Rhenium-based bimetallic catalysts for the effective hydrogenation of biomass-derived levulinic acid to 1,4-pentanediol

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Levulinic acid (LA) derived from lignocellulosic biomass can be hydrogenated to obtain a high-value chemical, 1,4-pentanediol (PDO). To date, various bimetallic catalysts, including noble metals combined with oxophilic promoters (e.g., Ir-Mo, Ru-Mo), non-noble metals (Ni-Cu), have been developed to convert LA to PDO with high yields, but they suffer from the low selectivity and low activity. In this study, we studied the rhenium-based bimetallic catalysts for the efficient hydrogenolysis of LA to PDO. It was reported that the high oxophilicity of rhenium allows for the co-existence of metallic, which help the selective activation of the carbonyl groups in the organic acids when combined with typical hydrogenation metals. We tested a various rhenium-pairing metals (e.g., Ru, Cu), carbon supports and found that selectivity to PDO is highest over the carbon-supported Ru-Re bimetallic catalysts. During the hydrogenation of LA, the major intermediate is γ-valerolactone (GVL), and the presence of rhenium is crucial for the hydrogenation of GVL to PDO. The critical role of carbon support properties and an atom ratio of Ru and Re in the PDO selectivity will be discussed in detail.