Overview of Biomaterials Research at Georgia Tech

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Why forest-based biomaterials?

- Sustainable paradigm → replacement of existing, non-renewable materials through “ingredient substitution” (short term) or product redesign (long term)

- Challenges → Fundamentals of synthesis and properties
  → Product design or redesign
  → Manufacturing changes
  → Market risks

- History
  - Natural rubber
  - Paper
  - Celluloid & cellophane
  - Pinenes & other tree-derived chemicals
Relevance to Forest Products Industry and US Forest Management

- Create underlying science and technology
  - Enable next generation of forest products
  - Support robust forest products industry
  - Aid in forests restoration

- Forest Products Industry
  - 19% mills closed since 2005
  - $9 Billion in lost wages

- Forests Restoration
  - 397 Million acres in need of mechanical thinning and profitable outlets
Breadth of Research in Biomaterials

- Extraction of CNCs / NFCs
  - Utilization in composites
    - High-strength / light-weight
    - Barrier materials
- Lignocellulosic Materials (beyond nanomaterials)
  - Plastics replacement
- Lifecycle and systems research
- Genetic influence on lignocellulosic production
- Novel characterization methods
- Novel properties and functionalities
  - Semiconducting / electronic
  - Sensors
Nanobiomaterials: Natural examples

Structural coloration
Eastern Bluebird

Strength: crab shell

Dufresne et al., Soft Matter, 5, 1792.

http://www.mpie.de/index.php?id=2957&L=0
Natural examples...

Cellulose in wood and plant structures

Forest products, biomass

Wood cells

Cell wall layers

Cellulose microfibrils

In cell walls

CNC’s consist of organized stacks of Iα, Iβ cellulose chains

AFM image of a cellulose Nanocrystal (CNC)

Chemical treatment releases crystalline phase
Connections

Georgia Tech / IPST researchers are engaged nationally & internationally
Forest Biomaterials and Related Areas
Researchers @ GaTech

Art Ragauskas (CHEM)
Yulin Deng (ChBE)
Meisha Schofner (MSE)
Anselm Griffin (MSE)
Sujit Banerjee (ChBE)
Carson Meredith (ChBE)
Cyrus Aiden (ME)
Rachel Chen (ChBE)
Carsten Sievers (ChBE)
Victor Breedveld (ChBE)
Sven Behrens (ChBE)
Jeff Hsieh (ChBE)
Haskell Beckham (MSE)
David Bucknall (MSE)
IPST & Ga Tech Resources

- School of Chemical & Biomolecular Engineering
- Woodruff School of Mechanical Engineering
- School of Chemistry and Biochemistry
- School of Materials Science and Engineering
- Marcus Nanotechnology Research Center
- Center for Nanostructural Characterization
- Center for Organic Photonics and Electronics
- GTRI Signature Technology Laboratory Materials Analysis Center
- Petit Institute for Bioscience and Biotechnology