

# EECE Department Seminar

Friday, April 7, 2017

11:00am

Brauer Hall, Room 12

## Catalytic Conversion of Biomass to Fuels and Chemicals

### ABSTRACT

Lignocellulosic biomass is an important renewable source of carbon for the sustainable production of fuels, chemicals, and materials. Presented here is our recent work on catalytic processing of biomass, with an emphasis on the synthesis of new catalytic materials and the elucidation of solvent effects for these processes. Specifically,  $\alpha$ - $\omega$ -diols were produced from biomass-derived reactants with bimetallic catalysts (e.g., RhRe, RhMo, PtMo). The active sites on these bimetallic catalysts are bi-functional in nature, where the more reducible metal (Rh, Pt) catalyzes hydrogenation/dehydrogenation processes, and the more oxophilic metal

(Re, Mo) provides sites that facilitate acid-catalyzed reactions.

These bimetallic catalysts were synthesized with controlled compositions by the deposition of organometallic compounds onto the surfaces of metal nanoparticles. The effects of polar aprotic organic solvents on reaction rates and selectivities of acid-catalyzed reactions of relevance for biomass conversion (e.g., xylose and fructose dehydration to furfural and hydroxymethylfurfural, respectively) were quantified by reaction kinetics studies. The aprotic organic solvent affects the stabilization of the acidic proton relative to the protonat-

ed transition states, leading to accelerated reaction rates for these acid-catalyzed biomass conversion reactions. This solvent effect was employed to develop a biomass processing approach that uses gamma-valerolactone (GVL) as a solvent to fractionate biomass to produce soluble carbohydrates from corn stover, hardwood and softwood at high yields (80-90%). These carbohydrates can then be recovered and concentrated (up to 150 g/L) in an aqueous phase or converted to produce furandicarboxylic acid.

### James A. Dumesic, Chairman

Department of Chemical & Biological Engineering, University of Wisconsin



James A. Dumesic earned his B.S. degree from UW-Madison and his M.S. and Ph.D. degrees from Stanford University, under the supervision of Professor Michel Boudart. Dumesic joined the Department of Chemical Engineering in 1976, and he is currently a Vilas Research Professor at the University of Wisconsin and the Michel Boudart Professor of Chemical and Biological Engineering. Widely recognized as a leading researcher in the fields of catalysis and chemical engineering, Dumesic has co-founded two companies (Virent and Glucan Biore-

newables) and pioneered new processes for creating bio-derived fuels and chemicals. He and colleagues at the Wisconsin Energy Institute have recently created an efficient, scalable process for producing sugars that can then be converted into biofuels.

Throughout his career, Dumesic has used spectroscopic, microcalorimetric, and reaction kinetics techniques to study the surface and dynamic properties of heterogeneous catalysts. Dumesic pioneered the field of microkinetic analysis, in which diverse information from experi-

mental and theoretical studies is combined to elucidate the essential surface chemistry that controls catalyst performance. He has recently studied how aqueous-phase reforming of biomass-derived carbohydrates can be tailored to selectively produce  $H_2$  or directed to produce liquid hydrocarbons. Most recently, he has been studying the use of furan compounds, levulinic acid, and  $\gamma$ -valerolactone as biomass-derived platform chemicals for the production of fuels and chemicals.