

Biomass Valorization: Making Molecules We Need through Heterogeneous Catalysis

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Abstract

The Catalysis Center for Energy Innovation (CCEI) is a DOE Energy Frontiers Research Center that focuses on the use of heterogeneous catalysis for upgrading biomass and biomass-derived species into fuels, commodity chemicals and value added products such as lubricants and surfactants. This talk will give an overview of the advances in catalytic technology that have been investigated at the CCEI to achieve the aforementioned goals.

In the first part of the talk I will describe work using solid Lewis acids, or Lewis acids in combination with supported metal catalysts for the selective dehydration and hydrogenation of sugars and others biomass-derived precursors. These reactions include the isomerization of glucose into other sugars (such as fructose), the use of metal/Lewis acid combinations for hydride-transfer reactions between carbonyls and primary or secondary alcohols. The advantages of on-pot cascade reactions for maintaining high selectivity at high yield in liquid phase reactions will be evaluated in the light of recent advances in catalysis.

In the second part of the talk I will discuss a number of pathways to transform furans (produced from glucose or xylose by dehydration) into valuable aromatic commodity chemicals. To this end we have developed and optimized zeolite catalyst compositions to form aromatic species out of the furans via Diels-Alder chemistry. This work includes the synthesis of p-xylene from 2,5-dimethyl-furan and more recently our efforts for producing benzoic acid and α -methylstyrene from furans in high selectivity and high yield.

This work will show that the synergy between materials synthesis, catalyst testing and characterization and advanced simulation techniques can be used to rapidly advance the field of catalysis from both a scientific and technological point of view.