Challenges and Opportunities in Manufacturing Panel

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Cellulose Nanomaterials – A Path Towards Commercialization
A Workshop Co-Sponsored by
USDA Forest Service
National Nanotechnology Initiative
American Process Inc.

- Currently installing a 1 ton per day (dry basis) nanocellulose pilot line at our existing AVAP Biorefinery in Thomaston, Georgia to produce cellulose nanocrystals (CNC), cellulose nanofibrils (CNF), and hydrophobic, lignin-coated varieties directly from biomass.
Manufacturing Opportunities

- **Low Production Cost for CNC and CNF** with estimates of <$1 lb (wet basis).
- **Low cost feedstock utilization** with omnivorous processes.
- **Low tonnage “side line” production** in existing pulp mills for coproduction with pulp, lignin, and biofuels or biochemicals.
- **High tonnage “stand alone” production** in repurposed pulp mills using existing infrastructure including wood delivery and handling, utilities, waste water treatment, bleach lines etc.
- **Large demand potential** with a near term global market size estimate for nanocellulose of 34 million tons per year (recent USDA funded study)\(^1\).

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Possible Global Production Curve

USDA’s near term global market size estimate for nanocellulose of 34 million tons per year.
Manufacturing Challenge: Drying

- Economical preservation of discrete nanocellulose particle morphology during drying for effective re-dispersion in hydrophobic plastic resins

**Cellulose Nanocrystals**


**Cellulose Nanofibrils**

Manufacturing Challenge: Drying

- **Lesson learned from similar experience:** Coating CNC with lignin appears to prevent hydrogen bonding during freeze-drying. Resulting powder can be uniformly re-dispersed in silicone for a semi-transparent, stronger composite.

- **Research Question:** Is there a low cost, hydrogen bonding “blocker” for freeze-drying of conventional CNC that maintains color/transparency and is compatible with hydrophobic plastics?
Manufacturing Challenge: Rapid Particle Size Characterization

- Develop rapid size characterization of CNC and CNF for process and product quality control

**TODAY**

- Cost: $$$$$
- Sample prep time: ~30 min per sample
- Characterization time: ~15-25 min per sample + manual image analysis
- Staff requirements: highly technical experts
- Location: Specially designed individual room - sensitivity to ambient conditions

**TOMORROW**

- Cost: $
- Sample prep time: <5 minutes per sample
- Characterization time: <5 min per test
- Staff requirements: process operators
- Location: Operating floor or process quality test lab
EHS Priorities

Safety

• Occupational Safety
  – Detection in environmental media
  – Airborne exposure methods
• Product Safety
  – Demonstrating safety of functionalized nanocellulosic materials
  – Human health testing
  – Environmental releases
• International Safety Standards

Regulatory

• Lack of clarity on regulatory requirements for nanomaterials
• Variability of requirements by geography and application
• Lack of standards for nanomaterials
• Lack of validated methods for assessing safety
Thank You

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