Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Supporting Information

Tailoring the activity and selectivity of Rh/SiO_2 in the selective hydrogenation of phenol by CoO_x promotion

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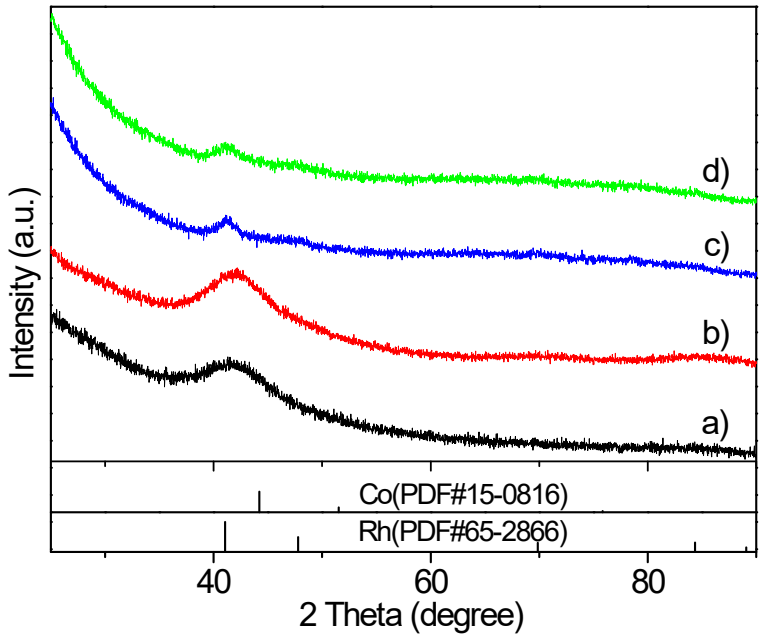

Fig. S1 XRD patterns showing: a) Rh_1Co_3 NPs; b) Rh_1Co_1 NPs; Rh_1-$(CoO_x)_3/SiO_2$ nanocatalysts; Rh_1-$(CoO_x)_1/SiO_2$ nano catalysts.

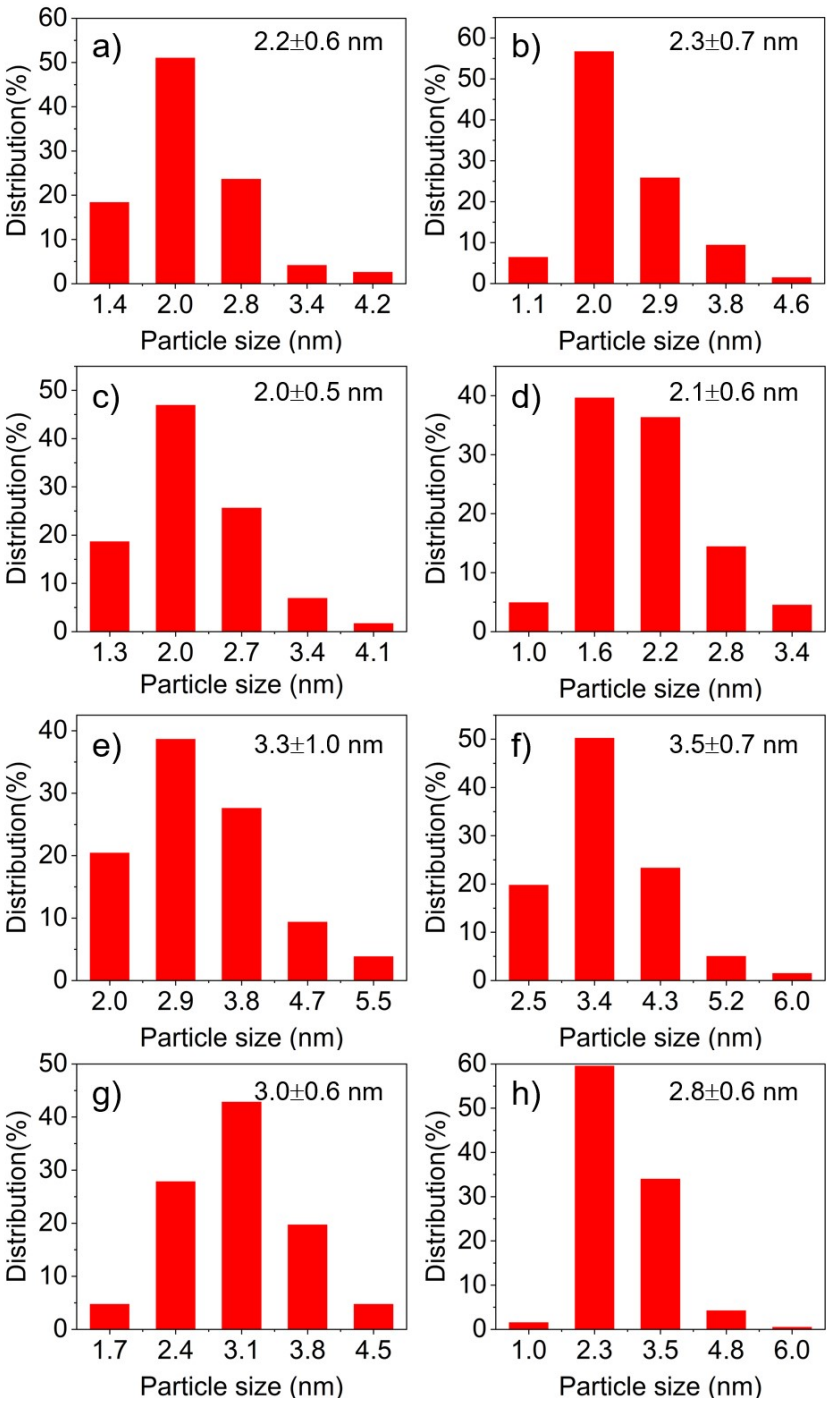

Fig. S2 Size distributions of as-synthesized nanomaterials showing: a), Rh NPs; b), Rh_3Co_1 NPs; c), Rh_1Co_1 NPs; d), Rh_1Co_3 NPs; e) Rh/SiO_2; f), Rh_3-$(CoO_x)_1/SiO_2$; g), Rh_1-$(CoO_x)_1/SiO_2$; and h), Rh_1-$(CoO_x)_3/SiO_2$.

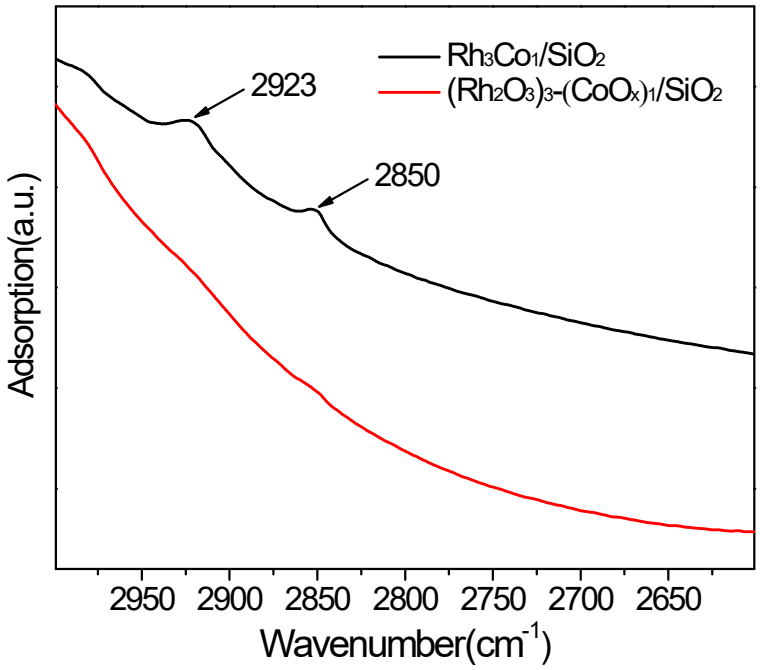

Fig. S3 FT-IR spectra of Rh_3Co_1/SiO_2 sample (without calcination) and $(Rh_2O_3)_3$-$(CoO_x)_1/SiO_2$ after calcination treatment.

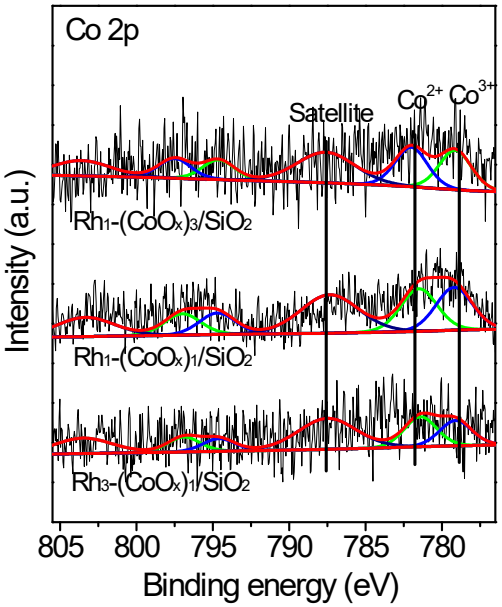

Figure S4 Co 2p XPS spectra of SiO_2 supported Rh-based nanocatalysts. (Rh loading, theoretical value 1 wt%).

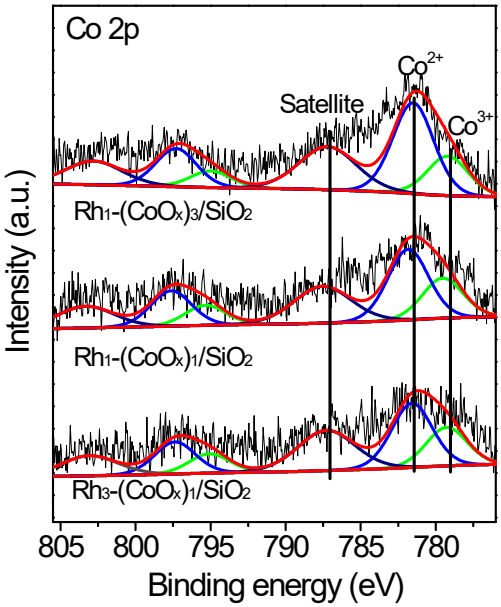

Figure S5 Co 2p XPS spectra of SiO_2 supported Rh-based nanocatalysts. (Rh loading, theoretical value 3 wt%).

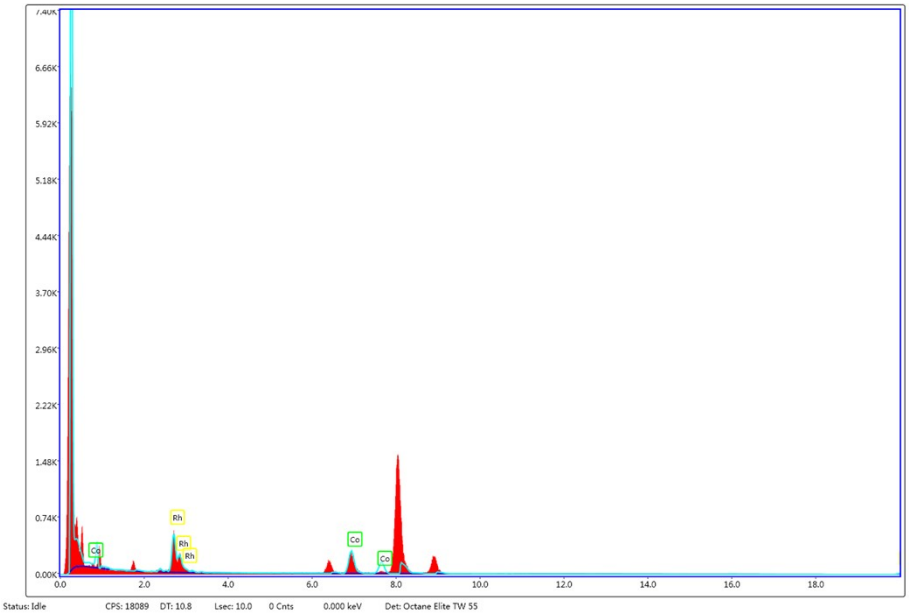

Fig. S6 EDS spectra of Rh_3-$(CoO_x)_1/SiO_2$ nano catalyst.

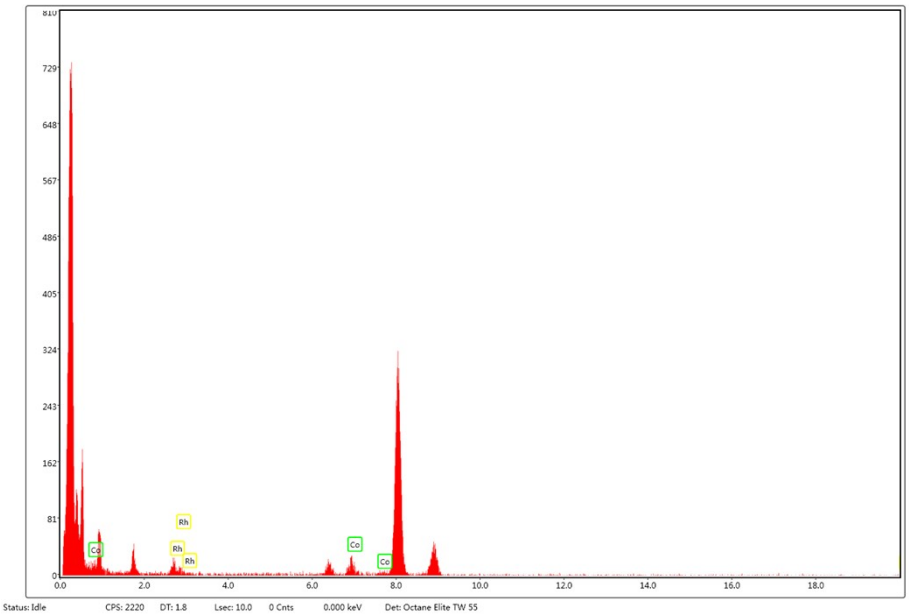

Fig. S7 EDS spectra of Rh_1-$(CoO_x)_1/SiO_2$ nano catalyst.

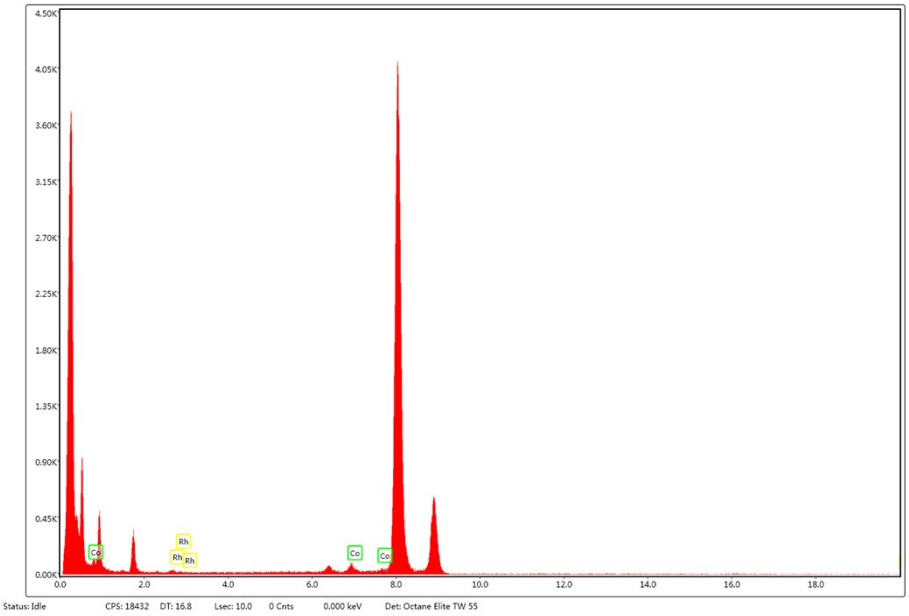

Fig. S8 EDS spectra of Rh_1-$(CoO_x)_3/SiO_2$ nano catalyst.

Table S1. The actual loadings of Rh and Co in Rh-CoO_x/SiO_2 catalysts analyzed by ICP-OES.

Sample	Rh loading (wt%)	Co loading (wt%)
Rh/SiO_2	0.99%	-
Rh_3-$(CoO_x)_1/SiO_2$	1.02%	0.18%
Rh_1-$(CoO_x)_1/SiO_2$	1.08%	0.56%
Rh_1-$(CoO_x)_3/SiO_2$	1.04%	1.65%

Table S2. The catalytic performance for hydrogenations of phenol over CoO_x/SiO_2 catalyst.

Catalyst[a]	**Conversion (%)**	**Selectivity (%)**	
		Cyclohexanol	**Others**
0.1000 g CoO_x/SiO_2	0	N/A	N/A

[a]Reaction conditions: phenol, 0.1000 g; temperature, 60 °C; ethanol, 10.0 mL; H_2, 1.0 MPa; reaction time, 100 min; speed of agitation, 600 rpm/min.

Synthesis of CoO_x/SiO_2 catalyst.

The CoO_x/SiO_2 catalyst was prepared by a wet impregnation method. A certain amount of $Co(NO_3)_2 \cdot 6H_2O$ aqueous solution was impregnated on 1.0 g of SiO_2 to prepare the 1.0 wt % CoO_x/SiO_2 catalyst. After 4h of immersion, the sample was dried for 5h at 110 °C, and followed by calcining at 500 °C for 3h in air to obtain CoO_x/SiO_2 catalyst.

Table S3. Comparison of catalytic performance of Rh_3-$(CoO_x)_1/SiO_2$ and previously reported heterogeneous catalysts for the selective hydrogenation of phenol.

Catalysts	Conditions			Conv. (%)	Sel. (%)	TON[a]/ h	Ref.
	T (^oC)	P (MPa)	t (h)				
Rh_3-$(CoO_x)_1/SiO_2$	60	1.0	1.7	98.1	99.4	213	This work
Rh/SiO_2	25	0.1	9.0	100	18	18	1
Rh@HMSNs	45	0.5	3.0	90.6	96.6	28	2
Rh/CNF	300	2.0	0.2	51	40	89	3
Rh-PAA	80	4.0	0.5	40	100	40	4
FFSiRh	75	0.6	2.0	100	52	10.	5
Rh@S-MIL-101	50	0.5	2.0	80	35	33	6

[a] Turnover number (TON) is measured as moles of products per total molar Rh atoms.

Reference

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