Electronic Supplementary Material (ESI) for RSC Advances

An Efficient and Stable Ru–Ni/C Nano-Bimetallic Catalyst with a Comparatively Low Ru Loading for benzene Hydrogenation under Mild Reaction Conditions

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Fig S1 N_2 adsorption-desorption isotherms for (a) carbon, (b) 1.03%Ni/C (uncalcined), (c) 1.03%Ni/C (calcined), (d) 0.07%Ru/C.

Fig S1

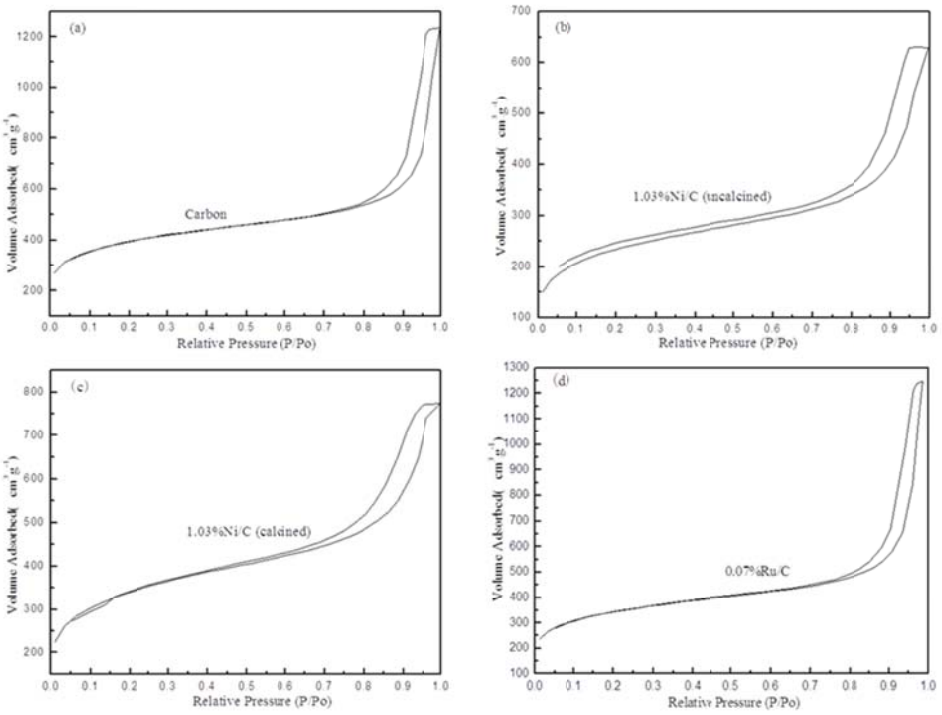

Fig S2 Pore size distributions of (a) carbon, (b) 1.03%Ni/C (uncalcined), (c) 1.03%Ni/C (calcined), (d) 0.07%Ru/C.

Fig S2

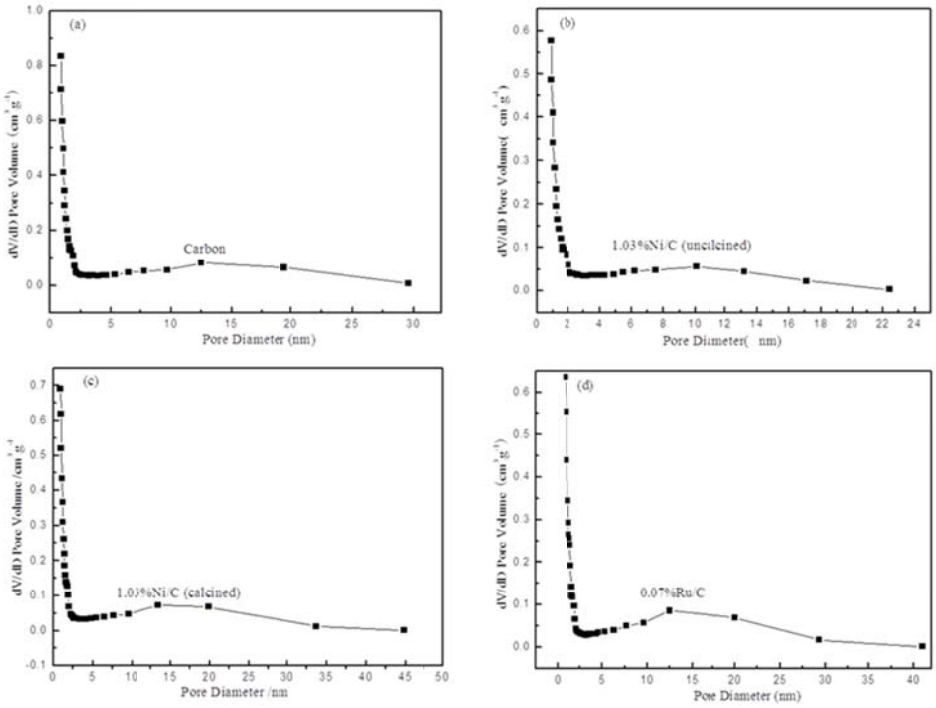

Fig S3 H_2-TPD profiles of (a) carbon, (b) 1.03%Ni/C (calcined), (c) 0.024%Ru–1.00%Ni/C, (d) 0.070%Ru/C.

Fig S3

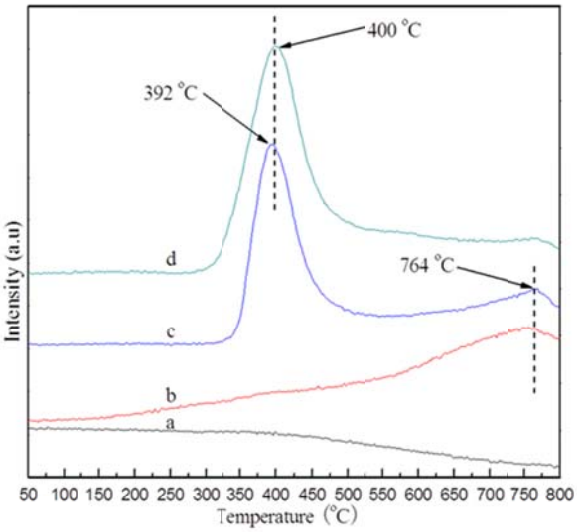

Fig S4 XPS spectrum of Ni 2p in (a) 1.03%Ni/C (uncalcined), (c) 0.024%Ru–1.00%Ni/C, XPS spectra at the Ru 3d edge of (b) 0.07%Ru/C, (d) 0.024%Ru–1.00%Ni/C.

Fig S4

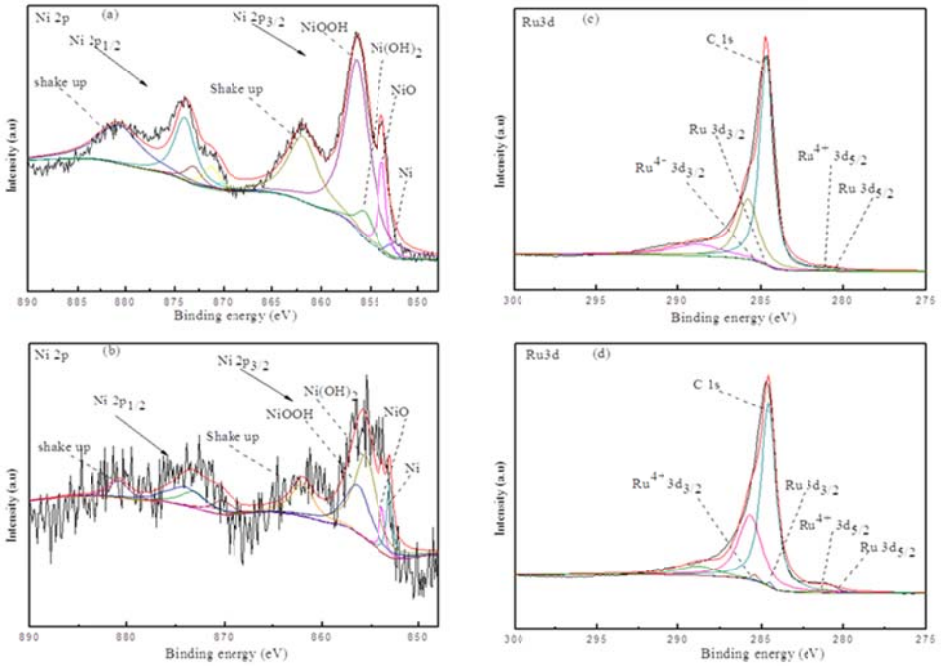

Fig S5 XPS spectra at the Ru $3p_{3/2}$ edge of 0.024%Ru–1.00%Ni/C.

Fig S5

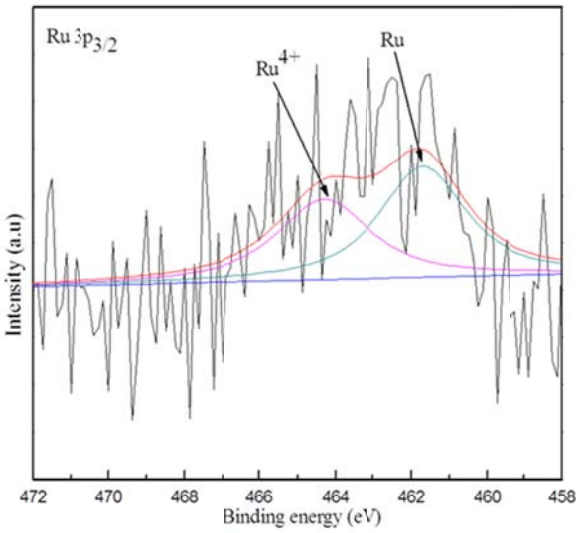

Fig S6 XRD patterns of (a) 1.03%Ni/C (uncalcined) (NO PVP), (b) 1.03%Ni/C (uncalcined) (**P**VP).

Fig S6

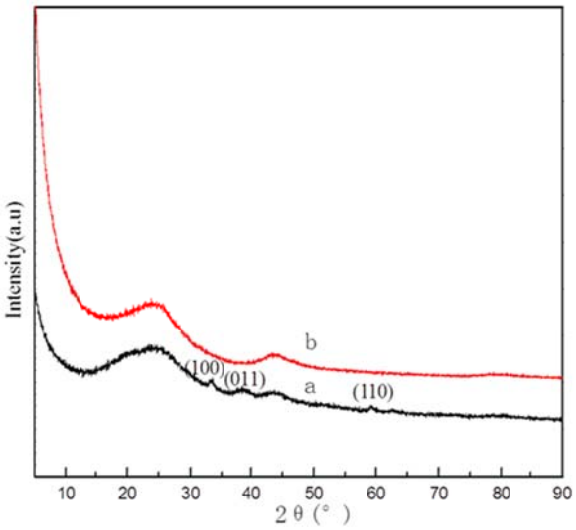

Fig S7 SEM images of (a) Carbon, (b) 1.03%Ni/C (uncalcined), (c) 0.070%Ru/C, (d) 0.024%Ru–1.00%Ni/C.

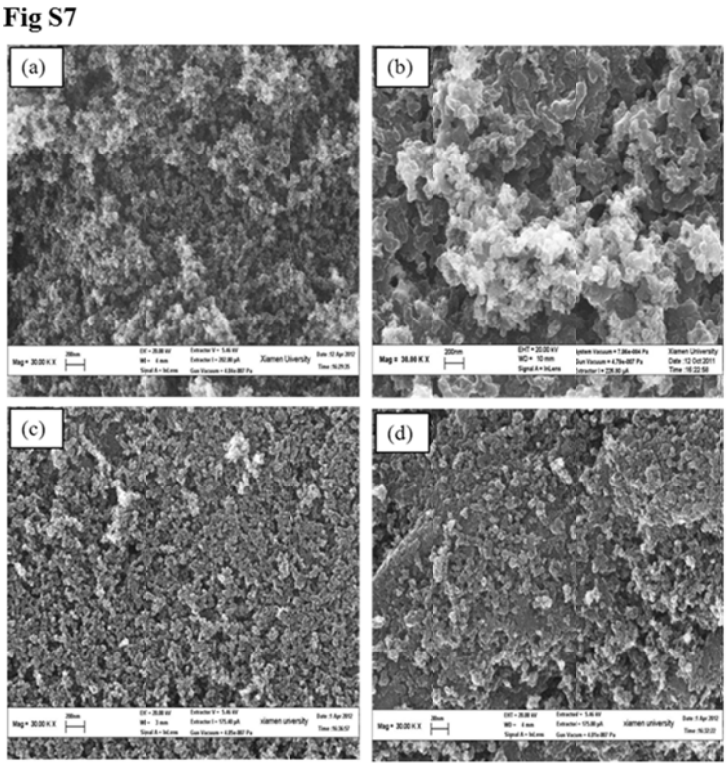

Fig S8 HRTEM images of (a, b, c, d) 0.07%Ru/C catalyst.

Fig S8

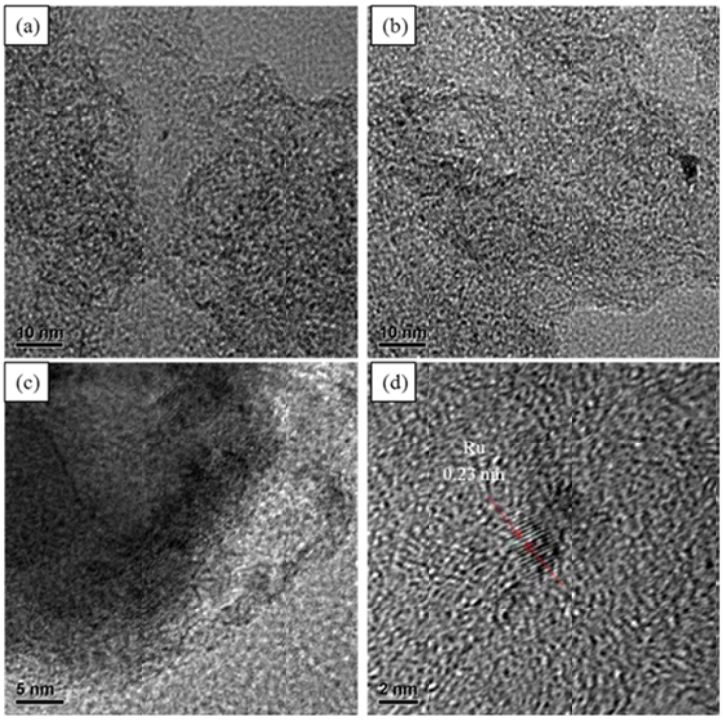

Fig S9 HRTEM images of (a, b) 0.024%Ru–1.00%Ni/C catalyst after used for ten times.

Fig S9

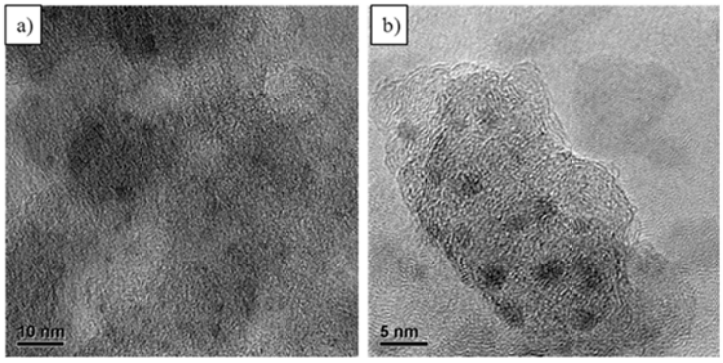

Table S1 Structure parameters of different catalysts

Entry	Sample	S_{BET} ($m^2 \cdot g^{-1}$)[a]	V_a ($cm^3 \cdot g^{-1}$)[b]	r_p (nm)[c]
1	Carbon	1385.3	1.91	2.75
2	1.03%Ni/C (uncalcined)	833.5	0.97	2.30
3	1.03%Ni/C (calcined)	1224.5	1.90	3.10
4	0.024%Ru–1.00%Ni/C	1201.9	1.20	2.0
5	0.070%Ru/C(calcined)	1209.4	1.93	3.19

[a] Specific surface area. [b] Pore volume. [c] Mean pore radius.

Table S2 Chemical states, binding energies (BE) and ratios of integrated intensities (atomic ratios; AR) of Ni element in 0.024%Ru–1.00%Ni/C before used and after used for 10 times

Samples		Ni (2p3/2)			
		Ni(0)	NiO	$Ni(OH)_2$	NiOOH
0.024%Ru–1.00%Ni/C	BE (eV)	852.8	853.7	855.6	856.4
	AR (%)	7.92	12.58	15.72	63.78
0.024%Ru–1.00%Ni/C (after used for 10 times)	BE (eV)	852.8	853.7	855.6	856.4
	AR (%)	8.45	13.69	16.61	61.25

Table S3 Chemical states, binding energies (BE) and ratios of integrated intensities (atomic ratios; AR) of Ru element in 0.024%Ru–1.00%Ni/C before used and after used for 10 times

Samples		Ru (3d5/2)	
		Ru(0)	RuO_2
0.024%Ru–1.00%Ni/C	BE (eV)	280.4	281.2
	AR (%)	48.56	51.44
0.024%Ru–1.00%Ni/C (after used for 10 times)	BE (eV)	461.7	464.3
	AR (%)	47.37	52.63