



2008 Research for Undergraduates (REU) Program

**Directors: Dr. David Neivandt, Dr. Douglas
Gardner, and Dr. Darrell Donahue**

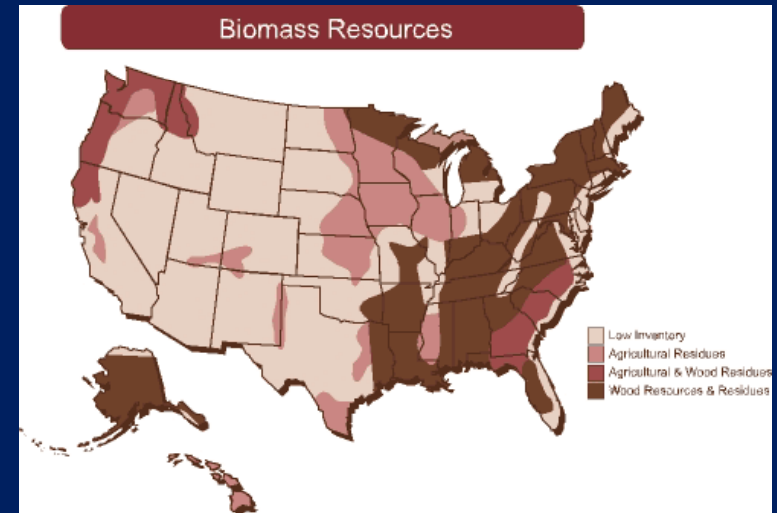


Public Concerns over Biomass Power Plants

Marci Scofield – University of Maine

Advisor: Dr. Jessica Leahy

- It is possible to determine public concern by analyzing newspapers?
- Nine New England Newspapers were selected to analyze
- Eleven categories, including economy, industry, and environmental impacts, were searched for using Word Stat content analysis software
- Found:
 - regional newspapers tended to have less coverage on woody biomass than local newspapers
 - local newspapers tended to have more coverage concerning the economy and less concerning the environment than regional papers



**Biomass map from
www.eere.energy.gov**

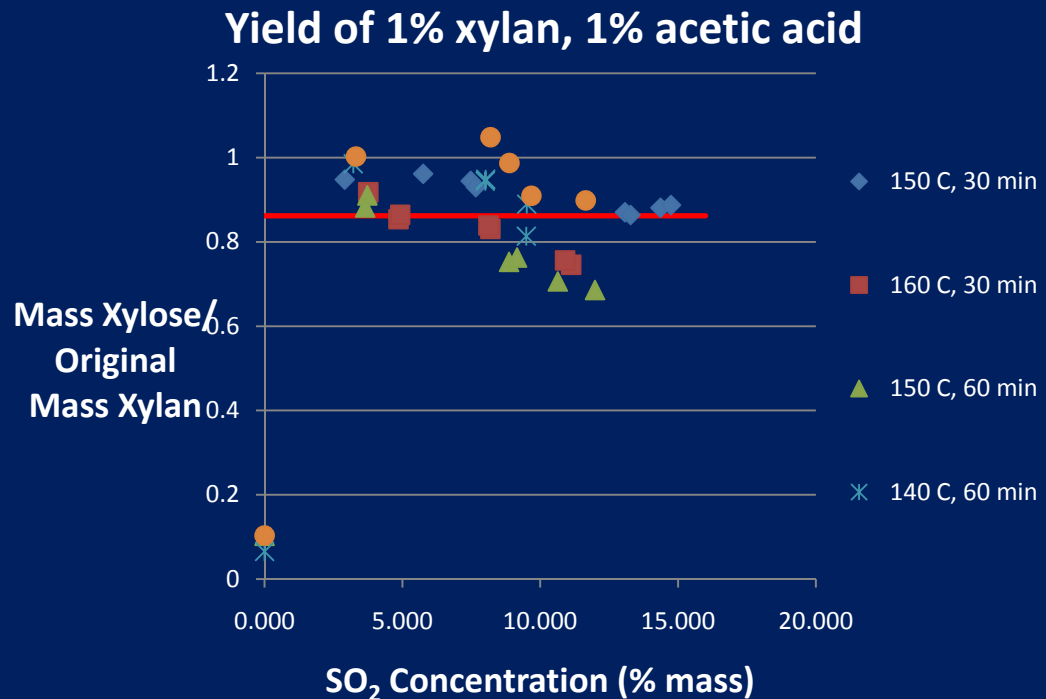
Studies of Hydrolysis of a Model Compound of Birch Xylan using Sulfur Dioxide

Jim Grundy – Harvard University

Advisor: Dr. Adriaan van Heiningen and Rory Jara (PhD candidate)

- 1% xylan, 1% acetic acid solution in water to simulate hot water extract
- SO_2 dissolved into solution, which is then batch reacted in a constant volume

Oil Bath Laboratory Multi-Digester



Result: Progress towards determining kinetic parameters for simulated hemicellulose extract hydrolysis

Survey of Various Logging Equipment and Its Relative Capacity to Harvest Biomass in Maine

Ian Stone – Louisiana State University

Advisor: Dr. Jeff Benjamin



- Project Goals
 - Quantify the amount of logging equipment in Maine
 - Assess the ability of the current logging operations to supply biomass
 - Assess loggers willingness to participate in this new market
- Project Methods
 - Use a survey to collect data on the amount of equipment types and setups in the state
- Project Benefits
 - Give potential investors in biomass plants an idea of deliverable feed stock supply
 - Show areas that could use improvement or have potential opportunity for development

A Comparative Analysis of Agglomeration and Pellets made by the Woodtruder

Zach Meehan – University of Maine

Advisor: Dr. Doug Gardner

Agglomeration- a process of particle size enlargement in which small, fine particles, such as dusts or powders, are gathered into larger masses, clusters, pellets or briquettes for use as end products or in a secondary processing step

Counter-rotating twin screw extruder- conventional wood-plastic compounding method in which multiple feeders feed into an extruder which then heats up the material and pushes it out through a die to shape it



Testing:

- 4 Point Bend
- Izod Impact
- Thermal Expansion
- Specific Gravity
- Tensile
- Burn Tests

Application of Near Infrared Technology for Moisture Detection in the Wood Industry

Mike Jacobson – West Virginia University

Advisor: Dr. Steve Shaler

MCT 600



MCT 300

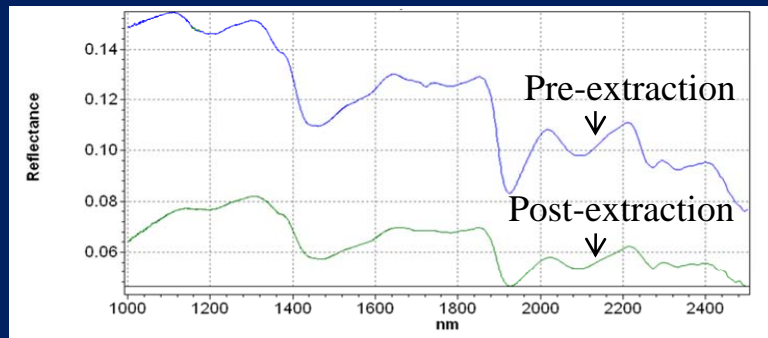


- How can the wood industry benefit from NIR technology?
- What are the problems associated with these two NIR devices?
- Are these machines easy to set-up, calibrate, and use?

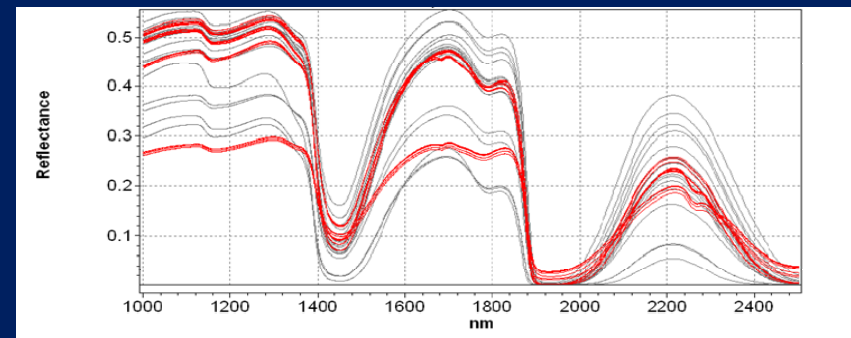
Identification of Forest Bio-Product Process Components through Near-Infrared Spectroscopy

Abby Hamilton – University of Maine

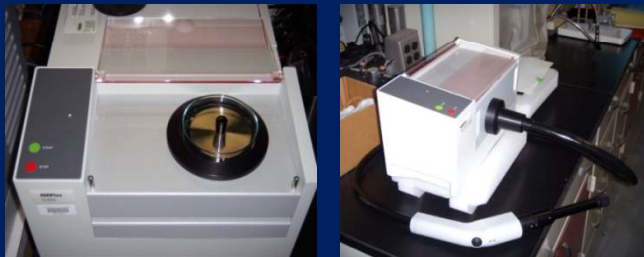
Advisor: Dr. Darrell Donahue



Wood Chip Spectra



Aqueous Extract Spectra



NIR Spectrometer

Objectives:

- Build database of wood chip and extract spectra
- Model spectra with PLS regression techniques
- Predict component composition using the model

Component of Aqueous Extract	Wavelength Range of Regression (nm)	Data Pretreatment	Number of PLS Factors	Standard Error of Prediction	Consistency (%)	Regression Coefficient
Xylan	1600-1900, 2100-2400	none	15	0.120	102.2	0.986
Glucomannan	1600-1900, 2100-2400	none	15	0.135	103.1	0.982
Acetic Acid	1600-1900, 2100-2400	none	15	0.063	94.7	0.997

Sample PLS Regressions of Aqueous Extract Spectra

High-value Chemicals from Bioresources

Melody Rhine – Emory University

Advisors: Dr. Barbara Cole and Dr. Ray Fort

Substantial amounts of forest biomaterials including knotwood, bark, and foliage are underutilized in the forest products industry. The nature and distribution of extractives in waste biomaterials provide us with a potential source of high-value chemicals

In an effort to make the most of our bioresources, several polyphenolic compounds with proven pharmaceutical and medical benefits are being extracted and isolated from these biomaterials.



Chemistry of Nanofibrillated Cellulose: Silylation of cellulose

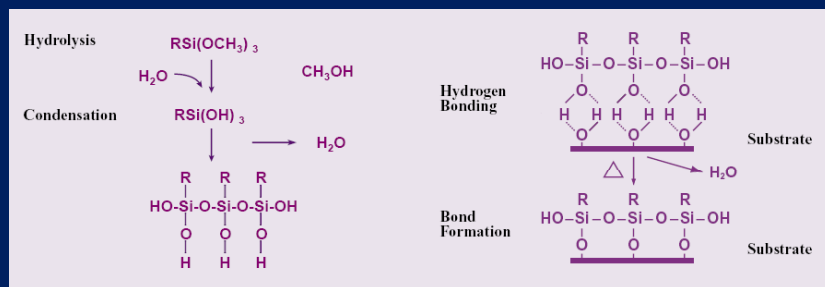
Tatyana Khamaturnova-Tomlin – University of Texas at Tyler

Advisors: Dr. Barbara Cole and Dr. Ray Fort

Process

Silylation is the most widely used derivatization procedure in which active hydrogen is replaced by an alkoxy silane, whose general formula is $R_n-Si-X(4-n)$, where R is a nonhydrolyzable organic moiety that can be either an alkyl, aromatic, organofunctional, or a combination of any of these groups. The groups provide the organic compatibility which allows silanes to form IPN

Mechanism



Results

The analysis of the silylated cellulose is carried out by using FT-IR. Figure 1 demonstrates unmodified cellulose. Figure 2 demonstrates the presence of aromatic compounds on cellulose surfaces after addition of phenyltrimethoxy silane

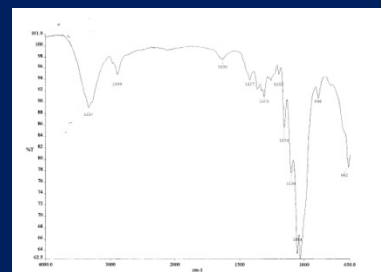


Figure 1 Unmodified cellulose

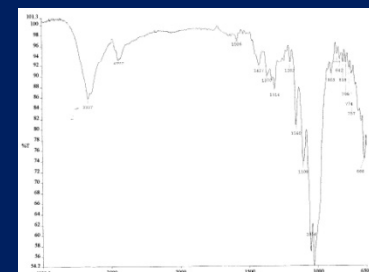


Figure 2 Cellulose silylated with phenyltrimethoxysilane

Applications

Cellulose fibers are used as reinforcing agents in composites and polymeric matrices and in many other applications such as packaging, building materials, etc

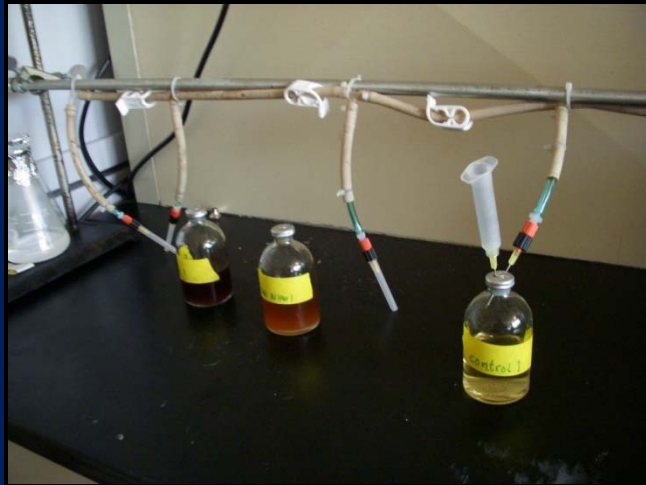
Fermenting Obligate Anaerobes for Ethanol Production

Jesse Capecelatro – SUNY, Binghamton

Advisors: Dr. Peter Van Walsum and Sara Walton (PhD candidate)

Five organisms were tested in different amounts of green liquor extract, northern hardwood hot water extract and a plain sugar media;

Pichia stipitis; *Clostridium phytofermentans*; *Moorella thermoacetica* ATCC 39073; *Thermoanaerobacterium thermosaccharolyticum* ATCC 31960; *Clostridium acetobutylicum* ATCC 824.



These microorganisms, with the exception of *Pichia stipitis* have the ability to produce an abundant amount of ethanol and acetic acid from the

hemicellulose extract without the need of a secondary hydrolysis. Introducing this form of integrated forest bio-refinery (IFBR) to existing mills will help them remain competitive while simultaneously improving today's fuel crisis.

Wood Polymer Composites from Extracted Wood

Lucas Andrusyk – Iowa State University

Advisor: Dr. Doug Gardner

Production Process

- Mixed northern hardwood chips extracted to 375 H-factor using 160°C hot water and pressure
- Extracted liquid analyzed for use in ethanol or other chemical production
- Chips were dried and hammer milled to wood flour
- Extruded with polypropylene at a 50:50 mixture



Tests & Results

- Four point bend: MOR increased in the extracted boards while MOE and max load had no significant change
- Coefficient of Linear Thermal Expansion: No significant difference
- Lineal Burn Rate: No significant difference
- IZOD Impact Resistance: No significant difference
- Density & Specific Gravity: No significant difference

Determining the Demand for Biofuels

Andrew Knox – Whitman College, Walla Walla, WA

Advisor: Dr. Jonathan Rubin

- Intensive industry research on biofuel production and lifecycle analysis of ethanol production
- Recruitment, setup and design of moderator's guide for local focus groups
- Preliminary design for a large survey to be distributed amongst northeast states to determine consumer demand



Research Experience for Teachers (RET)

Katy MacDonald

Advisor: Tracy Vassiliev (Sci/Math Teacher, Middle School, Bangor, ME)

Summer Goal: Develop curriculum activities that expose middle school students & teachers to the goals of FBRI

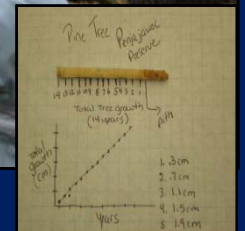
- **Develop Curriculum**

- Test different wood composites strengths (saw dust, flour, NaCl & H₂O)
- Tree core activity (increment borer)
 - Graph DBH, increment growth, and/or area verses time
- Leaf & Bark Extracts
 - Test properties (filter, chromatography, density, pH, etc...)
 - measure the antimicrobial effectiveness of different extracts by measuring zones of inhibition on bacterial culture plates

- **Interview all the REUs**

- post abstracts, pictures and podcasts on the FBRI teachers' blog

- **Lead teacher workshops (Fall 2008)**



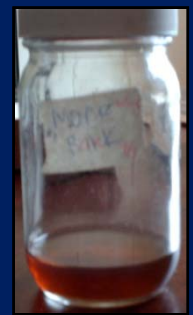
Tree Core Activity



Wood Composites



Antimicrobial tests



Maple Bark Extract