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Efficient transfer hydrogenation of alkyl levulinates to gamma-valerolactone catalyzed by simple Zr/Co-TiO2 bimetallic oxide

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PURPOSE OF THE ABSTRACT

Facing the depletion crisis of fossil resources and serious environmental pollution, more and more attensions focused on renewable resources valorization proess [1]. gamma?valerolactone (GVL) as biomass downstream derivatives could be directly employed as raw materials to prepare high calorific value liquid hydrocarbon fuels and fuel additives through ring-opening hydrogenation reactions [2]. Thus, strategies for the production of GVL using catalytic transfer hydrogenation (CTH) from ethyl levulinate (EL) attracted dramatic interest due to the inexpensive, environmentally friendly nature and safer properties of short-chain alcohols as H-donor [3].

Latest work involved the preparation of TiO2, 5%-10wt% Zr/TiO2, 5% Co/TiO2, as well as 5% Zr/Co-TiO2 via a facile sol?gel hydrothermal method [4], further employed in the CTH process starting from EL to GVL using 2-PrOH. Obtained catalysts were characterized by XRD, XPS, SEM, HR-TEM, FT-IR, ICP-OES, NH3/CO2-TPD, Pyridine-IR, H2-TPR, and N2 adsorption and desorption measurements. 5% Zr/Co-TiO2 exhibited the highest catalytic performance with 95% EL conversion and 88% GVL yield under optimum condition (0.2 M EL, 15 mL 2-PrOH, 190 oC, 11 h). The catalysts could still maintain the anatase TiO2 type after Zr and Co doping. 5% Zr/Co-TiO2 exhibited highest surface area and L/B acid ratio, Zr and Co elements showed a synergetic effect during CTH process. Co3+ and Co2+ were the active species, with the incorporation of Co onto Ti-Zr-O support increasing acidic and basic sites content. In addition, 5% Zr/Co-TiO2 exhibited high stability in 3 times recycling experiments. A full reactivation of the spent catalyst was possible after 300 oC calcination in 2 h. This contribution no doubt paved the way for the biomass downstream derivatives valorization process.

FIGURES

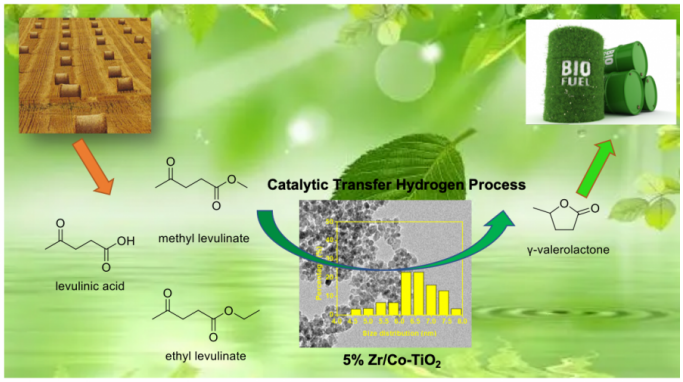

FIGURE 1

Scheme 1

Production of g-valerolactone from levulinic derivatives via Catalytic Transfer Hydrogen process in the presence of 5% Zr/Co-TiO2

FIGURE 2

KEYWORDS

Catalytic Transfer Hydrogen | g-valerolactone | heterogeneous catalysis | bimetallic oxide

BIBLIOGRAPHY