Electronic Supplementary Material (ESI) for RSC Advances.

Supporting information
Hydrodeoxygenation of phenol as a bio-oil model compound on intimate contact noble metal-Ni_2P/SiO_2 catalyst

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Figure S1 demonstrates the XRD patterns of Ni_2P/SiO_2 with different loadings. There is no prominent Ni_2P diffraction peak at 5%Ni_2P/SiO_2 compared with the other samples due to low loading and high distribution of Ni_2P. However, excess loading leads to the larger particle size of Ni_2P and correspondingly decreasing of hydrodeoxygenation activity.

Figure S2 shows phenol conversion and product selectivities at 453K and 2.0MPa for 3h on the pure noble metal. In comparison with noble metal-Ni_2P/SiO_2, cyclohexane and cyclohexanol products over supported noble metal catalysts decrease while cyclohexanone increases obviously.

Effect of reaction time on product selectivities over 1%Pd-10%Ni_2P/SiO_2 was also checked in Figure S3. Results show that cyclohexane selectivity increases accompanied with the decreasing in cyclohexanol when reaction time prolongs. This means that cyclohexanol gradually converts into cyclohexane with reaction proceeding on noble metal-Ni_2P/SiO_2.

Catalytic evaluation of physical mixture of 0.1g of 1%Pd/SiO_2 and 0.1g of 10% Ni_2P/SiO_2 has also been carried out to maintain the same active component loading, Pd and Ni_2P, to 0.1g 1% Pd-10% Ni_2P/SiO_2 for phenol hydrodeoxygenation (Table S1). However, since catalysts have doubled in total weight, this means that opportunity for reactant contacting with catalysts might be about two times higher than other reaction evaluation. Under the circumstances, catalytic performance over physical mixture of 0.1g of 1%Pd/SiO_2 and 0.1g of 10% Ni_2P/SiO_2 is similar to 0.1g 1%Pd-10%Ni_2P/SiO_2. On one hand, activity comparison is meaningless since phenol has been converted completely over these two catalysts. On the other hand, 0.1g 1%Pd-10% Ni_2P/SiO_2 has slight higher cyclohexane selectivity than physical mixture of 0.1g of 1%Pd/SiO_2 and 0.1g of 10% Ni_2P/SiO_2. Mixed catalyst system, however, deserves the higher cyclohexane selectivity because cyclohexanol can further convert into cyclohexane with the increasing in opportunity for reactant contacting with catalysts.

Relative surface atomic percentages with respect to Si, O and Pd on the basis of XPS analysis were also presented Table S2. Results confirm that there are more noble metal atoms on composite catalyst surface than SiO_2 supported noble metal and the existence of Ni_2P facilities the formation of noble metal nanoparticle.

Table S1 Comparison of catalytic performances[a] over 0.1g 1%Pd-10%Ni_2P/SiO_2 and physical mixture of 0.1g of 1%Pd/SiO_2 and 0.1g of 10% Ni_2P/SiO_2.

Catalysts	Conversion (%)	Selectivity (%)			
	Phenol	Cyclohexane	Cyclohexanone	Cyclohexanol	Benzene
Physical mixture of 0.1g of 1%Pd/SiO_2 and 0.1g of 10% Ni_2P/SiO_2	100	94.0	0	6.0	0
0.1g 1%Pd-10%Ni_2P/SiO_2	100	95.4	0	4.6	0

[a] Reaction conditions: temperature 493 K, Pressure 2.0 MPa, time 3h, phenol 0.27 g, 20 mL of dodecane as a solvent

Table S2 Relative surface atomic percentages with respect to Si, O and Pd on the basis of XPS analysis

Percentage	1%Pd-10%Ni_2P/SiO_2	1%Pd/SiO_2	1%Pt-10%Ni_2P/SiO_2	1%Pt/SiO_2	1%Ru-10%Ni_2P/SiO_2	1%Ru/SiO_2
Si	17.5	17.8	16.7	17.9	16.1	17.5
O	79.2	81.2	72.0	81.8	78.0	81.5
Noble metal	3.3	1.0	11.3	0.3	5.9	0.9

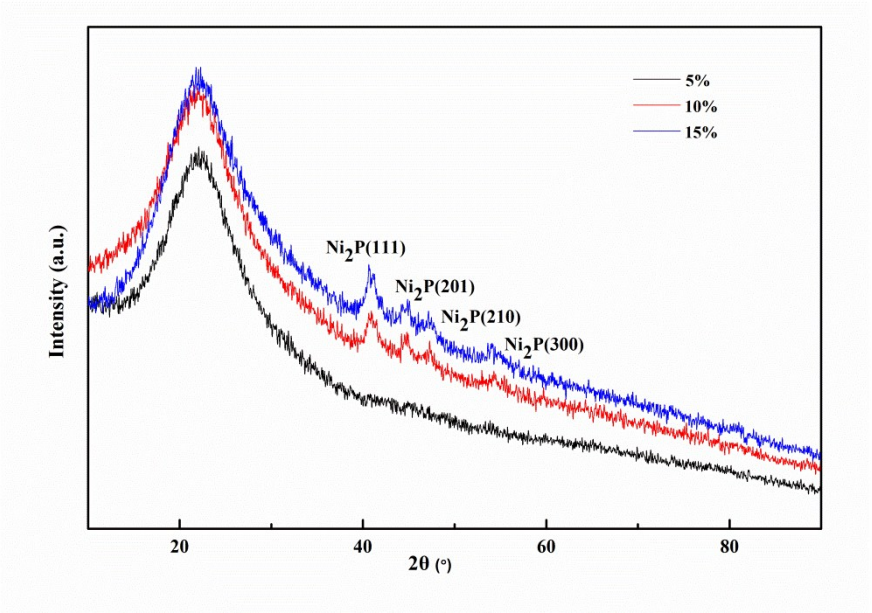
5%
10%
15%
Ni2P(111)
Ni2P(201)
Ni2P(210)
Ni2P(300)
Intensity (a.u.)
20
40
60
80
2θ (°)

Figure S1

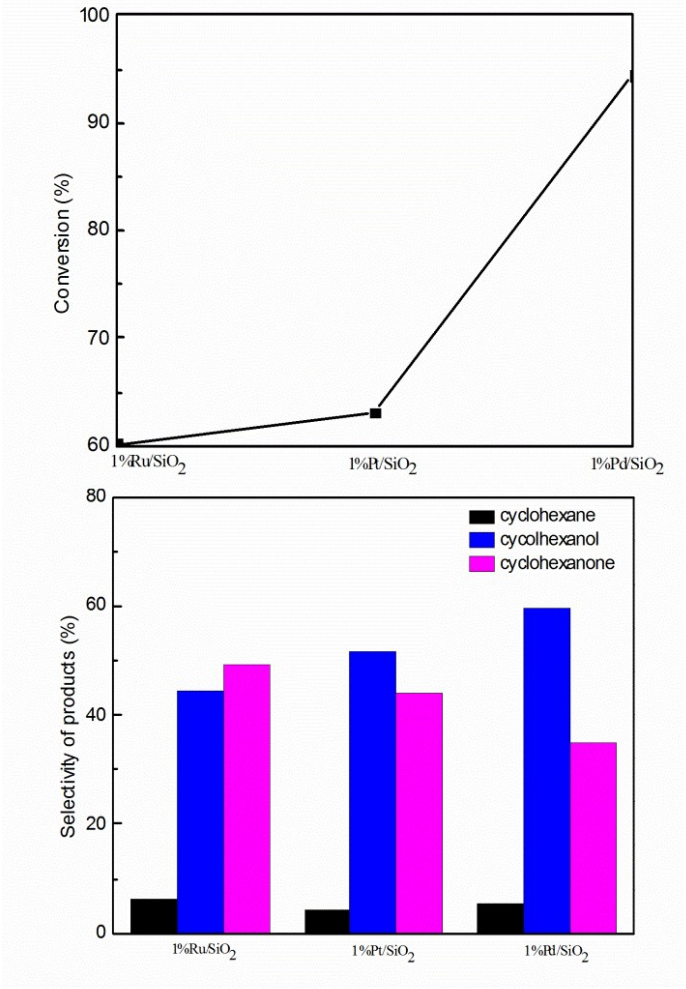
100
90
80
70
60
Conversion (%)
1%Ru/SiO2
1%Pt/SiO2
1%Pd/SiO2
80
60
40
20
0
Selectivity of products (%)
cyclohexane
cycolhexanol
cyclohexanone
1%Ru/SiO2
1%Pt/SiO2
1%Rd/SiO2

Figure S2

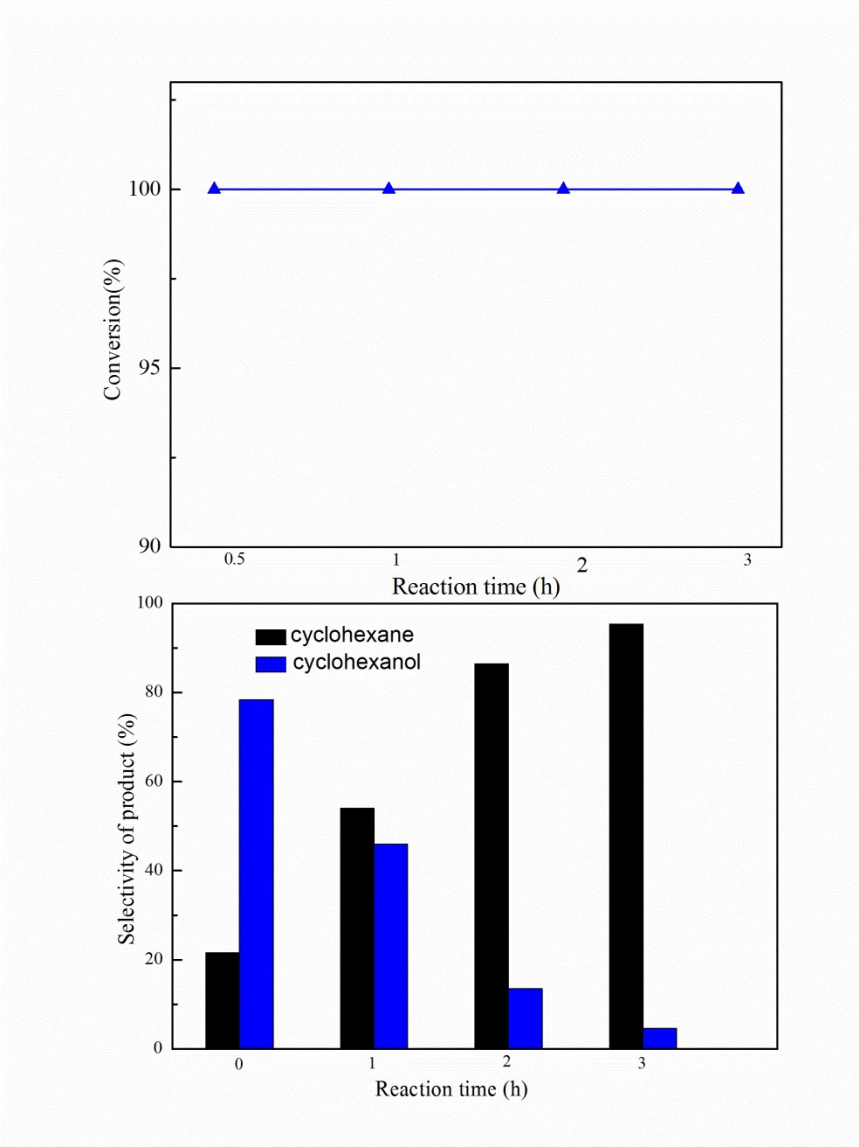
100
95
90
Conversion(%)
0.5
1
2
3
Reaction time (h)
cyclohexane
cyclohexanol
Selectivity of product (%)
100
80
60
40
20
0
0
1
2
3
Reaction time (h)

Figure S3