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Selective aqueous phase hydrogenation of succinic acid to 1,4-butanediol: MOx-Pd (M = Re, Mo) supported catalysts

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PURPOSE OF THE ABSTRACT

Succinic acid (SUC) is currently produced from petroleum, but thanks to new developments in biotechnology using fermentation process, it can be efficiently produced from biomass at a lower cost than petro-derived SUC [1]. It was identified as an important building block molecule in biorefinery. Indeed, SUC may be converted by catalytic hydrogenation to high-value derivative compounds including gamma-butyrolactone (GBL), tetrahydrofuran (THF) or 1,4- butanediol (BDO); BDO is an important material for producing polymers (polyesters, polyurethanes) [2].

A previous study dealing with the hydrogenation of an aqueous solution of SUC (5 wt%) at 160°C under 150 bar of H2 [3,4] has shown that ReOx-Pd catalyst supported on commercial titania and prepared by deposition-precipitation of Pd and successive impregnation of Re (DP-SI method) were mostly selective to BDO. However, these catalysts were not stable and a large amount of Re is leached in the solution upon loading, consistent with the known oxophilic character of Re and the solubility of some ReOx species in water.

The aim of this work was to enhance both stability and performance of the Re-promoted catalysts, and to replace expensive Re promoter by Mo. Different oxides (TiO2 or ZrO2) or mixed oxides (ReOx-TiO2 or MoOx-TiO2) were prepared using the non-hydrolytic sol-gel process (NHSG) to prepare the bimetallic catalysts. In this work, a second method of deposition of Pd in toluene was developed (Tol method).The catalysts was investigated toward the performance in hydrogenation of aqueous solutions of SUC at 160°C and 150 bar.

In a first step, ReOx-2%Pd or MoOx-2%Pd were prepared on mesoporous oxides (TiO2 or ZrO2 NHSG) by DP-SI or Tol-SI method. The results showed that the ReOx-Pd catalysts lead to a higher yield of BDO compared to the MoOx-Pd catalysts. In a second part, catalysts were prepared by deposition of Pd on the NHSG mixed oxides with different loadings of Re or Mo.The best yield of BDO (93% after 24 h) was obtained using the 2%Pd/ (5%ReOx-TiO2) while it was 73% after 48 h over the 2%Pd/ (4%MoOx-TiO2 NHSG) (Figure 1).

To better understand the structure-performance relationship, more characterizations (XPS, TEM and ETEM) of some supports or catalysts are carried out. The next steps will focus on the study of the stability of the catalysts by performing some recycling tests.

FIGURES

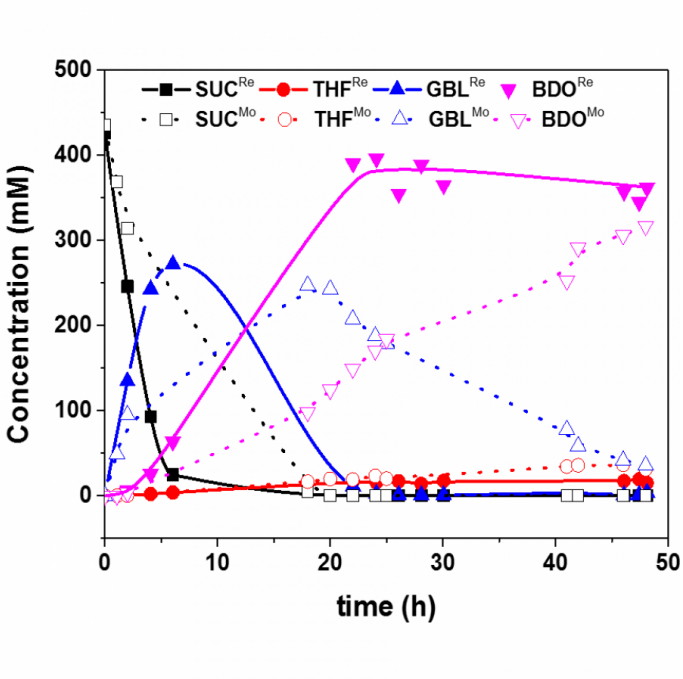

FIGURE 1

Hydrogenation of SUC (5%, 160 degree C, 150 bar H2)

2%Pd (tol) /(5%ReOx-TiO2 NHSG) or 2%Pd (tol) /(4%MoOx-TiO2 NHSG)

FIGURE 2

KEYWORDS

Biomass | Succinic acid | Selective hydrogenation | Bimetallic catalysts

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