Cellulosic Materials at Alberta Innovates-Technology Futures

Robert Jost
robert.jost@albertainnovates.ca
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Areas of Interest

- **Focus on polysaccharide technologies**
  - Extraction of wood or agricultural biomass
  - Polysaccharide modification
  - Properties
    - physical
    - mechanical
    - chemical

- **Application development**
  - Water soluble cellulose polymers for oil recovery
  - Modified polysaccharides for biomedical
  - Suspensions of nanocrystalline cellulose (NCC)
Coreflood experiments show oil recovery comparable to existing commercial polymers.

Unique benefit: excellent salt tolerance.
Transfection and Gene Therapy

- Better transfection efficiencies than commercial reagents
- Unique benefit: low toxicity
- Works on both plant and mammalian cells

Nanocrystalline Cellulose (NCC)

- A highly crystalline particle of cellulose derived from chemical wood pulp
- Prepared by using strong acid to hydrolyze amorphous regions of the cellulose
Types of Nanocellulose

Micro/nanofibrillated cellulose
Bacterial cellulose
Cellulose nanofibrils
Nanosized/Nanoscale fibers

Larger aspect ratios

Nanocrystalline cellulose (NCC)
Cellulose nanocrystals (CNC)
Cellulose microcrystals
Cellulose whiskers Cellulose crystallites Nanosized cellulose

Highly crystalline
Genesis of NCC

- Sulfite pulp treated with 2.5 N (11%) sulfuric acid
- Particle dimensions 46 X 7.3 nm

Transmission Electron Micrographs of Various NCCs

Typical NCC Preparation Methods

- Temp: 45–70°C
- Sulfuric acid concentration: 64%
- Cellulose concentration: 10%
- Time: 30–60 minutes
- Purification: centrifugation, filtration/dialysis, and drying
NCC Unique Properties

- Size: 10 nm X 200 nm rods
- Crystallinity: >80%
- Can form stable dispersions from dry state
- Liquid crystalline suspensions in water
- Suspensions can be oriented with an electric or magnetic field
- High strength, roughly 1/10 that of carbon nanotubes
- Biodegradable
NCC Pilot Plants

FPInnovations; Pointe-Claire, Quebec
CelluForce; Windsor, Quebec
USDA Forest Products Laboratory; Madison, Wisconsin
Alberta Innovates-Technology Futures; Edmonton, Alberta
Three year, $5.5 million project funded by federal and provincial governments

Objectives:

- Build a pilot plant capable of producing up to 100 kg NCC per week
- Gain NCC scale-up production knowledge
- Identify applications with sufficient volumes to justify a commercial facility
- Construct a commercial NCC facility in Alberta
Nanocrystalline cellulose pilot facility
- design
- construction
- equipment installation
- commissioning

Work closely with University of Alberta, National Institute of Nanotechnology, and industrial partners such as Alberta Pacific Forest Industries Inc. to advance NCC scale-up and application development.
Green chemical for energy sector
- stimulation chemicals
- enhanced oil recovery chemicals
- drilling fluids

Use of NCC-water suspensions
- rheology control
- address NCC limitations
Boluk, Yaman; Zhao, Liyan. *Aircraft Anti-Icing Fluids Formulated with Nanocrystalline Cellulose* US Patent# 8,105,430.
AITF’s Value Proposition

- Feedstock production and processing expertise
- Utility experience with viscosity control
- Western Canadian industry focused

Goals:
- forest industry
  - increase competitiveness
  - demonstration/commercial NCC facility
- energy industry
  - increase extraction efficiency
  - decrease environmental effects
Conclusions and Outlook

Alberta Forest Industry

Pulp

Commercial NCC Facility

Scale-up

NCC

Core Industries: Oil, Chemicals, & Materials

Needs

Pilot Plant

Solutions

Applied Research

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