Beyond the Boundaries:
Opportunities in Forest Bioproducts

Welcome

2014 Members Meeting
March 13-14, 2014
Paper Tricentennial Building
Atlanta, Georgia
Welcome

Safety:
  Emergency exits

Comfort:
  Restrooms

Access:
  Internet wireless access available
  Username/Password distributed at registration

Parking:
  Park in the safe zone “big lot” (not in front)
IPST Member Companies
FY 2014

AkzoNobel
ARAUCO
ASHLAND
Domtar
GRAPHIC PACKAGING CORPORATION
IMERYS
INTERNATIONAL PAPER
KAPSTONE
Kemira
Kimberly-Clark
MWV
NALCO
NewPage
Renmatix
sappi
UPM
Weyerhaeuser

Georgia Tech Institute of Paper Science and Technology
Welcome

Affiliated Organizations

Guest Companies
Georgia Tech: Recognized for Excellence


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

Additionally:

- Number 7 public university in the country; 36th among all private & public universities, US News 2014
- Ranked 8th in Engineering/Technology and Computer Science by Academic Ranking of World Universities
TOP SCHOOLS IN ENGINEERING DOCTORATES

Georgia Tech ranks first among the top 25 schools in total doctorate engineering degrees awarded between the years 2004 - 2012

Source: ASEE Connections, Jan’14

<table>
<thead>
<tr>
<th>Rank</th>
<th>School</th>
<th>Doctorate Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Georgia Institute of Technology</td>
<td>2,607</td>
</tr>
<tr>
<td>2</td>
<td>Massachusetts Institute of Technology</td>
<td>2,590</td>
</tr>
<tr>
<td>3</td>
<td>Stanford University</td>
<td>2,312</td>
</tr>
<tr>
<td>4</td>
<td>University of Illinois at Urbana-Champaign</td>
<td>2,301</td>
</tr>
<tr>
<td>5</td>
<td>University of Michigan</td>
<td>2,098</td>
</tr>
<tr>
<td>6</td>
<td>University of California-Berkeley</td>
<td>1,992</td>
</tr>
<tr>
<td>7</td>
<td>Purdue University</td>
<td>1,760</td>
</tr>
<tr>
<td>8</td>
<td>University of Florida</td>
<td>1,678</td>
</tr>
<tr>
<td>9</td>
<td>The University of Texas at Austin</td>
<td>1,644</td>
</tr>
<tr>
<td>10</td>
<td>Texas A&amp;M University</td>
<td>1,588</td>
</tr>
<tr>
<td>11</td>
<td>The Pennsylvania State University</td>
<td>1,506</td>
</tr>
<tr>
<td>12</td>
<td>University of California-Los Angeles</td>
<td>1,290</td>
</tr>
<tr>
<td>13</td>
<td>Virginia Polytechnic Institute and State University</td>
<td>1,277</td>
</tr>
<tr>
<td>14</td>
<td>University of Southern California</td>
<td>1,209</td>
</tr>
<tr>
<td>15</td>
<td>University of Maryland-College Park</td>
<td>1,188</td>
</tr>
<tr>
<td>16</td>
<td>North Carolina State University</td>
<td>1,138</td>
</tr>
<tr>
<td>17</td>
<td>Cornell University</td>
<td>1,131</td>
</tr>
<tr>
<td>18</td>
<td>The Ohio State University</td>
<td>1,110</td>
</tr>
<tr>
<td>19</td>
<td>University of Minnesota - Twin Cities</td>
<td>1,107</td>
</tr>
<tr>
<td>20</td>
<td>University of California-San Diego</td>
<td>1,047</td>
</tr>
<tr>
<td>21</td>
<td>University of California-Santa Cruz</td>
<td>1,039</td>
</tr>
<tr>
<td>22</td>
<td>University of Wisconsin-Madison</td>
<td>1,013</td>
</tr>
<tr>
<td>23</td>
<td>Northwestern University</td>
<td>990</td>
</tr>
<tr>
<td>24</td>
<td>Arizona State University</td>
<td>950</td>
</tr>
<tr>
<td>25</td>
<td>University of Washington</td>
<td>950</td>
</tr>
</tbody>
</table>
Strategic Thrusts

Strategic Research
- Operational Excellence
- Biomaterials
- Biorefining

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

Strategic Support
- Leadership, Business, Policy, and Sustainability
- Interdisciplinary Research Centers
- Testing Services
IPST -- 10th-Year Review
Team, recommendations

- IPST undertook a Tenth-Year Review in August, 2013, pursuant to merger agreements with Georgia Tech
- The IPC Foundation “concluded, without reservation, that IPST is performing satisfactorily in the industry environment in which it is working.”
- Reaffirmed the IPST strategy
- Recommended actions to deepen industry engagement and increase research investment at Georgia Tech
IPST Overview: Balanced Scorecard

FINANCIAL:

- Forest Bioproducts Research at GT (FY13 $8.1 mm)
- Ratio of External to Internal Funds (FY13 4.3)
- Industry-Sponsored Research at GT (FY13 $0.986mm)
- Gifts & Endowment Addition (FY13 $91k)
  - Includes estate gift of $40k in FY13 (note: FY12 $1.55mm)
- DS&S Lab Testing (FY13 $0.52mm)

Key indicators are moving in a positive direction
Examples by Funding Source

- **Industry-funded research projects:**
  - Hemicellulose addition to improve product performance
  - Reducing fouling of black liquor evaporators
  - Corrosion impact from reducing water use
  - 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**
IPST Overview: Balanced Scorecard

IPST collaborates closely with the forest products industry’s Agenda 2020 Technology Alliance – and recently proposed five consortium research opportunities in its five priority areas.

Two are at launch stage now:
• Corrosion Control in Paper Machines Using Reduced Fresh Water
• Robust Membranes for Concentration of Black Liquor

Participants in 2014 consortia: Domtar, International Paper, KapStone, MWV, Verso

Plan for FY14: Submit proposals by June
Sponsored Research by Strategic Area

Forest Biomaterials Sponsored research (five-year totals):
Corporate and Federal research spend: $23 MM
Forest biomaterials research total spend: $39 MM
Total: $51 MM

Research Spend from 2007 to 2011:
Total research spend increased 34%
Biorefining Increased 317%
New materials increased 139%

IPST Vision: To be premier research institute for the cost-competitive transformation of forest biomaterials into value-added products, including traditional and new forest products, renewable energy, chemicals, advanced materials and pharmaceuticals.
Creating the Future: IPST Research Is Evolving

- In FY2011-FY2014 a total of forty-two PSE Fellowships were awarded academic faculty through a competitive research proposal process.

<table>
<thead>
<tr>
<th>ChBE</th>
<th>MSE</th>
<th>Chem, CEE, ME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agrawal</td>
<td>Griffin</td>
<td>Aidun (ME)</td>
</tr>
<tr>
<td>Behrens</td>
<td>Kumar</td>
<td>Fedorov (ME)</td>
</tr>
<tr>
<td>Breedveld</td>
<td>Shofner</td>
<td>Jiao (ME)</td>
</tr>
<tr>
<td>Deng</td>
<td>Singh</td>
<td>Pavlostathis (CEE)</td>
</tr>
<tr>
<td>Hess</td>
<td>Srinivasarao</td>
<td>Ragauskas (Chem)</td>
</tr>
<tr>
<td>Hsieh</td>
<td>Wang, Y.</td>
<td>Rosen (ME)</td>
</tr>
<tr>
<td>Meredith</td>
<td>Yao</td>
<td></td>
</tr>
<tr>
<td>Nair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walton</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pie chart showing the distribution of PSE Fellowships awarded from 2011 to 2014 by category:
- Operational Excellence
- Biorefining
- Biomaterials

Bar chart showing the number of PSE Fellowships awarded by year:
- 2011: 7
- 2012: 8
- 2013: 10
- 2014: 9

Note: The chart is sourced from Georgia Tech Institute of Paper Science and Technology.
IPST Overview: Balanced Scorecard

FACULTY SUPPORT

- Faculty Engaged: total 47, including 11 research faculty and 36 academic faculty
- Equipment and Travel Awards (FY13 $185k)
- Four schools in two colleges confer degrees; also engage Civil & Environmental Engineering
- Tricentennial Building use promotes networking and collaboration:
  - 62% occupied by academic faculty from 5 schools (includes 90 labs, 75 fume hoods, 95 offices);
The faculty members on whom IPST draws are distinguished scientists, who participate as active leaders in important discipline-centric associations and win recognition from their peers and scientific organizations. Just a few examples:

- More than 30 awards to faculty members in recent years, one a Gunnar Nicholson Gold Medal winner and Fulbright Distinguished Chair designee
- 17 Fellow designations, including Fellow of the American Association for the Advancement of Science
- Sixteen patents and 270 refereed publications
- And at least 5 appointments to boards, councils, and commissions
IPST Overview: Balanced Scorecard

ECONOMIC & SOCIAL IMPACT

• Member Companies (FY14 -- 18)
• Futures Workshop in 2013 – 40 participants
• Intellectual Property: 10 licenses, 16 patents (2009-2013)
• 100 international collaborations with 13 countries
• Museum of Papermaking
  • International and local outreach & education
IPST Overview: Balanced Scorecard

ECONOMIC & SOCIAL IMPACT

• Paper Science & Engineering degrees: 51 conferred in five years FY 09-13 (36 PhD, 15 MS)
• 50 PSE Major/Minor enrolled MS/PhD students enrolled today
IPST Assets

• Experienced research and academic faculty familiar with industry challenges
• Strong research faculty dedicated to industry-focused research and testing services
• Talented graduate student researchers
• Integration within the capabilities of Georgia Tech – access; exposure; opportunity
• Federal and State research grants that can be leveraged by IPST members
• State budget support of IPST operations
• 18 member companies
• Opportunities for consortium research on innovative, breakthrough challenges
Welcome – Conference Overview

Four Segments:

• Pushing the Boundaries for New Materials from Lignocellulosics—cutting-edge research
• Advancing Tomorrow’s Operations—current research and opportunities
• Developing Tomorrow’s Leaders—student perspectives on the industry; developments in IPST graduate education
• IPST Research in Action—a showcase of IPST fellowship research
Welcome – Conference Overview

Contributors:
• EVP-Research Steve Cross
• Three Interdisciplinary Research Institutes (IPST, IMat, SEI)
• Faculty:
  • Two School Chairs
  • Faculty assignments: 3 from ChBE, 5 from MSE, 2 from ME
  • GT Professional Education, Aerospace Engineering
  • GTRC Office of Industry Engagement
• Eleven Students

A Conference—not a symposium!
• Interactive; two-way communication
Welcome – Executive Conference Agenda

Beyond the Boundaries:
Opportunities in Forest Bioproducts
March 13-14, 2014
Paper Tricentennial Building, Atlanta, GA

IPST 2014 EXECUTIVE CONFERENCE AGENDA AT A GLANCE

Thursday, March 13

7:30  Continental Breakfast

8:00  Welcome – Executive Conference Agenda

8:30  Dr. Norman Marzetta – Welcome and introduction to the conference

9:00  Dr. David McDowell, Executive Director – Materials Institute

9:30  Dr. David Skroll, Chair – School of Chemical and Biomolecular Engineering

10:00 Dr. Robert Moon and Dr. Norman Marzetta

10:15-10:30  Break

10:30  Dr. Sethukumar, Professor of Materials Science and Engineering

11:00  Dr. Yanan Dong, Professor of Chemical and Biomolecular Engineering

11:30  Dr. Paul Ruste, Professor and Lightbloom Chair in Biopolymers

11:45  Dr. Jerry Qi, Associate Professor of Mechanical Engineering


12:00  Lunch

1:00  Discussion: Building a Stronger Forest Bioproducts Industry [K. Bennett – Moderator]

Advancing Tomorrow’s Operations

2:00  Innovation Meets Commercialization in Manufacturing (INNOMR) – Dan McConnell, Executive Director, Industry Collaboration & Commercialization

2:20  Consortium Projects: FY 2014 Update and FY 2015 Opportunities

3:00-3:15  Break

Developing Tomorrow’s Leaders

3:15  Dr. Lee Mark, Professor and CIFL Associate Dean for Academic Programs

3:45  Panel Discussion – Dr. Lester Li, Research Project Leader, SAFFI (Moderator)

4:30  Dr. Steve Green, Executive Vice President Research, Georgia Tech Industry/Georgia Tech Partnerships

Evening

5:00-6:00  Reception and Museum Exhibition

6:00-9:00  Dinner [IPST Members’ Lounge]

Friday, March 14

7:30  Continental Breakfast

8:00  Kickoff

8:15  Dr. Tan Lawrenz, Professor and Executive Director, Strategic Energy Institute

9:45-11:00  IPST Research in Action: PSE Fellowship Research Showcase

11:00  Lunch

12:00  Lunch will be available – Optional

(Significant leaders)

21
Welcome – Executive Conference Agenda

Beyond the Boundaries: Opportunities in Forest Bioproducts

Thursday, March 13

Pushing the Boundaries for New Materials from Lignocellulose:
Materials Science Capabilities at Georgia Tech;
Opportunities for Forest Bioproducts

8:30  Dr. Naresh Thadhani, Chair – School of Materials Science and Engineering
Forest Bioproducts Opportunities at Georgia Tech

9:00  Dr. David McDowell, Executive Director – Materials Institute
The Materials Genome Initiative

9:30  Dr. David Sholl, Chair – School of Chemical and Biomolecular Engineering
Generating New Ideas and Products

10:00  Dr. Robert Moon
Georgia Tech’s Nanocellulose Resources and Capabilities

10:15-10:30  Break

(See handout for complete agenda)
## Welcome – Executive Conference Agenda

### Beyond the Boundaries: Opportunities in Forest Bioproducts

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30</td>
<td>Dr. Satish Kumar, Professor of Materials Science and Engineering</td>
<td>Carbon Fibers and Lignocellulosics</td>
</tr>
<tr>
<td>11:00</td>
<td>Dr. Yulin Deng, Professor of Chemical and Biomolecular Engineering</td>
<td>Solar-Induced Hybrid Fuel Cell Production of Electricity Directly from Biomass</td>
</tr>
<tr>
<td>11:20</td>
<td>Dr. Paul Russo, Professor and Hightower Chair in Biopolymers</td>
<td>Biopolymers from Cellulose-Derived Materials</td>
</tr>
<tr>
<td>11:35</td>
<td>Dr. Jerry Qi, Associate Professor of Mechanical Engineering</td>
<td>3D Printing with Biopolymers: Packaging Concepts</td>
</tr>
<tr>
<td>11:50</td>
<td>Paul Durocher, Director of Research, SAPPI N.A., and Co-Lead, Agenda 2020 Cellulosic Nanomaterials Team</td>
<td>The Industry’s Cellulosic Nanomaterials Research Priorities</td>
</tr>
<tr>
<td>12:00</td>
<td>Lunch</td>
<td></td>
</tr>
</tbody>
</table>

*(See handout for complete agenda)*
Welcome – Executive Conference Agenda

**Beyond the Boundaries:**  
*Opportunities in Forest Bioproducts*

1:00  Discussion:  Building a Stronger Forest Bioproducts Industry  
(K. Bennett – Moderator)

---

**Advancing Tomorrow's Operations**

2:00  Innovation Meets Commercialization in Manufacturing (NNMI)  
Don McConnell, Executive Director, Industry Collaboration & Commercialization

2:20  Consortium Projects:  FY 2014 Update and FY 2015 Opportunities  
Dr. Preet Singh on Water Reuse Impact  
Dr. M. Shofner and Dr. S. Sinquefield on Energy Reduction in Black Liquor Concentration

3:00-3:15  Break

(See handout for complete agenda)
Welcome – Executive Conference Agenda

Beyond the Boundaries:
Opportunities in Forest Bioproducts

Developing Tomorrow’s Leaders

3:15  Dr. Leo Mark, Professor and GTPE Associate Dean for Academic Programs
      Professional Master’s In Manufacturing Leadership: Forest Bioproducts

3:45  Panel Discussion - Dr. Lester Li, Research Project Leader, SAPPI (Moderator)
      PhD Georgia Tech, 2013, Chemical and Biomolecular Engineering
      Student Perspectives on the IPST Experience and the Forest Bioproducts Industry:

      Timi Fadiran (C Meredith), ChBE
      Gyungwon Kim (M Brown), Public Policy
      Sarah McNew (C Sievers), ChBE
      Caitlin Meree (M Shofner), MSE
      Qining Sun (A Ragauskas), Chemistry

4:30  Dr. Steve Cross, Executive Vice President-Research, Georgia Tech
      Industry/Georgia Tech Partnerships

(See handout for complete agenda)
Welcome – Executive Conference Agenda

Beyond the Boundaries: Opportunities in Forest Bioproducts

**Evening**

5:00-6:00  Reception and Museum Exhibition
           Mapping Place:  Africa Beyond Paper

6:00  Dinner (IPST Members’ Lounge)
      Recognition:  Dr. G. Ronald Brown (IPC, 1975)
      Speaker:  Dr. Martin Maldovan:  Treating Heat like Light

(See handout for complete agenda)
Introduction to Session I: Pushing the Boundaries for New Materials from Lignocellulosics

Session Overview

• The power of Georgia Tech engagement in lignocellulosic materials research – capabilities and connections
• Some specific examples of research exploring the boundaries of lignocellulosic applications
• A brief recap of Agenda 2020’s cellulosic nanomaterials perspective on nanocellulose research priorities--a segment of lignocellulosic research

Welcome—let’s get started