

EECE Department Seminar

Friday, April 14, 2017

11:00am

Brauer Hall, Room 12

Thermal Deconstruction of Lignocellulosic Biomass

ABSTRACT

Deconstruction of lignocellulosic biomass into fermentable sugars is among the major challenges in producing cellulosic biofuels and biobased products. The conventional approach to biomass deconstruction uses acid pretreatments to open up plant cell walls, making cellulose more susceptible to acid or enzymatic hydrolysis. Thermal deconstruction, on the other hand, uses heat to liberate plant polysaccharides as anhydrosugars and lignin as phenolic monomers and oligomers. The two major thermal deconstruction approaches are pyrolysis, which occurs in a gaseous environment to produce vapor products, and solvent processing, which occurs in a solvent environment to produce solubilized products. In both cases, plant polysaccharides can be directly solubilized

without acid or enzymatic hydrolysis.

Thermal deconstruction of biomass, despite being the foundational phenomenon of thermochemical processing of biomass, is poorly understood. When biopolymers are heated to temperatures in the range of 200-600° C, they undergo a number of chemical transformations, the most prominent including chain breaking, ring fragmentation, dehydration, decarbonylation, and decarboxylation. The relative contribution of each to products, whether solid, liquid, or gas, depends on heating rate, reaction environment (solvents or gases), temperature, residence time of reactants and products in the reactor, and the presence of catalysts. Our research group is investigating fun-

damental and applied problems in thermal deconstruction using both pyrolysis and solvent liquefaction. We have been able to dramatically increase yields of anhydro monosaccharides from pyrolysis of lignocellulose, which is the basis of commercial demonstration project with Easy Energy Systems. We have found that two-step solvent liquefaction with acid catalyst can substantially increase the rate of formation and yield of solubilized carbohydrates. We are also investigating pyrolysis under very limited time regimes to produce anhydro-celodextrins, which may prove to be directly fermentable by yeast strains in the genera *Bretanomyces* and *Candida*.

Robert C. Brown, Professor

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Dr. Brown is Anson Marston Distinguished Professor in Engineering and Gary and Donna Hoover Chair in Mechanical Engineering at Iowa State University (ISU). Dr. Brown is the founding director of the Bioeconomy Institute (BEI), which coordinates ISU's research, educational, and outreach activities related to bi-

obased products and bioenergy. Dr. Brown has built multidisciplinary teams at ISU around several promising thermochemical platforms including bio-oil production and upgrading, syngas production and upgrading, bio-oil and syngas fermentation, and biochar production and application. He has published over

200 refereed papers and book chapters. He is the recent recipient of the Don Klass Award for Excellence in Thermochemical Conversion Science. Dr. Brown received his PhD and Master's degrees in Mechanical Engineering from Michigan State University.