# Glucose hydrogenation/hydrogenolysis towards sugar alcohols over Pt/Ru catalysts supported on micro/mesoporous activated carbon

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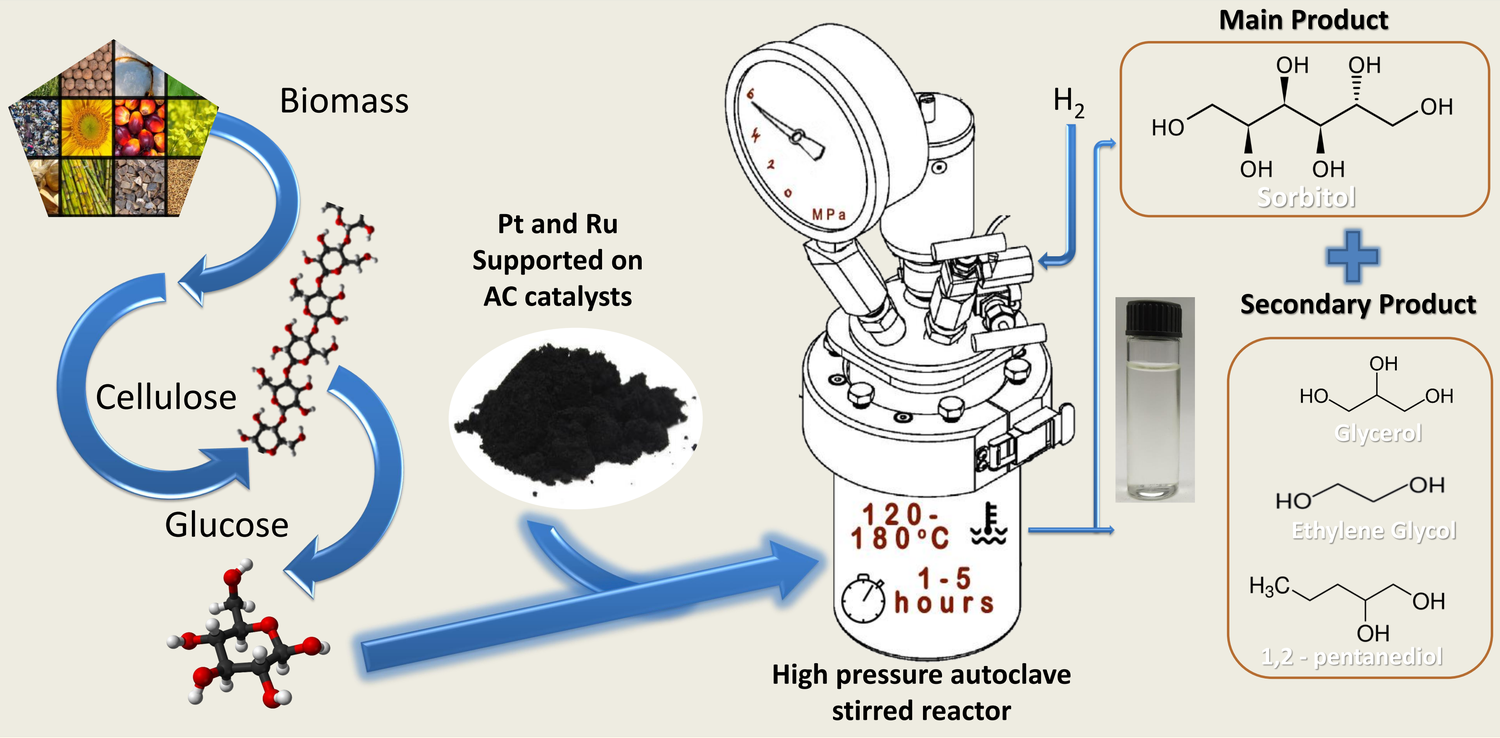
## Introduction

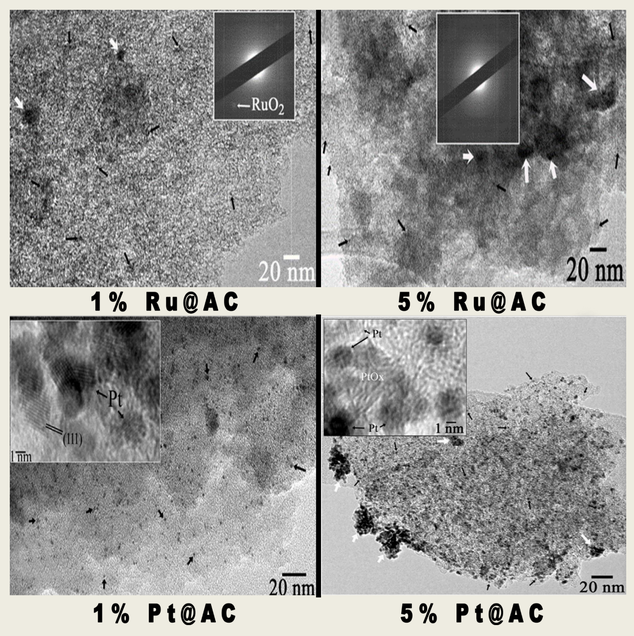
Most chemicals and fuels are produced from nonrenewable fossil, petroleum and carbon resources. The use of renewable and abundant natural resources, such as lignocellulosic biomass, is a promising alternative that has been put forward over the last decades. To this end, sustainable and efficient (bio)chemical processes need to be developed for a cost-competitive valorization of biomass and its fractions, i.e. carbohydrates (from cellulose and hemicellulose) and phenolics (from lignin). The hydrogenation/hydrogenolysis of glucose towards C2-C6 sugar alcohols has been recognized as one of the most promising biomass valorization routes to produce high added-value chemicals, such as sorbitol, 1,2-propanediol, glycerol, etc.

The hydrogenation/hydrogenolysis of glucose to sugar alcohols is based on catalytic reactions with the use of various types of catalysts, such as metals, e.g. Pt, Ru, Ni, etc, supported on activated carbons. In this work, we studied the performance of Ru and Pt catalysts supported on micro/mesoporous activated carbon, in the hydrogenation and hydrogenolysis of glucose, in neat water, at a range of temperatures (120 – 180°C), at relatively low hydrogen pressure of 3 MPa and at a range of reaction time (1 – 5h). The impact of metal loading (1–5 wt.%), on glucose conversion and selectivity to the various products was also systematically addressed.

## Experimental




## Catalysts Characterization

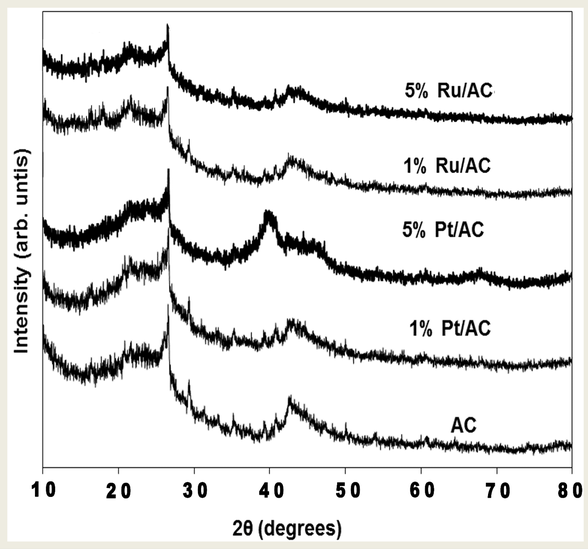



### HR-TEM of the catalysts

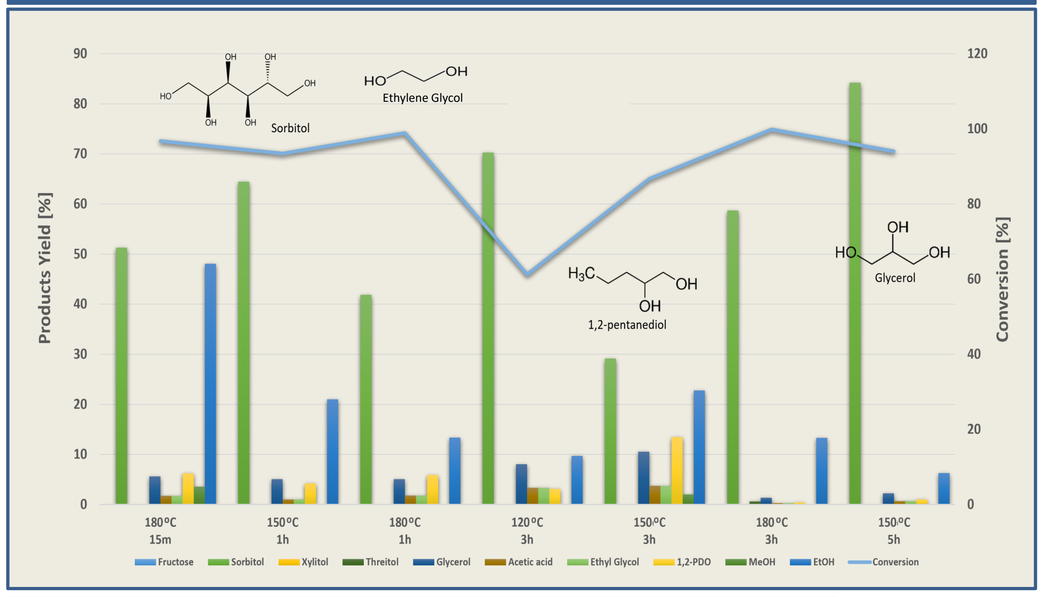
- Very good Pt and Ru dispersion on the AC surface
- Tiny Ru and Pt nanoparticles that are widely dispersed all over the AC surface
- For Ru catalysts the nanoparticles are 2–5 nm
- For Pt catalysts the nanoparticles are 1–6 nm
- Some agglomerates and amorphous oxygen enriched metal phases also exist

### XRD patterns of the catalysts

- No characteristic diffraction lines of metallic (or oxide) species can be observed in the XRD patterns of both the Ru and Pt catalysts
- For the 5%Pt@AC catalysts characteristic diffraction lines for metallic platinum were detected indicating a slight increase of the crystal size



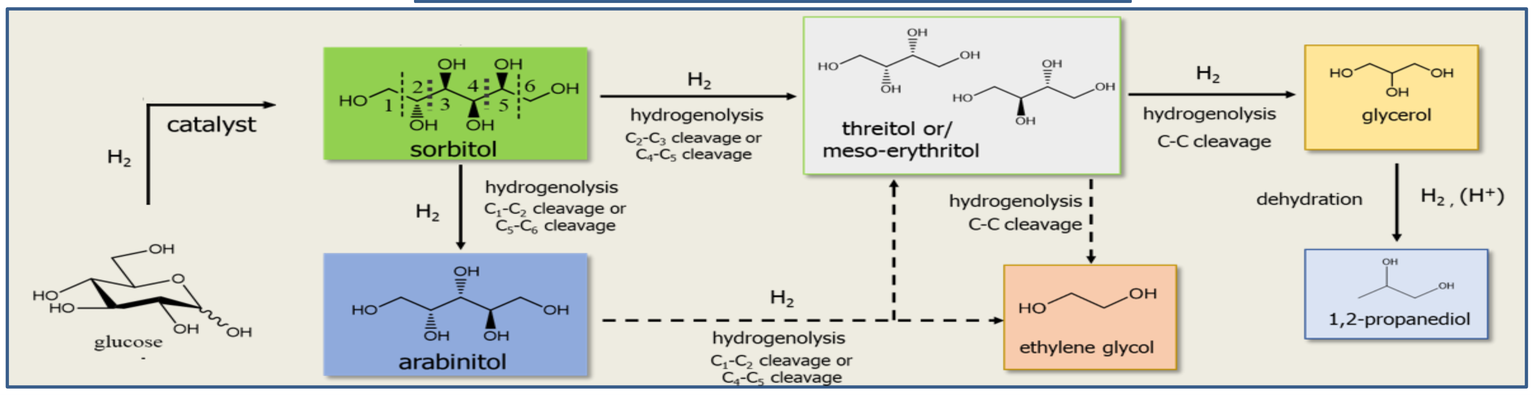

## Results




## Conclusions

It was shown that Pt is significantly more selective towards hexitols (sorbitol and mannitol) compared to Ru. For example, the 5wt% Pt/AC catalyst afforded hexitols yield of 84.2 wt.% (at 98.9% conversion) compared to 63.1 wt.% (at 97.6% wt.% conversion) obtained by the corresponding Ru catalyst, the latter being also selective towards glycerol and propane-1,2-diol. Optimization of the time/ temperature conditions, resulted to even higher sorbitol selectivity/yield of ca. 90 wt.% (at 100% conversion). Both Pt and Ru exhibited relatively high glucose hydrogenation activity towards hexitols, versus retro-aldol reactions that lead directly to smaller C2–C4 compounds, while the difference in the final product yields between the two metals was attributed to the higher hexitols hydrogenolysis (C-C cleavage) reactivity of Ru.

## Reaction Mechanism

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