NSF-EEC-0332554: CENTER FOR INNOVATIVE BIOMATERIAL EDUCATION AND RESEARCH (CIBER)

PI: Arthur J. Ragauskas; Institution: Georgia Institute of Technology; Award Years: 4 Years; Project Start Date: 10/22/04

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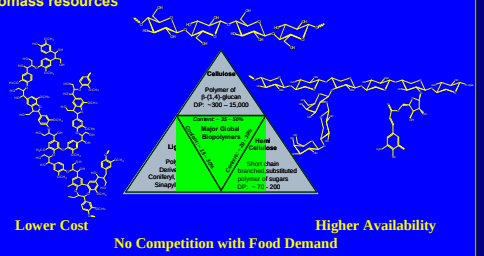
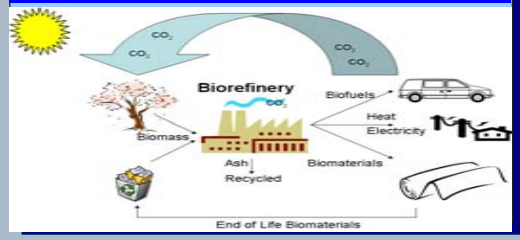
Research Objectives

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 CO_2 emissions.

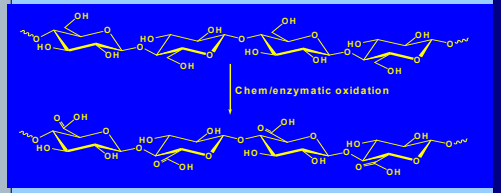
Biomass resources



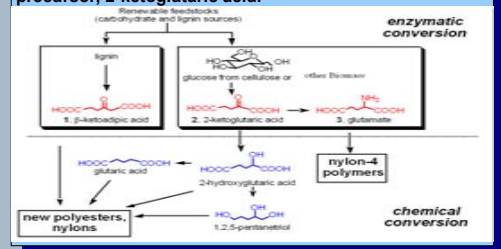


Approach

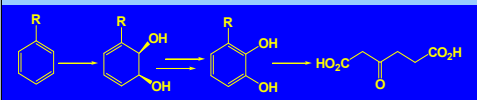
Our approach has been truly interdisciplinary. For example, in developing novel oxidative chemistry of cellulosic fibers, we have explored various catalytic chemical systems/enzymatic treatments (i.e., laccase mediator systems and peroxidases) to selectively oxidize hemicellulose and cellulosic materials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



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-ketoadipic acid, and its immediate biochemical precursor, 2-ketoglutaric acid.



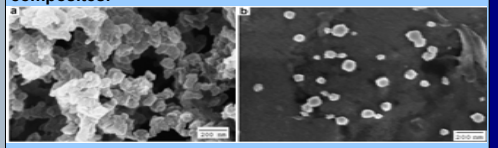
Investigation of biochemical dihydroxylation of lignins as a new approach for the production of biobased fuels and chemicals viathe b-ketoadipate pathway.



P. Putida reactions with aromatics for conversion of lignin into new building block of polymers.

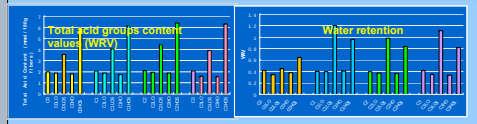
Progress made to date

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 cellulose nanoparticle size and treatment conditions; the hydrolyzed nanocelluloses shown to be predominantly the cellulose II polymorphic crystal structure with potential applications including drug delivery and composites.

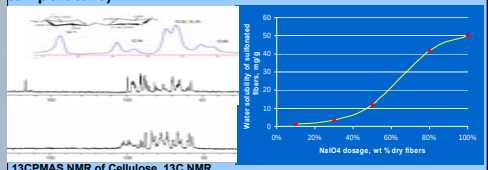


SEM image (a) of aggregated cellulose nanoparticles with an average diameter of 80 nm, 10 kV, and SEM image (b) of a well distributed sample of the same sample.

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 $NaIO_4$ dosage (wt% of dry fibers) on the water solubility of $NaHSO_3$-treated fibers. With the increased dosage of NaIO4 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).



13CPMAS NMR of Cellulose, 13C NMR of oxidized and sulfonated cellulosics

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 crossed linked cellulosic whiskers can function as a hydrogel. Additional studies included chemoenzymatic/enzymatic synthesis of novel biodegradable polymer.

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