# Center for BioEnergy Research and Development (CBERD)

South Dakota School of Mines and Technology, Duane Abata, Executive Director, 605.394.5264, duane.abata@sdsmt.edu

University of Hawaii, Scott Turn, 808.956.7800, sturn@hawaii.edu

Kansas State University, Mary Rezac, 785.532.5584, rezac@ksu.edu

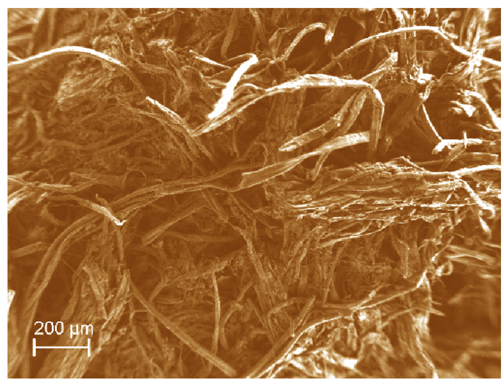
North Carolina State University, Steven Peretti, 919.515.6397, peretti@eos.ncsu.edu

State University of New York – Stony Brook, Devinder Mahajan, 631.632.1813, devinder.mahajan@stonybrook.edu

South Dakota School of Mines and Technology, David Dixon, 605.394.1235, david.dixon@sdsmt.edu

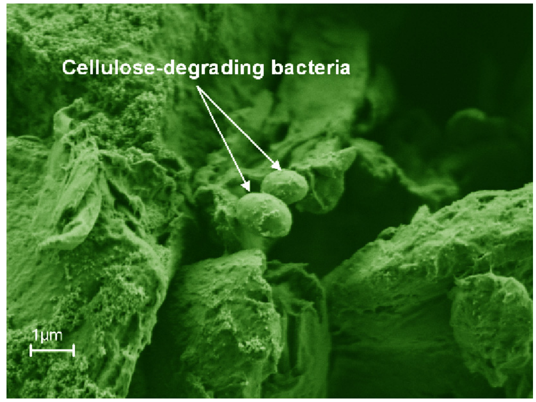
Center website: http://bioenergynow.org/

## Development of BioEnergy Bi-Products for use as Polymer Substitutes



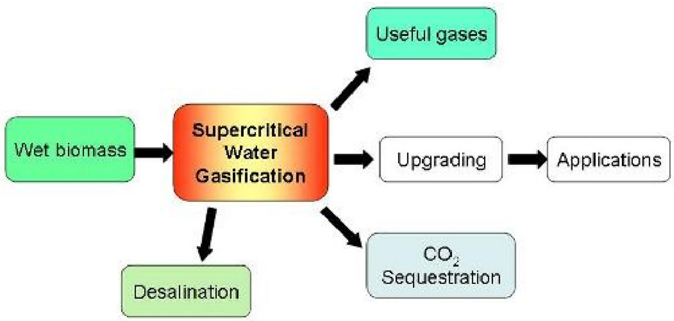

The bioprocessing industry will undergo a transformation in the next few years moving from food-based sources such as corn and soybeans to non-food-based sources such as grasslands and wood. As fuel is produced from these new sources there will be a variety of bi-products that will be of substantial economic value. Developing these bi-products into useful marketable products is an important area of research for CBERD. One such co-product is the lignin rich stream currently used as a boiler fuel. It would be economically advantageous to utilize this lignin co-product in polymeric composites, very much like wood is currently being used wood filled thermoplastics, which has seen significant use as building materials reaching nearly a half a billion dollars in sales in the last decade. This study will examine how this lignin co-product compares to wood in thermoplastics and other polymeric matrix systems. The first goal will be to characterize the chemistry and morphology of the lignin co-product. The lignin co-product from a woody biomass process will be the initial test case. The second goal will be to conduct polymer and polymer composite processing and mechanical property studies of systems utilizing this characterized lignin co-product.

## Development of Enzymes for the Production of Fuels from Non-Food Sources




Lignocellulose biomass, which includes agricultural, forestry and municipal wastes, is among the earth's most abundant renewable resources. However, the diverse nature of this lignocellulosic waste presents a major obstacle in developing conventional conversion processes in energy generation and environmental restoration. One of the best strategies for rapid release of fermentable sugars from cellulosic waste-materials is to develop thermostable enzyme systems. Thermophilic cellulose-degrading bacteria and their enzymes for bioenergy conversion processes are key targets in the development of biodiesel and bioethanol alternative fuels. There are distinctive and highly promising bacteria (hydrolytic extremophiles) living at high temperatures and pressures deep within the new NSF Deep Underground Science and Engineering Laboratory (DUSEL) which utilizes a very deep and old abandon gold mine (Homestake Gold Mine) located in western South Dakota. The specific research objectives of this project are to produce and characterize lignocellulose-deconstruction enzymes from these bacteria strains and to prepare a new thermostable mixed enzyme system for rapid release of fermentable sugars from lignocellulosic (wood, municipal waste, paper, and grassland) sources. The impact of this work will be significant to the national economy because success in this area will establish a new mixed thermostable enzyme system that will be able to convert waste into fermented sugars which then can be readily fermented into ethanol or be available for other high value products in a single step.

## Supercritical Water Gasification of Biomass and Selective Enrichment of Fuel




Thermochemical conversion of biomass into hydrocarbons and/or hydrogen is an important component in the advancement of bioenergy. The ideal conversion system selectively scavenges oxygen while simultaneously facilitating hydrogen recombination and/or hydrocarbon enrichment chemistry. It is possible to meet these requirements by combining supercritical water gasification of biomass with novel, mesoporous catalytic hydrocarbon enrichment. In addition, the use of supercritical water gasification makes this thermochemical process more economical, as drying of biomass is no longer required. The goals of this project are to synthesize and characterize supported catalysts for selective SCWG of biomass and mesoporous catalysts for hydrocarbon enrichment, and determine the kinetics and mechanisms of catalytic thermochemical biomass conversion into hydrocarbons. This includes controlling catalyst properties such as metal, loading, and pore size distribution and adjusting various process variables such as temperature, pressure, concentration of reactants and water, and reaction/residence time. Kinetic/mechanistic models are developed to describe the important chemistry of the process, and aid in detailed reactor design. One industrial member of CBERD is considering thermo chemical routes to hydrogen and hydrocarbon fuel formation from biomass. This requires information on novel catalysts and processing techniques to facilitate fast reaction and selective production of various energy sources. In addition, engineering models to describe the pertinent chemistry are important for subsequent process design and scale-up.