

# **Georgia Tech Library Collection Development Policy (Draft)**

## **School of Chemical and Biomolecular Engineering 2004**

### **Collection Development Objectives**

The Library & Information Center at Georgia Institute of Technology supports faculty and student research and the curriculum through doctoral degree level in the discipline of Chemical and Biomolecular Engineering; it also supports research projects and programs conducted on behalf of faculty researchers, research engineers, and research scientists in the School's various laboratories and research centers.

### **School Profile -- Overview**

The School of Chemical and Biomolecular Engineering is one of nine schools in the College of Engineering. The school has 37 primary faculty members, including 6 Assistant Professors, 9 Associate Professors, 19 Professors, and 3 Regents' Professors. There are 3 program faculty members associated with the School, including 2 faculty members from GA Tech School of Biomedical Engineering, and one from GA Tech School of Electrical & Computer Engineering. In addition there are 4 Adjunct Faculty and 7 Emeritus Professors.

### School Chair

Ronald W. Rousseau

The Cecil J. "Pete" Silas Chair & Professor

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### Group Email Address

None

### School Web Site

<http://www.che.gatech.edu/>

### Library Committee or Chair

None

### Professional Accreditation

The School is accredited by the Accreditation Board for Engineering and Technology (ABET).

## School Profile – Curriculum

### Enrollment

Enrollment	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Undergraduate	825	764	691	690	662	591	526	472	444	n/a
Graduate	117	110	109	100	106	123	123	132	152	n/a

Data from the Georgia Institute of Technology [2003 Fact Book](#), tables 4.17, 4.18.

### Degrees offered

Bachelor Degree -- B.S.	Master Degree - - M.S.	Five-Year B.S.- M.S. Program	Doctoral Degree -- Ph.D.	Undergraduate Certificates
Chemical Engineering	Chemical Engineering	Chemical Engineering	Chemical Engineering	Composites Undergraduate Certificate
	Bioengineering (Multidisciplinary Program)		Bioengineering (Multidisciplinary Program)	Multidisciplinary Undergraduate Certificate Programs in Polymer Engineering and Polymers
	Paper Science and Engineering (Multidisciplinary Program)		Paper Science and Engineering (Multidisciplinary Program)	Multidisciplinary Undergraduate Certificate Programs in Pulp and Paper
	Polymers (Multidisciplinary Program)			

### Undergraduate Program Educational Objectives:

- Educate and train students in the principles and methods essential to modern chemical engineering;
- Broaden perspectives of students regarding social issues and responsibilities, ethics, and professionalism;
- Graduate students recognized for excellence and selected for high-quality industrial, academic, and government positions;
- Conduct research and contribute to a literature supportive of the needs of chemical engineering; and
- Encourage and facilitate the growth of professionalism through continuing education.

### Degrees Awarded

Bachelor's Degrees	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Chemical Engineering	137	164	148	129	142	143	126	133	110	n/a

<b>Master's Degrees</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
Bioengineering	1	0	0	1	2	4	2	4	8	n/a
Chemical Engineering	11	18	14	13	9	7	13	4	14	n/a
Polymers	5	12	9	4	12	1	3	-	2	n/a
Total	17	30	23	18	23	12	18	8	24	n/a

<b>Ph.D. Degrees</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
Bioengineering	-	-	-	2	1	1	1	5	3	n/a
Chemical Engineering	4	18	13	15	17	11	18	17	8	n/a
Total	4	18	13	17	18	12	19	22	11	n/a

Data from the Georgia Institute of Technology [2003 Fact Book](#), tables 5.6, 5.7, 5.8.

### General Education Course Responsibility

None

### **School Profile -- Research**

#### Major Faculty Research Interests

**Biomedical Engineering** -use of engineering methods and technology to solve problems in medical research and clinical healthcare.

Some current studies include:

- **Biomaterials:** surfaces for enhanced cell function; block co-polypeptide hydrogels; plasma-assisted film formation.
- **Bioreactors:** large-scale production of engineered tissues for human implantation.
- **Combinatorial Synthesis:** polymeric tissue engineering materials.
- **Drug Delivery:** intracellular and transdermal delivery of drug and genes.
- **Hemodynamics:** effects on vascular endothelial biology.
- **High-Throughput Screening:** development of cell-surface assays.
- **Mathematical Modeling:** processes at the cellular, tissue and physiologic levels.
- **Microfabrication:** lithographic methods for tissue scaffold fabrication; microneedles for drug delivery.
- **Sickle Cell Anemia:** mechanisms of sickle red blood cell adherence to endothelium.
- **Tissue Engineering:** blood vessel substitutes; bioartificial pancreas; novel tissue scaffolds.
- **Ultrasound:** effects on transmembrane transport and cellular processes.

**Bioprocessing** - use of biological sources to solve engineering challenges via bioreactor design, biocatalysis, and bioseparations.

Some current studies include:

- Improving an enzyme template by directed evolution
- Pasting novel function on protein templates
- Protein biocatalyst stability in salt solutions
- Tunable Solvent Systems for Bioprocessing
- Recycle of Homogeneous Catalysts for Asymmetric Synthesis
- High Value-Added Chemicals from Renewable Resources
- Separation of chemotherapeutic agents from natural products using supercritical fluids

- Separation and purification of pharmaceuticals via crystallization
- Large-scale animal cell culture
- Animal cell bioreactors
- Genetic engineering for biomedical and bioprocessing applications
- Bioreactors and bioprocessing technologies for tissue engineering
- Mathematical modeling at the cell, population, and tissue levels

**Catalysis, Reaction Kinetics and Engineering** -methods for designing catalysts, reactors or reaction processes; kinetics and mechanism of reactive processes.

Some current studies include:

- Kinetics and mechanisms of reactions in solution
- Reactions and Catalysis in Supercritical Fluids
- Reactions and Catalysis in Gas-Expanded Liquids
- Phase Transfer Catalysis
- Tunable Fluids for Asymmetric Catalysis
- Dispersed-phase polymerization
- Homogeneous catalyst immobilization
- Ziegler-natta and metallocene-mediated olefin polymerization
- Rational design of silica-based catalysts
- Catalysis and biocatalysis for pharmaceutical and fine chemical production
- Deactivation mechanisms of protein-based catalysts
- Mixing in chemical reactors
- Engineering metal-mediated catalytic reactions in the presence of sulfur
- Catalysis and reaction engineering for clean-up of paper-making waste
- Ionic liquids as solvents and catalysts
- Strong, base catalysts derived from layered double hydroxides

**Complex Fluids and Multiphase Flow** -investigating the structure, rheology and flow of complex fluids such as colloidal suspensions, emulsions, hydrogels and polymer solutions. Application areas of special interest include bioengineering, microelectronics, paper manufacturing and coating and reactive mixing.

Some current studies include:

- Bioreactor hydrodynamics, mass transport, design and scale-up
- Experimental and theoretical investigations of blood cell adhesion and blood rheology.
- Structure and rheology of block copolypeptide hydrogels
- Molecular models & simulation of nanoparticle self-assembly
- Reactions in and viscoelastic properties of stereolithography polymer resins
- Effects of organic modifiers on nanoparticle surfaces
- Characterization of solid-filled polymers for microelectronics
- Modeling and development of advanced microfluidic devices
- Fluid flow through microchannels
- High-throughput microrheology
- Thermal conductivity of nanofluids containing dispersed nanoparticles and nanotubes
- Mixing in multiphase systems
- CFD analysis of bioreactors
- Emulsion and suspension stability
- Liquid membranes

**Electrochemical Engineering** -fuel cells, battery development, solar cells, electrodeposition, and membranes for inorganic and bioseparations.

Some current studies include:

- Direct methanol fuel cells
- Micro proton exchange membrane fuel cells
- Electrodeposition of copper and other metals for microelectronics
- Effect of aqueous electrolytes on VOC partitioning
- Novel ionic liquids
- Sodium and lithium-metal chloride batteries
- Selective electrochemical etching and micromachining of semiconductors
- Electrochemical membranes for SO<sub>2</sub> and H<sub>2</sub>S removal or elimination
- Novel solid oxide fuel cells

**Environmental Engineering and Sustainable Development** -applications of the principles of Chemical & Biomolecular Engineering to achieving sustainable systems and processes for the future. This means the development of techniques which are not only environmentally beneficial, but also are economically advantageous to promote broad implementation.

Some current studies include:

- Environmentally benign approaches to surface cleaning and modification in microelectronic device processing using super- and sub-critical fluids and gas-expanded liquids
- Tunable solvent systems for bioprocessing
- Nearcritical water for benign processes
- Tunable solvents for homogeneous catalyst recovery
- Benign solvents for green processes
- Solvent replacement opportunities by miniemulsion polymerization
- Sludge dewatering and wastewater treatment
- Reducing VOC emissions from building products manufacturing
- Kraft paper mill odor reduction
- Effect of electrolytes and polymers on VOC emissions
- Behavior of dilute solutions
- Reverse production systems
- Biorefinery systems
- Green polymerization - biodegradable polymers and use of waste gas as monomers
- Sensors for continuous monitoring of technetium in aquifers
- Building surface decontamination from radiological and biological weapons
- Efficient strategies for products from fuel cycle wastes
- Improved methods for UV processing of fruit juices
- Application of cavitation and UV for the disinfection of liquids
- Chemistry-aerosol-climate interactions within the NASA-GISS Global Model.
- Effects of organic species on cloud droplet formation
- Resource conservation by mitigation of surface fouling by inorganic crystalline species
- Greener crystallization while improving product yield and quality

**Microelectronics** -materials and processes used in the fabrication of electronic/optical/microfluidic devices, integrated circuits, and microelectromechanical systems (MEMS)

Some current studies include:

- Properties and performance of ultrathin polymer resists
- Photodefinable sacrificial polymers for microfabrication
- Micropatterning by surface monolayer initiated polymerization
- Photodefinable metal-organic materials
- Area-selective atomic layer deposition
- Deposition of high dielectric constant materials
- Design, fabrication, and characterization of integrated microfluidic devices

- Environmentally benign surface cleaning and modification using elevated pressure fluids
- Plasma processes for film etching, deposition, and polymerization
- Synthesis and characterization of high performance dielectric materials
- Polymeric and inorganic pellicle characterization
- Low temperature, rapid curing processes for polymer dielectrics
- Control strategies for chemical vapor deposition
- Real-time material property estimation using limited sensor data
- Process models for real-time process control
- Novel thermal management schemes for electronic devices
- Chemical mechanical polishing
- Molecular Modeling of Polymers for Microelectronic Applications

**Microfluidics** -microfluidics in general refers to systems which manipulate fluids in microchannels and microdevices ranging from nanometers to hundreds of microns in size. Typical fluid volumes elements that can be manipulated in such systems range in size from microliters to picoliters. One common name used for devices which handle fluids at these size scales is “lab-on-a-chip” devices. Such devices are already finding applications in a variety of areas including microchemical reactors systems, combinatorial materials synthesis and characterization, drug development and screening, genetic diagnostics and testing, and many other emerging areas. Microfluidics research in the School of Chemical & Biomolecular Engineering spans the full range of activities in the field of microfluidics including (1) materials design, synthesis, and selection for device fabrication, (2) development of novel fabrication processes, (3) design and characterization of novel microfluidic systems, (4) use of microfluidic systems as research tools for studying a variety of phenomena in fields ranging from bioengineering to polymer reaction engineering, and (5) integration of microfluidic systems with other microelectronic and microelectromechanical systems (MEMS).

Some current studies include:

- Development of photosensitive thermally sacrificial polymers and processes for microfluidic device fabrication
- Use of novel fabrication techniques to build on-chip, multi-layered, interconnected microchannel networks and devices
- Design, fabrication, and characterization of microfluidic fluid pumping devices
- Design, fabrication, and characterization of microfluidic separation devices
- Integration of microfluidic devices with CMOS integrated circuit (IC) technology
- Development of materials and processes for the fabrication of microfluidic fuel cell systems
- Development of materials and microfluidic devices for active cooling of microelectronic devices
- Use of microfluidic systems for microrheological studies of complex fluids

### **Nanotechnology in Chemical Engineering**

Researchers in this field are engaged in constructing, manipulating and understanding nanoscale and nanostructured materials or devices, which result in novel physical, chemical, or biological phenomena of relevance to new technological applications.

Two major areas are:

- **Nanomaterials for Energy Applications**
  - Formation of hybrid polymer-membrane materials using nanoporous carbon molecular sieving dispersed phases
  - Formation of hybrid polymer-membrane materials using nanoporous inorganic molecular sieving dispersed phases within continuous matrix phases

- Formation of asymmetric hollow fiber polymer-membranes using nanoporous inorganic molecular sieving dispersed phases within non-crosslinked continuous matrix phases
- Transport-model-independent experimental description of transport in nanoporous membranes by optical and thermo-optical spectroscopy
- Nanoporous materials and membranes for sorption heat pumping and refrigeration applications
- Continuous hydrothermal synthesis of inorganic nanoparticles (including battery electrode materials)
- **Nanostructures, Patterning, and Thin Film Deposition**
  - Physiochemical properties and behavior of confined and nanoscale polymer films
  - Development of novel photoresist materials for sub-100 nm electron beam lithography and optical lithography
  - Combined lithography and embossing methods for manufacturing complex nanoscale devices
  - Changes of chemical bonding and chain orientation in polymer films due to chemical mechanical polishing
  - Deposition of high dielectric constant insulators by metalorganic CVD
  - Olefin polymerization catalysts via the nanoscopic design of porous silica to create well-defined immobilized organometallic species on surfaces.
  - Formation and characterization of nanoporous molecular sieving carbon materials
  - Synthesis and characterization of inorganic single-walled nanotubes and fabrication of nanotubular single-molecular sensors
  - Water-based coatings via miniemulsion polymerization

**Polymeric Materials & High-Performance Fibers & Composites** -design, manipulation, and characterization of polymers and polymer composites

Some current studies include:

- Characterization and modeling of the dissolution behavior of polymer thin and thick films
- Photosensitive polymeric materials
- Miniemulsion and microsuspension polymerization
- Low-VOC coatings for architectural and industrial applications
- Repulpable pressure-sensitive adhesives
- Effects of supercritical fluids on polymers
- Supercritical fluid dyeing of polymers
- Catalytic synthesis of polyolefins
- Formation of electrically conducting polymers
- Thermal conductivity of anisotropic polymers
- Crystallization in syndiotactic polypropylene and in random copolymers
- Chemical kinetics and evolution of morphology in sol-gel systems
- Controlled transport through mobility restriction in glassy polymers
- Constant density crosslinking of polymers and polymer blends
- Correlation of free volume and free-volume distribution to bulk properties
- High-throughput characterization of polymer films and coatings

**Process Systems Engineering** -integrated design of products and processes, spanning across length scales from molecular to enterprise-wide.

Some current studies include:

- Computer simulation of synthetic and biological macromolecules
- Computer simulation and learning of directed evolution for biocatalyst design
- Polymerization reactor control
- On-line sensors for polymer processing and microelectronics

- Development of compact process models for molecular scale dynamics
- Forward and reverse supply-chain design and management to minimize environmental impact
- Data assisted modeling and learning control for complex process systems
- Algorithmic framework for multi-stage decision-making in a complex, uncertain system environment
- Modeling, analysis, and control of systems with switches, including simulated moving bed systems, micro-channel reactors, and bioreactors

**Pulp and Paper Engineering** -application of chemical engineering principles to enhance the performance of products and processes found in the pulp and paper industry.

Some current studies include:

- Black liquor gasification
- High value-added chemicals from renewable resources
- Nanotechnology in paper coating and papermaking
- Paper recycling
- VOC partitioning in pulp and paper streams
- Developing improved methods to transfect plant cells with DNA using ultrasound and other technologies
- Natural fiber reinforced thermoplastics
- Papermaking wet end chemistry and control
- Thin film barrier coatings for paper and paperboard products
- Environmental aspects of pulp manufacturing

**Separation and Purification** -Techniques for recovering species from mixtures and isolating them in desired forms; special focus is on supercritical fluids, crystallization, membranes and extraction; also includes design and modeling of processes based on these separation techniques

Some current studies include:

- Processes that determine crystal purity, morphology and size distribution
- Catalyzing the nucleation of protein crystals
- Crystal morphology, hydrates and solvates
- Separation and purification of near-isomorphous amino acids
- Crystallization of waxes and polymorphs
- Separation of chemotherapeutic agents from natural products
- CO<sub>2</sub>-enhanced aqueous extraction
- Supercritical fluid/near-critical fluid processes
- Smart solvents for benign separations
- Plasma-assisted deposition of membrane coatings and barriers
- Polymeric and carbon membranes for gas and liquid separations
- Inorganic and nanocomposite molecular sieving membranes for gas and hydrocarbon separations
- Liquid membranes for the recovery of aqueous metal contaminants
- Liquid/liquid extraction and contactor design
- Simulated moving bed separation systems
- Microfluidic systems for separation of nano- to micro-scale particles and species

**Thermodynamics and Intermolecular Interactions** -phase equilibria and thermophysical properties of importance to separations, chemical and bio-processing, particle formation, and environmental applications; solution chemistry at the molecular level; relating microscopic properties to intermolecular and intramolecular interactions

Some current studies include:

- Measurement, correlation, and prediction of limiting activity coefficients
- Optimal solvents and cosolvents for processing and product design
- Properties of gas-expanded liquids and supercritical fluids
- Solid-liquid equilibria in crystallization and purification
- Effect of hydrogen bonding on solution properties
- Transport properties of liquids and nanofluids
- Thermodynamics of electrolyte solutions
- Thermodynamic modeling of multiphase, multicomponent atmospheric aerosols
- Partitioning behavior of VOCs
- Thermodynamics of polymer solutions
- Relationship between thermophysical properties and spectroscopic measurements

### New and Expanding Areas of Interest

Biotechnology

### Research Centers

- [Center for Integrated Modeling, Process Control and Operations \(CIMPCO\)](#)
- [Center for Process Systems Engineering \(CPSE\)](#)
- [Fluid Properties Research Institute \(FPRI\)](#)
- [Georgia Tech/Emory Department of Biomedical Engineering](#)
- [Georgia Tech Research Institute \(GTRI\)](#)
- [Institute of Paper Science and Technology \(IPST\)](#)
- [Manufacturing Research Center](#)
- [Microelectronics Research Center \(MiRC\)](#)
- [Molecular Design Institute \(MDI\)](#)
- [Polymer Education Research Center \(PERC\)](#)
- [Specialty Separations Center](#)

**Collection Development Responsibility** [to be discussed in July 2004]

**Classed Analysis (based on Library of Congress classifications)** [to be discussed in fall 2004]