

SUPPORTING INFORMATION

Promotion of hydrogenation activity and sulfur resistance over Ni/ASA catalyst by support modification simultaneously with P and USY

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Hydrogenation activities of the Cat-IM and Cat catalysts

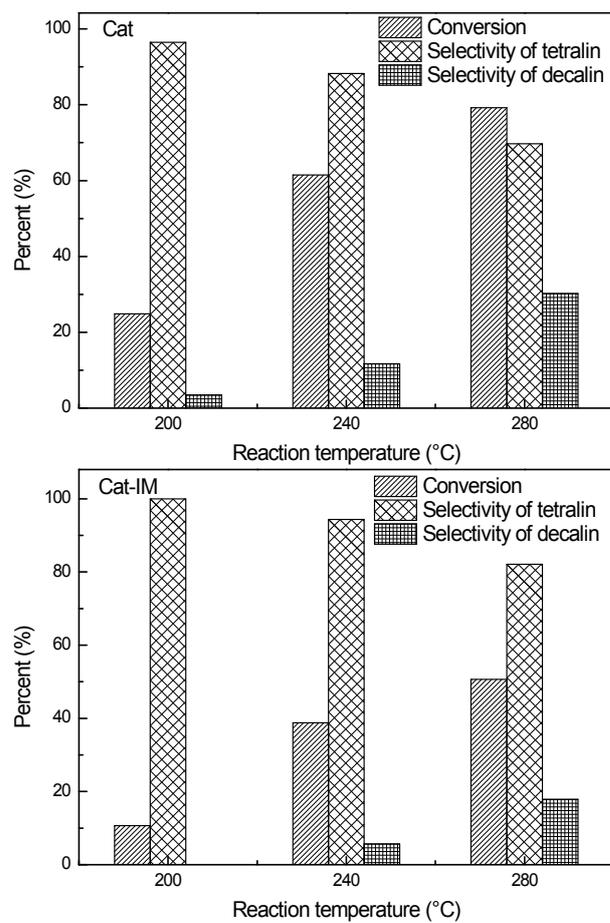


Figure S1. Naphthalene hydrogenation activities of Cat and Cat-IM.

Reaction conditions: $P = 4$ MPa, $GHSV = 16\text{h}^{-1}$, $\text{H}_2/\text{oil} = 600$ (v/v).

TEM

Figure S2. TEM results of the reductive Cat-IM and Cat catalysts.

H₂-TPR

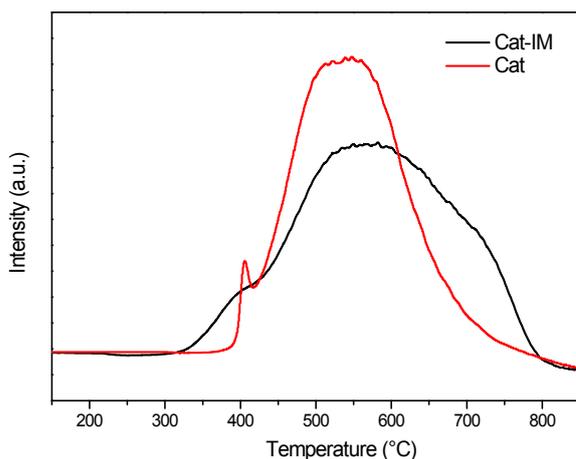


Figure S3. H₂-TPR patterns of the oxidic Cat-IM and Cat catalysts.

FT-IR

To confirm that the *cis*-9-octadecenylamine assistant was indeed participated in the preparation of Cat catalyst, the FT-IR experiment was performed and the results were listed in Figure S4. The identical bands at 3392 cm⁻¹ and 1635 cm⁻¹ represent the stretching vibration of structural OH groups derived from the water in the air and the another identical band at about 1095 cm⁻¹ is assigned to the antisymmetric stretching vibration of Si-O-Al structures that originate from the ASA support. The new IR band at 1376 cm⁻¹ in Ni-OA/ASA (composite prior to calcination of the Cat catalyst) is designated to the symmetric deformation of -CH₃ and the rocking vibration of -CH₂- which belong to *cis*-9-octadecenylamine. Besides, compared with ASA and Cat-IM, Ni-OA/ASA also displays peaks at 957 cm⁻¹, 796 cm⁻¹ and 722 cm⁻¹, which are the typical adsorption peak of *cis*-9-octadecenylamine. Due to the decomposition of *cis*-9-octadecenylamine by calcining the Ni-OA/ASA sample, Cat presents only a peak at about 796 cm⁻¹ that should be residual *cis*-9-octadecenylamine. The above results confirm that *cis*-9-octadecenylamine is participated in the preparation of catalysts.

Cis-9-octadecenylamine as a lipophilic complexing agent could release OH⁻ ions under high temperature and high pressure hydrothermal environment which furtherance the hydrolysis of nickel nitrate and form Ni(OH)₂ crystal particles. And the hydrothermal method makes for the decrease of preparation system viscosity that promotes the dispersion to obtain NiO particles with smaller size. The previous literature¹ also reported that long alkyl chains of organic could stop from the aggregation of particles and made the metal oxides mutual separate.

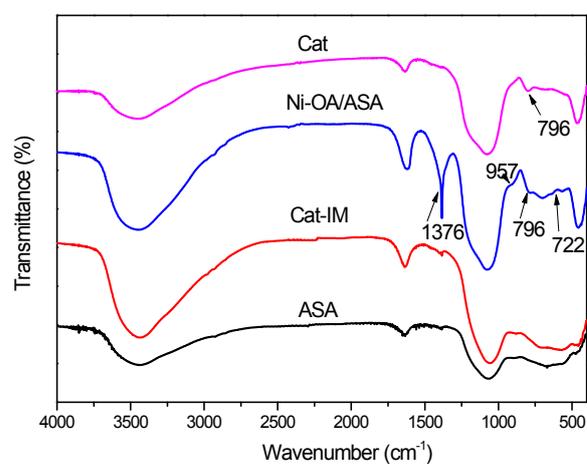


Figure S4. FT-IR spectra of the samples.

XRD

The XRD patterns of the samples are displayed in Figure S5. From Figure S5a, it could be observed that Ni-OA/ASA presents the characteristic peaks of Ni(OH)₂. As seen in Figure S5b, the diffraction patterns of the oxidic catalysts display the Ni oxide lines at $2\theta = 37.5, 43.4$ and 62.7° , implying the presence of NiO. For the reductive catalyst, Cat holds Ni⁰ characteristic peak: 44.4 and 51.7° . The above results imply that the cis-9-octadecenylamine-assisted catalyst is formed by the following process: Ni-cis-9-octadecenylamine complex/ASA (mixture process) \rightarrow Ni(OH)₂/ASA (hydrothermal process) \rightarrow NiO/ASA (calcination process) \rightarrow Ni/ASA (reduction process).

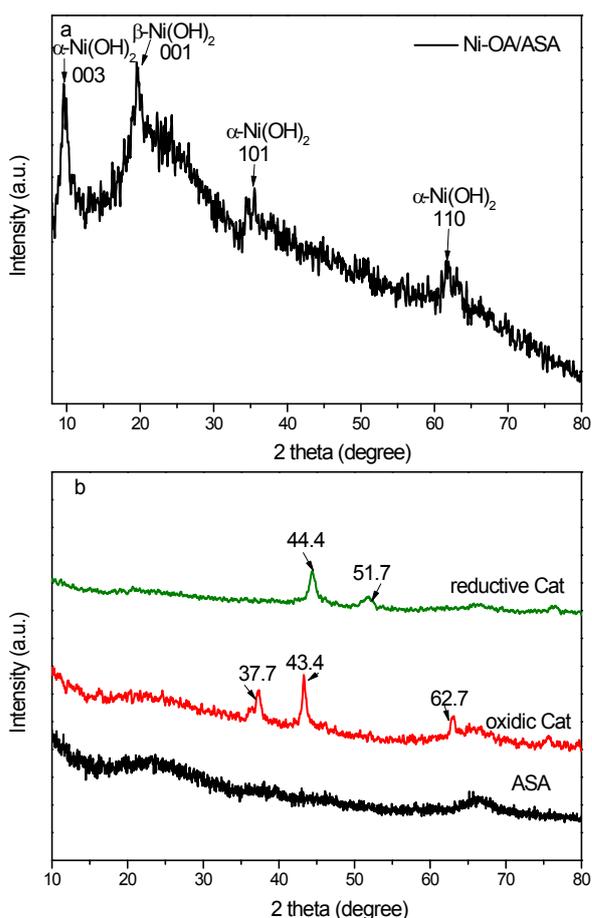


Figure S5. XRD patterns of the Ni-OA/ASA sample (a) and the support and oxidic and reductive Cat catalyst (b).

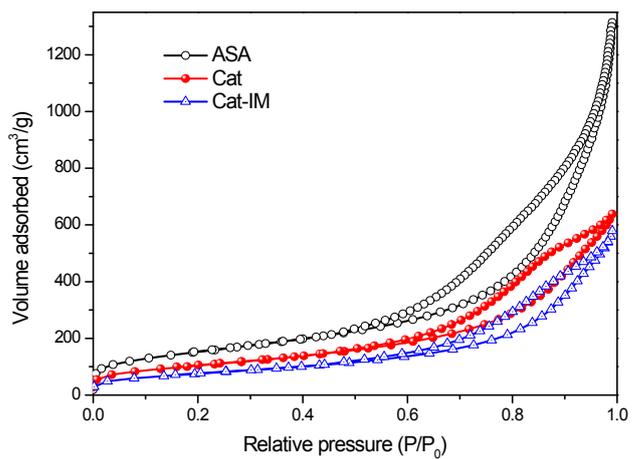


Figure S6. N₂ adsorption-desorption isotherms of ASA, Cat and Cat-IM.

References:

- 1 J. Xu, T. Huang and Y. Fan, *Appl. Catal., B*, 2017, **203**, 839-850.