Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Information

Reductive amination of bio-based 2-hydroxytetrahydropyran to 5-Amino-1-pentanol over nano-Ni-Al_2O_3 catalysts

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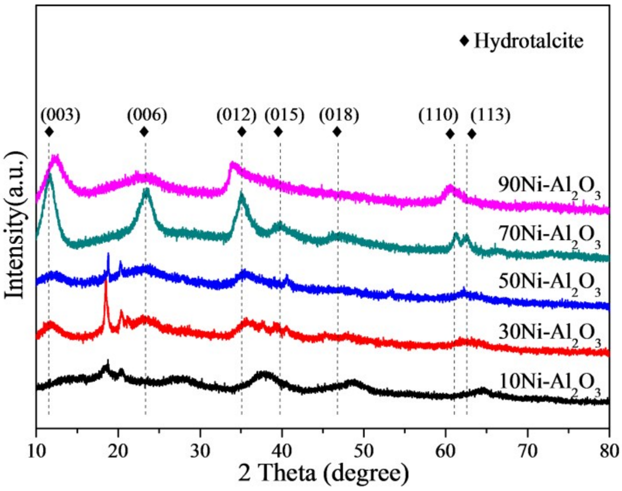


Figure S1. XRD patterns of the dried Ni-Al_2O_3 samples with different Ni loadings from 10-90 wt%.

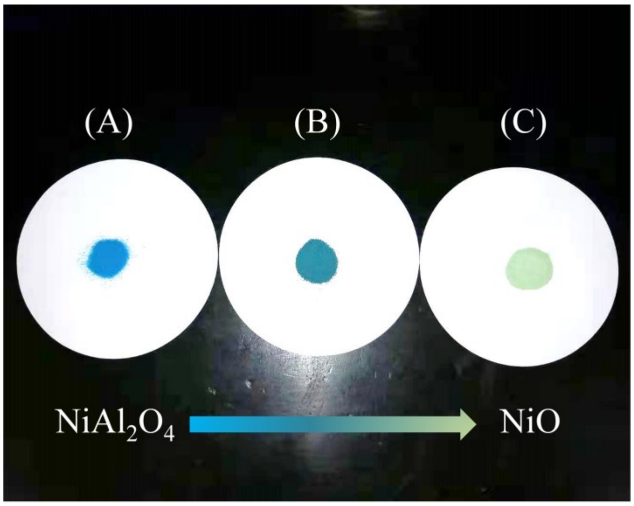


Figure S2. The picture of the calcined NiO-Al_2O_3 samples with (A) 10NiO-Al_2O_3, (B) 30NiO-Al_2O_3 and (C) 70NiO-Al_2O_3.

As shown in Figure S2, the color of the 10NiO-Al_2O_3 sample is blue, implying the formation of $NiAl_2O_4$, and then the color of the calcined samples gradually changed from blue to dark green or light green with increased Ni loadings, indicating that larger amount of NiO present in the Ni-rich samples, which further confirmed by XPS characterization.[1-3]

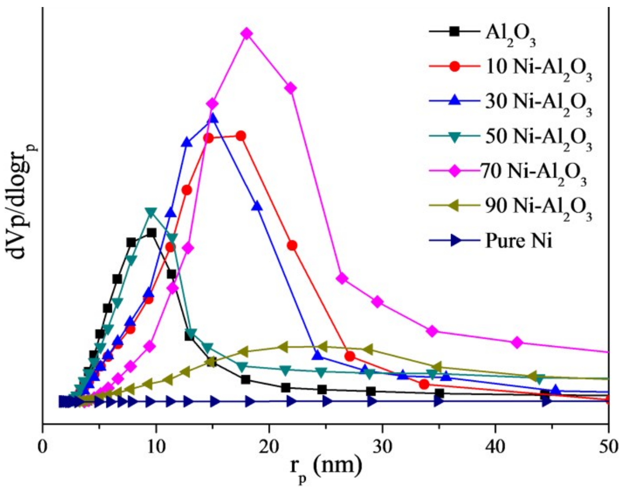


Figure S3. Pore size distributions of xNi-Al_2O_3 with different Ni contents.

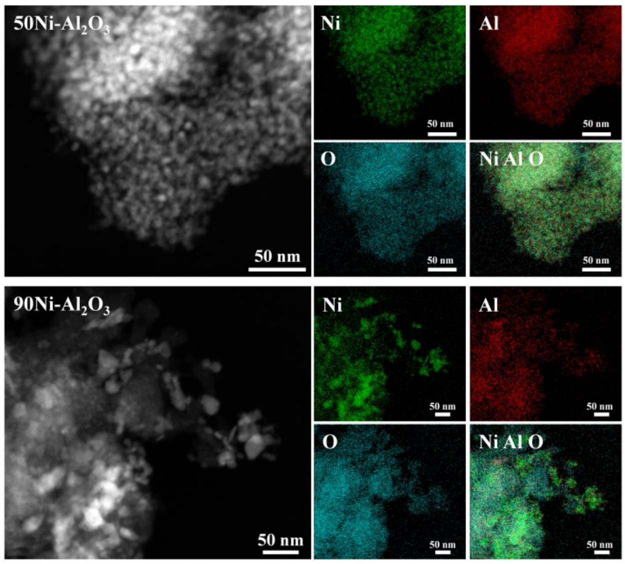


Figure S4. HAADF-STEM image of the representative 50Ni-Al_2O_3 and 90Ni-Al_2O_3 catalysts and the corresponding EDX elemental mappings of Ni, Al and O.

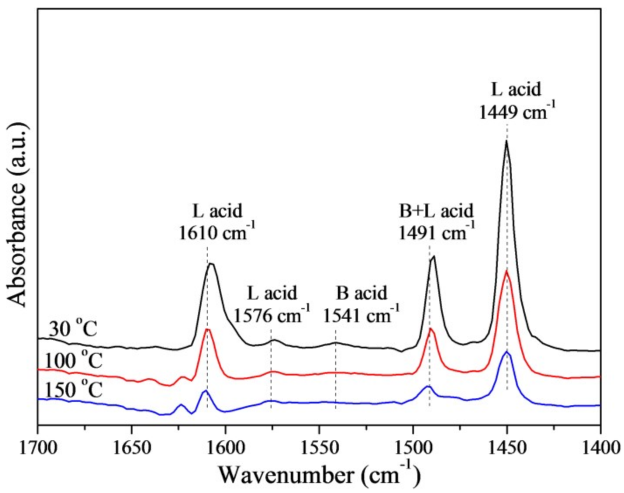


Figure S5. FT-IR spectra of pyridine on the representative 50Ni-Al_2O_3 catalyst at different temperatures.

It can be seen from Figure S5 that the obvious IR peaks around 1449 and 1610 cm^{-1} due to characteristic of abundant Lewis acid sites, while 1491 cm^{-1} was assigned to both Brønsted and Lewis acidic sites. There are almost no Brønsted acid sites for the catalyst.[4,5]

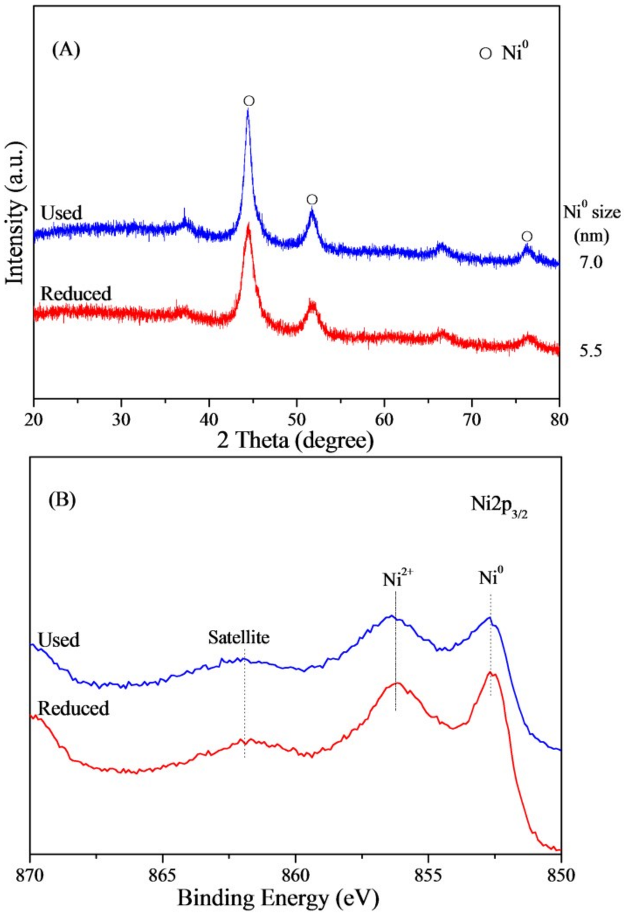
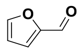
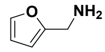
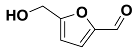
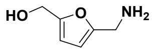
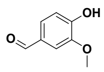
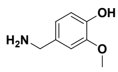
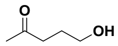
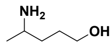
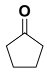
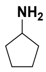


Figure S6. XRD (A) and XPS (B) analysis of the used 50Ni-Al_2O_3 catalyst after 150 h time-on-stream along with the reduced 50Ni-Al_2O_3 catalyst.

Table S1 Reductive amination of biomass-derived aldehydes and ketones over Ni-Al_2O_3 catalyst.

Entry	Substrate	Products	Yield (%)	Optimized conditions
1			89	10 wt% reactant solution (3 g substrate, 27 g 25 wt% aqueous ammonia), 60 °C, 4 MPa H_2, 1 h.
2			99	10 wt% reactant solution (3 g substrate, 27 g 25 wt% aqueous ammonia), 60 °C, 2 MPa H_2, 1 h.
3			88	5 wt% reactant solution (1.5 g substrate, 6 g ethanol, 22.5 g 25 wt% aqueous ammonia), 80 °C, 2 MPa H_2, 10 h.
4			99	10 wt% reactant solution (3 g substrate, 3 g ethanol, 24 g 25 wt% aqueous ammonia), 80 °C, 2 MPa H_2, 2 h.
5			97	10 wt% reactant solution (3 g substrate, 3 g ethanol, 24 g 25 wt% aqueous ammonia), 80 °C, 4 MPa H_2, 2 h.

[a] Reaction conditions: 0.1 g catalyst.

Reference

1. F. Rahbar Shamskar, M. Rezaei and F. Meshkani, *Int. J. Hydrogen Energy*, 2017, **42**, 4155-4164.
2. C. Jiménez-González, Z. Boukha, B. de Rivas, J. J. Delgado, M. Á. Cauqui, J. R. González-Velasco, J. I. Gutiérrez-Ortiz and R. López-Fonseca, *Appl. Catal., A*, 2013, **466**, 9-20.
3. C. Jiménez-González, Z. Boukha, B. de Rivas, J. R. González-Velasco, J. I. Gutiérrez-Ortiz and R. López-Fonseca, *Energy Fuels*, 2014, **28**, 7109-7121.
4. J. Zhang, Z. An, Y. Zhu, X. Shu, H. Song, Y. Jiang, W. Wang, X. Xiang, L. Xu and J. He, *ACS Catal.,* 2019, **9**, 11438-11446.
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