GEORGIA INSTITUTE OF TECHNOLOGY

• 944 faculty; 23,100 undergrad/grad students

• USN&WR - No. 7 public; Top 10 in Res. Exp.

• Business Insider – Smartest public school; Payscale – 1st in Return on Investment

COLLEGE OF ENGINEERING - #4UG, #6G

• Largest & most diverse engineering college
  (430 Faculty; 9,250 UG; 4,090 G students)

• All graduate & undergrad programs in top 10 rank by U.S. News & World Report

• No. 1 in B.S. Eng. degrees to women
  No. 2 in Engineering B.S. degrees overall to all minorities & No. 4 to African-Americans
  No. 1 in Eng. Ph.D. degrees awarded overall to all minorities, African Amer., Hispanics

• 30% of CoE students are women, with BME, ChBE, EnvE, MSE programs at ~40%

• 18 Regents’ Professors; 110 Named Chairs;
  20 GRA scholars; 25 NAE members;
  >160 recipients of NSF CAREER Awards
1897 – President Lyman Hall founded the A. French School of Textile Engineering – 3rd School to open at GT

1924 - Advent of kaolin industry - School of Ceramic Engineering formed with B.S. degree program

1959 - Metallurgy Program established in Chemical Engg.

1985 - School of Materials Science & Engineering formed from merger of Ceramics and Metallurgy

2003 - Textile Engineering School renamed School of Polymer, Textile and Fiber Engineering (PTFE)

2010 – Complete integration of all materials by merger of PTFE with Ceramics & Metallurgy into the largest and most diverse MSE program in the nation.
### School of Materials Science & Engineering – The Present

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSE Faculty</td>
<td>32.4 FTEs, 32 majority, 37 headcount</td>
</tr>
<tr>
<td>Research Active Faculty</td>
<td>61 (16 Courtesy, 8 Emeritus)</td>
</tr>
<tr>
<td>Chaired and Regents Profs</td>
<td>8 Chaired and 5 Regents’ Professors</td>
</tr>
<tr>
<td>Professional Society Fellows</td>
<td>19 (9 of more than two, 34 Fellowships)</td>
</tr>
<tr>
<td>NSF CAREER Awardees</td>
<td>12</td>
</tr>
<tr>
<td>National Academy Members</td>
<td>2 NAE-US; 1 NAE-China; 1 NAS-China</td>
</tr>
<tr>
<td>Total Publications &amp; Patents</td>
<td>357 Pubs; 12 Patents; 46 Inv Disclosure</td>
</tr>
<tr>
<td>Research Expenditures</td>
<td>$12.6M (~$400K/ majority faculty)</td>
</tr>
<tr>
<td>Undergrad Program</td>
<td>375 (61% Male / 39% Female)</td>
</tr>
<tr>
<td></td>
<td>100% Research/Co-op/Internship</td>
</tr>
<tr>
<td></td>
<td>USN&amp;WR Ranking – 8th</td>
</tr>
<tr>
<td>Graduate Program</td>
<td>184 MSE (81% M/19% F) + 20 non-MSE</td>
</tr>
<tr>
<td></td>
<td>10% pursuing internships</td>
</tr>
<tr>
<td></td>
<td>USN&amp;WR Ranking - 6th</td>
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</tbody>
</table>
MSE Strategic Plan

Vision
MSE at Georgia Tech will define the materials science and engineering program of the 21st century and be recognized globally as the preeminent leader in materials education, innovation, and research.

Mission
To create leaders through education, innovation in materials research, and service to society.
Materials Science & Engineering (MSE) – Academics

**UG - B.S. Degree:** 132 hours
- 21 hours in concentration & 6 hours of capstone design
- **Conc:** Bio-Materials, Polymer & Fiber Materials, Structural and Functional Materials
- **Options:** Co-op, Research, Study-abroad, Business

**GRAD – M.S. & Ph.D.**
- **Course-work, qualifier, dissertation defense**

**Materials Certificate Programs**

---

**UG - B.S. Degree:**
132 hours

- 21 hours in concentration & 6 hours of capstone design
- **Conc:** Bio-Materials, Polymer & Fiber Materials, Structural and Functional Materials
- **Options:** Co-op, Research, Study-abroad, Business

**GRAD – M.S. & Ph.D.**
- **Course-work, qualifier, dissertation defense**
With synthesis, processing, computations, modeling, characterization, and measurements as our tools, we work on all materials forms including metals, ceramics, polymers, textiles, fibers, composites, nanostructures, & biomolecular solids.

We study material response under various environments, to design and develop next generation materials systems for structural, electronic, optoelectronic, photonic, bio-enabled, & energy storage/harvesting applications.

Research in MSE @ GT is aimed at envisioning, predicting, designing, and developing materials for meeting national and societal Grand Challenges related to Environment, Energy, Health & Human Welfare, Infrastructure, Security, and Transportation.
The World of Materials Research in MSE @ GT

Controlling Light

Communications

Security

Energy

Health & Human Welfare

Infrastructure

Mimicking Nature

Transportation

Environment

Goldfish

Carassius auratus

Lotus-Effect surface

smooth surface
Bio-enabled and Bio-inspired Materials

Vladimir Tsukruk

Valeria Milam

Gold Seed

Thymine-rich ssDNA Sequence

Pure Thymine ssDNA Sequence

Mohan Srinivasarao

John Reynolds

Bio colloidal particles functionalized with various oligonucleotides serve as building blocks for biomaterials and as platforms for biosensing applications.
Materials For Health & Human Welfare

Paul Russo  
Therapeutic drug delivery

Dong Qin  
Bio-compatible Nano-platforms

Sundaresan Jayaraman  
Smart Multi-Functional Textiles

Suman Das  
Computational Design and Digital Manufacturing of Anatomically Shaped Microarchitectured Scaffolds

Karl Jacob
Ten years of Innovations in Nanogenerators

Zhong Li Wang

Piezotronics

2D Material Piezotronics (2014)
Smart Skin (2014)
Human-Machine Interface (2013)
Piezo-phototronic LED (2011)
Piezotronics (2006)
Nanowires LED (2009)
Nanowires Assembly (2001)
Piezoelectric Nanogenerator (2006)
Harvesting Human Energy (2010)
Triboelectric Nanogenerator (2012)
Self-Charging Power Cell (2012)
Self-Powered Nanodevice (2010)
Hybrid Cell (2009)
In-vivo Nanogenerator (2010)

Semiconductor

Active electronics (2013)
Powering Electronics (2014)

Optoelectronics

Photoexcitation

Piezophotonics
Energy Storage Devices and Sensors

Mark Losego

Rosario Gerhardt

Faisal Alamgir

Eric Vogel

Interfacial Thermal Conductance (MW/m²K)

Low pH

High pH

SiO\(_2\) (BOX)

Si

Si (active)

Metal (Au)

Nitride

Electrolyte at VEL

Low pH

High pH

Small Precipitates

Larger Precipitates

Correlation peak from small γ'

Debye region from larger γ'

Porod regions from micron-sized objects

Q\(^{-4}\)

Q\(^{-n}\)
Electronic Packaging & Communications

Wenshan Cai

Chris Summers

C.P. Wong

Rao Tummala

Lotus Effect - Hydrophobicity

Stretchable RF antenna

Lotus-Effected surface

smooth surface
Infrastructure and Transportation

Tensegrity-Inspired Structures

In situ Composite Synthesis

Processing Strategies

Polymer Nanocomposites

Stress Corrosion Cracking of Pipelines

Development of Non-Equilibrium Morphologies of \( \gamma' \), Low Misfit Alloy

(a) 10 min at 1090 C,
(b) 15 min at 1095 C,
(c) 30 min at 1095 C
(d) and 30 min at 1100 C
Multiscale modeling approaches can be used to inform models at high scales with data generated using sub-models simulated at finer scales. 

- **Nanoscale** (~1-100nm) 
  - Molecular Dynamics 
  - Dislocation dynamics using Coarse Grained MD 
  - Crystal Plasticity 

- **Mesoscale** (~100 nm - <1nm) 
  - Dislocation dynamics using Coarse Grained MD 
  - Crystal Plasticity 

- ** Macroscale** (>1mm) 
  - Empirical Models (e.g., Paris law) 
  - Microstructure-sensitive plasticity macro models 
  - Informed 

Funding from NSF, DOE NEUP, ONR, NAVAIR, QuoTek
In-situ Characterization & Measurements

Mathew McDowell

In situ TEM of electrochemical reactions:

Device Scale

Mesoscale

Nanoscale
Protection and Security

Robert Speyer
Boron carbide modular helmet armor
Boron carbide flexible armor

Joe Cochran
Maraging Steel
4 x 4 Square Cell
2 x 6 Square Cell
Triangular Core Panel
Energetic Munitions Exoskeleton
Layered Extrusion Fuel Cell
Super Invar

Naresh Thadhani
Copper Ni Alloy
Inconel/YSZ

School of Materials Science and Engineering
STUDENT LED OUTREACH ACTIVITIES

- Graduate (GSAG) and Undergraduate Student Advisory Group (USAG) – provide feedback, serve as ambassadors, and assist with recruitment
- Materials Umbrella Society (Materials Advantage, Psi-Phi, MRS) - Georgia High School Outreach for Science and Technology (GHOST) in area inner-city schools; Materials Camp; Industry Tours; Professional Development Workshops; Women Students’ Lunch.
Materials Genome Initiative

The Materials Innovation Ecosystem

- Entrepreneurial Support: Startups, Spin-offs
- Multiscale Modeling
  - process-structure
  - structure-property
- Process models for manufacturing and scale-up
- Sensors and in situ measurements, automation
- Designer materials knowledge systems and representation
- High Throughput
  - Computational Tools
  - Experimental Tools
  - Digital Data
- Materials characterization and microstructure representation
- Materials discovery - first principles and atomistics
- Systems design and MDO
  - Design exploration
  - Detail design
- Databases, data sciences and material informatics
- Synthesis and processing

Discovery

1. Development
2. Property Optimization
3. Systems Design and Integration
4. Certification
5. Manufacturing
6. Deployment*

* Includes Sustainment and Recovery
Ben Wang, Executive Director, GTMI
Chief Manufacturing Officer, GaTech
Norman Marsolan,
Director, RBI

Bio-refining: leveraging leadership in cellulose and lignin chemistry

Biomaterials: leveraging materials expertise for new products

Advancing the Horizons of the Forest Bio-economy

Sustainable Chemicals
Communications
Sustainable Energy
Advanced Packaging
Health and Hygiene
Food & Beverage
Pharmaceuticals
Electronics

Bio-refining: leveraging leadership in cellulose and lignin chemistry

Biomaterials: leveraging materials expertise for new products
<table>
<thead>
<tr>
<th>Basic Research</th>
<th>Applied Research</th>
<th>Demonstration</th>
<th>Specialized Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explore fundamental challenges in a technical area</td>
<td>Identify solutions to real-world</td>
<td>Improve an existing technology</td>
<td>Test new and existing products</td>
</tr>
<tr>
<td></td>
<td>challenges</td>
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<td></td>
</tr>
</tbody>
</table>

As one of the nation’s top research universities, Georgia Tech is committed to conducting basic research that advances our fundamental understanding of the world. This form of research is typically driven by scientific questions that lay the foundation for technological progress.

When Georgia Tech collaborates with industry via a Basic Research agreement, the industry partner has the opportunity to license the resulting intellectual property (IP). These early collaborations are often the foundation for new products that spur business growth for a company.

The Applied Research agreement enables Georgia Tech researchers to help industry partners explore the viability of a technology and overcome practical challenges.

Under an Applied Research agreement, the company pays a defined fee to gain access to IP that is generated during the project. The company obtains rights for exclusive access to the IP for a specified period of time within a defined field of use. This enables industry partners to develop and launch a product with very low risk, gaining a first-mover advantage. After the exclusivity period is over, the company can 1) extend the exclusive rights or 2) convert to a non-exclusive license.

For industry partners working on product development, the Demonstration agreement enables Georgia Tech researchers to help a company improve existing technology.

The Demonstration agreement offers a straightforward and advantageous intellectual property policy for industry partners. Simply put, when a company introduces background IP under a Demonstration project, the company shall have exclusive rights to any improvements at no additional cost. For companies that have licensed a Georgia Tech innovation, any improvements to the licensed IP shall be incorporated into the terms and conditions of the original licensing agreement.

Georgia Tech offers expertise and state-of-the-art equipment that can be leveraged in the final stages of development to test products and help a company ensure that they are market-ready. The Specialized Testing agreement provides a cost-effective and secure way for companies to access this equipment without making a large capital investment. This work is often instrumental in enabling a successful product launch.

The Specialized Testing agreement also offers a straightforward intellectual property policy for industry partners. The sponsoring company will own all test results.

*The Applied Research, Demonstration, and Specialized Testing contracts may not be available for all projects. Work related to Applied Research and Demonstration contracts must be performed in approved facilities on campus.*
We are MSE

A versatile degree with infinite possibilities

Materials Science and Engineering

The degree that opens the door to career possibilities in aerospace, automotive, biomedical, defense, electronics, energy, manufacturing, and virtually all industries.

It also prepares you to become an entrepreneur, innovator, consulting engineer, or research scientist.

MSE – envisioning, predicting, designing, and developing materials to overcome the societal challenges of today and tomorrow.

www.mse.gatech.edu
Thank You for visiting