The main objectives of our program is to develop a far-reaching, multi-institutional center focused on efficiently developing innovative biomaterials from the renewable biomass resources, including the cellulose, hemicellulose, and lignin. These will address the key material science-chemistry-biochemistry limits on the better exploitation of biomass for biopolymers, and thus enhance this nation’s energy independence and improve environmental performance, including the reductions in CO2 emissions.

Research Objectives

The development of combined biological and chemical technology for the depolymerization of lignocellulosics would convert lignin and carbohydrates into valuable mainstream chemical feedstocks, such as are glutamic acid, β-ketoacrylic acid, and its immediate biochemical precursor, 2-ketoglutaric acid.

Approach

Our approach has been truly interdisciplinary. For example, in developing novel oxidative chemistry of cellulosic fibers, we have explored various catalytic chemical systems/enzymatic treatments (i.e., laccase mediator systems and peroxidases) to selectively oxidize hemicellulose and cellulosic materials for the preparation of novel superabsorbers, new crosslinking agents, and metal chelation agents.

Investigation of biochemical dihydroxylation of lignins as a new approach for the production of biobased fuels and chemicals via the b-ketoacid pathway.

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Investigate the crosslink of cellulose nanowhiskers (200-400 nm length and less than 10 nm width) with poly-(methyl vinyl ether-co-maleic) and poly(ethylene glycol). This study has showed, for the first time, that crosslinked cellulose whiskers can function as a hydrogel. Additional studies included chemoenzymatic/enzymatic synthesis of novel biodegradable polymer.

No Competition with Food Demand

Lower Cost

Higher Availability

Biomass resources

Investigate periodation and sulfonation of cellulosic materials, such as pulp fibers and nanocellulose; evaluated the chemical and physical properties of various cellulose and determine physical dimensions, functional groups, and their water absorbency properties; observed a significant increase (8.0-199.0%) on the water absorbency of cellulosic materials.

Investigate effect of NaIO4 dosage (wt% of dry fibers) on the water solubility of NaHSO4-treated fibers. With the increased dosage of NaI04 for periodation of fibers, the sulfonated fibers show enhanced water solubility. First time the sulfonated fibers have shown excellent water solubility (as high as 5.0 g per 100 g water at room temperature).

Develop a practical procedure for the preparation of the cellulose nanospheres with sizes ranging from 70 to over 570 nm; demonstrates a near linear relationship between NaIO4 dosage, wt % dry fibers, and Water retention (WRV) as a new approach for the production of biobased fuels and chemicals via the b-ketoacid pathway.

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Focus/Content/Locus

Project focus: Transformation of knowledge and national innovation enterprise
Project locus: National
Project content: Biotechnology, economic development, environment and natural resources, energy, materials, and nanotechnology

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