Supporting Information

Size effect of Ru colloidal particles on the self-reforming-driven hydrogenolysis of lignin model compound

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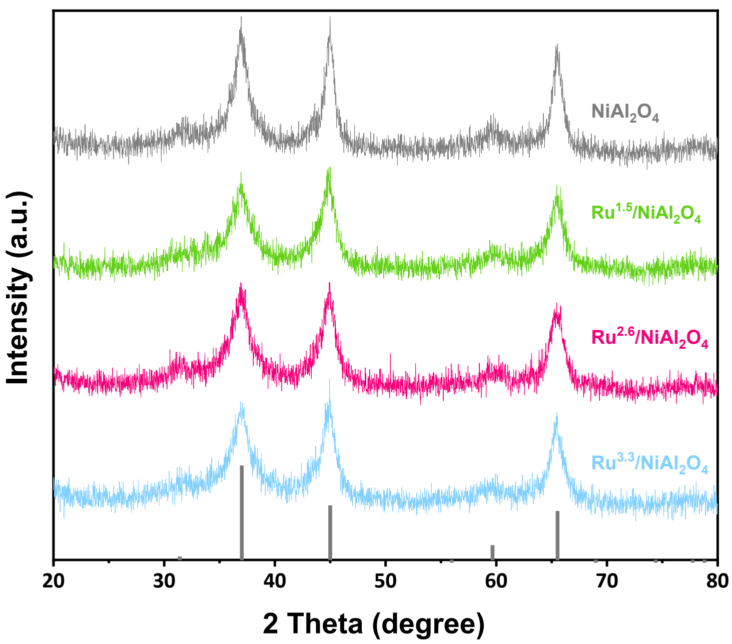


Figure S1. XRD patterns of $NiAl_2O_4$, $Ru^{1.5}/NiAl_2O_4$, $Ru^{2.6}/NiAl_2O_4$ and $Ru^{3.3}/NiAl_2O_4$.

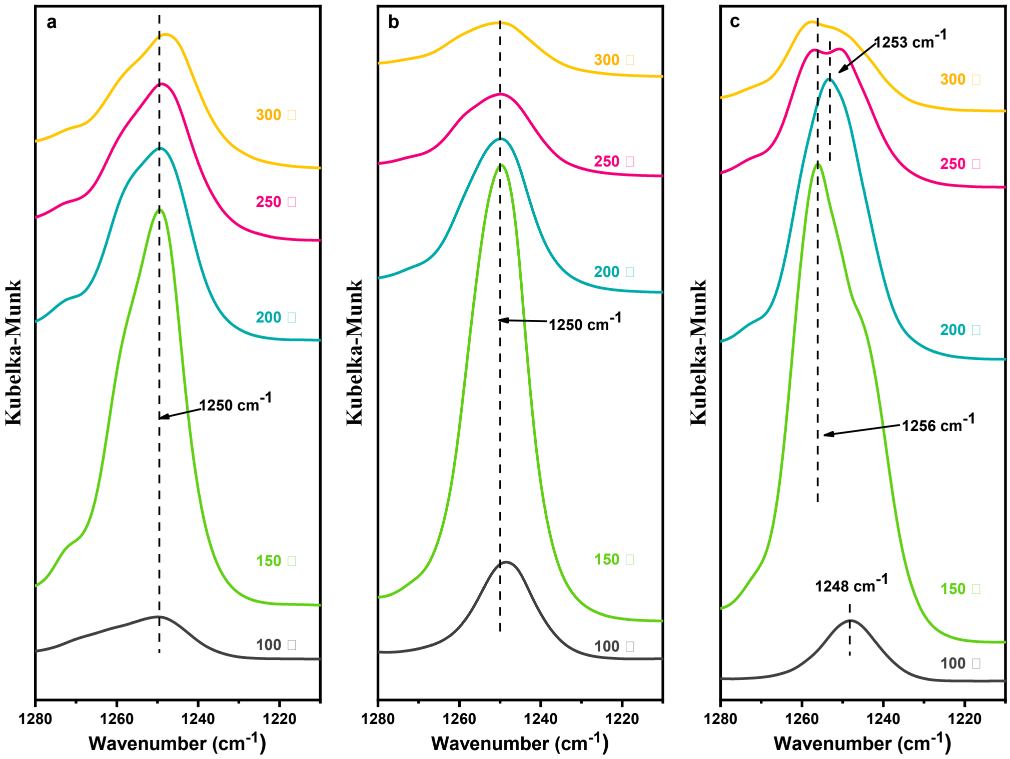


Figure S2. In-situ DRIFT spectra of adsorption of 1-(4-methoxyphenyl)-ethanol over three catalysts and standard spectrum.

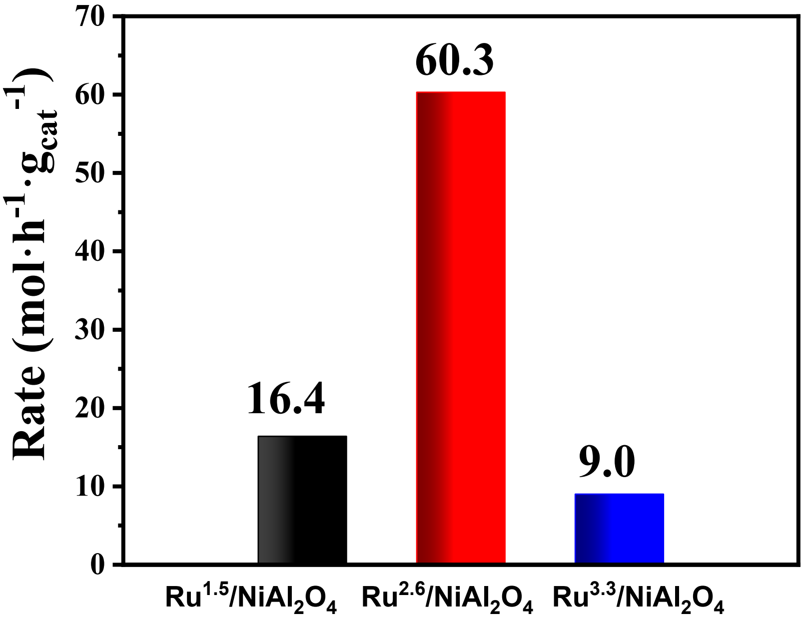


Figure S3. Demethoxylation rate of 4-EG catalyzed by Ru particle catalyst at 250 °C.

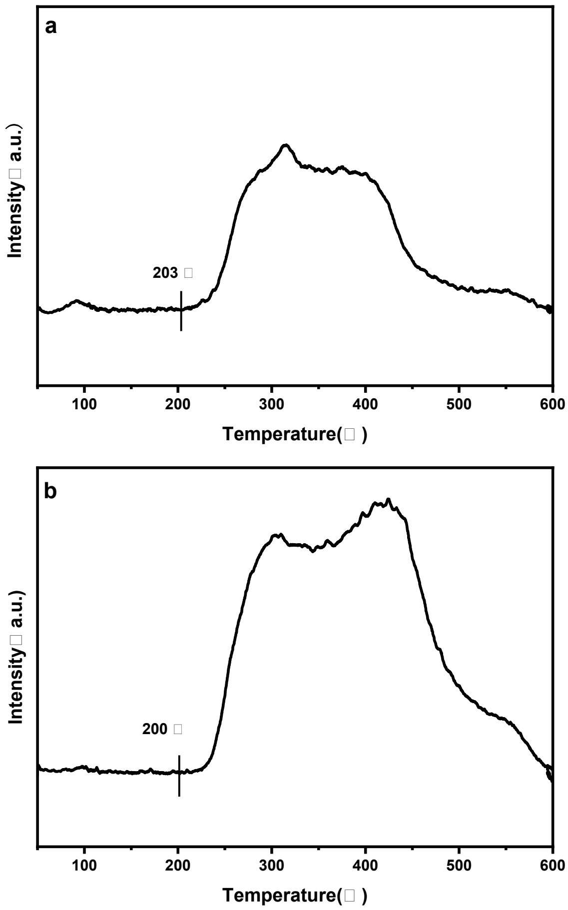


Figure S4. H_2-TPD profiles of (a) $Ru^{1.5}/NiAl_2O_4$ and (b) $Ru^{2.6}/NiAl_2O_4$.

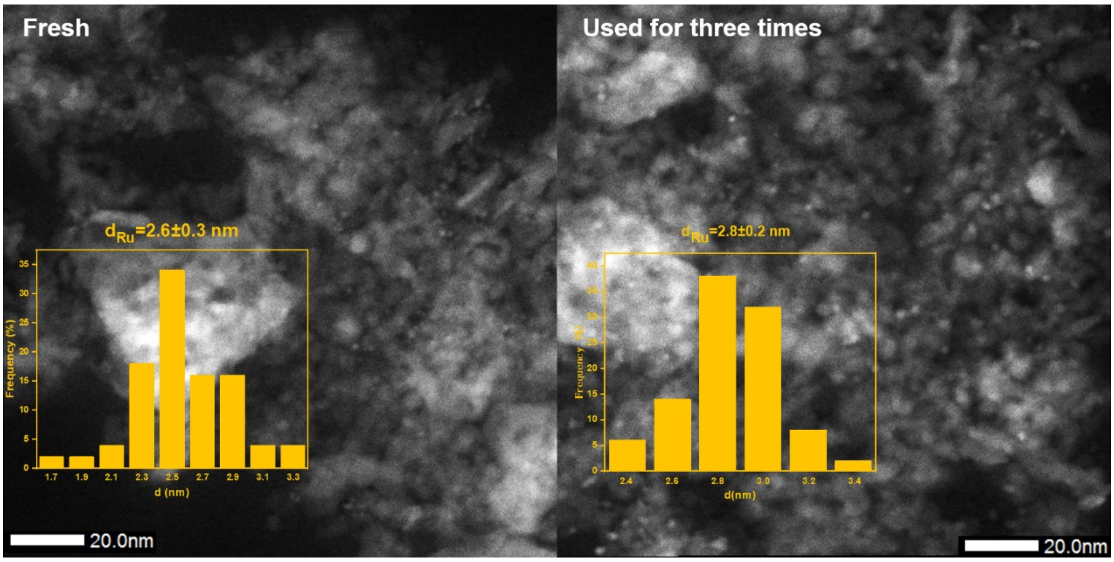
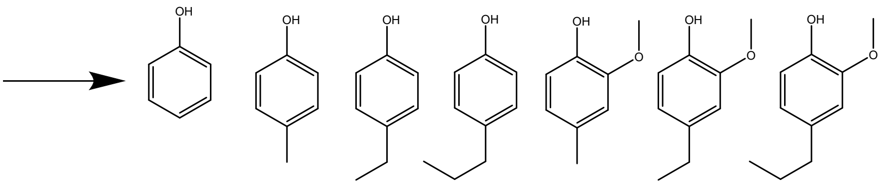


Figure S5. STEM images of $Ru^{2.6}/NiAl_2O_4$ before and after used for three times.

Table S1. Monomer yields of birch lignin oil over three Ru NPs catalysts [a].

BIRCH LIGNIN OIL



1 **2** **3** **4** **5** **6** **7**

Catalyst	Monomer yield (wt%)							Total monomers yield (wt%)
	1	2	3	4	5	6	7	
$Ru^{1.5}/NiAl_2O_4$	-	-	1.9	1.4	0.8	3.6	2.9	33.9
$Ru^{2.6}/NiAl_2O_4$	-	-	2.5	2.4	0.5	5.0	5.1	44.5
$Ru^{3.0}/NiAl_2O_4$	-	-	0.4	0.1	0.7	0.3	0.4	5.8

[a] Reaction condition：0.08 g catalyst, 0.1 g birch lignin oil, 15 mL H_2O, 2 MPa N_2, 290 °C, 20 h.

Table S2. Comparison of experimental results from different works.

Substrate	Catalyst	Reaction Conditions	Yield (%)	Reference
Birch Lignin Oil	$Ru^{2.6}/NiAl_2O_4$	290 °C, 2 MPa N_2, 20 h, H_2O	Total Monomers Yield, 44.5%	This work
C-Lignin	Ru/ZnO/C	200 °C, 3 MPa H_2, 4h, methanol	Catechol, 66%	1
Alkaline Lignin	$Ni_{0.2}Co_{2.8}O_4$	250 °C, 2 bar H_2, 5 h, ethanol and sopropanol	G-type and S-type Phenolics, 48.3%	2
Lignin	Br-Ru/C	180 °C, 5 bar H_2, 6 h, methanol	Mono-aromatic Product, 26.2%	3
Lignin	Ni-Fe-Mo_2C/AC	260 °C, 3 MPa H_2, 4 h, H_2O/methanol=4/1	Phenolic Monomers, 35.53%	4
Birch Lignin	Ru/CNT	220 °C, 30 atm H_2, 4 h, methanol	Aromatic Phenols, 46.0%	5
Kraft Lignin	Fe-Fe_3C/C	290 °C, 0.5 MPa N_2, 5 h, supercritical ethanol	Lignin Oil, 48%	6
Sinocalamus Oldhami Alkali Lignin	NaOH+Na_2SO_3 +Ni-W_2C/AC	260 °C, 5 h, H_2O	Monophenol, 17.18%	7
Beech Dioxasolv Lignin	WO_x/C (N_2-1000)	200 °C, 1 MPa H_2, 6 h, methanol	Total Monomers Yield, 10.8%	8

Table S3. Ru contents of $Ru^{2.6}/NiAl_2O_4$ before and after used for three times.

Catalyst Status	Ru Contents[a] (wt%)
Fresh	0.64
Used-3 times	0.58

[a] Measured by ICP-OES.

References

1. S. Wang, K. Zhang, H. Li, L. P. Xiao and G. Song, *Nat. Commun.* , 2021, **12**, 416.
2. Y. Qi, X. Xiao, Y. Mei, L. Xiong, L. Chen, X. Lin, Z. Lin, S. Sun, B. Han, D. Yang, Y. Qin and X. Qiu, *Adv. Funct.*, 2022, **32**, 2111615.
3. D. Wu, Q. Wang, O. V. Safonova, D. V. Peron, W. Zhou, Z. Yan, M. Marinova, A. Y. Khodakov and V. V. Ordomsky, *Angew. Chem. Int. Ed. Engl.*, 2021, **60**, 12513-12523.
4. B. Yan, X. Lin, Z. Chen, Q. Cai and S. Zhang, *Bioresour. Technol.*, 2021, **321**, 124503.
5. S. Su, L. P. Xiao, X. Chen, S. Wang, X. H. Chen, Y. Guo and S. R. Zhai, *ChemSusChem*, 2022, DOI: 10.1002/cssc.202200365.
6. C. Li, J. Shi, K. Zhang, Y. Wang, Z. Tang and M. Chen, *Fuel*, 2022, **315**, 123249.
7. X. Lin, L. Chen, H. Li, Y. Lv, Y. Liu, X. Lu and M. Liu, *Bioresour. Technol.*, 2021, **333**, 125136.
8. H. Guo, Z. Qi, Y. Liu, H. Xia, L. Li, Q. Huang, A. Wang and C. Li, *Catal. Sci. & Technol.*, 2019, **9**, 2144-2151.