WE ARE DELIGHTED TO PROVIDE THIS BROCHURE WITH INFORMATION ABOUT our department and its exciting graduate program. Our department is among the largest and highest ranked Chemical Engineering programs in the southeastern region. Our renowned faculty includes several Distinguished Professors, Fellows of professional societies including: The American Institute of Chemical Engineers, The American Institute of Medical and Biological Engineers, The American Physical Society, The Electrochemical Society, and The American Vacuum Society and recipients of the highest teaching awards bestowed by the University of Florida: the Teacher-of-the-Year Award and the Academy of Distinguished Teaching Scholars.

Our research and educational activities are not hindered by Departmental or College boundaries, as many of our faculty either lead or are active members of multidisciplinary centers, such as the Florida Energy Systems Consortium, the Institute of Cellular Engineering and Regenerative Medicine, and the Nanoscience Institute for Medical and Engineering Technology. We are located within a short walk to the UF College of Medicine, the Emerging Pathogens Institute, the UF Cancer & Genetics Research Complex, and the UF Clinical & Translation Science Institute, which facilitate fruitful research collaborations for our faculty with research interests in the life sciences.

While the University of Florida, with its exceptional faculty and resources and picturesque campus, provides a wonderful academic environment, the quality of life in the city of Gainesville and the surrounding community is second to none. Serving as the cultural, educational, and commerce center of beautiful North Central Florida, Gainesville is only an hour from both the Atlantic Ocean and the Gulf of Mexico and less than two hours from Jacksonville, Orlando, and Tampa.

- Richard Dickinson - Department Chair

21 FACULTY MEMBERS ENGAGED IN GRADUATE RESEARCH AND TEACHING

We are pleased to introduce our 21 faculty members who are engaged in graduate research and teaching.

1. JASON BUTLER
2. ANUJ CHAUNHAN
3. OSCAR CRISALLE
4. RICHARD DICKINSON
5. HELENA HAGELIN-WEAVER
6. DAVID HIBBITTS
7. PENG JIANG
8. LEWIS JOHNS
9. DMITRY KOPELEVICH
10. ANTHONY LADD
11. TANMAY LELE
12. RANGA NARAYANAN
13. MARK ORAZEM
14. CHANG-WON PARK
15. FAN REN
16. LEWIS JONES
17. SYPROS SVORONOS
18. YIDER TSENG
19. SERGEY VASENKOV
20. JASON WEAVER
21. KIRK ZIEGLER
TODAY, WITH APPROXIMATELY 56,000 STUDENTS, UF IS THE SIXTH LARGEST UNIVERSITY IN THE UNITED STATES. UF HAS 16 COLLEGES AND SCHOOLS OFFERING MORE THAN 100 UNDERGRADUATE DEGREE PROGRAMS.

The University of Florida is the oldest and largest of Florida’s 11 state universities. Today, with approximately 56,000 students, UF is the sixth largest university in the United States. UF has 16 colleges and schools offering more than 100 undergraduate degree programs.

The Graduate School coordinates more than 200 graduate programs. Professional degree programs include dentistry, medicine, pharmacy, veterinary medicine and law.

As a land-grant university identified by the Morrill Act of 1862, UF has a special focus on engineering, as well as agriculture, with a mandate to deliver the practical benefits of university research throughout the state. To meet this goal, UF has over 200 interdisciplinary research centers, bureaus and institutes on campus. UF is ranked among the nation’s top research universities and is one of only 17 public, land-grant universities that belong to the Association of American Universities.

The university employs approximately 5,000 faculty members and more than 7,000 administrative, professional and support employees. In addition to the 2,000-acre main Gainesville campus, UF has research centers, extension operations, clinics and other facilities and affiliates in every Florida county.

THE HERBERT WERTHEIM COLLEGE OF ENGINEERING IS THE LARGEST professional school at the University of Florida, the second largest of all the colleges, and one of the three largest research units. There are over 270 faculty members in 9 academic departments, which offer bachelor’s, master’s and doctoral degrees in 15 disciplines, including aerospace, agricultural, biomedical, chemical, civil, coastal and oceanographic, computer and information science, computer engineering, electrical, environmental, industrial and systems, materials science, mechanical, nuclear and radiological engineering and medical physics, as well as interdisciplinary studies.

The engineering student body of more than 10,000 includes over 7,000 undergraduates and above 3,000 on-campus graduate students. The college grants nearly 2,200 degrees annually, including 112 PhD degrees.

In 2016, annual research expenditures exceeded $70 million. A significant amount of interdisciplinary research is conducted through centers such as the Florida Institute for National Security, the Florida Institute for Sustainable Energy, the Nanoscience Institute for Medical and Engineering Technology, the Institute for Cell Engineering and Regenerative Medicine and the Institute for Computational Engineering.
THE DEPARTMENT

THE DEPARTMENT HAS 21 FACULTY MEMBERS ENGAGED IN GRADUATE RESEARCH AND TEACHING. Their interests span a wide range of topics including bioengineering, nanotechnology, complex fluids, advanced materials processing and surface and interfacial phenomena. These diverse interests are reflected in the types of graduate courses available at both the department and the college, allowing our students excellent opportunities to obtain a broad background in chemical engineering.

Listed in this brochure are the present members of the graduate faculty, with a brief description of their major areas of research. Please contact them directly via e-mail for more details concerning their research programs. Many are leading members or directors of special university centers such as the NSF Engineering Research Center for Particle Science and Technology, the Center for Surface Science and Engineering and the Florida Energy Systems Consortium.

Our annual funding level from contracts and grants typically exceeds 4.5 million dollars. Support for our programs comes from federal agencies such as NSF, NIH, NASA, DOE, a variety of Defense agencies and non-profit organizations such as the American Chemical Society and the Gas Research Institute. The department’s emphasis is on the fundamentals that academic work traditionally provides as the basis for commercial development and manufacturing. The relevance of our research studies is demonstrated by industrial funds from a large number of chemical, aerospace, defense and semiconductor companies that also complement the support we receive from government funding agencies.

PROGRAMS OF STUDY

MASTER OF SCIENCE DEGREE – THESIS OPTION

Completion of this program is possible in 16 months, and the usual duration ranges from 16 to 24 months. The principal requirements for the M.S. degree are 30 semester hours and a research thesis approved by the student’s supervisory committee. These credits include:

1. Twelve graduate semester hours in the basis of chemical engineering courses (Mathematical Basis, Continuum Basis, Molecular Basis, and Chemical and Bio Lab). Molecular Basis can be replaced with an Elective for students on Applied Track.
2. Six credits of Chemical Engineering Science courses, including at least one course in reaction engineering, bioengineering, or kinetics.
3. Up to six semester hours of supervised research.

Students must submit a final thesis and pass an oral thesis-defense examination.

MASTER OF SCIENCE DEGREE – NON-THESIS OPTION

This program is designed for completion in 12 months, although some students prefer longer durations. The MS-Non Thesis provides an opportunity to develop an in-depth knowledge of chemical engineering fundamentals, to emphasize a specific specialization area and to acquire basic experience in research or industrial practice through a short internship. The principal requirements are 30 credits of courses including an option for 7 credits of research work in a laboratory or of work in an industrial internship. The core course requirements for this program are identical to that for the MS-Thesis. A Final thesis document is not required but a written report on a project, internship or a contemporary Chemical Engineering topic is required for graduation.

All new students for the MS program are admitted to the non-thesis option at the time of admission and some are converted to the thesis option upon approval by the Research Advisor and the Director of Graduate Programs.

UNIVERSITY OF FLORIDA
Department of Chemical Engineering

IN ADDITION, WE RECENTLY COMPLETED OUR 10,000 SQUARE-FOOT CHEMICAL ENGINEERING STUDENT CENTER, WHICH HOUSES THE STUDENT ADVISING CENTER, THE DEPARTMENT ADMINISTRATION AND AMPLE STUDENT COLLABORATION SPACE. THIS FACILITY WAS 100% FUNDED BY OUR GENEROUS ALUMNI.

Graduate student professional and social life is enhanced by the chemical engineering’s graduate student society, GRACE (Graduate Association of Chemical Engineers). One of GRACE’s many activities is organizing the annual Graduate Student Research Symposium, where students have an opportunity to present and discuss their research with each other, the faculty and visiting industrial representatives.
The Department of Chemical Engineering offers a large selection of graduate courses. Students intending to obtain a professionally oriented M.E. degree would normally complete their undergraduate requirements in 1-2 semesters. The graduate course requirements of 30 credits of coursework require another 3-4 semesters. The M.E. students can apply for conversion to the MS-Thesis program after satisfactory completion of the undergraduate courses.

PH.D. DEGREE

The Ph.D. degree plan is primarily a research program. The granting of the degree is based essentially on general proficiency and distinctive attainments in Chemical Engineering and particularly on the demonstrated ability to conduct an independent investigation as exhibited in the doctoral dissertation. Briefly, the formal requirements for the Ph.D. degree are:

1. Maintaining a GPA of 3.0 or higher with B- or higher in all basis courses
2. Successful completion of written and oral examinations for advancement to candidacy. The written examination is comprised of the candidate’s objectives and achievements towards his/her doctoral dissertation. The oral examination is based on the written part and related areas. The oral section also includes the Qualifying Examination to test the student’s breadth of knowledge in Chemical Engineering fundamentals.
3. Preparing a dissertation based on original research
4. Passing the final examination based on the dissertation
5. The graduation requirements include 90 credits including at least 30 credits in coursework. Details and minor changes in any of these requirements will be given upon the student’s arrival.

FINANCIAL ASSISTANCE

The department offers research assistantships and/or fellowships to all admitted Ph.D. students and some M.S. students. Financial assistance decisions are made at the time of admission, or shortly after. For Fall-term admission, the following items should be submitted by January 15 for full consideration. Late applications may be considered under exceptional circumstances.

DOCUMENTS TO BE SENT TO THE OFFICE OF ADMISSIONS:
1. On-Line Admission Application (http://www.admissions.ufl.edu/start.html)
2. Application fee (application fee waived for domestic applicants)
3. Official transcripts from all colleges and universities attended
4. Official GRE scores from ETS
5. Official English Language Test (TOEFL, IELTS, MELAB) scores for international applicants

DOCUMENTS TO BE SENT TO THE CHEMICAL ENGINEERING DEPARTMENT:
1. Graduate fellowship / assistantship application
2. Statement of Purpose (unless submitted on-line)
3. Three recommendation letters (unless submitted on-line)
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5. Photocopy of GRE and English Language Test scores (copy of the original sent to Office of Admissions)
6. A resume no longer than two pages (optional)

All relevant forms and more detailed information can be found on the university’s web page: http://www.admissions.ufl.edu/grad/

PH.D. DEGREE

UNIVERSITY REQUIREMENTS FOR ADMISSIONS

GPA ≥ 3.0
International Students:
1. GRE verbal ≥ 140 and
2. TOEFL: 550 (CBT), 213, 6.0 (IBT), 77
ETS codes for submission of GRE & TOEFL scores: 5812 (UF), 1001 (ChE Dept.)

UNIVERSITY OF FLORIDA

The GPA and GRE scores of accepted students are typically significantly higher than the minimum requirements.

GRADUATE COURSES

The most frequently offered courses are listed below:

UNIVERSITY OF FLORIDA

LAB COURSES

Chemical and Biological Lab
Unit Operations Management Lab
Semiconductor Device Fabrication Lab

SPECIAL TOPICS

Electronic Materials Processing
Interfacial Phenomena
Biocatalysis Engineering
Biomedical Engineering
Polymer Processing
Advanced Numerical Analysis
Several other special topics

ENTREPRENEURSHIP, LEADERSHIP AND INNOVATION

The following courses offered by the Engineering Innovation Institute (ELI) are available to all ChE graduate students. The ELI is instilling a culture of innovation and entrepreneurship in students through experiential and curricular based education that focuses on delivering key creativity, innovation, leadership, and entrepreneurship skill sets.

Engineering Leadership
Engineering Innovation
Engineering Entrepreneurship / Entrepreneurship for Engineers
Principles of Ethical Engineering Practice
Engineering Project Management
Divergent Thinking

ASSISTANTSHIPS

Graduate assistantships pay very attractive stipends plus tuition and are awarded to students for research duties. Graduate students who receive assistantships and have completed more than one year of study are generally expected to serve as teaching assistants for two terms if satisfactory progress is maintained (3.0 GPA or better, and satisfactory grades in thesis and assistantship work) and funds are available. Support is continued till graduation.

Research constitutes the most important focus of graduate work. New graduate students are encouraged to begin research as soon as possible. Early in the fall semester, the faculty make available descriptions of their research projects. In the weeks that follow, students consult with the faculty members and become better acquainted with the research in the department. The students then indicate their preferences for individual advisors. The assignments are then made based on the preferences expressed by the students.

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MEET
THE
FACULTY
1. Bihi, I., Baudoin, M., Butler, J.E., Faille, C., & Zoueshtiagh, F. (2016). Inverse Saffman-Taylor Experiments with particles lead to capillarity driven instabilities and model, macromolecular motion within these small devices. As one effort, we have been examining transport dynamics of DNA, a polyelectrolyte, through electrodeless channels. The work has demonstrated new and unexpected methods that can be harnessed to control the cross-stream distribution of DNA using a combination of pressure gradients and electric fields. We are validating our model of this phenomenon through rigorous comparison of experimental results and simulations while simultaneously investigating technological applications.


Selected Publications


Selected Publications:


WE WORK ON HETEROGENEOUS CATALYST DEVELOPMENT

in my laboratory and our ultimate goal is to obtain a fundamental understanding of these catalysts at the atomic level. Our approach is to prepare well-defined heterogeneous catalysts using nanoparticle oxides with various shapes and sizes as supports and use different methods, including conventional precipitation-deposition and incipient wetness impregnation as well as atomic layer deposition, to deposit active metals onto these supports. Since different shapes of nanoparticle oxides expose different surface facets, the use of these materials allows us to investigate how the active metal-support interactions vary with surface facets, and how this ultimate affects the catalytic activities. Furthermore, the fraction of corner and edge sites (relative to terrace sites) increases with decreasing particle size. Therefore, by varying the size of the nanoparticle oxides, we can investigate the effects of coordinatively unsaturated sites (i.e. corner and edge sites) of the support on the active metal. The use of atomic layer deposition of metal (or metal oxides) onto these nanoparticle oxides will provide better control over the metal particle size on the support.

OUR RESEARCH INVOLVES SYNTHESIZE

shapes and sizes of the oxide support influence the active metal and thus also the catalytic activities and selectivities. The analytical techniques include for example: Brunauer-Emmett-Teller (BET) surface area measurements, chemisorption of probe molecules (such as carbon monoxide or hydrogen) to determine active metal surface area, temperature programmed reduction and oxidation (TPR and TPO) experiments to determine reduction-oxidation (redox) properties, x-ray photoelectron spectroscopy (XPS) to determine active metal composition and coordination environment, high-resolution transmission electron microscopy (TEM) images obtained from CeO2 nano-octahedra particles have been deposited using a microemulsion technique (right).

WE FOCUS MAINLY ON ENVIRONMENTALLY FRIENDLY, ENERGY-RELATED REACTIONS

Our projects include catalyst development for hydrogen production via catalytic steam reforming of methanol (for proton exchange membrane (PEM) fuel cell applications), C-H activation and C-C coupling of aromatic compounds, oxidative coupling of methane (methane to higher-value chemicals), Fischer-Tropsch synthesis of diesel fuel from biomass-derived synthesis gas (CO+H2), and thermochemical water-splitting using solar energy.

Selected Publications


We present a high-resolution transmission electron microscopy (TEM) image obtained from CeO2 nano-octahedra onto which a thin layer of Al2O3 have been deposited using a microemulsion technique (right).
Self-Assembled Photonic Crystals & Plasmonic Crystals, Biomimetic Broadband Antireflection Coatings, Novel Stimuli-Responsive Shape Memory Polymers, & Smart Window Coatings for Energy-Efficient Buildings

Selected Publications


LEWIS JOHNS, PROFESSOR
Ph.D., 1964, Carnegie Mellon University

My work involved the stability of phase boundaries as one phase displaces another. Other areas of interest are electro-deposition, solidification, precipitation, and other related phenomena.

Selected Publications


Great to be a GATOR
**TRANSPORT IN SELF-ASSEMBLED SYSTEMS**

The process of mass transfer across surfactant-covered microemulsion interfaces and lipid bilayers plays an important role in numerous applications, including separations, reactions, drug delivery, and detoxification. We investigate the molecular mechanisms of solute transport across an interface composed of tightly packed amphiphilic molecules and assess various factors that affect this transport.

**Selected Publications**


CELL MECHANICS
We are studying the molecular mechanisms of force generation in the cell cytoskeleton with a (current) focus on nuclear forces. We employ techniques like femtosecond laser ablation, micromanipulation and photoactivation for manipulating the cellular force balance. We are also interested in how cells sense and respond to micro-environmental mechanical cues and how cytoskeletal forces are altered in pathologies like cancer and muscular dystrophies.

CELL AND TISSUE ENGINEERING
New technologies for controlling cell and tissue function are an important focus. We are developing novel materials for controlling cell adhesion, new methods to apply mechanical forces to cells and to micropattern intracellular structure.

QUANTITATIVE CELL BIOLOGY
We have developed new methods for analyzing protein binding interactions in living cells using a combination of mathematical modeling and fluorescence-based methods. We continue to refine these methods and apply them for developing a quantitative understanding of intracellular processes.

Selected Publications

IN THE AREA OF INSTABILITIES, IT IS THE GOAL of the present research to examine the physics of the spontaneous generation of spatial patterns in processes that involve solidification, electrodeposition and free-surface convection. The pattern formation is associated with instabilities of a parent state as a control parameter is changed. Other processes of interest that involve instabilities are shearing flows with viscous dissipation of heat and oscillatory flows where flow reversal is the cause of non-rectilinear patterns.

THE MATHEMATICAL METHODS USED IN OUR RESEARCH are related to bifurcation theory, non-linear energy methods, and perturbation techniques. The experimental methods involve flow sensing by infrared imaging, shadowgraphy and electrochemical titration.

STUDIES ARE ALSO BEING CONDUCTED IN TRANSPORT PHENOMENA AS applied to regenerative life support. In this regard, the effect of pulsatile flow on mass and heat transfer is being investigated with the objective of enhancing transport and separation of species. In addition, these studies have application to biomedical fields such as transport in the lungs.

Selected Publications
Selective Publications


Current projects include impedance of enzyme-based sensors for biological systems and development of impedance-based sensors to detect failure of segmentally constructed bridges.

Selected Publications


THERE ARE THREE MAJOR TOPICS UNDER INVESTIGATION:

(1) Deposition of silicon-nitride based dielectrics using different precursors such as SiH4/NH3, SiH4/N2, SiD4/N2, SiD4/ND3 and gen passivation effect.

(2) Optimization of the dielectric material quality with different deposition techniques and conditions. The systems considered hydrogen-free dielectric and incorporation of a D, O, or N plasma treatment to reduce the occurrence of dangling bonds.

(3) Characterization of device degradation mechanisms related to deposition techniques, dielectric film quality and the hydro-vapor deposition (ECRCVD), and inductively coupled plasma chemical vapor deposition (ICPCVD).

WIDE BANDGAP SEMICONDUCTOR DEVICES

Wide energy-bandgap electronic devices, typically based on GaN films, have been extensively investigated in recent years due to their unique optical and electronic properties and exciting potential applications. In particular, visible and ultraviolet lasers and light-emitting diodes have been demonstrated for display and data-storage applications. This effort is part of a consortium chartered with developing the requisite technologies for high power and high breakdown voltage electronics based on GaN materials. Contact metallization, passivation, device integration and characterization studies are routinely performed using state-of-the-art equipment. This work has been supported by the Office of Naval Research, the Electric Power Research Institute and the Defense Advanced Research Projects Agency.

SEMICONDUCTOR DEVICE PASSIVATION

This research program aims to develop the basic science and technology of low-temperature deposition methods that can provide reliable and reproducible passivation, device integration and high electron mobility transistors by varying photon flux during deposition.

Selected Publications


NANOMEDICINE, CANCER NANOTECHNOLOGY, MAGNETIC NANOPARTICLES, COLLOIDAL HYDRODYNAMICS, AND TRANSPORT PHENOMENA

MY GROUP STUDIES THE BEHAVIOR AND APPLICATIONS OF suspensions of magnetic nanoparticles in applied magnetic fields. This field has seen explosive growth due to potential in biomedical applications such as magnetic resonance and magnetic particle imaging, biosensors, targeted delivery and triggered release of drugs, magnetomechanical actuation of cell response, and the ability to deliver magnetic energy at the nanoscale in the form of heat. We combine expertise in synthesis and surface modification of magnetic nanoparticles, physical, chemical, and magnetic characterization, and modeling of the coupling of magnetic, hydrodynamic, and Brownian forces and torques to answer fundamental questions regarding the behavior of magnetic nanoparticle suspensions, understand their interaction with biological entities, and to develop novel biomedical applications taking advantage of their unique properties.

ENGINEERING CELL FATE THROUGH NANOSCALE ENERGY DELIVERY

Magnetic nanoparticles (MNPs) can be engineered to target specific cells or even cellular components. Under an alternating magnetic field (AMF) they can deliver energy locally, in the form of shear or heat. This ability to deliver energy at the nanoscale and selectively to targeted cells or cellular components allows for novel biomedical applications. In one potential application, magnetic nanoparticles can target and destroy cancer by disruption of cellular components. Because traditional cancer treatments can have synergistic effects with thermal treatment, their combination with hyperthermia induced by magnetic nanoparticles is promising. Our group is interested in understanding how nanoscale energy delivery by magnetic nanoparticles kills cancer cells, with the objective of engineering novel, more effective magnetic nanoparticle-based strategies to treat cancer.

PROBING BIOLOGICAL ENVIRONMENTS USING MAGNETIC NANOPARTICLES

In this line of research we take advantage of the fact that nanoparticle rotation is sensitive to the mechanical properties of the environment surrounding the nanoparticles and to the presence of biomacromolecules that bind to the nanoparticle surface. The rotation of collections of magnetic nanoparticles can be monitored remotely through their magnetization. We apply our fundamental understanding of the coupling of magnetic, hydrodynamic and Brownian forces and torques to use magnetic nanoparticles as nanoscale probes in biological complex fluids.

Selected Publications


SPYROS SVORONOS, PROFESSOR
Ph.D., 1981, University of Minnesota
svoronos@che.ufl.edu

Modeling and Optimization of Biological, Chemical, and Particle Processes

ACTIVE PROJECT: BIOFUEL PRODUCTION FROM SALINE CYANOBACTERIA

Although microalgae provide excellent means of capturing sunlight and atmospheric carbon dioxide, impediments to their widespread utilization are the inability to grow algae in a sustainable manner without large inputs of freshwater and nutrients—and to economically separate valuable products. The research aims to establish a path for the economic production of a biofuel (methane) and an extracellular bioproduct. It utilizes a remarkable cyanobacterium that eliminates the need for fresh water inputs or external addition of nitrogenous nutrients and avoids expensive purification methods for product recovery. The project is in collaboration with Professor Pratap Pullammanappallil of the UF Agricultural and Biological Engineering Department and Professor Edward J. Phlips of the UF School of Forest Resources and Conservation.

Selected Publications

YIDER TSENG, ASSOCIATE PROFESSOR
Ph.D., 1999, Johns Hopkins University
ytsgeng@che.ufl.edu

Interactomics, Systems Biology Approaches, and Molecular Biomechanics

GROUNDING IN SCIENCE AND ENGINEERING FUNDAMENTALS, research in my laboratory focuses on combining new engineering principles with advanced life science methods for the purpose of developing a systematic, quantitative and integrative way to understand fundamental biological phenomena at the molecular and cellular levels. My research has implications on tissue engineering, wound repairs, microorganism invasions and disease states such as cancer metastasis.

MY RESEARCH LABORATORY ADDRESSES THE FOLLOWING:
(1) Developing high-throughput methods to establish the complete interactome of the recently discovered bacterial cytoskeleton. After identifying the regulators of the cytoskeleton, we will be able to pursue new molecular strategies to prevent bacterial invasion processes.
(2) Combining micromanipulation and systems-biology approaches to elucidate the distribution and function of lipids in cellular processes. The technique of total internal reflection microscopy, combined with cellular engineering, helps understand the relationships between spatial and temporal micro-heterogeneity of the cell membrane and the roles of lipids in regulating cellular activities.
(3) Applying in vivo multiple-particle tracking microrheology to study cell-mechanical phenomena where force plays an essential role. The focus is on the effect of forces on the regulation of drug delivery, viral infection and bacterial invasion.

Selected Publications
Selected Publications


4. Hazelbaker, E. D., Guillet-Nicolas, R., Thommes, M., Kleitz, F., & Vasenkov, S. (2016). Diffusion studies of gaseous sorbates in systems of one-dimensional nanochannels are of high fundamental interest and also of high relevance for a number of applications including molecular separations, nanofluidics and catalysis. Confinement of sorbate transport to one dimension can lead to anomalous single-file diffusion (SFD). We estimated the barrier-free diffusion coefficient of CO2, H2, and CH4 in ZIF-8 as a function of temperature, and in ZIF-8/6FDA-DAM mixed-matrix membranes, and correlated our results with simulations.


Nearly all nanomaterial applications require an interface with other materials, including, for example, polymers in composites, electrodes in devices, pharmaceuticals in drug delivery, body fluids and cells in biomaging and biosensors, or analytes in chemical sensors. Our group focuses on developing a fundamental understanding of interfaces in nanoscale systems, which can have far-reaching implications to various fields of nanotechnology. The goal is to manipulate interfaces to dictate the nanostructures that are fabricated and to control reactions and transport at the surface of the nanostructures. Once these interfaces can be controlled and manipulated, it will be possible to fabricate nanomaterials with novel functionality, improving their integration and performance in several applications.

**Manipulating Interfaces**

The ultimate objective is to compensate for poor interfaces and create new functionality by manipulating the interface. The manipulation of these interfaces can alter the wettability, interaction of nanomaterials with matrices, and their stability to environmental effects. For example, the organization of highly-ordered arrays of nanoparticles is typically disturbed once the temperature is raised due to agglomeration and Ostwald ripening. These changes limit the organization and dimensions of nanowires that are subsequently fabricated from the nanoparticles. Figure 1 shows that we can alter these interfaces to yield thermally-stable surfaces. In the field of single walled carbon nanotubes (SWCNTs), we have exploited the natural sensing capabilities of the nanotubes to help us characterize the localized environment surrounding them. The ability to characterize the surface of SWCNTs has enabled the development of processes to alter the surfactant structure surrounding the nanotube, providing more stable suspensions, better fluorescence intensities, selective adsorption onto surfaces, and reduced toxicity.

**Controlling Reactions and Transport at Surfaces**

Nanotechnology offers significant promise to improving the performance of solar cells, batteries, and supercapacitors because of the large surface area and unique properties of nanomaterials. However, designing these devices requires exceptional control of the chemical and electronic processes that occur at interfaces. Since many of the atoms in nanosystems exist on the surface, their reaction and transport properties depend strongly on the interface. Our group develops nanomaterial interfaces that help control biological function or accessibility, enhance the collection of photons, improve charge transport, yield better heat transfer, and generate more plasma.

**Selected Publications**

THE NEW ENGINEER IS:

A LEADER

INNOVATIVE

INTERDISCIPLINARY

ENTREPRENEURIAL

POWERING THE NEW ENGINEER.