Metal/Acid bifunctional catalyst for the one-pot conversion of sugars into high-added value chemicals

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Introduction

The depletion of fossil resources has compelled the scientific community to search alternative raw materials for the production of platform and high-added value molecules. In this sense, lignocellulosic biomass, due to their large non-edible portion, is replacing petrochemical sources in the last years. Several methods have been developed, which often entail complex reaction sequences (reduction and acid-mediated catalytic steps), harsh reaction conditions or modest yields, with significant drawbacks in terms of cost, waste emission, efficiency, space and energy. A potential solution for the optimization of these methodologies may be the use of bifunctional catalyst, that is, a single catalytic body showing both acidic and metallic functions and being able of working under the same reaction conditions. In the present work, we report the selective, direct conversion of aqueous solutions of glucose and xylose into fine chemicals using a novel resin-supported bifunctional ruthenium catalyst Ru@Dowex-H.

The key element

BIFUNCTIONAL METAL/ACID CATALYST

- 2-step synthesis: metallation and formation of RuNPs.
- 1 catalyst able to perform acid and hydrogenation reactions in one-pot.
- Double role of the commercial ion-exchange resin; solid support stabilizing RuNPs of small dimension and acid catalyst.
- Egg shell distribution of the metal within the bead.
- 0.2 wt% Ru loading.

One-pot conversion of glucose into isosorbide

Direct catalytic conversion of glucose by Ru@Dowex-H under batch conditions.

<table>
<thead>
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<th>Entry</th>
<th>T (°C)</th>
<th>H₂ (bar)</th>
<th>Time (h)</th>
<th>Conv (%)</th>
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<th>Selectivity (%)</th>
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</table>

4. 0.2 w% Ru, glucose 0.1 M in water. * Data from HPLC analysis. ** Unidentified soluble products.

Conclusions

- truly bifunctional, heterogeneous catalysts for one-pot conversions.
- simple catalyst design.
- commercial, low cost materials.
- green solvent.
- no acidic additives.
- no metal contamination.
- selection of the desired product by tuning the reaction conditions.

References


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