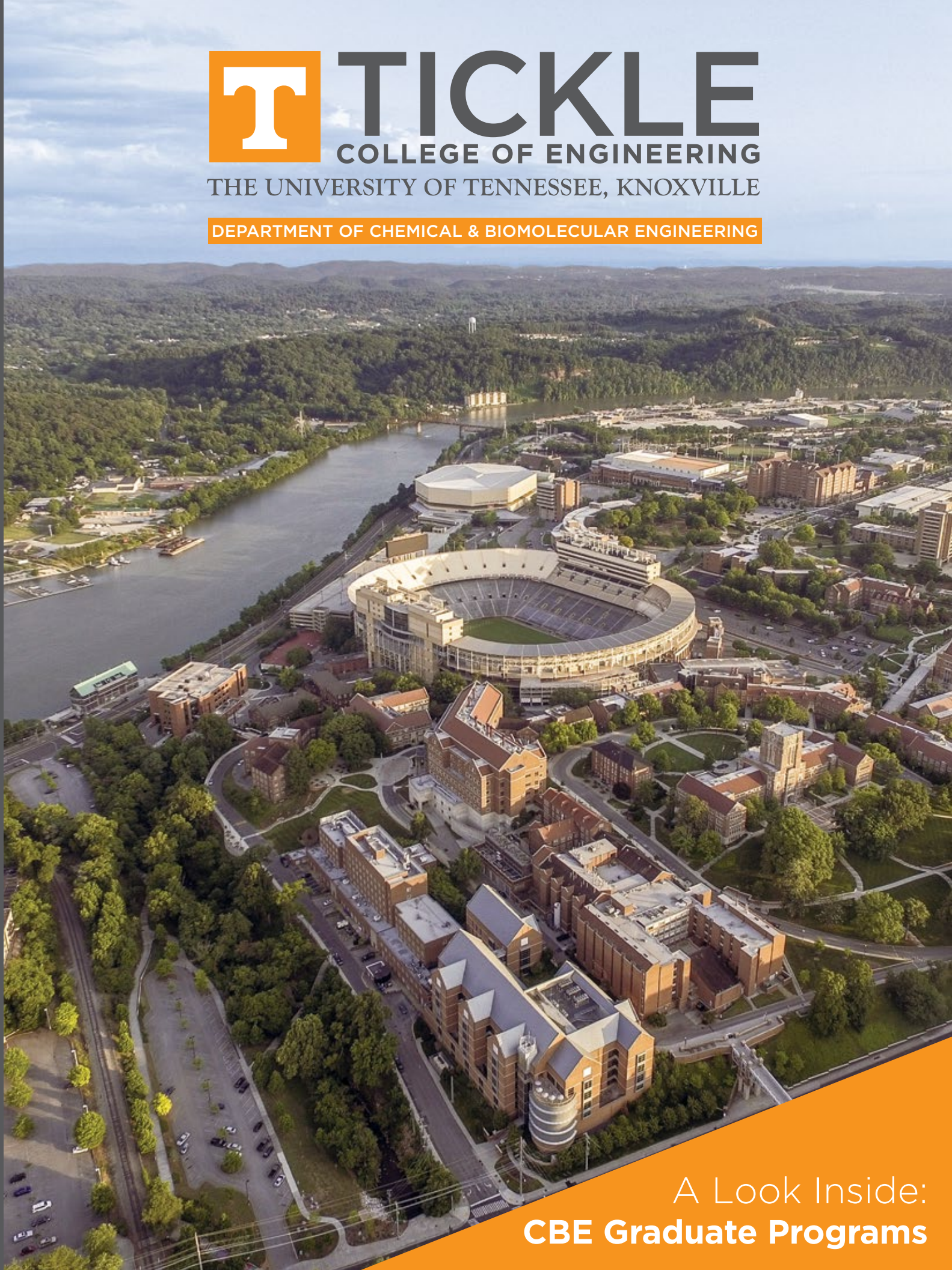
TICKLE COLLEGE OF ENGINEERING

THE UNIVERSITY OF TENNESSEE, KNOXVILLE

DEPARTMENT OF CHEMICAL & BIOMOLECULAR ENGINEERING



A Look Inside:
CBE Graduate Programs

Established in 1838, the Tickle College of Engineering has a long tradition of commitment to excellence in scientific research and the training of engineering professionals. The college consists of seven departments of study, seven nationally renowned research centers, and more than 100 state-of-the-art laboratories.

Rankings

Ranked 33rd (undergraduate) and 29th (graduate) among public colleges of engineering.
(U.S. News & World Report 2019).

Enrollment

Undergraduate: 3,509
Master's: 381
Doctoral: 728
Total: 4,618

Quick Facts

- 33% growth in PhD enrollment since 2012 —one of the fastest-growing PhD programs in the nation
- Three new buildings opened since 2012, with a fourth in the design phase (to open in 2021)
- 27,900+ alumni worldwide

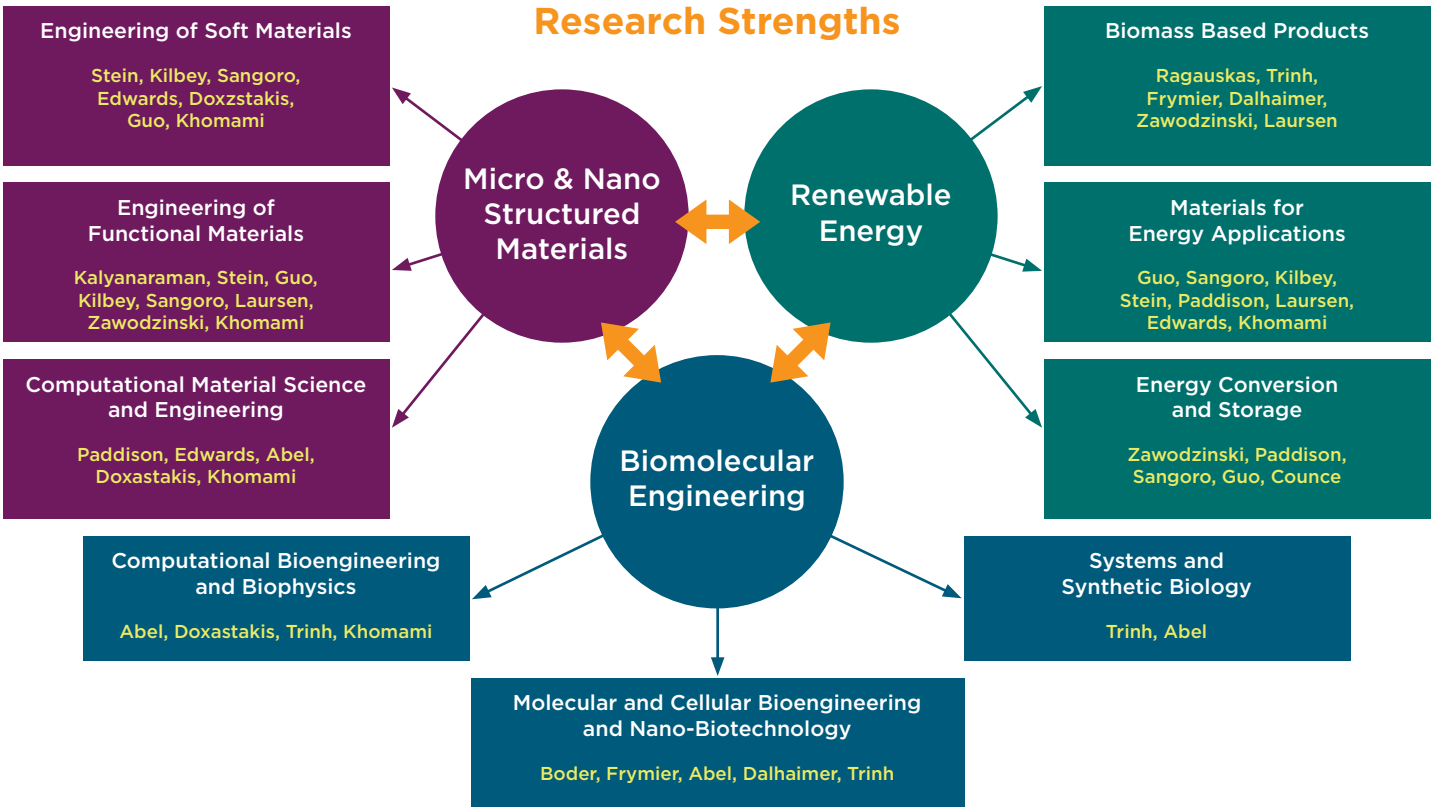
CBE Admission Requirements

Minimum standards: must have a bachelor's degree from an accredited institution and a 3.0 out of a possible 4.0 GPA. Satisfactory performance on the Graduate Record Exam(GRE) general test is also required for consideration for admission. Competitive applicants have GRE quantitative scores of approximately 160 or better and a combined score on the verbal and quantitative sections of 315 or better. Contact the department for specific additional application or program requirements.

International applicants whose native language is not English must submit TOEFL or IELTS test scores to be fully admitted.

Estimated Cost of Attentance

Academic Year 2018–2019
Graduate In-State Student $13,120
Graduate Out-of-State Student $31,538 Engineering Fee (per semester hour) $64
Additional special course fees may apply.
onestop.utk.edu/tuition-detail

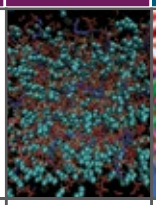
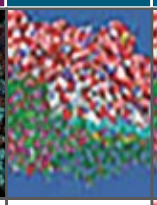
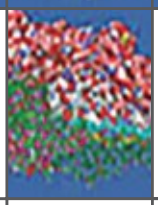


In order to meet global challenges in health care, the environment, renewable energy sources, national security, and economic prosperity, the Department of Chemical and Biomolecular Engineering has instituted innovative partnerships with nearby **Oak Ridge National Laboratory** (ORNL), local industry, and other disciplines at the University of Tennessee, such as medical, life, physical sciences, and business.

- BESC: DOE Bioenergy Solutions Center
- CEB: Center for Environmental Biotechnology
- Eastman Chemical Company
- ISSE: Institute for Secure & Sustainable Environment
- JIAM: Joint Institute for Advanced Materials
- JICS: Joint Institute for Computational Sciences
- Neutron Science Research at ORNL
- Oak Ridge National Laboratory
- SEERC: Sustainable Energy & Education Research Center

The National Institute for Computational Sciences (NICS) is one of the leading high-performance computing centers for excellence in the United States. NICS is co-located on the University of Tennessee, Knoxville, and ORNL campuses. The institute's mission is to expand the boundaries of human understanding while ensuring the United States' continued leadership in science, technology, engineering, and mathematics.

Research Strengths

Faculty	Micro & Nano Structured Materials			Biomolecular Engineering			Renewable Energy		
	Engineering of Soft Materials	Engineering of Functional Materials	Computational Material Science and Engineering	Computational Bioengineering and Biophysics	Molecular and Cellular Bioengineering and Nano-Biotechnology	Systems and Synthetic Biology	Biomass Based Products	Materials for Energy Applications	Energy Conversion and Storage
Abel									
Boder									
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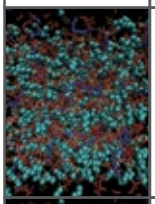
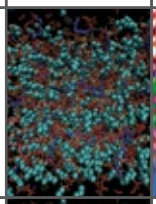
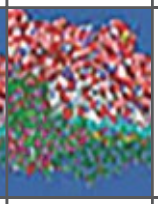
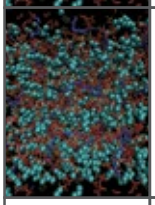
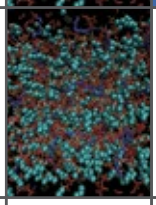
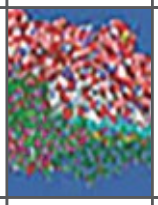
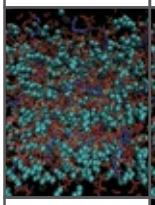
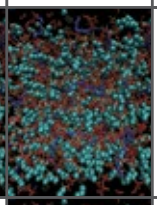
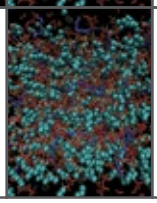
Dalhaimer									
Doxastakis									
Edwards									
Frymier									
Guo									
Kalyanaraman									

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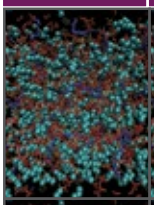
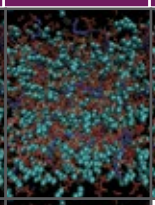
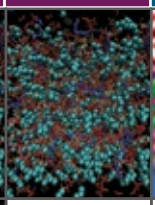
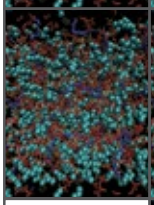
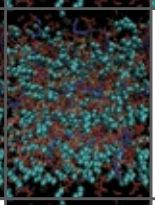
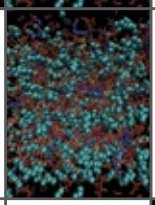
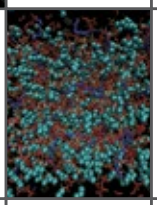
Khomani									
Kilbey									
Laursen									
Paddison									
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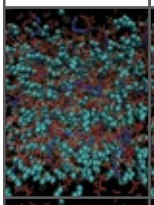
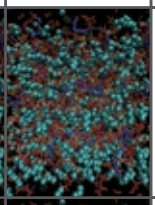
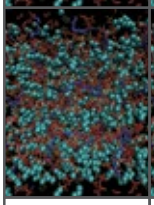
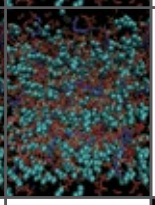
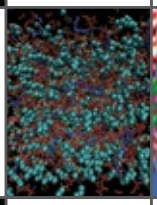
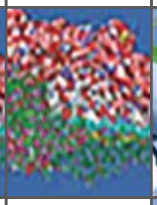
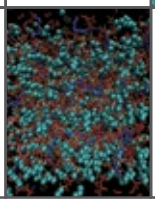
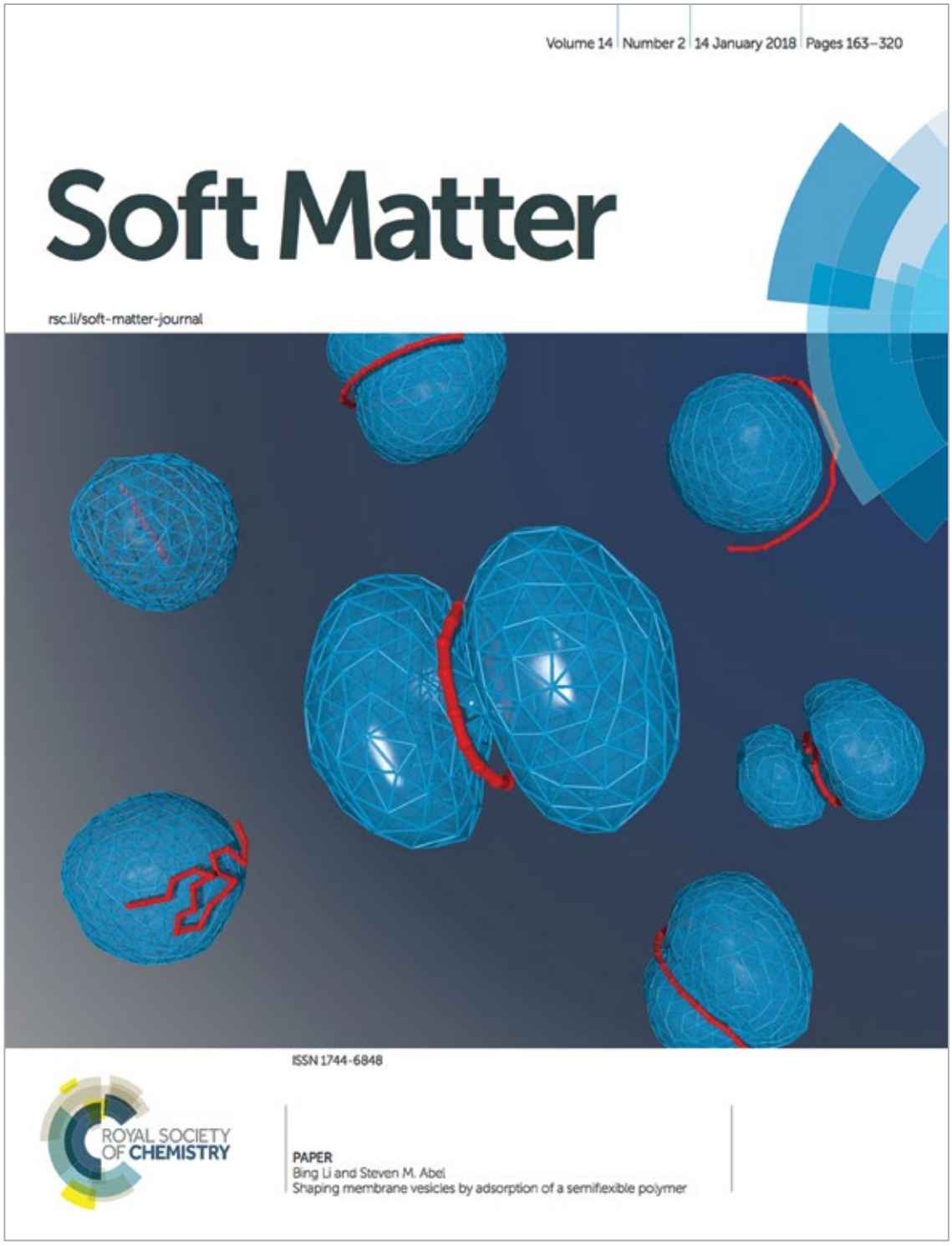
Sangoro									
Stein									
Trinh									
Zawodzinski									

High-Impact Research

Micro & Nano Structured Materials



Steven Abel

Li, B, Abel, SM (2018). Shaping membrane vesicles by adsorption of a semiflexible polymer. *Soft Matter*, 14(2), 185–193. doi: 10.1039/c7sm01751k

High-Impact Research

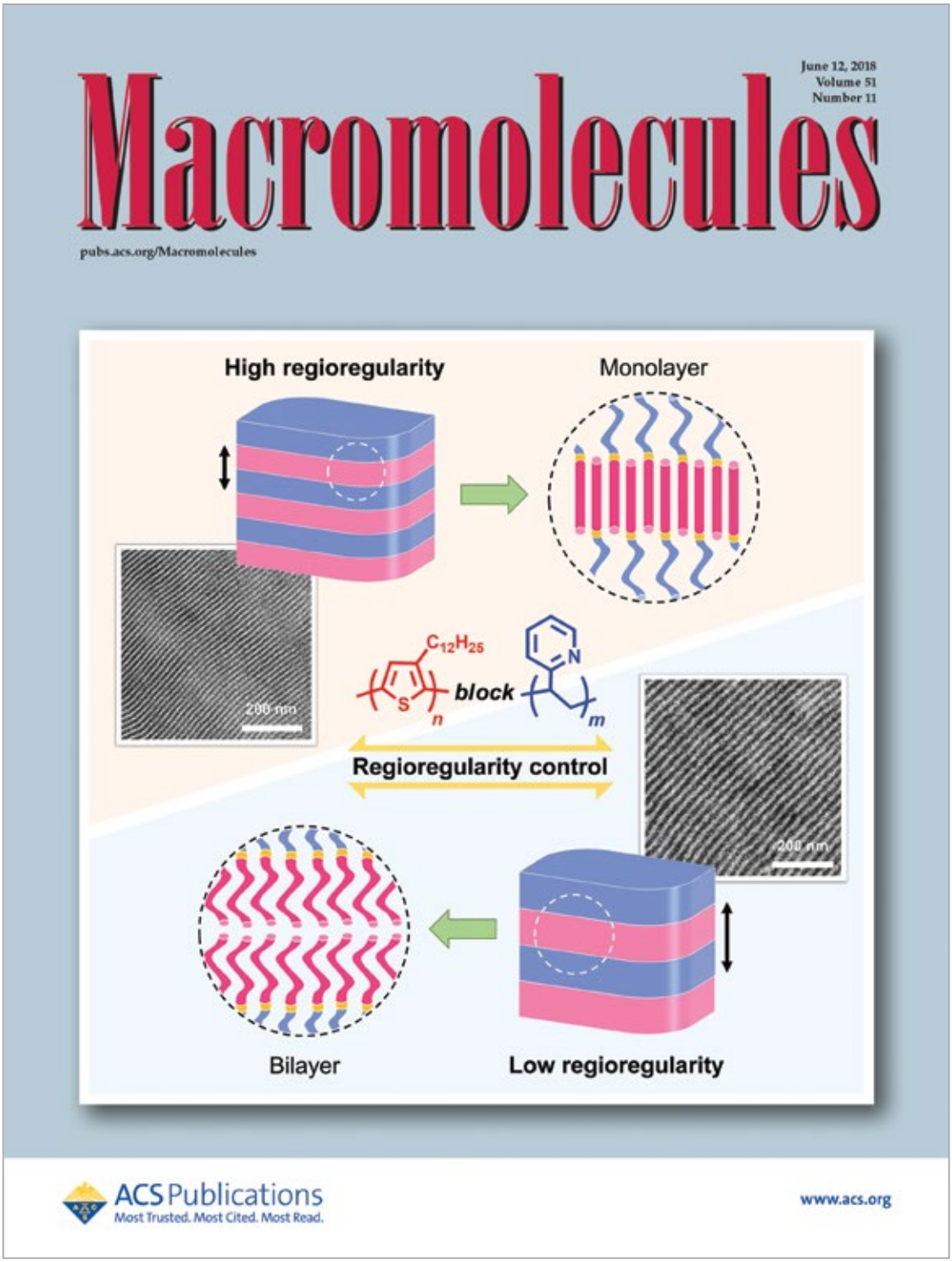
Micro & Nano Structured Materials

Brian Edwards

Sefiddashti, MHN, Edwards, BJ, Khomami, B. (2015). Individual chain dynamics of a polyethylene melt undergoing steady shear flow. *Journal of Rheology*, 59(1). doi: 10.1122/1.4903498

High-Impact Research

Micro & Nano Structured Materials

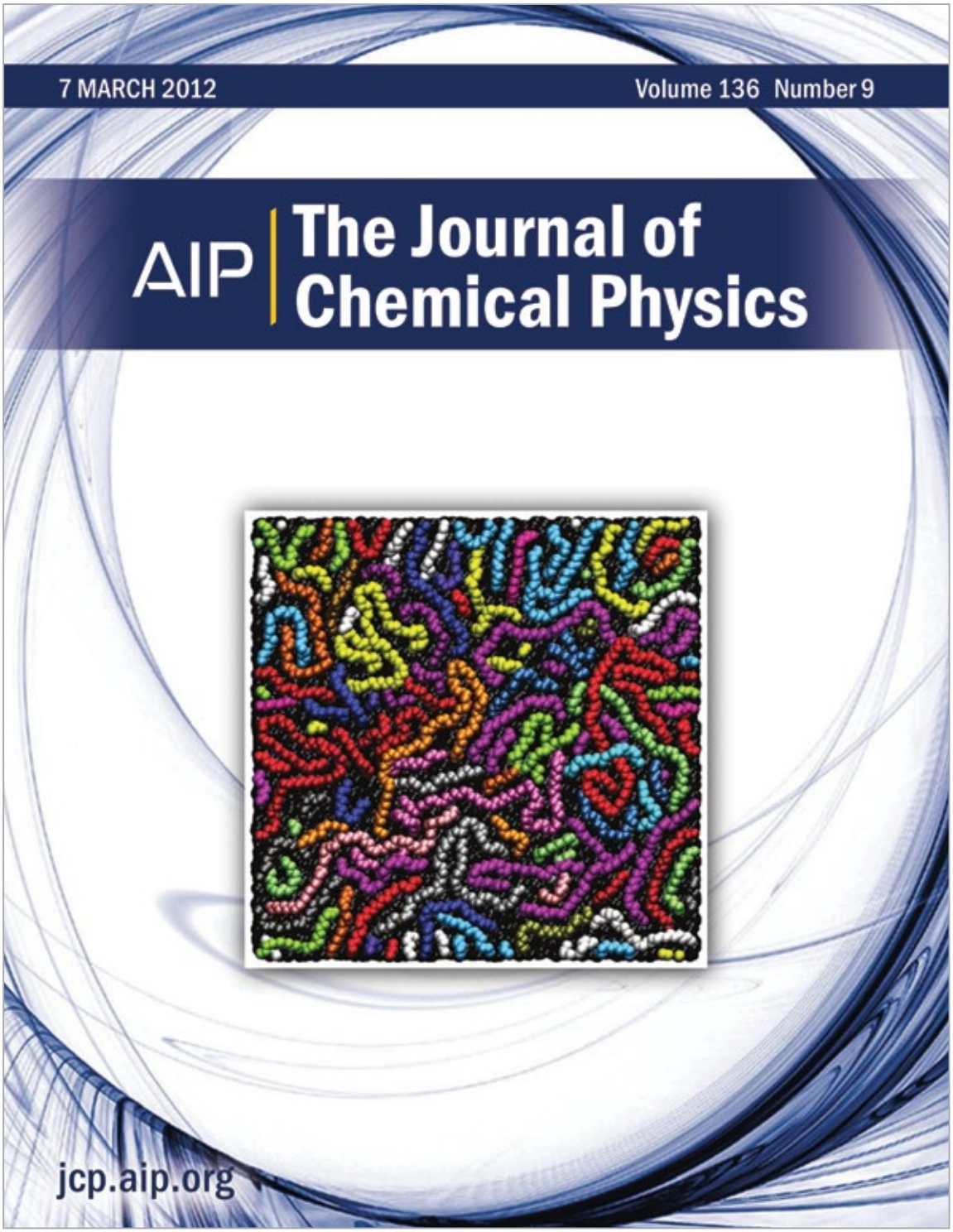


Gila Stein

Kim, JS, Han, J, Kim, Y, Park, H, Coote, JP, Stein, GE, Kim, BJ. (2018). Domain Structures of Poly(3-dodecylthiophene)-Based Block Copolymers Depend on Regioregularity. *Macromolecules*, 51(11), 4077-4084. doi: 10./acs.macromal.8b00795

High-Impact Research

Micro & Nano Structured Materials

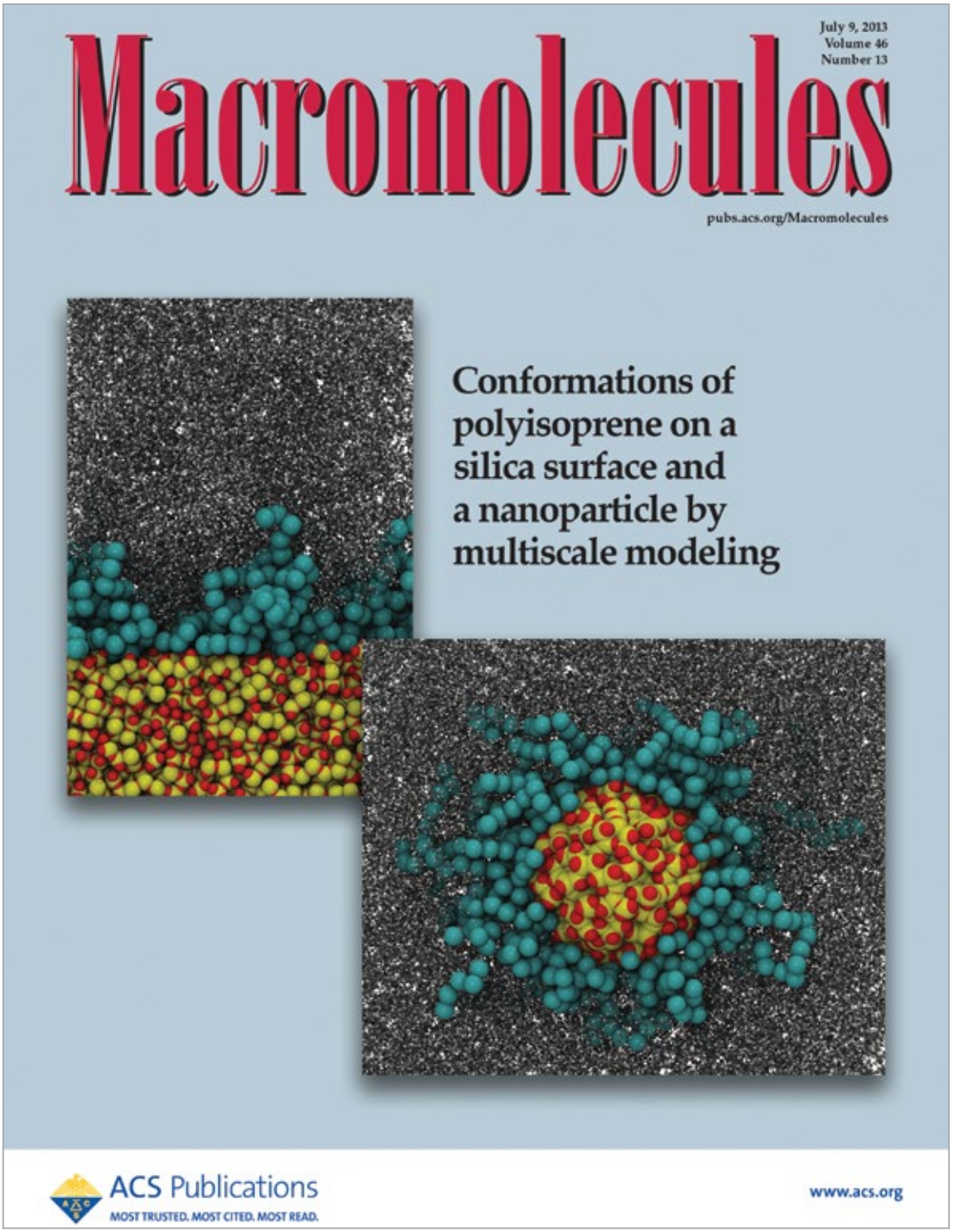


Manolis Doxastakis

Pandey, YN, Papakonstantopoulos, GJ, Doxastakis, M. (2013). Polymer/Nanoparticle Interactions: Bridging the Gap. *Macromolecules* 46 (13) 5097-5106. doi: 10.1021/ma400444w

High-Impact Research

Micro & Nano Structured Materials

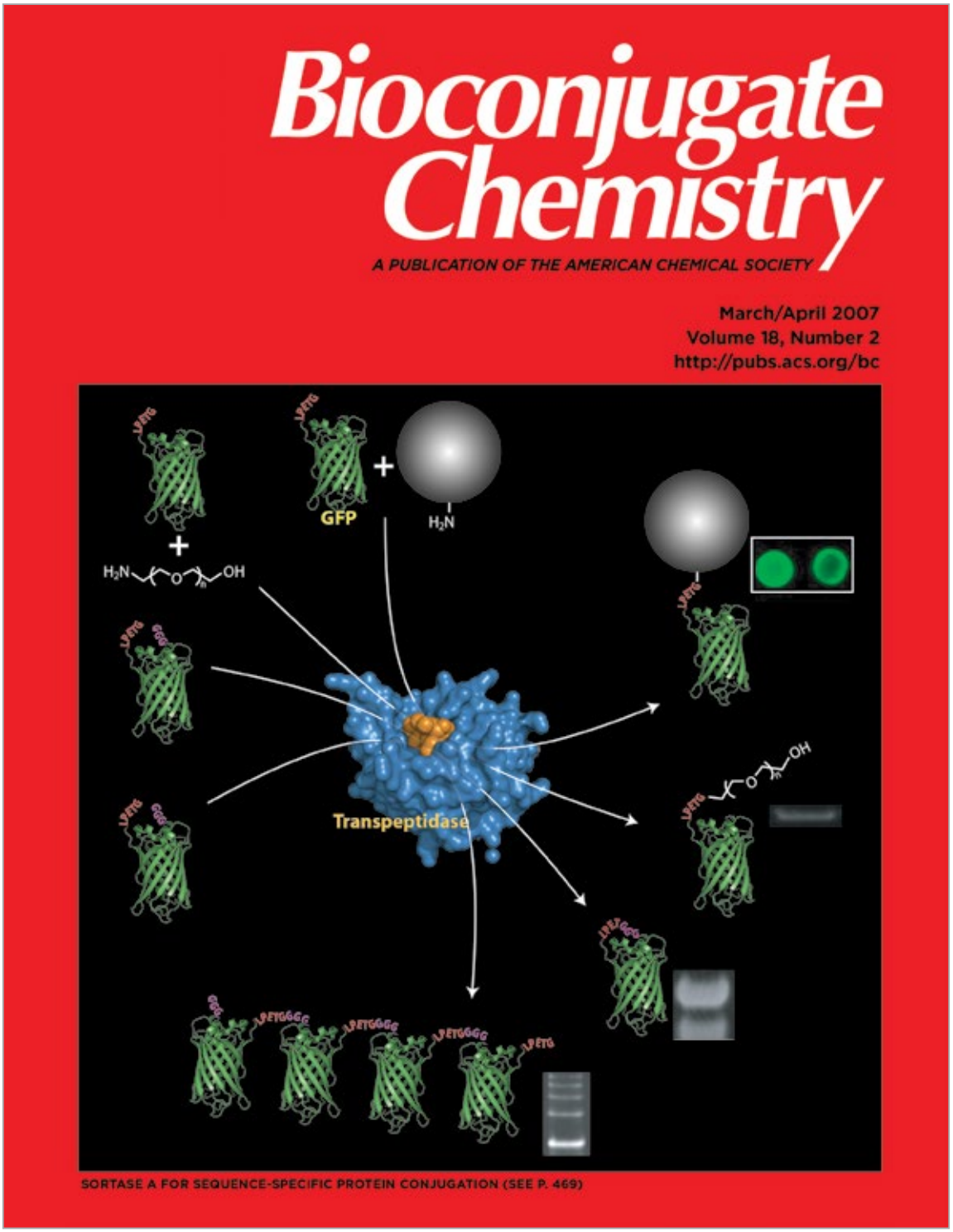


Manolis Doxastakis

Pandey, YN, Doxastakis, M. (2012). Detailed atomistic Monte Carlo simulations of a polymer melt on a solid surface and around a nanoparticle. *Journal of Chemical Physics* 136(9) 094901. doi: 10.1063/1.3689316

High-Impact Research

Biomolecular Engineering

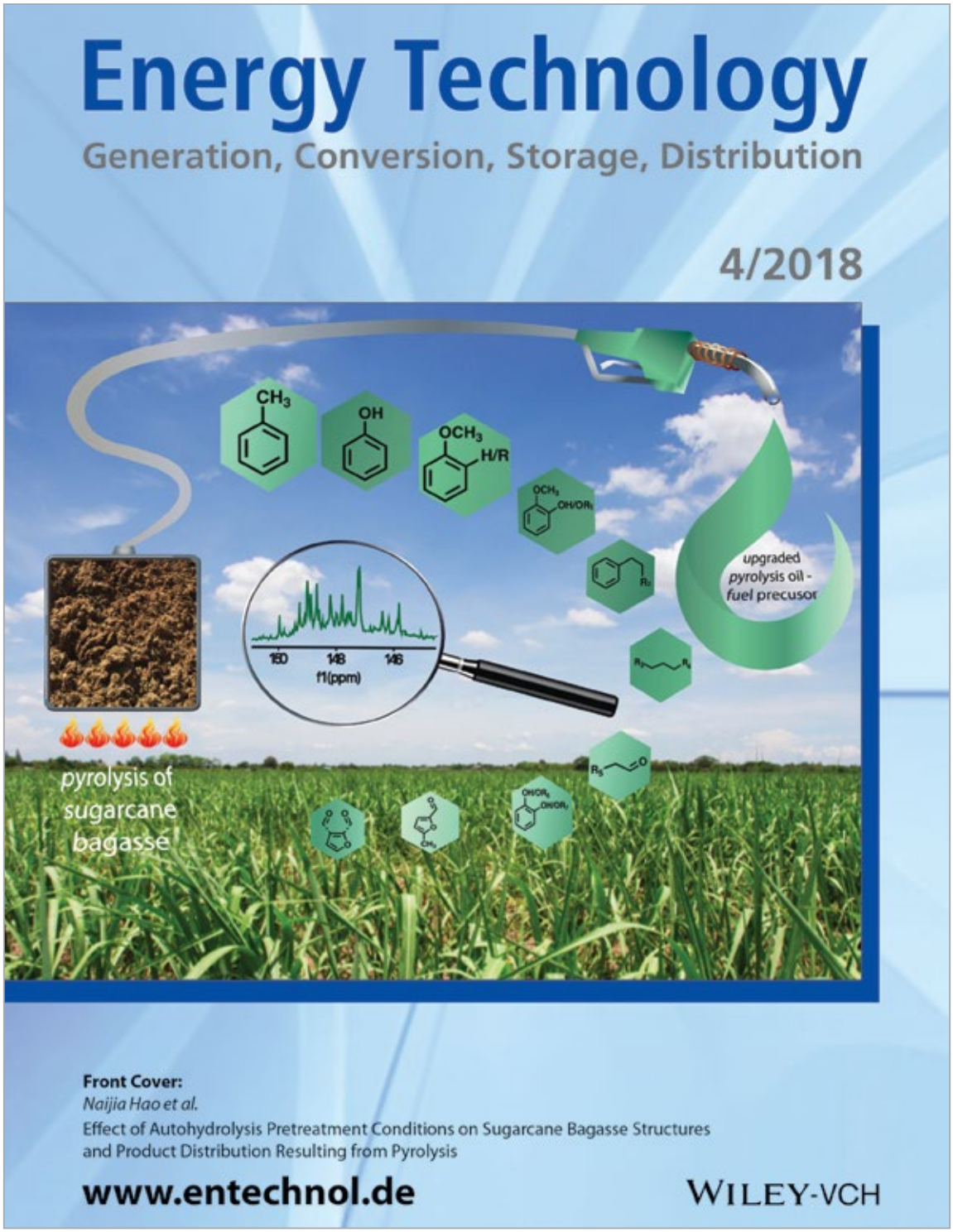


Eric Boder

Parthasarathy, R, Subramanian, S, Boder, ET. (2007). Sortase A as a novel molecular "stapler" for sequence-specific protein conjugation. *Bioconjugate Chemistry*, 18(2), 496-476. doi: 10.1021/bc060339w

High-Impact Research

Renewable Energy

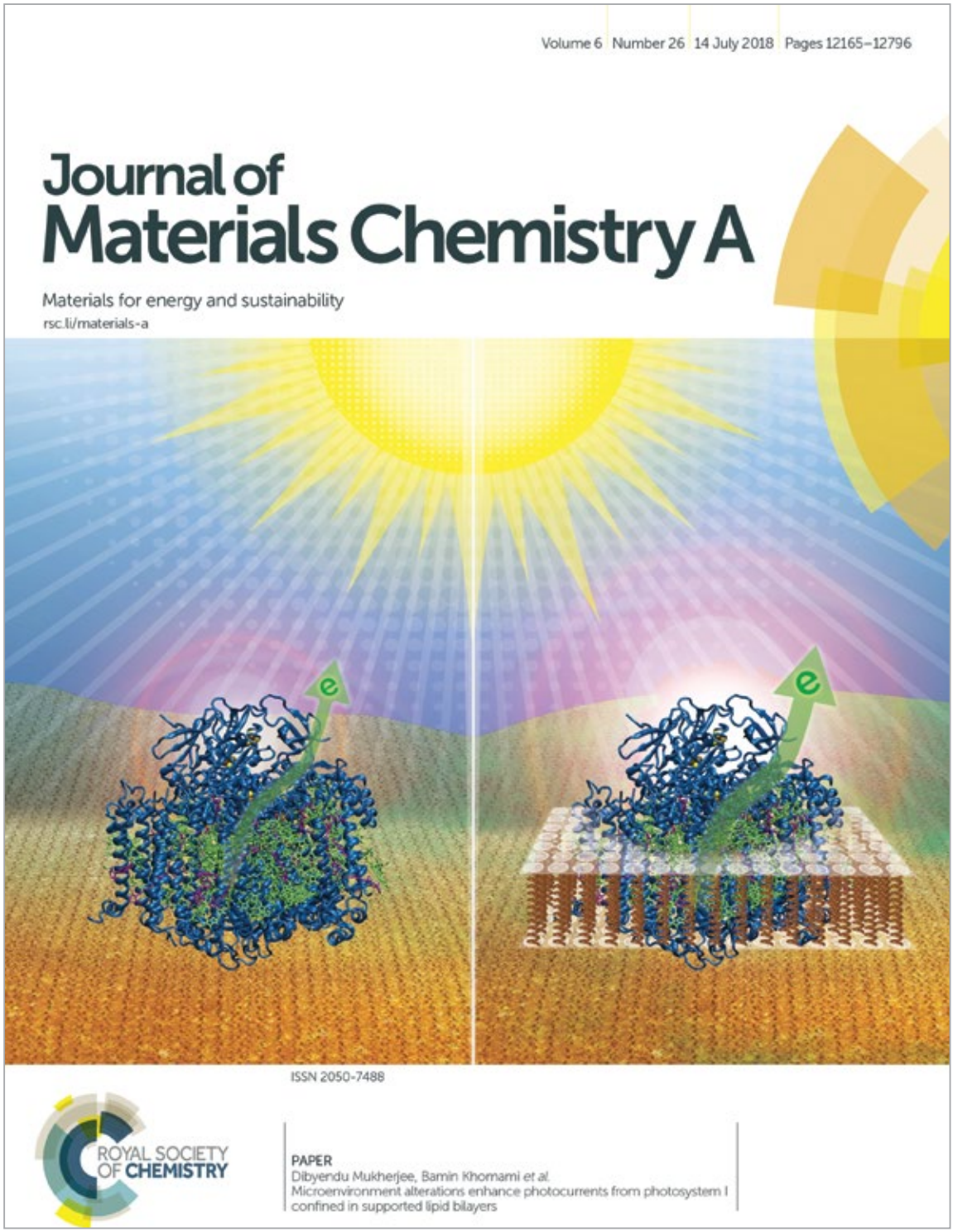


Arthur Ragauskas

Hao, NJ, Lu, KY, Ben, HX, Adhikari, S, Lacerda, TB, Ragauskas, AJ. (2018). Effect of Autohydrolysis Pretreatment Conditions on Sugarcane Bagasse Structures and Product Distribution Resulting from Pyrolysis. *Energy Technology*, 6(4), 640-648. doi: 10.1002/ente.201700490

High-Impact Research

Renewable Energy

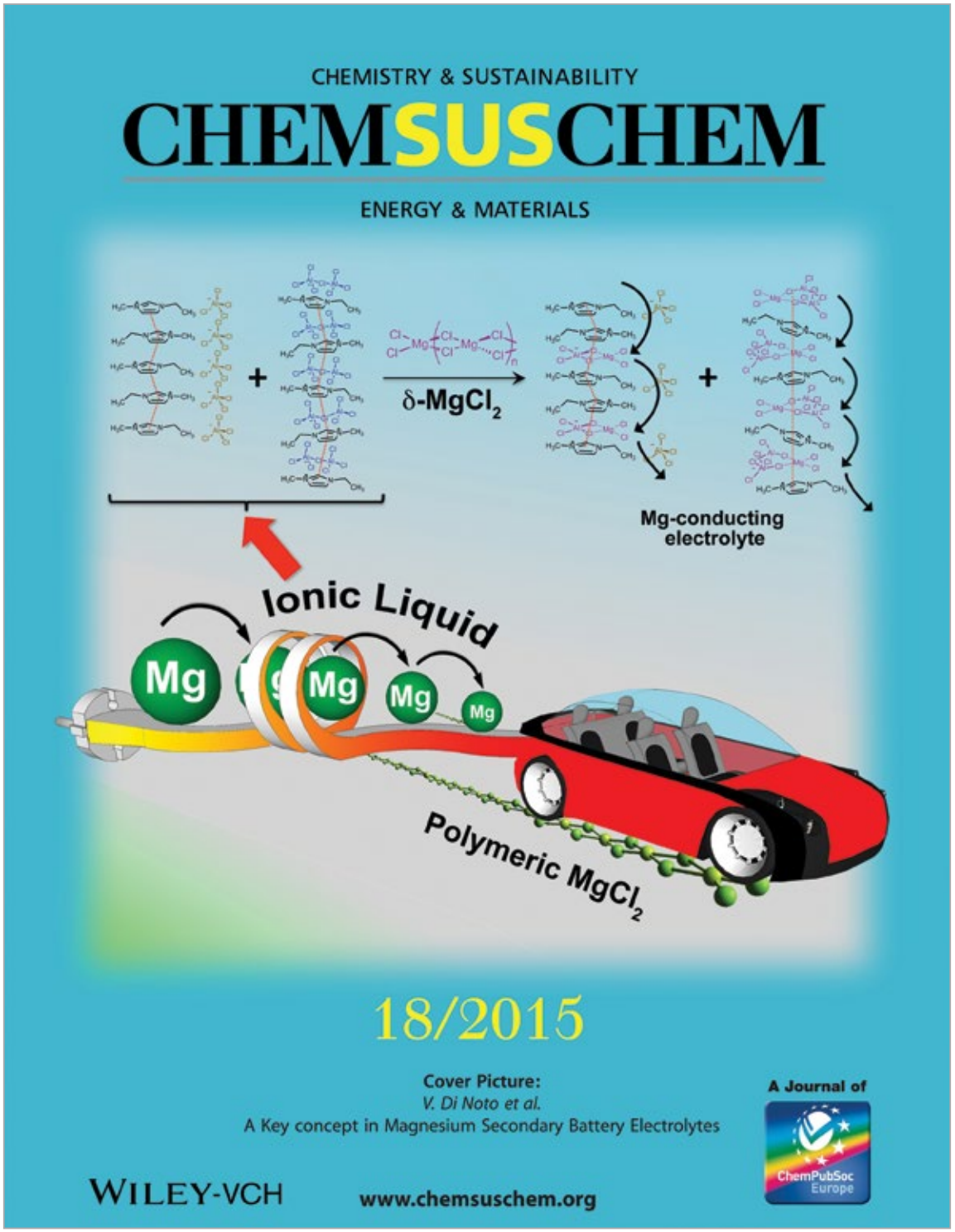


Bamin Khomami

Niroomand, H, Pamu, R, Mukherjee, D, Khomami, B. (2018). Microenvironment alterations enhance photocurrents from photosystem I confined in supported lipid bilayers. *Journal of Materials Chemistry A*, 6(26), 12281-12290. doi: 10.1039/c8ta00898a

High-Impact Research

Renewable Energy



Stephen Paddison

Bertasi, F, Herrige, C, Sepehr, F, Bogle, X, Pagot, G, Vezzu, K, Negro, E, Paddison SJ, Greenbaum, SG, Vittadello, M, DiNoto, V. (2015). A Key concept in Magnesium Secondary Battery Electrolytes. *Chemsuschem*, 8(18), 3069-3076. doi: 10.1002/cssc.201500339

Chemical & Biomolecular Engineering

Faculty

Bamin Khomami
Head, Department of Chemical and Biomolecular Engineering / Granger and Beaman Distinguished University Professor / Director, Sustainable Energy Education and Research Center
PhD, University of Illinois

Structure Dynamics and Rheology of Complex Fluids
Soft Matter

"Diversity of our research area provides us with a great opportunity to elucidate various fundamental physico-chemical phenomena and translate them into rational design and engineering of advanced materials."

Eric T. Boder
Career Development Associate Professor
PhD, University of Illinois

Protein Engineering
Applied Molecular Biology

"Our laboratory develops new tools to enable the redesign of natural protein machinery, focusing on proteins that undergo conformational regulation of activity (i.e., molecular switches). Such engineered proteins can be used as biosensors or developed as biotherapeutics."

Brian J. Edwards
Professor, Associate Head
PhD, University of Delaware

Nonequilibrium Thermodynamics

"My primary research focus is the theory of nonequilibrium thermodynamics, which I use to explore the boundaries between thermodynamics and fluid mechanics for complex flow systems such as polymeric melts and solutions, liquid crystals, and chemical delivery systems."

Steven M. Abel
Assistant Professor
PhD, Stanford University

Applies theoretical and computational methods to investigate fundamental problems in cell biology and immunology

"The Abel group investigates problems in cell biology, immunology, and soft biological materials using theoretical and computational methods. Specific interests include antigen recognition and immune cell activation, membrane and polymer biophysics, intracellular transport, and stochasticity in biochemical reaction networks."

Chemical & Biomolecular Engineering

Faculty

Robert M. (Pete) Counce
Professor
PhD, University of Tennessee

Applying green engineering approaches to design and modification of industrial processes

"Our group focuses on chemical separations and processes associated with converting chemical and radiochemical waste materials into useful products. Recent research topics include producing useful products from waste biomaterials from ethanol production, recovering and purifying radioactive species for use in medical diagnose and treatment of disease, and recovering rare-earth elements from waste streams associated with phosphoric acid production."

Manolis Doxastakis
Associate Professor
PhD, University of Patras

Uses computational methods as applied to a broad spectrum of soft matter that covers polymer melts, blends, copolymers as well as lipid membranes and protein assemblies

"Our research employs multiscale computational methods to study a broad spectrum of soft materials, such as polymer melts, blends, copolymers as well as lipid membranes and protein assemblies. Our ultimate goal is to engineer macroscopic behavior by tuning molecular structure."

Paul Dalhaimer
Associate Professor
PhD, University of Pennsylvania

Our laboratory is focused on two projects, 1) lipid droplet formation and distribution in eukaryotes, and 2) improving the efficacies of nanotechnologies for cancer treatment in patients with non-ideal metabolic conditions such as obesity

"Our laboratory focuses on cellular and organism-wide responses to fat imbalances. On the cellular level, we are interested in the formation, distribution, and breakdown of an organelle called a lipid droplet. Lipid droplets form from the endoplasmic reticulum when cells need to store fat. They are broken down when cells need energy or materials for phospholipids. On the organism-wide level we are interested in how obesity affects the efficacy of chemotherapy, especially chemo that is delivered via nanoparticles."

Paul D. Frymier
Associate Dean for Faculty Affairs and Engagement,
and Professor
PhD, University of Virginia

The study of microbial fuel cells and biological systems based on algae and cyanobacterial photosynthetic and electron transport systems for the production of electricity and hydrogen

"In my lab, we work with proteins that change redox state when exposed to light. These proteins to power a series of redox reactions for applications such as sustainable energy capture or biological sensing."

Chemical & Biomolecular Engineering

Faculty

John Zhanhu Guo
Associate Professor
PhD, Louisiana State University

Fundamental studies behind the multifunctional nanocomposites for energy harvesting
Environmental remediation
Pollutants treatment and recycling
Safety, sensing, and electromagnetic wave treatments (radiation) and applications (heating resources)

"To reach the goal of miniaturization and mulfunctions in devices and chemical units, Dr. Guo's Integrated Composites Laboratory (ICL) focuses on polymer, carbon, metal and ceramic nanocomposites with unique structures by designing, synthesizing, manufacturing and processing."

S. Michael Kilbey II
Professor
PhD, North Carolina State University

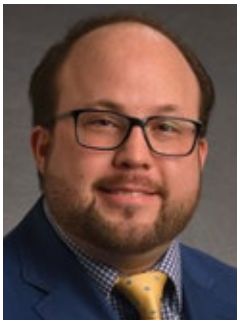
Assembly-structure-property relationships of polymer brushes made by self-assembly and by surface-initiated polymerizations
Swelling behavior of stimuli-responsive polymer layers and dynamics of preferential adsorption of amphiphilic block copolymers
Surface behavior and characterization of conducting polymer thin films

"Research in the Kilbey group is focused on design-structure-property relationships of polymers in solution and their thin films. We practice modern methods of polymer synthesis and characterize structure and properties at the molecular level with a focus on responsive and optoelectronic polymers."

Ramki Kalyanaraman
Professor
PhD, North Carolina State University

Advanced functional materials.
Solar energy
Plasmonics & optics
Nanomanufacturing

"Research in the group for nano and thin film science (GNATS) is focused on the betterment of humankind through a discovery-based approach focused on advanced materials and their cost-effective manufacturing for applications in nanotechnology, sustainability, electronics, and sensing."



Siris O. Laursen
Assistant Professor
PhD, University
of Michigan

Directed design of catalytic materials
The fundamentals of surface science
The fundamentals of chemical reaction thermodynamics and kinetics of molecules and materials

"The Laursen lab studies materials, surface, and catalytic chemistry of non-noble metal ceramics and intermetallic compounds such that wholly new and inexpensive heterogeneous catalysis may be developed and optimized for an ever-changing industrial chemistry landscape. A full suite of experimental and quantum chemical modeling approaches enable these pursuits."

Chemical & Biomolecular Engineering

Faculty

Stephen J. Paddison
Gibson Endowed Chair
in Engineering
PhD, University of Calgary, Canada

Pursuing a fundamental molecular-level understanding of transport in ion containing polymer through a variety of multiscale modeling paradigms

"The Paddison group is interesting in elucidating structure/function relationships in ion containing polymers through a broad range of computational methodologies. Ion containing polymers (i.e. ionomers, polymer electrolyte membranes, polymerized ionic liquids) often feature as the central component in energy storage (batteries) and conversion (fuel cells) devices. Molecular-level understanding of how the chemical structure of these materials determines the transport of ions is pursued in the research of this group through connecting experimental and simulation results."

Joshua R. Sangoro
Assistant Professor
PhD, University of
Leipzig, Germany

To understand the key structure-property relationships in different classes of soft materials and how to tune the different material properties for more efficient electrochemical energy applications

"The overarching goal of our research is to develop fundamental basis for rational design of novel safe, efficient, and environmentally benign electrolytes for current and future energy technologies."

Arthur J. Ragauskas
UT-ORNL Governor's Chair
for Biorefining
PhD, University of Western Ontario

Biorefining
Nanolignocellulosics
Green Chemistry

"Our research program is directed at exploring the fundamental principles involved in biorefining bioresources to biofuels and bio-derived chemicals and materials. These studies utilize advances in biotechnology and thermal conversion approaches. At the core, students utilize the basics of chemical engineering as they apply to cellulose, hemicellulose and lignin with a special emphasis on green catalysis and biomass characterization."

Gila E. Stein
Prados Associate Professor
PhD, University of California,
Santa Barbara

Design and characterization of functional polymer films

"Our research is focused on the design and characterization of functional polymer films. Our work can be applied to semiconductor device manufacturing, membranes, advanced coatings, and low-cost plastic electronics."

Chemical & Biomolecular Engineering

Faculty

Cong T. Trinh
Ferguson Faculty Fellow
in Chemical Engineering
PhD, University of Minnesota

One of his research thrusts is to develop the transformative technology, named MODCELL (Modular Cell), to engineer modular (chassis) cells for rapid development of novel microbial biocatalysts for industrial biotechnology. The other research thrust is to develop the transformative technology, named ViPaRe (Virulent Pathogen Resistance), to effectively combat rapidly evolving and resistant pathogens

"Trinh's research is focused on fundamentally understanding and harnessing complex cellular systems for industrial biocatalysis and disease prevention. To achieve the goal, we employ and develop various experimental and computational tools in interdisciplinary areas of systems and synthetic biology, metabolic engineering, and computational biology."

Matthew Mench
MABE Department Head
Condra Chair of Excellence Professor
Joint Faculty
PhD, Pennsylvania State University

Electrochemical power conversion and storage including polymer electrolyte fuel cells, flow battery systems, and biological energy systems
Multi-phase transport visualization and characterization.
Computational simulation of electrochemical power conversion and storage systems
Electrochemical methods of hazardous waste conversion.
Simulation of the influence of rapidly evolving socio-cultural factors on decision making and group opinion dynamics

"Dr. Mench's research interests span multi-phase transport phenomena, diagnostics, sensors, and electrochemical power conversion and storage systems such as fuel cells, electolyzers and flow batteries."

Thomas A. Zawodzinski
UT-ORNL Governor's Chair for
Electrical Energy Conversion
and Storage
PhD, SUNY/Buffalo

Electrolytes and composite electrodes for fuel cells
Fundamentals of energy storage materials and systems
Water management in fuel cells
Application of NMR to chemical engineering problems

"Our group is concerned with understanding and engineering processes in electrochemical devices (batteries, fuel cells and reactors) and the materials that are used in them. We deploy a wide range of methods to study processes from the molecular to the device level. We have studied polymer, liquid and solid electrolytes, electrocatalysts and chemical conversions in detail, often using modeling or computation. Advanced NMR and electrochemistry are the bread and butter methods but we invent methods or synthesize materials as needed. We have also commercialized materials and devices via extensive industry interactions, licensing and spin-offs."

Dibyendu Mukherjee
Assistant Professor
Adjunct Faculty
PhD, University of Minnesota

Nano-bio materials for energy, energetics and environment

"Research objectives for nbml-E3 lab center on experimental and theoretical investigations into the design, synthesis, assembly and structure-property characterizations of advanced nanomaterials and/or, their interactions and integrations with bio-inspired systems for sustainable energy, energetics and environmental applications."

Chemical & Biomolecular Engineering

Joint Faculty (ORNL)

Kunlun Hong
Associate Professor
PhD, University of Alabama-Birmingham
ORNL Center for Nanophase Materials Sciences

"My expertise is polymer synthesis and characterization. My main research interest is development of various functional soft materials (including polymers with different architectures and functionalities, polymeric colloids, isotopically labelled polymers) for energy applications."

Benjamin Lawrie
Assistant Professor
PhD, Vanderbilt University
ORNL Computational Sciences and Engineering Division

"Dr. Lawrie is an expert in quantum sensing with continuous variable entanglement. His recent research has centered on quantum-enhanced variations of ubiquitous sensors in which the noise floor falls below the standard quantum limit, enabling detection of signals that are otherwise buried in quantum noise."

Jared A. Johnson
Assistant Professor
PhD, University of Tennessee
ORNL National Security and Nuclear Energy Team
Nuclear Material Processing Group

"The group I lead performs research anchored in understanding and improving chemical separation processes applied to radioactive materials. Our research includes the development of a process to produce 238Pu for NASA at ORNL, studies of advanced technologies for recycling used nuclear fuel, and creation of transuranic targets for super heavy element discovery."

Jagjit Nanda
Professor
PhD, Indian Institute of Science
ORNL Materials Science & Technology Division

"The research is directed to developing low cost Na-ion conducting membranes for high capacity non-aqueous redox flow batteries. We will use a combined experimental-modelling approach for tailoring the cation conductivity and minimize the cross-over of species under operating electrochemical conditions."

Oak Ridge National Laboratory

Chemical & Biomolecular Engineering

Equipment and Facilities

Micro & Nano Structured Materials

- **Summit: ORNL's Latest Super Computer**

Summit is the next leap in leadership-class computing systems for open science. With Summit, we will address, with greater complexity and higher fidelity, questions concerning who we are, our place on earth, and in our universe.

Summit delivers more than five times the computational performance of Titan's 18,688 nodes, using only 4,608 nodes. Like Titan, Summit has a hybrid architecture, and each node contains multiple IBM POWER9 CPUs and NVIDIA Volta GPUs all connected together with NVIDIA's high-speed NVLink. Each node has over half a terabyte of coherent memory (high bandwidth memory + DDR4) addressable by all CPUs and GPUs plus 800GB of non-volatile RAM that can be used as a burst buffer or as extended memory. To provide a high rate of I/O throughput, the nodes are connected in a non-blocking fat-tree using a dual-rail Mellanox EDR InfiniBand interconnect.

Summit will allow researchers in all fields of science unprecedented access to solving some of the world's most pressing challenges.

- Advanced Computing Facility (ACF) at JICS

The ACF comprises ACF-Newton and ACF-SIP (Secure Information Processing) to provide environments necessary to meet the computing needs of faculty working on either open or sensitive applications, or both. ACF-Newton combines the Beacon and Newton clusters, which offers a computing resource that supports serial and parallel computing, in the latter case with and without coprocessors, and most memory needs, including the need for terascale memory per node. ACF-Newton is coupled to a petascale, high-speed parallel file system to provide a balanced system offering high-performance computing along with fast data access and ample storage.

ACF-SIP is a rapidly growing environment providing both computing and storage resources to process sensitive data. JICS staff support users across the critical spectrum of user assistance, operations, scientific computing, and education, outreach, and training.

- Ellipsometer
- Rheometer
- Light Scattering
- Modular Atomic Force and Scanning Probe Microscope

Biomolecular Engineering

- Fluorescence-Activated Cell Sorter (Ctr for Env. Biotech)
- Fluorescence microscope
- Atomic force microscope (Adv. Microscopy and Imaging Facility)
- Bioreactors
- Anaerobic Chambers
- **Liquid-handling robots**
- High-performance liquid chromatography

Renewable Energy

- **Optical Train**
- Rheometer

Chemical & Biomolecular Engineering

Advanced Degree Placement

Upon completion of a doctoral or master's degree, CBE students are prepared to continue their research and foster careers in well-respect academic facilities or companies across the country and the world. A few graduates have even gone on to start their own companies.

Postdoctoral Positions:

- Stanford
- MIT
- US Naval Research Laboratory
- UC Berkeley
- Georgia Institute of Technology
- University of Pennsylvania
- Virginia Tech
- Mayo Clinic
- National Renewable Energy Laboratory

Industry:

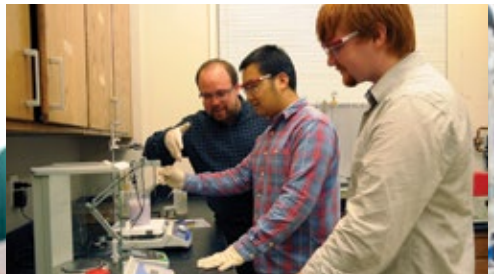
- Eastman Chemical Company
- Proctor & Gamble
- Dow Chemical Company
- Corning Inc.,
- The Goodyear Tire & Rubber Company
- ORNL
- Johnson & Johnson
- Facebook

UT Sponsored Startups:

- Celtig LLC
- Peroxygen Systems Inc.

Academia:

- University of Tennessee, Knoxville
- Washington University
- University of Tennessee at Chattanooga

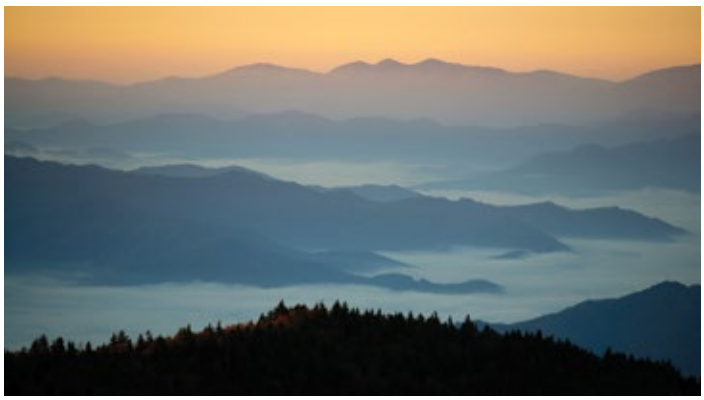

Living in Knoxville, Tennessee

The Heart of East Tennessee

Knoxville draws enthusiastic praise as a great place to live. Located in the heart of East Tennessee with the Great Smoky Mountains for a backyard, Knoxville offers the charm of a small Southern city with opportunities and activities that range from green energy initiatives to thriving culinary and music scenes. Citing both affordability and quality of life, U.S. News and World Report ranked Knoxville among the 100 best places to live in 2017.

The Great Smoky Mountains National Park, about an hour away, is home to more than 800 miles of maintained trails that are perfect for hiking and camping. Numerous rivers and lakes in the region provide easily accessible sites for fishing, kayaking, and tubing. Closer to home, Knoxville itself has more than 100 miles of greenway trails, some of which connect to our acclaimed Urban Wilderness—1,000 acres of parks, trails, and forests along Knoxville's south waterfront, less than a mile from downtown.

With its low cost of living and affordable real estate, Knoxville is a great place to put down roots. Housing options are suited to a wide variety of tastes, with downtown buildings, walkable historic neighborhoods, riverfront properties, suburban areas, and even country life within convenient commuting range. Both the L&N STEM Academy, a magnet school near campus, and Farragut High School are ranked among the best public high schools in the state.



THE UNIVERSITY OF TENNESSEE KNOXVILLE

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