Furfural hydrogenation on P-promoted Ru/Al_2O_3

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Hydrogenation of furfural has gained increasing attention as it represents one of the platform chemicals with a large pool of useful chemical products such as furfuryl alcohol [1]. Investigation of phosphorus as a promoter for Ru nanoparticles (NP) supported on Al_2O_3 for the selective hydrogenation of furfural to furfuryl alcohol in isopropanol has been the focus of this work. For this purpose, two Ru/Al_2O_3 catalysts were prepared by impregnation of ɣ-Al_2O_3 with $Ru(NO)(NO_3)_3$. The resulting Ru_{salt}/Al_2O_3 was split in two batches. The first batch was processed by reduction at 500°C, while the second batch was further impregnated with $NH_4H_2PO_2$ followed by reduction at 500°C. The catalysts were characterized by XRD, STEM, NMR, CO and pyridine adsorption and XAS at the Ru k-edge. The sample treated with P exhibited a homogeneous dispersion of small Ru NP. Beside the difference in Ru particle size between the two samples, the catalysts exhibited different acidic properties. RuP/Al_2O_3 displayed predominantly Brønsted acidity, which may also contribute to the better conversion rate and selectivity towards furfuryl alcohol compared to the Ru/Al_2O_3 homologue. Finally, catalytic activity was also compared to that of commercial Ru/C in batch reactor at 180°C and 5 bar of H_2. Phosphorus also improved the stability of the catalyst; leaching tests indicated a loss of 4% Ru in RuP/Al_2O_3 that did not change further after the first cycle, whereas Ru/C showed an initial loss of 7%. Despite the difficulty to discriminate the contribution of Brønsted acidity and smaller and well dispersed Ru NP, phosphorus appears to be a promising catalyst promoter for the selective hydrogenation of furfural to furfuryl alcohol.

[1] Andrea B. Merlo, Virginia Vetere, José F. Ruggera, Mónica L. Casella, *Catalysis Communications*, **2009**, *10*, 1665-1669.