Conversion of Cellulosic Biomass into High-value Chemicals & Fuels: A Perspective of Heterogeneous & Electrochemical Catalysis

Koteswara Rao Vuyyuru
Prof. Dr. Peter Strasser

Department of Chemistry, Chemical Engineering Division,
Technical University Berlin, 10623 Berlin, Germany
90% of chemicals are deriving from crude oil

Goal
1. Conversion of cellulosic biomass into high value chemicals using liquid phase heterogeneous catalysis
2. Electro-catalytic oxidation & reduction reaction of biomass derived compounds
Reaction pathway

Cellulose → Dehydration → Glucose + Fructose

Starting material
Dumesic et al, Davis et al

Intermediate/ platform

5-Hydroxymethylfurfural (HMF)

Targets

Bio-polymer
Pharmaceutical
Fuel
Fuel-additive

2,5 Furandicarboxylic acid (FDCA)
2,5-Furandicarbaldehyde (FDC)
2,5-Dimethylfuran (DMF)
2-Methylfuran (MF)

Oxidation
Reduction
Oxidation of HMF at pH 13: Effect of temp. & pressure

- Insignificant amount of FDC formation at pH 13
- Pressure from 1 bar to 10 bar increases 7% FDCA yield
- Temperature 25°C to 50°C influence 10% FDCA yield
- 100% conversion with hemiacetel formation
Electrochemical catalytic oxidation

OH
\[
\begin{array}{c}
\text{O} \\
\text{C}
\end{array}
\]

Hydroxymethylfurfural

5mM HMF

Electrochemical catalysis

LC-MS
Electrocatalytic oxidation of HMF using Pt electrode at pH10

- 5mM HMF, 0.44mA/cm², 25°C, N₂, pH10, Pt foil (4.5cm²)

- HMF is stable in absence Pt electrode
- 5% HMF conversion with Pt electrode
- 18% FDC with 25% selectivity, 70% HMF conversion with electrocatalysis
Thank You!

For more discussion
Please visit

Poster No: 7