The Renewable Bioproducts Institute at Georgia Tech

October 2014
Who is Georgia Tech?

Georgia Tech Capability

• 900 full-time instructional faculty
• 21,500 undergraduate and graduate students
• National and international leader in scientific and technological research and education
• Greater than $700 million in annual research expenditures
• Top ten in research expenditures among universities without a medical school

“[Because of this Institute], our experts across Georgia Tech have a portal into the industry with expertise on cellulose and its practically unlimited potential.” — Georgia Tech President Bud Peterson, April 17, 2013
Georgia Tech Record of Excellence

Georgia Tech Reputation

  - #5 best undergraduate engineering program
  - #6 best graduate engineering college
  - Specialty ranks of participating schools:
    - Chemical Engineering: #10
    - Materials Science and Engineering: #9
    - Mechanical Engineering: #5
    - Chemistry: #24
  - Number 1 graduate industrial engineering program (24th consecutive #1 ranking)

Ranked 9th in Engineering/Technology and Computer Science by Academic Ranking of World Universities, 2013
Georgia Tech’s Mission and Strategy

Georgia Tech mission:

- Technological change is fundamental to the advancement of the human condition.... We will be leaders in improving the human condition in Georgia, the United States, and around the globe.
- To position itself as the defining technological research university of the twenty-first century

Georgia Tech’s strategic plan:

- Research portfolio, guided by industry priorities
- Education of future leaders—and innovation in program offerings
- Impact on the industry—new products, advanced processes

“The RBI is a model for all three elements—research partnership, education, and impact—that we intend to propagate across campus.” —EVPR Steve Cross, Georgia Tech
Georgia Tech Research Strategy

- Create Transformative Opportunities
- Enhance Economic and Societal Impact
- Strengthen Collaborative Partnerships

Discover
- Grand Challenge
- Curiosity

Apply
- Experimentation
- Mature

Deploy
**Contract Continuum:**
*4 Contract Mechanisms Tailored to Meet Industry Needs*

<table>
<thead>
<tr>
<th>Agreement</th>
<th>Description</th>
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| **Basic Research Agreement**  | Explore potential solutions in a broad technical area  
Default IP license is non-exclusive  
Option to negotiate exclusive license IP |
| **Applied Research Agreement** | Identify solutions to targeted problems  
Default IP license is non-exclusive  
Exclusive rights in return for single fee at contract signing |
| **Demonstration Agreement**    | Develop incremental improvements for an existing technology: company or licensed GT IP  
All improvements licensed *without* additional fees |
| **Specialized Testing Agreement** | Access to unique GT technical assets to evaluate new and existing products  
Sole deliverable is test report: no IP rights transfer |

[www.industry.gatech.edu](http://www.industry.gatech.edu)
Welcome to Georgia Tech!
Core Research Areas

- Big Data
- Bioengineering and Bioscience
- Electronics and Nanotechnology
- Energy and Sustainable Infrastructure
- Manufacturing, Trade, and Logistics
- Materials
- National Security
- Renewable Bioproducts
- People and Technology
- Public Service, Leadership, and Policy
- Robotics
- Systems
Interdisciplinary Research Institutes

**BIOENGINEERING AND BIOSCIENCE**
- Parker H. Petit Institute for Bioengineering & Bioscience

**ELECTRONICS AND NANO TECHNOLOGY**
- Institute for Electronics and Nanotechnology

**ENERGY AND SUSTAINABLE INFRASTRUCTURE**
- Strategic Energy Institute
- Brook Byers Institute for Sustainable Systems

**MATERIALS**
- Institute for Materials

**MANUFACTURING, TRADE, & LOGISTICS**
- Georgia Tech Manufacturing Institute

**NATIONAL SECURITY**
- Georgia Tech Research Institute

**RENEWABLE BIOPRODUCTS**
- Renewable Bioproducts Institute

**PEOPLE AND TECHNOLOGY**
- Institute for People and Technology

**ROBOTICS**
- Institute for Robotics and Intelligent Machines
Interdisciplinary Research Institutes

Support & connect those doing basic & applied research across the entire Georgia Tech campus

Blur the lines between academic disciplines through collaboration and interdisciplinary teaming

Make it easier to move research results into real-world use
Introducing RBI

Serving the development of bio-based markets:
- Biochemicals
- Specialty papers
- Food & Bev Packaging
- Biofuels
- Health & Hygiene
- Pharma
- Automotive
- Electronics
- Advanced Materials

Advancing the use of renewable raw materials in existing and new markets

Drawing on the full range of Georgia Tech’s relationships to help promote and capture the opportunities

Investing in core laboratory facilities to align with the expanded research focus

Leveraging a significant endowment to understand the science, build the technology and train future leaders

Promoting an efficient, competitive and profitable bioproducts industry based on forest and agricultural raw materials
Renewable Bioproducts:
A Range of Products and Applications
RBI’s Strategic Thrusts

RBI’s strategic thrusts are supported and enhanced on campus

**Strategic Research**
- Biorefining
- Biochemicals
- Biomaterials

**Education**
- World-class graduate education
- Professional Master’s Program
- Industry connections and networking

**Strategic Support**
- Leadership, Business, Policy, and Sustainability
- Interdisciplinary Research Centers
- Testing Services
Faculty Leadership in Innovation

The faculty members on whom RBI draws are distinguished scientists, who participate as active leaders in important discipline-centric associations and win recognition from their peers and scientific organizations. A few examples include:

More than 30 awards to faculty members in recent years—including a Gunnar Nicholson Gold Medal Winner and a Fulbright Distinguished Chair designation

17 Fellow designations, including Fellow of the American Association for the Advancement of Science

Sixteen patents and 270 refereed publications in last 5 years

And at least 5 appointments to boards, councils, and commissions
Strategic Research – Examples

Examples by Funding Source

• Industry-funded research projects:
  • Hemicellulose addition to improve product performance
  • Nanocellulose production and characterization
  • Reducing fouling of black liquor evaporators
  • Corrosion control from reduced fresh water use
  • Robust membranes for concentration of process liquors
  • Alternative fibers for product and carbon footprint improvement

• Government-funded research projects:
  • Dry pulping of wood for energy & water use reduction
  • Characterization of biomass for biofuels
  • Microbes to convert lignin to lipid to biodiesel

A culture of commercialization with a cross-disciplinary focus
Strategic Research – Additional Research Examples

• Sustainable bioproducts from forest biomass
  • Cross-linked Lignocellulosic Fibers and Cellulose Nanowhiskers to Create Novel Water-Absorbing Materials
  • Characterization and Use of Pollen as a Biorenewable Filler for Polymer Composites

• Biorefining for high-value sustainable biochemicals
  • Thermal Conversion of Biomass and Biomass Components to Biofuels and Biochemicals
  • Direct and Multistep Conversion of Lignin to Biofuels
  • High-Pressure Biomass Pyrolysis in an Entrained-Flow Reactor

• Operational excellence in manufacturing and bioproducts
  • Rheological and Thermal Transport Properties of High Solids Ratio Black Liquor
  • Black Liquor Hemicellulose Recovery and Utilization for Pulp Improvement
  • Designing Superamphiphobic Paper Surfaces
  • Effect of Whitewater Chemistry on Passivation Behavior of 304L Stainless Steel
  • Optimal Resource Balancing and Mill Loading for Energy Cost Reduction
### NEW FY2015 PSE FELLOWSHIP PROJECT AWARDS

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<th>Project Title</th>
<th>PI(s)</th>
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<td>Fiber Orientation in Multiphase Forming Technology</td>
<td>Aidun, Cyrus</td>
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<td>Advanced Froth Flotation for the Separation of Water-soluble and Mildly Hydrophobic Contaminants from Aqueous Pulps and Slurries</td>
<td>Behrens, Sven; Meredith, Carson</td>
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<td>Process Systems Engineering of Novel Mild Chemical Pretreatment Options of Lignocellulosics</td>
<td>Bommarius, Andreas; Realff, Matthew</td>
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<td>Multimode Micro/Nanoscale Imaging to Enable Enhanced Pulp Washing</td>
<td>Fedorov, Andrei</td>
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<td>Bio-Inspired, Ultra-Strong Biopolymer-Based Nanocomposites</td>
<td>Jacob, Karl; Garmestani, Hamid</td>
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<td>Nanocellulose-based Biomimetic Chemocatalysts for Conversion of Furan Compounds to Fuels</td>
<td>Jones, Chris</td>
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<td>High Performance Cellulose Fibers Based on Cellulose Nano Crystals</td>
<td>Kumar, Satish; Moon, Robert</td>
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<td>Strain Field Mining: The Key to Engineering the Strength and Fracture Toughness of Paper and Packaging Products</td>
<td>Muhlstein, Christopher</td>
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<td>High Performance Barrier Coating Packages from Well Designed InkJet Printing Using Cellulose Nanocystal-Polymer Composite</td>
<td>Qi, Jerry; Deng, Yulin</td>
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<td>Protein-assisted Functional Active Packaging for Safety and Security: the Intersection of Cellulosics and Fungal Hydrophobins with Semiconducting Polymers</td>
<td>Russo, Paul; Reichmanis, Elsa</td>
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<td>Rapid, Reliable Optical Analysis of Cellulose Nanocrystal Morphology/Size</td>
<td>Sandhage, Ken; Moon, Robert</td>
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<td>Tensegrity-Inspired Microstructures for Cellulose Nanocrystal Composites in Film and Packaging Applications</td>
<td>Shofner, Meisha</td>
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<td>Mechanocatalytic Depolymerization of Lignin over Kaolin-Based Catalysts</td>
<td>Sievers, Carsten</td>
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<td>Effect of Strain on Repassivation and Corrosion Behavior of Duplex Stainless Steels in Pulp and Paper Mill Environments</td>
<td>Singh, Preet</td>
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RBI Member Companies

FY 2014-15

- AkzoNobel
- AMERICAN PROCESS
- ARAUCO
- Domtar
- Georgia-Pacific
- GRAPHIC PACKAGING CORPORATION
- IMERYS
- INTERNATIONAL PAPER
- KAPSTONE PAPER and PACKAGING CORPORATION
- Kimberly-Clark
- NALCO
- NewPage
- Renmatix
- Sappi
- Solenis
- UPM
- VERSO
RBI Member Benefits

- Insights into future vision and research needs of industry
- Insights into emerging industry opportunities
- Concierge entrée into Georgia Tech
- Conferences and workshops with bioproducts and other industry representatives
- Cross-industry, multidisciplinary networking
- Consortium research opportunities
- Introduction to graduate students and their research
- A cost-effective investment: annual dues of $10,000
Conclusion

• Georgia Tech can be an important collaborator in and contributor to your business success

• RBI membership is an affordable, high-value opportunity for manufacturers and suppliers in the bioproducts industry

• We look forward to welcoming you to membership