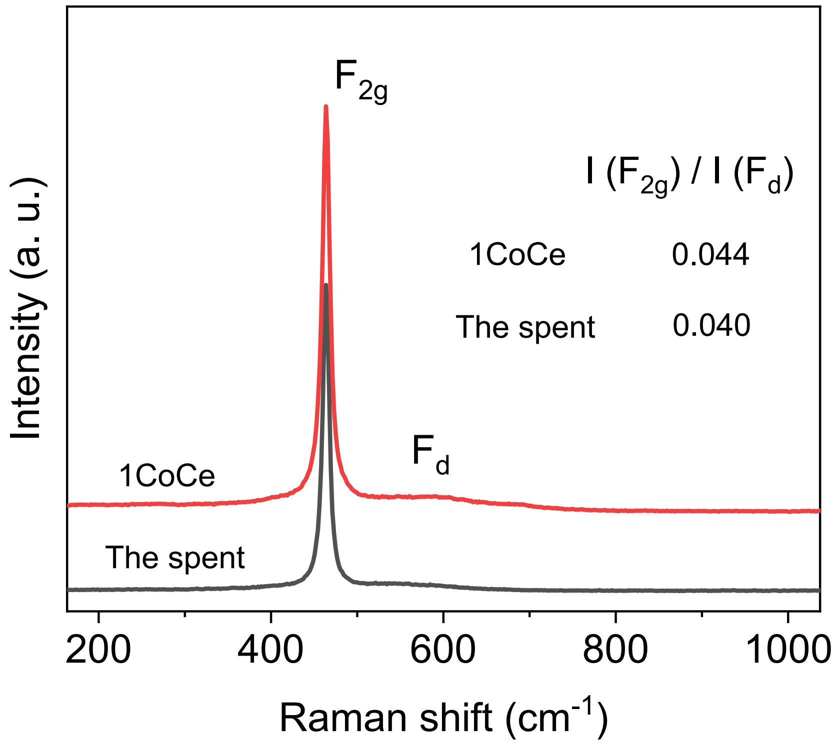

Figure S1. Comparison of Raman of 1CoCe and the spent (from fixed bed).