Department of Chemical and Biomolecular Engineering

A Letter from the Chair

It is my pleasure to introduce you to the Department of Chemical and Biomolecular Engineering at Vanderbilt University. Our department and the discipline of chemical engineering have undergone considerable growth and change in recent years, expanding into the fields of biology, medicine, and materials science. We have been fortunate in adding new faculty members who are pursuing novel applications of chemical engineering principles both in their own research and on interdisciplinary teams.

We recognize the essential need of chemical engineering in contemporary society and the department is positioned at the forefront of modern research and development. Our program prepares chemical engineers to play key roles in the discovery and production of pharmaceuticals and bioengineered materials, high-strength composites and specialty polymers, semiconductors and microelectronic devices, energy conversion devices such as fuel cells and batteries, and a wide range of ultrapure fine chemical compounds and other commercially important products.

As you peruse this brochure and read about individual faculty interests, you will note seven main areas for graduate research—advanced materials, biochemical engineering and biotechnology, the environment, adsorption and surface chemistry, chemical reaction engineering, electrochemical engineering, and process modeling and control. Problems are approached through experimentation and simulation at the atomistic level through commercial production scales.

Interdisciplinary research is important at Vanderbilt. In addition to working with researchers in other departments in the School of Engineering, we collaborate outside the school with Vanderbilt faculty in the natural sciences and medicine. Professors in the department participate in university-supported interdisciplinary research initiatives such as the Vanderbilt Institute of Nanoscale Science and Engineering (VINSE), the Vanderbilt Institute for Integrative Bioengineering Research and Education (VIIBRE), and the Vanderbilt Institute of Chemical Biology (VICB).

Most of our graduate students are pursuing a Ph.D. degree. We have reduced our course work requirements to a reasonably low level to permit a greater concentration on creative thinking and the research experience. We have an active Chemical Engineering Graduate Student Association (ChEGSA), which represents graduate student interests and sponsors a variety of social events. I serve as their adviser.

Several forms of financial aid are available to graduate students. New students are usually awarded a Teaching Assistantship (TA), which is funded by the university. Teaching assistants tutor undergraduate students, grade undergraduate student homework, or assist in our Undergraduate Laboratory. After the first academic year, most students are transferred to a Research Assistant (RA) appointment. RAs are supported by federal and industrial research grants obtained by the faculty. Students choose a research topic and adviser during their first academic semester at Vanderbilt. Special honor fellowships are also available to incoming students.

Vanderbilt is a great university and the Department of Chemical and Biomolecular Engineering is at the forefront of research and teaching. You will learn more about us from the information contained in this brochure. Our Web site (www.che.vanderbilt.edu) is an additional departmental resource and, of course, I would be delighted to discuss with you the opportunities we offer students who are interested in chemical and biomolecular engineering.

Peter N. Pintauro
H. Eugene McBrayer Professor of Chemical Engineering and Chair of the Department
PROGRAMS OF STUDY

Master of Science

Candidates for the Master of Science must complete 24 semester hours of graduate-level courses. Fifteen hours are taken in chemical engineering core courses. The remaining 9 semester hours are selected from courses in the major or from related areas of interest approved by the research adviser.

An M.S. program for non-chemical-engineering undergraduates also exists at Vanderbilt. Graduates holding a B.S. in science, mathematics, or other engineering disciplines must demonstrate sufficient skill and knowledge in problem solving for placement into the core chemical engineering courses. In most cases, undergraduate courses in chemical engineering are required. Persons interested in this program should contact the director of graduate programs in chemical engineering for more detailed information.

In addition to course work, each degree candidate conducts research under the supervision of a faculty adviser, prepares a written thesis, and presents the thesis orally to the faculty.
**Doctor of Philosophy**

Candidates for the Doctor of Philosophy degree complete a minimum of 72 semester hours of work beyond the bachelor’s degree. At least 30 of these hours are course work (at least 21 hours in chemical engineering graduate courses and a minimum of 6 hours taken outside of the department). The remaining hours are Ph.D. dissertation research. The course load is designed to allow students to spend the majority of their studies on original research.

Up to 24 hours of graduate course work with an equivalent of an A or B grade may be transferred to Vanderbilt and applied to the Ph.D.

Following core course work, students complete written and oral examinations on fundamentals that are presented in the chemical engineering core courses. Admission to candidacy in the Ph.D. program is based upon this departmental examination and the Ph.D. qualifying examination. The Ph.D. qualifying exam consists of written and oral presentation of a proposal for doctoral research.

Following the examinations and at least 24 semester hours of dissertation research, the student prepares and publicly defends a dissertation presenting results of original research in chemical engineering.

**FINANCIAL ASSISTANCE**

Financial aid is available to qualified students in the form of research assistantships and teaching assistantships, which include a stipend and payment of tuition and health insurance. Exceptional students may be nominated for supplemental awards.

**INFORMATION AND APPLICATION**

Apply online at [www.vanderbilt.edu/gradschool](http://www.vanderbilt.edu/gradschool)

For further information, contact:

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**COURSE WORK**

All graduate students complete a set of core courses that stress the broad, fundamental, and scientific principles of the chemical engineering discipline. These courses serve as the basis for the departmental examination, which is normally taken at the end of the first academic year of graduate studies. These core courses are:

- Applied Mathematics in Chemical Engineering
- Advanced ChE Thermodynamics
- Transport Phenomena
- Applied Chemical Kinetics

Recognizing that all research areas rely on modeling and simulation to varying degrees, all graduate students take the following course:

- Chemical Engineering Simulation

Students in the Ph.D. program are required to take two additional courses in chemical engineering. These courses may be taken from the following offerings. These courses are offered on an every-year or an every-other-year basis.

- Atmospheric Pollution
- Biochemical Engineering
- Bioprocess Engineering
- Semiconductor Materials Processing
- Molecular Simulation
- Molecular Aspects of Chemical Engineering
- Physiological Transport Phenomena
- Polymer Science and Engineering
- Systems Analysis for Process Design and Control
- Surfaces and Adsorption
- Special Topics in Chemical Engineering
Research Interests

- **Molecular modeling of fluids.** We apply the techniques of molecular simulation and molecular theory to understand the properties of fluid systems, particularly aqueous systems, supercritical fluid mixtures and fluids with nanoscale structure (such as reversed micelles in supercritical fluids and polyelectrolytes).

- **Computational nanoscience.** We are interested in nanostructured systems, such as hybrid organic-inorganic nanocomposites, the nanoscale complexity found at metal oxide/aqueous solution interfaces, and nanoparticles formed from hydrothermal solution. In addition, we have interests in molecular electronics (electronic devices made from single molecules) and the effect of nanoscale confinement on the phase and structure of the confined fluid.

- **Molecular rheology of lubricants.** Using several non-equilibrium molecular dynamics simulation methods, we study the rheology (particularly viscosity) of typical lubricants in conventional uses (e.g., automotive) and unconventional uses (e.g., disk drive lubrication). Our goal is to develop tools which will enable lubricant designs to be tested computationally before deciding a lubricant is sufficiently superior to others that it is worth synthesizing. We additionally study the effect of nanoscale confinement on lubricants.

- **Mathematical modeling of cancer invasion.** We are collaborating with researchers in the cancer biology department of the Vanderbilt University Medical Center to develop cancer-cell-based mathematical models of cancer tumors, with a particular emphasis on the invasion process whereby cancer spreads to other parts of the human body.

Selected Publications


Selected Invited Conference Presentations

Peter T. Cummings, “Molecular Simulation of Supercritical Fluids and Mixtures: Supercritical Aqueous Systems and Reverse Micelles in Supercritical Carbon Dioxide,” 8th International Meeting of the International Society for the Advancement of Supercritical Fluids, Bordeaux, France, April 14-17, 2002.


Kenneth A. Debelak
Associate Professor of Chemical and Biomolecular Engineering
Ph.D., University of Kentucky

Research Interests
Research topics that I advise include the following:

- **In-situ resource recovery (ISRU)** is recognized as an enabling technology for exploration of the moon and Mars which can significantly reduce the mass, cost, and risk of robotic and human missions. We are working on design of reaction systems for the extraction of oxygen for life support from lunar regolith containing oxide forms, e.g., ilmenite. On Mars, we are exploring the use of supercritical carbon dioxide to extract mineral matter from Martian soils. We have performed initial experiments with chelating agents to enhance the solubility of metals in supercritical carbon dioxide. The addition of chelating agents such as perfluoropolyethers has been successful in recovering magnesium and copper at extraction rates of over 50 percent of the initial metal. The recovery of magnesium is significant since it has been proposed as a solid rocket fuel for a vehicle blasting off the Martian surface. Both projects support the exploration and development of space based on the concept of “living off the land.”

- **Plant-wide modeling, simulation, and control.** The first commercial version of the Intelligent Process Control System (IPCS) software was developed. We have since rewritten this software to include features such as vectored input and output variables, a better graphical editor, and new operator display interface. There is considerable interest in chemical engineering in plant-wide control. Our “commercialized” applications, a coherent material balance, and an operator interface, which displays key process variables, have been updated for the new software. We are expanding this tool for environmental modeling and monitoring. We plan for emissions control for NO\textsubscript{x} and CO control.

- **Polymer processing.** Polyethylene terephthalate (PET) is widely used in the form of fibers, films, and containers. The commercial applications of PET polymer depend on the molecular weight. The solid state polymerization process is used to produce higher molecular weight PET materials. We are studying the structural heterogeneity, which exists in commercial PET products, and can be classified into an amorphous phase, a crystallized phase, void regions, and structural defects.

The structural heterogeneity and defects deteriorate the mechanical and chemical properties of PET. We have been using surface techniques such as atomic force microscopy (AFM), low voltage scanning electron microscopy (SEM) to investigate the crystallization in several commercial PET products. The crystallization gradient and microstructural features on cross-sections of PET are examined at the nanometer scale. A model of the crystallization process in the PET solid polymerization is suggested consisting of a shell of a highly crystallized phase of PET encasing a core of an amorphous phase.

Selected Publications


While autologous grafts stimulate healing of tissue defects, explantation both introduces additional surgery pain and also risks donor-site morbidity.

One promising alternative to autograft is polymeric biomaterials that are designed to enhance healing through the natural tissue remodeling process. Polyurethanes comprise a class of synthetic polymers that are of fundamental interest to us because their mechanical and biological properties can be tuned to targeted values by controlling the structure. New materials currently under development include:

- **Dual delivery of growth factors and antibiotics for healing of infected bone wounds.** Infections often compromise the healing of open fractures. In the current conflicts in Iraq and Afghanistan, approximately 80 percent of all extremity amputations are attributed to complications due to infection. Local delivery of antibiotics from PMMA beads is an established clinical treatment of infected fractures, but the beads must be surgically removed before bone graft can be implanted to regenerate the bone. A more ideal implant would comprise a scaffold and antibiotic delivery system administered in one procedure. We are developing biodegradable polyurethane scaffolds that release growth factors, such as BMP-2, and antibiotics to promote healing of infected fractures through one surgical procedure.

- **Injectable scaffolds and delivery systems for bone and skin tissue engineering.** Two-component reactive polymers are promising scaffolds because they can be formed in situ without the use of solvents. Porous PUR scaffolds prepared from lysine-derived and aliphatic polyisocyanates by reactive liquid molding have been reported to undergo controlled degradation to non-toxic decomposition products, while supporting the migration of cells and ingrowth of new tissue in vitro and in vivo. Additionally, these biomaterials have elastomeric mechanical properties, which enable them to maintain good contact with tissue. We are developing injectable polyurethane scaffolds that can be administered by minimally invasive surgical techniques and conform to the shape of the wounds being treated. Biologics, such as antibiotics and growth factors, can be added to the two-component polyurethane prior to mixing.

- **Weight-bearing bone/polymer composite implants.** Traditionally, bone fractures are treated by fracture reduction and subsequent fixation. There is a compelling clinical need for a resorbable biomaterial that has the appropriate biomechanical and biological properties for fracture reduction and fixation, eliminates the need for removal surgery, and integrates with host bone. To address this clinical need, we are developing resorbable allograft bone/polyurethane composite fracture fixation devices using reactive liquid molding processes.

**Industrial experience**

1999-2002, Bayer Corporation, Polyurethanes Division

**Selected Publications**


Research Interests
The modification and engineering of interfaces has vital consequences in many technological applications. My research utilizes a molecular-level approach to design and assemble tailor-made ultrathin organic films on various surfaces to impact the processing of advanced materials. Two fundamentally important systems that we study are self-assembled monolayers (SAMs) and polymer films grown from surfaces by surface-initiated and surface-catalyzed approaches. These systems are prepared by straightforward immersion processes, can coat objects of any shape, and represent highly uniform films with controlled thickness and composition to impact energy-related issues, including solar energy conversion and proton conduction for fuel cells, as well as friction/wear, adhesion, and wettability.

- **New Lubrication Strategies for Microelectromechanical Systems (MEMS).** We are working with Professor Clare McCabe to develop new strategies to lubricate MEMS devices. We are currently using both experimental and computational approaches to investigate the interfacial behavior and lubricating properties of ionic liquids and self-assembled monolayers as combined mobile/bound coatings. Upon examination of just the bound monolayer coatings on silicon, a low-energy surface (−CH₃, −CH₂, −CF₃) and a critical chain length of ~10 carbons are required to achieve the lowest coefficients of friction. The use of mixed monolayers containing a short component and a long component can provide a dense underlayer and a liquid-like overlayer to yield low coefficients of friction and oleophilic surface properties.

- **Interfacial Engineering in Proton Exchange Membrane (PEM) Fuel Cells.** We are using surface-initiated, ring-opening metathesis polymerization (ROMP) to prepare new fluorocarbon-containing, ion-conducting thin films and achieve more highly conducting and better defined interfaces for protons, oxygen, and electrons to combine with Pt catalysts on the cathode side of the PEM fuel cell. The ionomer chains can be grown from the surface of pore walls to provide direct transfer of reactants to the catalytic surface without interfering with the performance of the catalyst. By molecular design of the monomers, we seek to promote self-organization of the polymer chains to create a hydrophobic matrix for gas transport and hydrophilic channels for proton conduction.

- **Superhydrophobic Surfaces.** Superhydrophobic interfaces, where advancing and receding water contact angles exceed 160°, are useful for creating self-cleaning surfaces, designing water-repellant materials, and promoting slip at interfaces. We have developed a new surface-initiated strategy to grow superhydrophobic polyethylene films from borane-modified surfaces. These films can be grown from virtually any material and may be useful as inexpensive, superhydrophobic top coats. We are also developing new synthetic strategies to prepare responsive monolayer films that are assembled from precisely tailored macromolecular adsorbates.

**Biomimetic Solar Energy Conversion with Photosystem I.** We are developing biomimetic solar cells containing Nature’s optimized nanoscale components harvested from green plants as the active elements. Our chief component is Photosystem I (PSI), a 10 nm protein complex that functions as a photodiode and is one of the fundamental machines that powers photosynthesis. We have prepared hand-held devices that contain monolayer and multilayer films of PSI, which, along with aqueous mediators, are sandwiched between electrode surfaces to convert light into electrical current that can power simple calculators. Our results show that PSI surface density and covalent attachment greatly affect the performance of the cells. We have recently assembled PSI within ~100 nm-thick nanoporous gold leaf films (figure; scale bar = 300 nm) to enhance the PSI/electrode interfacial area and boost photocurrents by up to an order of magnitude.

**Selected Publications**


Paul E. Laibinis
Professor of Chemical and Biomolecular Engineering
Ph.D., Harvard University

Research Interests

Our work focuses on the assembly of systems whose performance is a direct result of surface effects. These systems include chemical sensors, antifouling coatings, responsive interfaces, and nanoparticle dispersions. A common element in these efforts is a molecular perspective on the structure of species at surfaces as a way to control interfacial behavior. Systems range in complexity from single-atom coatings useful in chemical sensing to polymeric films employed to retard biomolecule adsorption to arrays of immobilized DNA molecules for genetic analyses or programmed multi-particle assembly.

- **Antifouling coatings.** Using both molecular and polymeric approaches, we prepare surfaces that are able to avoid non-specific adsorption processes that often lead to losses in activity when materials are introduced into biological media. We are developing these strategies for enhancing the biological activity of species when tethered to a surface as employed in biological sensing applications. Another effort involves tailoring the strength of adsorption levels towards various biomolecules as a means for enhancing separation processes that are limited in efficacy by non-specific adsorption events that lead to losses in activity.

- **Chemical sensing.** Electrodes modified to expose a monolayer of a less noble metal can provide electrochemical signatures useful in sensing applications. Our efforts are directed toward the integration of such readily fabricated electrodes within microfluidic systems as a means to provide automated measurements of specific analytes.

- **Magnetic nanoparticle dispersions.** Nanoparticles offer a range of useful properties by virtue of their high surface areas and short interparticle separation distances. By chemically tailoring their surfaces, these particles can be prepared to have desired adsorptive (or non-adsorptive) properties. By employing magnetic materials for the core of the particle assembly, nanoparticle dispersions can be directed to move or be collected while retaining their nanoscopic properties. Their utility for performing separations and mixing in microfluidic systems is under investigation.

- **DNA at surfaces.** Automated DNA synthesis provides an ability to tailor surfaces with DNA strands of readily selectable sequence and at controlled densities. Our efforts with these systems are directed toward providing enhanced methods for performing genetic analyses, particularly in the area of single-nucleotide polymorphism detection. In another direction, we are using DNA as a programmable template on a surface for coding the directed self-assembly of various structures into larger aggregates. Key goals are establishing generic approaches for controlling the assembly of multi-particle and multi-object systems into definable structures for achieving new types of integrated functions.

Selected Publications


Research Interests

The laboratory focuses broadly on gas-solid adsorption processes to increase understanding and improve design methods. Research is balanced equally between theory and experiment. Topics of current interest include:

- **Adsorption equilibria for highly nonideal multicomponent mixtures and microporous adsorbent materials.** Our interests involve the thermodynamic interpretation and accurate descriptions of adsorption equilibria. Coadsorption of organic molecules and water on activated carbons has been an area of major focus, as has measuring absorption equilibrium at ultra low concentrations.

- **Modeling of fixed-bed adsorption processes.** We develop models of varying degrees of complexity. Some simple models are based on the assumption of local equilibrium. More complex models include complex equilibria, complex rate behavior, and nonisothermal behavior. Additionally, we have developed general methods to give accelerated convergence of the models to the final cyclic condition, i.e., the periodic state. Recent emphasis has been on pressure swing adsorption, temperature swing adsorption, and adsorptive refrigeration (providing a halocarbon-free alternative to current heat pump technology).

- **Treatment of rate mechanisms for fixed-bed adsorption.** We have been developing novel frequency response methods for measuring rate parameters. We also place emphasis on dispersion mechanisms.

- **Synthesis and characterization of novel adsorbents.** We are emphasizing well-characterized, nanoporous carbonaceous materials. We also develop methods to improve interpretation of pore size distributions.

Selected Publications


Clare McCabe  
Associate Professor of Chemical and Biomolecular Engineering  
Ph.D., Sheffield University

Research Interests
Computational technologies are increasingly impacting a wide range of chemical industry applications, from molecular modeling on the atomistic scale to process simulation and control. Our research uses a combination of molecular simulation, computational quantum chemistry, and molecular theory to describe a wide range of systems with application in the chemical industry, biotechnology, and environmental technology.

In particular, current projects include:

- **Development and Application of Molecular Theories.** The ability to accurately predict the thermodynamic properties of fluids is central to product and process design. Our work focuses on the development and application of molecular-based approaches to determine the thermodynamic properties and phase behavior of a wide range of fluids such as hydrocarbons, polymers, ionic liquids, and electrolytes.

- **Molecular Modeling of Nanoscale Systems.** Molecular modeling is a particularly useful tool for studying nanoscale systems where experimental investigation is often difficult due to the time and length scales involved. Areas of interest include understanding lubrication in nanoscale devices and predicting the properties and solution behavior of nanostructured materials, such as carbon nanotubes, polyhedral oligomeric silsesquioxanes (Figure 1), and biological membranes.

- **Improving the Efficiency of BioFuel Conversion.** Biofuels are a very promising component of the solution to the problem of meeting the energy needs of the 21st century. However, the potential of biofuels is currently limited by low efficiencies and high cost. Our work in this area focuses on developing models and tools that can be used to understand the biochemical depolymerization of cellulose by cellulases (figure 2), with the ultimate aim of providing molecular-level insight to enable the engineering of more efficient and active cellulases.

Selected Publications


Research Interests

Proton-Exchange Membranes for Fuel Cells

- **Composite Nanofiber Network Membranes.** We are developing a completely new approach to ion-exchange membrane preparation, where a three-dimensional interconnected network of electrospun polyelectrolyte nanofibers is created and then the interfiber voids are filled with an inert/uncharged polymer. The polyelectrolyte composition, fiber diameter, fiber volume fraction, and inert matrix polymer can be chosen independently. The uncharged (hydrophobic) polymer which surrounds each nanofiber restricts fiber swelling in water and provides mechanical strength to the membrane.

- **Alkaline Fuel Cell Membranes.** Our approach is to fabricate a phase-separated segmented copolymer anion-exchange membrane with hydrophobic (non-polar) blocks to limit membrane swelling and impart mechanical strength to the membrane and hydrophilic (polyelectrolyte) blocks with backbone dimethyl ammonium anion-exchange groups for OH⁻ conduction. We are targeting membranes with the following properties: (i) a hydroxyl ion conductivity between 0.08 and 0.15 S/cm for a water-equilibrated membrane at 25°C, (ii) a water swelling at 25°C of 25-75%, and (iii) good mechanical properties when immersed in water or an aqueous methanol solution.

- **Polyphosphazene-Based Membranes.** Polyphosphazenes, a class of hybrid organic/inorganic polymers, are being investigated for use as the membrane material in direct liquid methanol and hydrogen/air PEM (proton exchange membrane) fuel cells. Work in this area includes fundamental polymer chemistry (sulfonation of polymers, polymer blending, and solid-state crosslinking), membrane characterization (measurement of solvent permeability, proton conductivity, solvent swelling, and mechanical/thermal properties), and fuel cell evaluation.

- **Space-Charge Models for Ion Uptake and Transport in Ion-Exchange Membranes.** Theories for multicomponent ion uptake and transport are being developed and tested. The models consider solvation free energy changes that occur during ion sorption, the orientation of solvent dipoles inside a membrane pore (due to the strong electric field generated by the membrane’s fixed charge groups), and ion-pair formation between multivalent counterions and membrane fixed-charge sites. Models have been applied to sorption and transport of monovalent and monovalent/divalent cation salt mixtures in Nafion® cation-exchange membranes and in commercial anion-exchange membranes.

Organic Electrochemical Synthesis

- **Organic electrochemical reactions are being carried out in PEM (proton-exchange membrane) fuel cell reactors that do not require a supporting electrolyte salt and can accommodate gaseous feed streams.** In one project, edible oils (e.g., soybean and canola oils) have been partially hydrogenated electrochemically in a PEM reactor. Partially hydrogenated oil products were characterized by a low percentage of trans fatty acid isomers (which are known contributors to coronary heart disease) and a moderately/sufficiently high concentration of saturated stearic acid for food applications.

Selected Publications


Bridget R. Rogers  
Associate Professor of Chemical and Biomolecular Engineering  
Ph.D., Arizona State University

Research Interests

The focus of our research is on surfaces, interfaces, and films of technically important materials. We work to establish relationships between the processing parameters, the material properties, and finally the performance of the film in its proposed application. We create films using chemical vapor deposition and characterize them using spectroscopic ellipsometry, medium energy ion beam backscattering, Rutherford backscattering spectrometry, Auger electron spectroscopy, X-ray photoelectron spectroscopy, and X-ray diffraction. We currently have three project thrusts.

■ UHV-CVD of metal oxide thin films for high-permittivity gate dielectrics.  
   Application—CMOS transistors.

■ Understanding the effects of high temperature, dissociated oxygen/nitrogen environments on materials exposed to extreme environment.  
   Application—Sharp leading edges and control surfaces for hypersonic flight.

■ Engineer coatings that will perform in high-temperature, high-flow, reactive environments. Applications—Materials protection for use in extreme environments.

Industrial Experience

1984-1998: Motorola, Inc., Semiconductor Products Sector, Mesa, AZ

Selected Publications


Julie E. Sharp
Associate Professor of the Practice of Technical Communications
Ph.D., Vanderbilt University

Research Interests
Professor Julie E. Sharp is the chemical engineering department’s resident technical communications professor, preparing prospective engineers for future writing and presentation tasks at work. Her research interests are in the areas of communication and learning style theory in engineering education.

Professor Sharp has been recognized for her contributions to engineering education. She uses learning style theory to promote targeting the audience and enhancing teamwork skills. She earned the American Society for Engineering Education (ASEE) Southeastern Section’s 2004 Thomas C. Evans Award for “The Most Outstanding Paper Pertaining to Engineering Education in 2003.” Her work applying Kolb learning theory and the Soloman-Felder Index to Learning Styles to technical communication and engineering classes has been recognized by Richard Felder in his January 2005 Journal of Engineering Education article and previously in his December 1996 PRISM article, “Matters of Style.” Her techniques and research on using e-mail as a teaching tool were commended as innovative and summarized by a reporter in the article, “You’ve Got Mail,” in the February 2001 PRISM magazine, published by the American Society for Engineering Education.

Professor Sharp designs and instructs combined chemical engineering lab/technical communication courses and team-teaches these with a chemical engineering professor. She also teaches a course in technical communication for all engineering majors, serving as course coordinator. Additionally, she is available to help graduate and undergraduate students prepare for communication tasks during a job search.

Professor Sharp has presented numerous papers and workshops on communication and learning style theory for engineering educators, technical communicators, students, and other professional groups. She regularly presents papers at national conferences, such as the American Society for Engineering Education (ASEE) and Frontiers in Education (sponsored by ASEE and IEEE). She is a member of the Society for Technical Communication (past president of the Middle Tennessee Chapter), the Association of Professional Communication Consultants, the Conference on College Composition and Communication, and ASEE.

As a communication consultant, Professor Sharp specializes in business and engineering documents and training workshops. Several of her projects have won national and regional awards for clients.

Her Web site at www.vuse.vanderbilt.edu/~sharpje/persinfo.htm gives more information, helpful links, and access to her online articles.

Selected Publications


Jamey D. Young
Assistant Professor of Chemical and Biomolecular Engineering
Ph.D., Purdue University

Research Interests
Research in the Young lab involves development and application of quantitative approaches to analyze and redirect metabolism. Our work relies on both experimentation and computation. We collect high-resolution metabolite measurements from cell culture and in vivo experiments and leverage them with rigorous mathematical modeling to maximize the descriptive and predictive power of those measurements. Our primary tools include the use of stable isotope tracers and mass spectrometry (GC- and LC-MS) to perform metabolic flux analysis (MFA) and comprehensive metabolic profiling (see inset). Combining these approaches with measurements of intracellular signaling and gene expression provides an integrated approach to study physiology across many functional and regulatory levels and to interrogate the system-wide response of cells, tissues, or whole organisms to targeted perturbations.

We are applying these tools to several prominent biomedical and biotechnological problems. Working with researchers in the Vanderbilt Diabetes Research and Training Center (VDRTC) and Mouse Metabolic Phenotyping Center (MMPC), we are developing novel isotope tracer methods to study in vivo metabolism in whole animals and to investigate the effects of metabolic disorders such as obesity and type 2 diabetes. Another line of research involves collaborators at the Vanderbilt-Ingram Cancer Center. We are applying MFA to explore the metabolic differences between tumor cell lines that vary in their degree of tumorigenicity and invasiveness. This will allow us to pinpoint the metabolic pathways that are altered in cancer cells and determine how those changes promote tumor growth. Finally, we are applying our metabolic analysis tools to improve mammalian cell lines used in the production of therapeutic proteins. This requires a rational metabolic engineering approach relying on MFA and metabolic profiling to quantify the effects of imposed genetic changes and to then use those findings to guide further strain improvement.

Selected Publications

An integrated metabolomic approach to study mammalian physiology and pathophysiology using isotope tracers. We apply MFA and metabolic profiling to quantitatively determine intracellular fluxes (size of arrows) and metabolite concentrations (size of circles). Both analyses are enabled by powerful GC- and LC-MS methods that can simultaneously measure metabolite abundance and isotopic labeling. By comparing metabolic maps obtained under varying conditions, we can pinpoint the effects of genetic and environmental changes within the metabolic network.
Tomlinson Fort
Centennial Professor of Chemical and Biomolecular Engineering, Emeritus
Ph.D., University of Tennessee

Research Interests
My research is in surface chemistry. Recent work has included studies of capillary pressure driven flow of liquids in wet unsaturated porous media and of the thickness of solvation layers on nanoparticles dispersed in different fluids. Results of this work are fundamental to understanding and optimizing a wide range of solid-liquid systems where interfaces control system behavior.

Selected Publications


John A. Roth
Professor of Chemical and Biomolecular Engineering, Emeritus
Professor of Environmental Engineering, Emeritus
Ph.D., University of Louisville

Research Interests
Research is being carried out on chemical oxidation of pollutants, the emissions of volatile organic carbons (VOCs) from surface impoundments, and the efficient production of oxygen by the reduction of ilmenite.

Selected Publications


Robert D. Tanner
Professor of Chemical and Biomolecular Engineering, Emeritus
Ph.D., Case Western Reserve University

Research Interests
Research is being carried out in the area of separating proteins in the laboratory by bubble and foam fractionation processes. These processes are promising engineering tools for protein concentration and separation because they are simple and inexpensive and can be readily scaled up from laboratory-size to commercial-size equipment. Such on-line protein separation processes, when combined with protein-producing reactors (such as fermentors), have much potential for reducing the cost of protein recovery in the pharmaceutical and food industries. One of the problems with foam fractionation, however, is that the bubbles required in the process can denature some biologically active proteins, such as enzymes. Under extreme conditions (e.g., low and high pH), proteins can lose their desired structure and function.

Selected Publications:
The Nashville area is home to more than a dozen colleges and universities that attract some 30,000 students from the United States and around the world to Middle Tennessee. These institutions form a broad, influential community of higher education that has earned Nashville the title “Athens of the South.” Nashville offers many types of entertainment, including the Nashville Symphony, the Nashville Ballet, the Nashville Opera Association, a number of professional and amateur theatre companies, two professional sports teams, and the Nashville Zoo. Many nationally known rock, jazz, blues, pop, and country musicians live and perform in the Nashville area. Local residents enjoy a variety of restaurants that include unique eateries, eclectic cafes, and many different ethnic restaurants.

More than seventy art galleries complement the exhibits and collections of the Tennessee State Museum, the Sankofa-African Heritage Museum, the Evins Appalachian Center for Crafts (nearby, in Smithville), the Adventure Science Center, the Parthenon, Frist Center for the Visual Arts, and the Cheekwood Botanical Gardens and Museum.

Nestled in the central basin of Tennessee and rimmed by wooded hills, Nashville has many outdoor recreational opportunities. A network of public parks and two large lakes are within about thirty minutes of campus. The Great Smoky Mountains National Park in East Tennessee offers extensive and beautiful hiking trails and is about a three-hour drive away.
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