The University of Oklahoma
Research Activities

Chemical, Biological and Materials Engineering
Dear Reader,

It is my pleasure to welcome you to the School of Chemical, Biological and Materials Engineering at the University of Oklahoma.

The scope of this brochure is to showcase the research activities that are currently undertaken by our graduate students, supervised by a diverse group of active and internationally renowned faculty members. I am certain that our research interests, our accomplishments, and the success of our former students will fascinate you.

It is no news that chemical engineering is a dynamic discipline. Our research responds to the needs of our society, and contributes to meet them. The current most pressing problems include securing independence from foreign oil, preventing environmental disasters such as global warming, addressing the expected needs for our aging population, and enabling technological developments in various market segments including consumer electronics. In response, our students and faculty focus on bio-fuels (production of fuel from agricultural products), environmental remediation (e.g., CO₂ capture and sequestration), tissue engineering (development of synthetic materials used, e.g., in prosthetic devices), and materials engineering (including nano-structured materials based on carbon nanotubes, graphene sheets, polymers, etc.)

To facilitate these achievements, we strategically hired junior faculty members to enrich and complement our department. The three most recent additions are Dr. Friederike C. Jentoft, who develops catalytic processes for converting bio-mass to usable fuels, Dr. Alberto Striolo, who combines experimental and simulation techniques to unravel the properties of materials at the nano-scale, and Dr. Peter S. McFetridge, who designs reactors for cell cultures and derives medical materials from umbilical cords.

Because these new research areas build on and complement traditional research strengths in our department (i.e., energy, thermodynamics, surfactants, polymers, and process systems engineering), our future looks brighter than ever!

Should you have any question or comment, please do not hesitate to contact us.

Enjoy this brochure,

Lance L. Lobban
Director and Francis W. Winn Chair
Master of Science and Doctor of Philosophy degree programs are offered in Chemical Engineering. Students who hold bachelor degrees in an area other than chemical engineering may have to take additional courses to earn a graduate degree from our department.

Students interested in biochemical engineering have two options. They can enter the CBME graduate program for a degree in Chemical Engineering; or they can enter the graduate program in our affiliated program, the University of Oklahoma Bioengineering Center. More information about this program is at www.oubc.ou.edu

Graduate Program in Chemical Engineering
- Master of Science in Chemical Engineering
- Doctor of Philosophy in Chemical Engineering
- Details on course requirements can be found at http://cbme.ou.edu/graduate/degrees.htm

Special Graduate Program in Chemical Engineering
- Master of Science in Chemical Engineering for students with a degree other than Bachelor of Science in Chemical Engineering
- Details on course requirements can be found at http://cbme.ou.edu/graduate/degrees.htm

Interdisciplinary Graduate Programs in Bioengineering
- We are a major component of the University of Oklahoma Bioengineering Center
- Master’s and Doctoral degrees in Bioengineering are available
- Information is available at www.oubc.ou.edu
Chemical engineering is a continuously evolving discipline that seeks to answer our society’s most pressing needs. As some needs are satisfied, others are brought to our attention, and our research is in continuous evolution.

Recent trends show that modern research is becoming more and more interdisciplinary. Chemical engineers are able to use their strong mathematical background and solid fundamental understanding of thermodynamics, transport, and kinetic phenomena to solve problems in a variety of fields. Thus we can contribute to solve any problem, often collaborating with experts from other disciplines.

We are proud that all of our faculty members are active in research. The department’s excellence in research has attracted private donations that have led to the endowment of seven faculty positions (three chairs and four professorships). Thus almost half of the faculty positions in our department are endowed, a truly remarkable reality.

As detailed in the pages to follow, we are involved in a number of diverse activities that is difficult to group in individual areas. But, let’s try:

We conduct basic and applied research in both biochemical and biomedical engineering. For example, we seek to understand the flux of nutrients through human tissues, we design bioreactors to grow engineered organs, we study the fundamental events linked to blood coagulation, we design sensors to monitor glucose concentration, we investigate the mechanism of lubrication in human joints, fight cancer…

continued on page 4
Energy and Chemicals

We are involved in searching for new methods to produce energy and chemicals, to process feedstock into usable chemicals, and to facilitate their consumer use. A large number of faculty members are interested in catalysis, which is becoming crucial for the development of biofuels. Others investigate the flow of fluids within the pores found in rocks, which is crucial if our society is really interested not only in extracting fossil fuels from the earth, but also in sequestering carbon dioxide in sub-surface reservoirs. A distinctive characteristic of chemical engineers is the search for more and more economical ways to operate chemical plants and produce new goods and refine others. We are leaders in such research.

Environmental

Let’s not forget the world around us! We have all the tools necessary to prevent environmental contamination, and clean the environment when necessary. We apply surfactants to decontaminate soil from spilled oil and to restore contaminated aquifers. We use catalytical processes for the abatement of gaseous pollutants such as CO and NOx, produced in most combustion processes. We design processes for optimum environmental risk management. We develop new membranes for water desalination, a technology that will become more and more important as water resources deplete and our population increases.

Materials Science

Yes, as engineers we make things! We design materials with new desirable macroscopic properties by understanding the interactions between the constituent molecules, and by manipulating the processing of the raw materials into the final product. Within this broad area of research, our faculty design hydrophobic cotton, polymeric microfibers that are 10 times as strong as steel, ordered polymeric structures on flat surfaces for the development of nano-batteries, carbon nanotubes with controlled diameter and chirality, forests of aligned carbon nanotubes, etc.

And what will we do in the future?
That depends; join us, and define your own area of chemical engineering research!

http://www.cbme.ou.edu
A Bright Future Ahead!

School of

Chemical, Biological, and Materials Engineering

Diversification, Globalization, Emerging Technologies . . .

With a graduate degree from our School you will stand out in a changing, demanding, exciting world!

We seek students holding a baccalaureate degree or equivalent from an accredited college or university, with a strong academic background, and a serious interest in research. All our exceptional graduate students are granted financial assistance with stipends competitive nationally.

Applicants will be required to provide transcripts, three letters of reference, GRE, and, if necessary, TOEFL test scores. Information about GRE and TOEFL tests is available through the world wide web at [www.ets.org](http://www.ets.org)

Inquiries and requests for application materials can be directed to the address below, requested from our Graduate Liaison (Dr. Matthias U. Nollert, (800) 601 9360, nollert@ou.edu), or obtained from our website (www.cbme.ou.edu).

**Graduate Program**

School of Chemical, Biological and Materials Engineering

The University of Oklahoma

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Sarkeys Energy Center, T-335

Norman, Oklahoma, 73019-1004, USA

E-mail: chegrad@ou.edu

[http://www.cbme.ou.edu](http://www.cbme.ou.edu)
Faculty at a Glance

Miguel J. Bagajewicz  
Process System Engineering; Instrumentation Networks, Oil and Gas; Product Design

Richard G. Mallinson  
Sustainable Use of Natural Resources

David W. Schmidtke  
Cell Adhesion, Microfluidics, Biosensors, Mechanobiology, Carbon Nanotubes

Brian P. Grady  
Polymer, Surfactant and Colloid Science

Peter McFetridge  
Wound Healing and Tissue Regeneration

Robert L. Shambaugh  
Polymer Processing and Characterization: Fiber Spinning and Nonwovens

Roger G. Harrison  
Targeted Therapeutics to Treat Cancer, Obesity, and Hemophilia

Matthias U. Nollert  
Blood Cells, Blood Vessels, and Coagulation

Vassilios I. Sikavitsas  
Tissue Engineering, Biomaterials, Bioreactors, Biosensors

Jeffrey H. Harwell  
Surfactants and Colloid Science

Edgar A. O’Rear III  
Surfactants and Bioengineering

Alberto Striolo  
Molecular Science and Engineering

Friederike C. Jentoft  
Catalysis and Spectroscopy

Dimitrios V. Papavassiliou  
Computational Transport Processes

John Scamehorn  
Professor Emeritus Surfactants Science and Technology

Lance L. Lobban  
Catalysis and Reaction Engineering

Daniel E. Resasco  
Heterogeneous Catalysis - Fuel Upgrading and Biofuel Synthesis - Carbon Nanotubes

http://www.cbme.ou.edu
Procressses need to be optimized to achieve maximum profitability and minimum emission of pollutants ($\text{CO}_2$ mainly). We concentrate on the use of mathematical optimization to achieve these goals.

We concentrate on developing methodologies to optimize process systems and products. Our methods concentrate on increasing profitability and reducing financial risk. For financial risk, for example, we developed methodologies that allow the appropriate decision making under the uncertainty of different parameters, process, demands, etc. We have developed (among others)

- Methodologies for the optimal design of petroleum fractionation units
- Methods for energy integration and retrofit of heat exchanger networks to improve energy efficiency
- Methods to design and retrofit water usage systems in process plants
- Methodologies for product design that incorporate pricing theory and consumer preferences at early design stages
- Methods for the planning of refinery operations under uncertainty
- Methods for the design and retrofit of Instrumentation networks
- Methods for optimizing maintenance and heat exchanger cleaning operations.

We also specialize in developing methodologies to improve the mathematical optimization methods, specifically global optimization.

**Selected Publications**


Over the past 50 years, plastics and rubbers have become part of our daily lives; in fact, one-third to one-half of all chemical engineers are employed in a polymer-related industry. Our research has three focuses: the first is on polymer systems with two different components, such as polymer-matrix composites, phase separated copolymers or polymer blends. The second is the use of surfactants to make nanostructured polymers, both on surfaces and in solution. For the former, we use a process called admicellar polymerization which uses adsorbed surfactant structure, while for the latter we use emulsions to create nanoparticles from biodegradable polymers for drug delivery. The second goal has led to the third area of interest to our group: the fundamental characteristics of surfactants in solution with an emphasis on adsorption at the solid-liquid interface. The goal of our research is to quantify how and why the separate components influence the properties of the material by understanding the underlying micro- or nanostructure. In other words, we are interested in determining the fundamental interrelationship between chemical structure, morphology, and properties. Our group uses extremely high-tech equipment to explore these characteristics including x-ray and light scattering, electron and atomic force microscopy and high-pressure liquid chromatography. Our laboratory is involved in collaborations with both academic and industrial colleagues in which we bring these important characterization tools to study relevant and practical problems.

As of October 2008, the results of our research have been featured in over 70 peer-reviewed journal articles and 10 book chapters.

Selected Publications


http://coecs.ou.edu/Brian.P.Grady/index.html
The major emphasis of our research is on the development of targeted therapies that have minimal or no side effects.

The general area of my research is the application of biotechnology to solve medical problems. Toward this end, my research group has developed significant expertise in the engineering, expression, and purification of recombinant proteins produced in Escherichia coli bacteria. We developed the NusA fusion protein system for expressing recombinant proteins in soluble form, which has been licensed by the University of Oklahoma to a biotechnology company for the worldwide research market. A major emphasis of my current research is the development of new protein conjugates for the treatment of cancer, obesity, and hemophilia.

In one project for cancer treatment, we are targeting conjugates of recombinant proteins and single-walled carbon nanotubes (SWNTs) to tumors. SWNTs are unique in that they strongly absorb near-infrared light, while biological systems have very low levels of absorption of NIR light. The targeting of SWNTs to tumors and subsequent application of NIR light will allow the selective elimination of tumors. A radiofrequency field can be used instead of NIR light.

In another project, an enzyme is specifically targeted to the tumor. This enzyme converts a prodrug to a drug only in the tumor. The prodrug is a biologically safe compound, whereas the drug is toxic to tumor cells. The enzyme is part of a “fusion protein,” that contains a protein that binds specifically to cells in the tumor. The fusion protein can be delivered directly to the bloodstream.

Selected Publications


http://www.cbme.ou.edu/faculty/harrison.htm
Our goal is to employ surfactants in a wide range of practical applications, ranging from environmental remediation and enhanced oil recovery to stabilization of carbon nanotubes in aqueous systems.

Almost all of my research concerns surfactants and colloid science; much of it is directly related to applications. I am very interested in seeing people use what I have discovered or developed. Consequently, the importance of surfactants and colloid science in many different industrial applications involves me in a variety of technologies.

My research ranges from applied areas such as environmental remediation (in-situ ground water remediation) or enhanced oil recovery, to basic areas such as microemulsion theory and surfactant precipitation, which support the large number of industries that utilize surfactants. Applications of my research range from remediation of ground water contaminated by fuels or solvents, to recovering more oil from a water flood, improved cleaning formulations, and working with nanoparticles. All of these topics are connected through the importance of surfactants in controlling interfacial properties in engineering systems.

Surfactants will play critical roles in the evolution of nanotechnology, from catalyst preparation, to dispersal of nanotubes in a matrix, to development of the separations processes required to produce commercial quantities of fullerene nanotubes. With the return of high oil prices, surfactant enhanced oil recovery will play an important role in maintaining the world’s oil supply until alternative fuel sources can be commercialized.

Selected Publications


http://www.cbme.ou.edu/faculty/harwell.htm
Acid–base catalysis is a core area of our research. Solid acid catalysts are important in tailoring the size and structure of hydrocarbons for their use as fuels. An emerging application of acid and base catalysts is the conversion of biomass compounds. Additional target transformations are selective hydrogenation and oxidation.

Our goal is to improve activity, selectivity, and stability of catalysts on the basis of a fundamental understanding of the catalytic process. Our key competences are in the areas of catalyst preparation, testing, and spectroscopic characterization.

We tune the chemical and morphological properties of oxide catalysts through promotion—that is, by adding the right amount of the right ingredient—and through optimized thermal treatment. These skills are applied to the preparation of solid acids and bases, and oxide-supported metal nanoparticles.

One of our primary techniques is infrared (IR) spectroscopy, which delivers information on surface structures through their vibrational signature. We developed an apparatus for quantitative measurements and determine molar absorption coefficients, which allow us to track how individual chemical bonds are activated through interaction with the catalyst surface.

Ultraviolet–visible (UV–vis) spectroscopy is widely used to investigate valence and dispersion of catalyst components. Our expertise includes the analysis of surface deposits that are responsible for catalyst deactivation, and the characterization of small metal particles by their surface plasmon resonance.

The diffuse reflectance technology enables analysis of samples under a wide range of temperature and pressure conditions, and IR and UV–vis spectroscopy can be used to watch catalysts at work.

Selected Publications


http://www.cbme.ou.edu/faculty/jentoff.htm
Bio mass is currently the only sustainable source of feedstock for liquid transportation fuels.

Over the last several years, my research emphasis has been on catalytic and thermochemical processes to convert biomass to fungible fuels and chemicals. Our studies cover a broad range of methods, including biomass pyrolysis, liquefaction, gasification, and (particularly) the catalytic conversion of the intermediate molecules to ideal fuel and chemical molecules. Our biofuels research program involves seven CBME faculty, several post-docs or full time researchers, and around fifteen PhD and MS students, with collaborators in several disciplines across campus and at other institutions. The research projects include experimental studies of heterogeneous catalysts in both gas phase and liquid phase reactions; experimental studies of biomass pyrolysis and liquefaction; and theoretical studies of adsorbate-catalyst interactions, active component-support interactions, and complex reactor design. My own research projects involve studies of catalyst activity and selectivity under different reaction conditions. These studies are coupled with characterization of the catalysts to help elucidate reaction mechanisms. Studies of catalytic reaction kinetics are included to facilitate the next step, reactor design.

Selected Publications


http://www.cbme.ou.edu/faculty/lobban.htm
Current research is primarily focused on the sustainable use of natural resources, including biofuels. The emphasis has been on understanding chemical and physical processes underlying the observable thermodynamic and rate behavior.

Dr. Mallinson’s research began in the area of fuels processing, working on coal liquefaction, coal fluids and shale oil. He developed methods for representing the chemical structure of these complex feedstocks and chemical models for the kinetics of their conversion as well as correlations of their properties. A sabbatical at Lawrence Livermore National Laboratory as an Associated Western Universities Faculty Fellow was spent developing an understanding of the effect of high pressures on the chemistry and kinetics of hydrocarbon pyrolysis. A sabbatical at the NASA Kennedy Space Center focused on polymerization kinetics of high temperature polymer coatings.

Dr. Mallinson is a member of the American Chemical Society, American Institute of Chemical Engineers, as well as Sigma Xi. He has served as Secretary, Vice Chairs, Chair and Past Chair of the Fuels and Petrochemicals Division of AIChE as well as the programming co-chair for gas. He has held a five year Kerr-McGee Distinguished Lectureship in the OU College of Engineering. He has been listed in Who’s Who in Science and Engineering, in America and in The World. He has been a Guest Professor of Tianjin University with their Key Laboratory for Green Chemistry and was a Visiting Associate Professor at Chulalongkorn University in their Petroleum and Petrol-chemical College. He reviews for a number of journals and agencies and has consulted for a number of companies, the Energy Research and Development Authority of the State of New York and the Department of Energy and National Science Foundation.

Selected Publications


http://www.cbme.ou.edu/faculty/mallinson.htm
Our main research objective is to develop transplant materials that behave more appropriately when implanted resulting in improved repair or regeneration of diseased tissues.

From vision and hearing implants to an artificial heart and blood vessels, biomedical engineering has become a crucial component of the drive to improve the quality of life in our aging society. Our laboratories research aims to develop medical devices that improve the life-style and reduce suffering of those afflicted with organ loss or failure. Our focus is on the use of a unique biomaterial used as a 3D template or bioscaffold to promote tissue/organ regeneration. This approach, called ‘Tissue Engineering’, has shown significant promise as a medical therapy, but translation from the research lab to clinic has proven difficult. In light of these issues our investigations aim to understand key conditions that enhance the regenerative capacity of tissue constructs.

Our research encompasses the three main phases of the tissue engineering approach: 1) biomaterial/scaffold development and characterization, 2) bioreactor design (to grow the living tissue), and 3) in vitro culture of the re-seeded scaffolds under replicated physiological conditions. The unique structure of these ex vivo vascular derived materials allows a number of vascular and non-vascular projects to be investigated. These materials can be used as a direct acellular implants, or as re-engineered tissues ‘grown’ within specifically designed bioreactors that control the chemical and mechanical environment. Projects under investigation includes developing coronary and peripheral bypass grafts, tissue engineered soft-tissue implants for periodontal wound repair, tubular materials for the repair of damaged peripheral nerves, and conductive hydrogels. More specific investigations include furthering our understanding of scaffold design and function, cell adhesion, growth, gene expression, conductivity modulation and its effects on cell function, and the influence of gas concentrations on organ development.

Selected Publications


http://www.cbme.ou.edu/faculty/mcfetridge.htm
We apply bioengineering research to understand, cure, and prevent vascular diseases.

Our research in the area of biomedical engineering seeks to understand the role of fluid mechanics in modulating the biology of blood cells and the cells of the blood vessel wall. There is good evidence that changes in blood flow characteristics may lead to the development of vascular disease. Only by studying vascular cells in a flowing system that closely mimics the environment found in the blood vessels can we understand how these cells behave in the body and why vascular diseases occur.

We are currently examining alterations in protein production in blood vessel wall cells that are exposed to fluid flow. We are also investigating how the response of cells to certain hormones may change if the cells are exposed to flow. In collaboration with investigators at the University of Oklahoma Health Sciences Center, we are looking at the influence of fluid mechanics on the interaction between white blood cells and the blood vessel wall. These studies will determine the molecular mechanism of this interaction and may indicate new approaches for the development of drugs to prevent an inappropriate immune response.

Selected Publications


http://cbme.ou.edu/faculty/nollert.htm
My research interests are in the two principal areas of surfactant science and biomedical engineering.

Using an interfacial polymerization process very similar to emulsion polymerization, we are modifying the surfaces of commercially important materials and also exploring the technique as a means of forming unusual polymers. Our efforts focus on learning the range of versatility of the method and on adapting the process for production. Recently, we’ve been applying admicellar polymerization to the modification of fabrics, such as formation of water-repellent cotton by application of a very thin polymer coating.

Other projects in the surface science group involve surfactant-based separations and the synthesis and study of novel surfactants. One of these is a double tail surfactant with a hydrocarbon chain and a fluorocarbon chain. We believe this extraordinary surfactant will form striated reverse, rod-like micellar aggregates, which we have called “candy cane” micelles.

Within biomedical engineering, my students and I are interested in biorheology and particularly in thrombolysis or the dissolution of blood clots by plasminogen activators. Aspects of this research include developing a rheologic test for the study of thrombolysis and examining another possible mechanism for the so-called “no-reflow” phenomenon. This work may be important in the treatment of acute myocardial infarction and other cardiovascular disorders. Our group is also studying certain pathologic flows and their possible contributions to hypertension.

Selected Publications


http://www.cbme.ou.edu/faculty/eorear.htm
Novel computational methods are developed and applied to explore turbulent transport of mass and heat, turbulent drag reduction, turbulent jet flows, flow and transport through porous media, hemodynamics, and heat transfer in micro- and nano-fluidics.

We conduct numerical experiments in what one could call a “virtual laboratory” – one that utilizes computers to provide excellent measurements for cases where actual experiments are either too expensive or impractical to perform. Our Lagrangian scalar tracking (LST) methodology has recently been used to investigate flow effects on the progress of chemical reactions, to study the transport of contaminants in microscopic pores, and to explore the thermal properties of carbon nanotube composite materials. We are also employing multiscale methods for transport through porous materials, including fiber scaffolds in bioreactors. High End Computers are utilized to conduct the numerical experiments and to interpret the data. Parallel to the development of prototype software, off-the-shelf software is used to predict flows that can improve industrially important process, such as melt-blowing, or can predict hemodynamics, such as blood flow in the human carotid or the human renal arteries.

Selected Publications


Heterogeneous catalysis is of fundamental importance in the chemical and energy sectors, it is the key to the development of green fuels that reduce the environmental impact of energy production and it plays a central role in the fabrication of nanostructured materials that exhibit enhanced electronic and mechanical properties.

We study the structure-property relationships that govern the activity of solid catalysts. We conduct a detailed investigation of the solid surface and its interaction with adsorbates. To that end, we use a large number of modern techniques such as X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), electron microscopy (TEM/SEM), UV-visible spectroscopy, Raman scattering, infrared spectroscopy (FTIR), temperature programmed reduction/desorption/oxidation (TPR/TPD/TPO), and X-ray absorption (EXAFS/XANES) that provide molecular-level information about the structure and chemical state of the surface under different environments.

The detailed characterization of the catalyst structure is combined with the results obtained on the catalytic reaction tests. Catalytic studies are conducted in a series of different reactors – flow reactors, packed bed, fluidized bed, liquid phase stirred tanks, trickle bed reactors, etc. The studies conducted in these reactors attempt to mimic the typical conditions encountered in industrial processes. Therefore, many of them operate at high pressures and temperatures. In-situ studies are conducted inside cells connected to the surface characterization equipment to obtain information about the state of the surface under reaction conditions.

We have developed the ability to preferentially open a specific C-C bond to maximize a desired fuel property (e.g. cetane number of diesels). We have also designed catalysts that produce nanotubes of a specific chirality and diameter, a tailored synthesis that is only possible through a careful design of the catalyst composition and structure.

As of October 2008, the results of our research have been published in 145 articles and have been cited more than 4,000 times.

Selected Publications


http://www.cbme.ou.edu/faculty/resasco.htm
The need for new medical devices and materials to replace damaged or worn tissues and organs is increasing as the average age of our population increases. Our research involves the design and development of new analytical devices and biotechnologies for medical therapy.

Research in the Schmidtke Lab lies at the interface of medicine and engineering, and can be divided into three research directions: 1. Cell Adhesion; 2. Micro-/Nanofabrication; and 3. Biosensors. In the area of cell adhesion we investigate the biophysics and mechanobiology of leukocyte and platelet adhesion and rolling under flow. In the area of Micro/Nanofabrication we are developing techniques to spatially pattern proteins on the nanometer and micrometer level for use in cell adhesion studies and biosensor development. In the area of biosensors we are developing novel redox polymers which enhance the electrical communication with redox enzymes, and exploiting the unique properties of single-walled carbon nanotubes to develop nanometer scaled biosensors that are highly sensitive.

Selected Publications


A main thrust area of our research is the fundamental understanding of (a) the spinning process for producing polymer fibers, and (b) the fabrication of nonwoven fibers from these polymer fibers. Actual experiments and the use of mathematical modeling are combined and used in our studies. Our goals include the economically-viable production of high strength nonwovens for diverse uses such as filtration, sorption, biologically-compatible structures, and composites reinforcement.

One method we are using to produce nonwovens is the melt blowing process. In melt blowing, a high velocity gas stream impacts upon a stream of molten polymer as the polymer exits a fine capillary. The result of this impact is that the polymer rapidly (in about 50 microseconds) attenuates into fiber strands as fine as 0.1 micron in diameter. Extremely interesting and potentially very strong crystal structures are formed under these high strain rate conditions. With appropriate energy, momentum, and continuity equations, we are modeling the rheological behavior of the fiber formation process. We use high speed photography and infrared thermography to do on-line measurements of the melt blowing process. Off-line, we analyze the fibers with DSC, WAXS, SEM, and other analytical techniques.

The melt blowing process is amenable to any thermo-plastic material. Polymers that we have successfully melt-blown include polypropylene, polyethylene, polyurethane, polyester, atactic polystyrene, syndiotactic polystyrene, ethylene vinyl alcohol, polymethylpentene, and numerous others. We have produced single component fibers, bicomponent fibers, and hollow fibers. The hollow fibers can be used for diverse applications such as high performance insulation, reverse osmosis, and kidney dialysis.

Selected Publications


I am interested in applying engineering concepts to biological and medical problems. I focus in developing new cell culturing strategies and novel biomaterials for use in tissue and organ regeneration.

My research interests are geared towards the development of novel experimental strategies for tissue regeneration. Specifically, the following areas are the main focus of my research:

- Bone tissue engineering bioreactors
- Surface modification of biomaterials for improved cell function
- Mesenchymal stem cell therapies for bone regeneration
- Tendon tissue regeneration using stem cells and mechanical stimulation
- Wharton’s jelly stem cell isolation and differentiation
- Surface modification of dental implants

My research group works in the general area of biomedical engineering and in the more specific areas of tissue engineering, biomaterials, and stem cell differentiation, and it is motivated by the needs directed from physicians trying to improve the currently available but inadequate therapies for organ replacement and regeneration. Tissue engineering strategies utilize biomaterials, cells, and bioactive molecules. The fundamental hypothesis motivating my research is that the mechanical and the biochemical characteristics of the microenvironment where stem cells grow, differentiate, and form neo-tissue control the fate of these cells and their specific differentiation path. By understanding the complex interplay between the mechanical, and biochemical stimuli on stem cells, we will be able to develop strategies leading to cell/scaffolding constructs that will allow the regeneration of lost or damaged musculoskeletal tissue.

Selected Publications


http://www.cbme.ou.edu/faculty/sikavitsas.htm
Our research aims at understanding how various molecules behave at interfaces (solid-liquid, liquid-gas, and liquid-liquid). The molecules of interest include proteins, polymers, surfactants, solvents, and, most importantly, water. We believe that our research, exquisitely fundamental, will result in practical applications as diverse as nanofluidic devices, safe storage systems for nuclear waste, enhanced oil recovery, and water desalination operations.

Our currently active projects investigate aqueous electrolyte solutions (towards enhancing ion-exchange processes), lubrication in cartilage (to remediate osteoarthritis symptoms), self-assembling colloidal systems (to design ‘molecular factories’), heat transfer in nanocomposite materials (to engineer advanced lubricants for extreme conditions), and the optimization of heterogeneous catalysts (our goal is 100% product selectivity).

Our activities require an arsenal of inter-disciplinary approaches in which accurate experimental results are coupled with state-of-the-art computational and theoretical investigations. Our laboratory is equipped with one computational cluster, hotohke, and with experimental machinery suitable for the study of interfacial phenomena. We developed significant expertise in conducting classical Monte Carlo and molecular dynamics simulations. We are extending our capabilities to include ab initio methods and integral equations. When the experiments required to validate our theoretical predictions cannot be performed within our facilities, we rely on experienced collaborators with whom we have established a fruitful intellectual exchange of ideas, problems, and solutions.

The results of our research have been featured in over 50 peer-reviewed journal articles and 3 book chapters, and discussed at over 70 invited or contributed seminars.

**Selected Publications**


http://hotohke.ou.edu/~astriolo/
IASR was established in 1986 as a Research Center/Institute and is the oldest continuous Industrial Consortium at the University of Oklahoma. Although research grants from Federal and State agencies are an important part of the Institute, our core mission is to provide our sponsors with the highest quality applied surfactant research in their areas of interest. The centerpiece of our center is our annual meeting, where sponsors are invited to attend a day-long conference where IASR students and faculty present the results of their research. We strive to provide an informal atmosphere at the meeting to maximize interaction between our faculty, students and sponsor representatives.

Peer-reviewed publications describing work performed in the center number 15-20 each year. Four of the seven professors belonging to IASR are members of CBME. Two of these have been recognized by the University as George Lynn Cross Research Professors because of the quality of their work in surfactants. Many of our former students have gone on to permanent employment with a sponsor; part of the value of IASR to a sponsor is the ability to meet students who have been trained in areas of interest to their companies.

Sponsors of IASR (November 2008)
- Akzo Nobel
- Church & Dwight
- Clorox
- Conoco/Phillips
- Dow Chemical
- Ecolab
- Halliburton Services
- Huntsman
- Oxiteno
- Procter & Gamble
- Sasol
- SC Johnson
- Shell Chemical

Bottom Row (L to R): Tohren Kibbey, John Scamehorn, Dave Sabatini
Top Row (L to R): Jeff Harwell, Brian Grady, Ed O’Rear.
Not pictured Ben Shiau.
Single-walled carbon nanotubes (SWNTs) are exceptional materials with unmatched electrical, thermal, mechanical, and optical properties. The University of Oklahoma (OU) has a technological advantage in the production of SWNTs, via the use of a proprietary catalyst and a truly scalable production process (6 key patents issued, strong position in the IP field). Based on this novel technology, an OU startup company (South-West Nanotechnologies, SWeNT) is developing a large-scale process (CoMoCAT) that will greatly increase the availability of SWNTs of the highest quality.

CaNTeC, the Carbon Nanotubes Technology Center at the University of Oklahoma, focuses on enabling new technologies based on the availability of CoMoCAT SWNTs. We capitalize on our unique position of having available large quantities of well-characterized SWNTs. The research scope is multidisciplinary and incorporates experts from different areas who work in the development of nanotube applications of high impact in the energy, biological, and environmental sectors.

Specific CaNTeC research objectives include:

- optimize the synthesis, purification, and separation of specific SWNTs for unique applications;
- develop smart SWNT films that can interact with light and molecules in a predictable way for sensor and biosensor applications;
- produce novel SWNT-metal and SWNT-polymer composites with improved mechanical, thermal, and electrical properties;
- investigate the interactions between SWNTs and living cells for development of diagnostic techniques and explore potential health effects.

Funding for CaNTeC is generously provided by the US Department of Energy and the Oklahoma Center for the Advancement of Science and Technology (OCAST).

CaNTeC is directed by Daniel Resasco. Current members are Brian Grady, Roger Harrison, Dimitrios Papavassiliou, Peter McFetridge, David Schmitdke, and Alberto Striolo.
As engineers, our discoveries become important when they provide a positive impact to our society. There is no better way to measure this than by counting the patents issued to our faculty. Reflecting the research activities conducted within the department, our patents offer different flavors of innovations. A brief summary is provided below. These discoveries sometimes lead to companies that, spinning-off from the University of Oklahoma, generate a strong positive impact on our State’s economy.

**Measurement Techniques**

**Materials and Conversion**

**Advanced Processing Methodologies**

**Energy**

**Pharmaceuticals Development**

**Environmental Protection**

**Consumer Goods**

**Design**
2008 Peer-Reviewed Journal Contributions


The quality of research carried out in our department is recognized by a broad base of external research support, which is steadily increasing over the years, as shown below.

In 2008 our research was supported by a number of extramural agencies, including, but not limited to: the U.S. Department of Energy (DoE), National Science Foundation (NSF), National Institutes of Health (NIH), Department of Defense (DoD), Department of Education, Department of Transportation, the Oklahoma Department of Transportation, the A.C.S. Petroleum Research Fund (ACS PRF), the Oklahoma Center for the Advancement of Science and Technology (OCAST), the Oklahoma Bioenergy Center (OBC), the Oklahoma State Regents for Higher Education, the American Heart Association and several private enterprises. Based on the first four months of fiscal year 2009, the estimated extramural research expenditures in our department will surpass $3 million in fiscal year 2009.

We thank all the institutions listed above for their continuous vital support.

Also important are the following chairs and professorships, made possible by private donations. The impact of these donations will last for generations to come.

- Asahi Glass Chair, established 1989
- Francis W. Winn Chair, established 1999
- Douglas and Hilda Bourne Chair, established 2004

- C.M. Sliepcevich Centennial Professorship, established 1989
- Conoco / Du Pont Professorship, established 1992
- Sam A. Wilson Professorship, established 1996
- Francis W. Winn Professorship, established 1999
Jose Efrain Herrera, Ph.D.

José graduated in 2004. After a two-year postdoctoral fellowship at Pacific Northwest National Laboratories, José joined the Faculty of Engineering at the University of Western Ontario. José’s research is focused on the design and synthesis of nanomaterials, with specific emphasis in environmental applications. The research goal is to establish activity-structure relationships for novel nano-scale materials. His work will lead to the characterization and design of a new generation of nanomaterials. José is co-director of RESTORE, a multidisciplinary group focused on the development of novel sustainable environmental remediation technologies.

Edgar J. Acosta, Ph.D.

Ed received his Ph.D. in 2003. He then joined the Department of Chemical Engineering and Applied Chemistry at the University of Toronto, Canada. He studies lung surfactants, lecithin-based microemulsions as drug-delivery vehicles, low-surface-tension films, and the interfacial curvature of surface-active compounds. The guiding principle of his research is to employ thermodynamic principles to characterize and utilize natural surfactants. The goal consists of designing consumer products based on sustainable ingredients. Surfactants are for example extracted from wastewater sludge, and even from heavy crude oils. Lipids extracted from calf lungs, and lecithin extracted from plant seeds are being used to formulate drug-delivery systems.

Holly Krutka, Ph.D.

Holly received her Ph.D. in 2007, and she then joined ADA Environmental Solutions, where she holds the position of Research Scientist. Holly researches and develops environmental technologies to reduce emissions from electric utilities, with the specific focus of CO₂ capture. The goal of her research is to identify promising materials and collaborate with others to develop a process that can reduce the energy needs for commercial-scale CO₂ capture. She is already the technical lead on a $3.2 million, 27-month research program supported by the US Department of Energy National Energy Technology Laboratory.

Leandro Balzano, PhD

Leandro graduated in 2006. In 2003 he co-founded SouthWest Nanotechnologies with Dr. Daniel Resasco. In this company, he occupied the position of Chief Development Engineer for almost 4 years. In late 2006 Leandro joined Shell Global Solutions where he was in charge of developing Shell’s Nanotechnology Strategy. He currently coordinates a group of more than 40 people from different Shell organizations that are looking into nanotechnology to provide novel solutions for both downstream and upstream operations. Leandro is also Shell’s technical lead at the Advanced Energy Consortium, which is a $30 million initiative exploring the use of nanotechnology for Reservoir Surveillance and Enhanced Oil Recovery.

Rising and Shining Stars

We have so far presented patents, books, and papers that we have produced over the years. However, the mission of an academic research institution is primarily to prepare the next generation of scientists. The success of our alumni is for us the greatest source of pride and gratification. Out of many examples, we provide herein some bright stars, selected over a wide temporal period to testify to the continuous contribution of our department to the technological development not only in the US, but worldwide!
Gary Jacobs, Ph.D.
Gary graduated in 2000 and joined the University of Kentucky’s Center for Applied Energy Research, where he is Engineer Associate IV in the Catalysis Group headed by Professor Burton H. Davis. Gary applies in-situ catalyst characterization techniques (e.g., synchrotron, adsorption, isotope tracer and infrared methods) to shed light on the surface active sites and reaction mechanisms of working catalysts in several areas, including Fischer-Tropsch synthesis, hydrogen production and purification for fuel cell applications (e.g., in collaboration with Honda Research USA, Inc.), and NOx conversion. He has coauthored over 75 peer-reviewed publications, and has been awarded two top-50 most cited article awards from Elsevier. He is PI or co-PI on various projects, the most recent being a $1.4 million 3-year contract sponsored by the US DOE-NETL for investigating the response of Fischer-Tropsch and water-gas shift catalysts to contaminants arising from syngas feeds generated from biomass and coal blends.

Susan M. Stagg-Williams, Ph.D.
After receiving her Ph.D in 1999, Susan joined the Chemical and Petroleum Engineering faculty of the University of Kansas where she is currently an Associate Professor. Her research group focuses on the synthesis and characterization of catalysts and membrane reactors for the production of alternative fuels. She is the lead PI of the “Feedstock to Tailpipe” integrated research team including faculty and students from geography, ecology, chemical, mechanical and environmental engineering. This team investigates all aspects of biofuels and chemicals production from biomass, including feedstock production, chemical transformation, fuel assessment, and ecosystem impacts. She is also the Director of the KU Biodiesel Initiative, an undergraduate student initiative to convert the used cooking oil from the campus dining services to biodiesel for use in campus vehicles. In the last year the student volunteers from a variety of disciplines on campus produced over 1000 gallons of biodiesel which is currently used to fuel all diesel landscaping vehicles on campus.

Bojan Mitrovic, MSc
After receiving his MS in 2003, Bojan joined Veeco Instruments, Inc where he currently holds the position of Senior Scientist. He leads the process modeling group in the advanced systems development department, as well as all activities related to MOCVD (Metal-Organic Chemical Vapor Deposition) equipment modeling, including: advanced Computational Fluid Dynamics (CFD), process, thermal, and structural modeling. Bojan also serves as a principal advisor/engineer in conceptualizing and designing new generation MOCVD Reactors, used for large-scale production of advanced semiconductor materials, especially for GaN-based blue and green LEDs, lasers, as well as structures used in solar cell industry. Bojan is author of several US patent applications, as well as of a number of peer-reviewed journal publications.

David W. Larkin, Ph.D.
David got his Ph.D. in 2001. Since graduating from the University of Oklahoma, David has worked in the petroleum industry for about 8 years in which he has done hydroprocessing research and engineering technical support for lube and light oil processes within oil refineries located around the world (i.e. United States, Japan, South Korea, Egypt, and China). Currently, he works in the Refining Technical Services (RTS) department for Conoco-Phillips. In RTS he serves as a principal advisor for a light oil processing network. The network supports light oil catalytic and solvent based technologies within ConocoPhillips refineries. This would include such technologies as Isomerization, Reforming, Aromatic Extraction, Alkylation, and S Zorb® SRT.

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Rising and Shining Stars

School of Chemical, Biological and Materials Engineering
Mariano J. Savelski, Ph.D.
Mariano is associate professor of Chemical Engineering at Rowan University, which he joined after earning his Ph.D. in 1999. Mariano’s research interests include the design of sustainable processes and Life Cycle Assessment studies for the pharmaceutical industry, solvent recovery, and food manufacturing. He has also been actively involved in the development of new strains of E. coli bacteria for the optimal production of bioethanol from biomass.

Hatice Gecol, Ph.D.
Hatice joined the Nevada Governor’s Office as the Energy and Science Advisor to Governor Gibbons and the Director of the State Office of Energy in 2007. She is one of the leaders in formulating policy and developing Nevada’s abundant renewable energy resources. She worked as an associate professor in the Chemical Engineering Department at the University of Nevada, Reno from July 2006 until December 2008. She was also assistant professor in that department from August 2000 until July 2006. However, her best memories are the two years she spent as a post doctoral research associate with Dr. Scamehorn at the then School of Chemical and Materials Engineering, University of Oklahoma after receiving her Ph.D. in 1998.

John O’Haver, Ph.D.
John received his Ph.D. in 1995, and has held a faculty position at the University of Mississippi since 1996. He is now professor in the Department of Chemical Engineering at that University. His research is focused on fundamental and applied surfactant science, K-12 outreach, and engineering education. John is the Director of the Center for Mathematics and Science Education at the University of Mississippi.

Chon-Lin Lee, Ph.D.
Chon-Lin graduated in 1989. Since 1999 he is professor in the Department of Marine Environment and Engineering, National Sun Yat-sen University, Taiwan. His research interests include coastal environmental chemistry, contaminant fate and transport, water quality, colloid and surface chemistry, and wastewater treatment.

Nicholas P. Hankins, Ph.D.
Nick graduated in 1989. He has over 6 years of industrial experience in the petroleum and chemicals industries and over 15 years of academic experience in both US and UK institutions. He is now University Lecturer in Chemical Engineering at the University of Oxford, UK and a Fellow of Lady Margaret Hall (one of the Oxford Colleges). His current research interests lie in the field of colloidal and interfacial processes, with emphasis on separations. He is the Director of the Centre for Sustainable Water Engineering at Oxford University.

James Rathman, Ph.D.
Jim received his Ph.D. in 1987. After nearly 5 years working in R&D for the Clorox Company, he joined The Ohio State University, where he is now professor of Chemical & Biomolecular Engineering. His research focuses on molecular self assembly at interfaces and in colloidal systems.

Robert O. Dunn Jr., Ph.D.
Bob graduated in 1987, took a post-doctoral position at the DoE lab in Morgantown, WV, and then joined the USDA Agricultural Research Service in Peoria, IL, as a Senior Research Scientist. Bob worked on developing biofuels long before it became a hot topic. His research focuses on improving fuel properties and performance of biodiesel made from vegetable oils and animal fats.
University and Community

Located in Norman, Oklahoma, the University of Oklahoma is the center of a variety of activities that enhance the graduate education experience. Norman is a wonderful settlement of around 100,000 people with a small community feel. Students enjoy opportunities for intellectual, cultural, and recreational activities, as well as other entertainment options.

- **History of Science Collection**
  OU’s History of Science Collection, part of the University Library system, is the largest history of science collection in the world. It includes, among others, a first edition of Galileo’s ‘Dialogo’, with Galileo’s own handwritten corrections, and other 470 books by or about Galileo.

- **Museums**
  OU’s two public museums, the Fred Jones Jr. Museum of Art and the Sam Noble Oklahoma Museum of Natural History are among the top university-based museums in the country. The art museum boasts an impressive French impressionism collection including works by Degas, Monet, Van Gogh, Renoir, and others, as well as East-Asian, twentieth-century American, contemporary, and Native American collections.

- **University Theatre**
  OU students perform in a variety of musicals, plays, ballets, operas, modern dance shows, and concerts each year in the University Theatre Season.

- **Sooner Sports**
  The Sooners boast 26 national championships in men’s and women’s sports, more than 225 team conference titles and more than 700 All-Americans.

- **Oklahoma City**
  Just a short drive takes you from Norman to Oklahoma City, home of the Bricktown Entertainment District, NBA games, AAA baseball games, major concerts, and other fun attractions.

The diversity of Oklahoma is reflected in its breathtaking landscapes. From pristine mountain streams and piney forests to peaceful lakes and sandy beaches, the state offers endless vistas. Oklahoma’s 55 state parks and numerous wildlife refuges and recreation areas offer a wealth of outdoor adventure: fishing, camping, mountain biking, canoeing, horseback riding, rappelling, and scuba diving. There’s great golf to be found in every corner of the state.

The state hosts festivals, fairs and special events which reflect the state’s sense of heritage and community. These festivals include the Medieval Fair in Norman, Shakespeare in the Park in Edmond, Woody Guthrie Folk Festival in Okemah, Rattlesnake Festival in Apache, Kolache Festival in Prague, Reggaefest in Tulsa, Red Earth Festival in Oklahoma City, and Grant’s Bluegrass Festival in Hugo.

Whether it is musical entertainment, historical re-enactments, outdoor performances, cultural demonstrations, or unique arts and crafts, Oklahoma has an event for everyone. Visit http://travelok.com/ for information on all the wonderful things Oklahoma has to offer, including outdoor activities.
Make a difference,
Join our team!
Created by the Oklahoma Territorial Legislature in 1890, the University of Oklahoma is a doctoral degree-granting research university serving the educational, cultural, economic and health-care needs of the state, region and nation. The Norman campus serves as home to all of the university’s academic programs except health-related fields. Both the Norman and Health Sciences Center colleges offer programs at the Schusterman Center, the site of OU-Tulsa. The OU Health Sciences Center, which is located in Oklahoma City, is one of only four comprehensive academic health centers in the nation with seven professional colleges. OU enrolls more than 30,000 students, has more than 2,300 full-time faculty members, and has 20 colleges offering 158 majors at the baccalaureate level, 167 majors at the master’s level, 81 majors at the doctoral level, 26 majors at the doctoral professional level, and 24 graduate certificates. The university’s annual operating budget is $1.46 billion. The University of Oklahoma is an equal opportunity institution.