Nano-metal Esterification

Simon Suhr Borkenfelt, Jesper Brandt Rasmussen, Nanette Zahrtmann, Trine Marie Hartmann Arndal, Anne Margrethe Loft Andersen

DTU Chemistry, Technical University of Denmark

Esters constitute an abundant functional group in natural and synthetic organic compounds. This makes esterification one of the most important processes in the formation of organic products and platform chemicals. Simple esters are synthesized from alcohols and acids at elevated temperature and pressure using harmful drying agents leading to difficult waste streams. The alcohols and acids for synthesis can be produced from aldehydes by heterogeneous and homogeneous processes (Anthony G. Abatjoglou, 2011) and the direct esterification of aldehydes could thus circumvent these intermediate operations.

This project is an attempt to design a direct synthesis of esters running at room temperature and normal pressure with a solid catalyst and without the formation of by-products. The aim is to reduce both energy consumption and the use of harmful chemicals in the synthesis of organic chemicals. This is achieved by the use of solid nano-metal catalysts, most commonly gold, that enable oxidation of aldehydes, e.g. from biomass, to esters using only oxygen and alcohol as reactants.

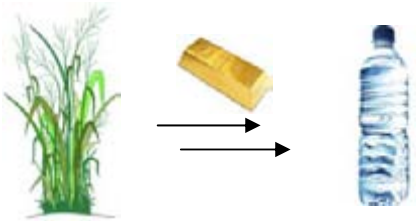

Figure 1 From biomass to consumer goods

Catalysts with three different metals are prepared and tested for the oxidation of benzaldehyde into its corresponding ester, methyl benzoate, as sole product. Apart from gold nano-catalysts also platinum and palladium catalysts are prepared and tested. The catalytic testing is carried out in a liquid mixture of methanol and benzaldehyde in the presence of a surplus of oxygen at normal temperature and pressure. Samples are taken at selected times and analyzed by Gas Chromatography.

Conversion and selectivity towards the product are found for each of the tested catalysts. Preliminary results show conversions up to100 % and yields up to 90 %. This indicates that the optimized catalyst is able to fully convert benzaldehyde into methyl benzoate under mild reaction conditions without the formation of by-products and within reasonable time.

In conclusion, efficient esterification can be accomplished with a solid nano-metal catalyst without the use or formation of unwanted or environmentally harmful products. The major contribution to the carbon footprint of the process stems from the use of oxygen. This can be minimized by applying atmospheric air in the reaction. Further work in terms of catalyst characterization, preparation optimization, and operational optimization is needed in order to fully investigate and understand and commercialize the catalytic systems presented.

REFERENCES

Anthony G. Abatjoglou, D.J. (2011). Aldehydes. In *Kirk-Othmer Encyclopedia of Chemical Technology.* John Wiley & Sons, Inc.