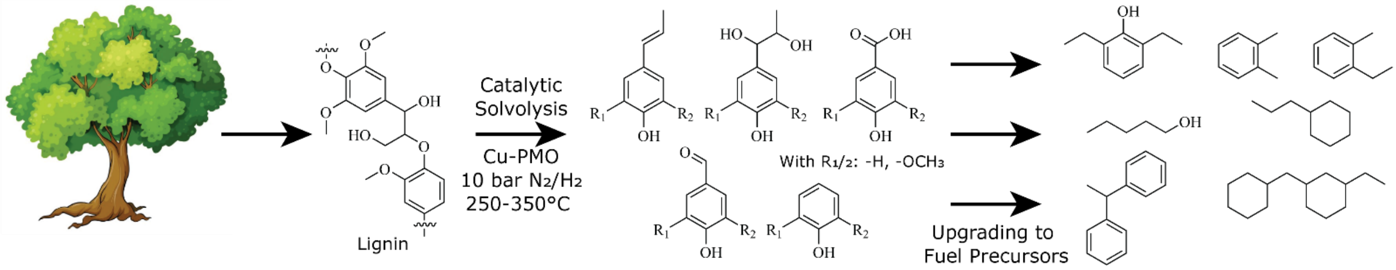
Chemical Transformation of Enzymatic Hydrolysis Lignin with Catalytic Solvolysis to Fuel Commodities

Increasing concerns to reduce carbon emissions has inspired investigations into more sustainable pathways for fuel production. Lignocellulosic biomass can herein play an important role in enabling more environmentally friendly fuel components.[1] Lignocellulosic biomass, a bio-polymer, consists of a complex network of cellulose, hemicellulose, and lignin in various ratios depending on the precedence of the biomass source.[2] A lot of attention is given to the former two, but lignin is given increasing attention in recent years due to its inherent aromatic nature, making it a prime feedstock for renewable aromatics. Lignin however, is a complex recalcitrant compound and is proving challenging to selectively produce specific fuel commodities. Therefore, rational design of the catalyst is of importance in order to tailor towards better defined product distributions from lignin depolymerisation.



Within this project the valorisation of enzymatic hydrolysis lignin is investigated by means of catalytic solvolysis in the presence of a copper based catalyst. Based on earlier work from the IMC group[3], copper based porous metal oxides are proven to facilitate cleavage of lignin. However, selectivity and activity could be further improved upon in order to promote industrial feasibility. This will be done by means of doping non-precious transition metals, such as Fe, Mn, or Ni, to promote catalytic activity. A multitude of catalysts combinations can provide synergetic effects which positively impact selectivity towards certain product distributions.

Catalytic solvolysis is a challenging process and is hindered by recondensation of active oxygen species. Additional strategies could be employed besides catalyst doping to reduce side reactions. As example, reactive solvent components are known to actively cap reactive species reducing undesired side reactions.[4] In practice a high number of catalyst/solvent systems are available which could enhance selectivity and activity for the selective production of fuel commodities.

Techniques used:

During this project copper based catalyst will be synthesised via co-precipitation methods, and will be characterised by various techniques, e.g. XRD, ICP, N_2-Physisorption, CO/CO_2-TPD and XPS. After catalytic solvolysis of the lignin the product distribution will be analysed using GC-MS, GC-FID, 2D NMR, and GPC. Spent catalyst can eventually be further characterised by XRD, TGA, and ICP to analyse coke formation and stability of the catalyst.

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