

Highly efficient, NiAu-catalyzed hydrogenolysis of lignin into phenolic chemicals

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1 Introduction

Lignin, composing ca. 30% of lignocellulosic biomass and carrying 40% of its energy, is an attractive fraction in the woody biomass in future biorefinery. We found NiAu bimetallic nanocatalysts exhibit catalytic activity toward hydrogenolysis of lignin. In this report, XAFS spectra study of the catalysts is discussed briefly. [1]

2 Experimental

Ni, Au or NiAu nanoparticles were prepared in the following procedure. Desired amount of precursor aqueous stock solution (total metal content: 0.3 mmol) and PVP (666 mg, 6.0 mmol) were stirred at room temperature to form homogeneous solution. An aqueous solution (1 mL) of NaBH₄ (56.7 mg, 1.5 mmol) was poured into the solution at once with vigorous stirring. The color of the solution suddenly turned to black with harsh effervescence within several seconds. The mixture was stirred for ca. 10 min to obtain black homogeneous suspension. XAS measurements at Ni K-edge and Au L₃-edge for these materials were performed immediately after the formation of these NPs.

3 Results and Discussion

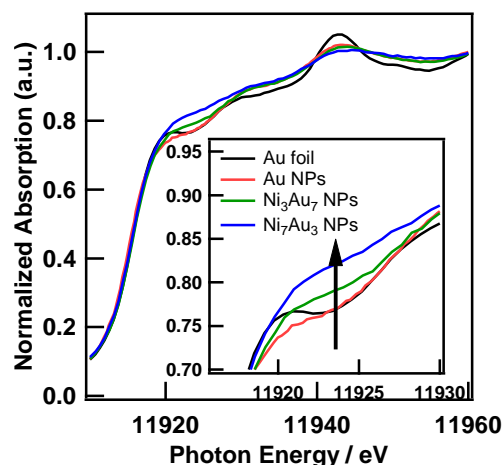


Figure 1: Au L₃-edge XANES spectra of Au, Ni₃Au₇, Ni₇Au₃ catalysts and Au foil.

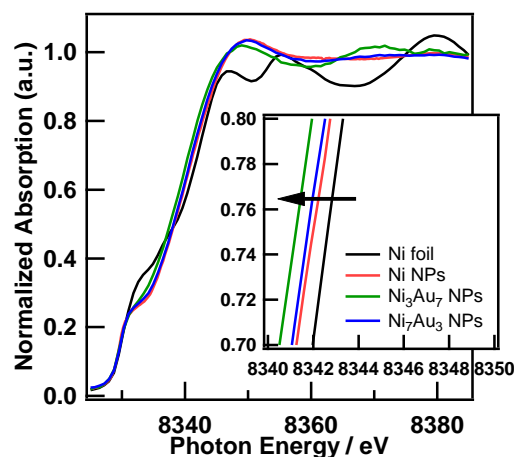


Figure 2: Ni K-edge XANES spectra of Ni, Ni₃Au₇, Ni₇Au₃ catalysts and Ni foil.

NiM bimetallic nanoparticles (M = Ru, Rh, Pd, Pt, Ir, Ag, Au, Cu, Fe, Co, Re and Sn) were screened for hydrogenolysis of 2-phenoxy-1-phenylethanol (lignin model compound) and NiAu exhibits the best activity. Screening of the NiAu catalyst for different Ni:Au ratio was also done and Ni₇Au₃ nanoparticle was found to be the catalyst. For the characterization of the catalyst, we performed XAFS measurement both at the Au L₃-edge and Ni K-edge of the nanoparticles. Figure 1 and 2 show the Au L₃-edge and the Ni K-edge XANES spectra of the Ni, Au, Ni₃Au₇, or Ni₇Au₃ nanoparticles. As clearly shown, the shoulder peak at around 11925 eV at the Au L₃-edge monotonously evolved as the content of Ni increased. In contrast, the absorption edge at the Ni K-edge of Ni₇Au₃ nanoparticles shows slightly lower energy than that of Ni foil. This may indicate charge transfer from Au to Ni, which enhanced the catalytic activity toward 2-phenoxy-1-phenylethanol hydrogenolysis.

Reference

[1] J. Zhang *et al.*, *Green Chem.*, **16**, 243 (2014).