NANO SEC NEWS

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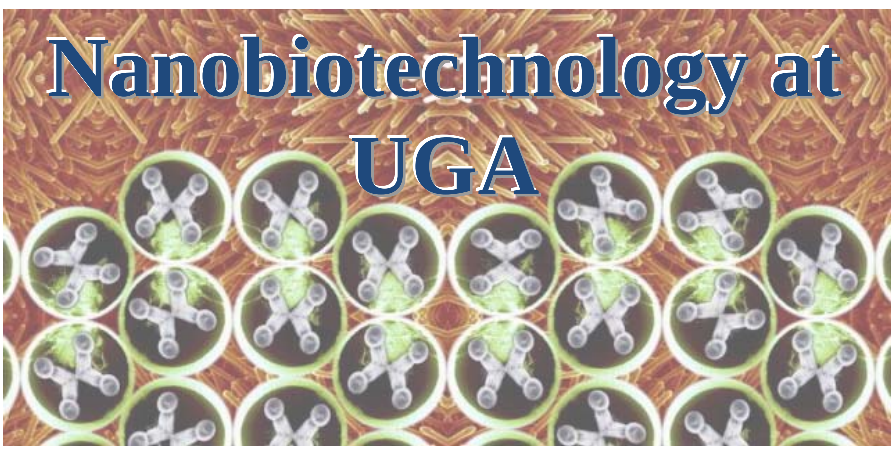
August 2009

nanoscale science & engineering at the university of georgia

Nanobiotechnology at UGA



Nanotechnology has found extensive applications in a wide range of biomedical and bioscience applications including disease diagnostics, medical imaging, drug delivery, tumor treatment, and systems biology. Specifically, nanobiotechnology is a multidisciplinary science representing the convergence of a wide variety of scientific disciplines that leverage the principles and experimental methodologies from the physical sciences and engineering to facilitate a better understanding of cell and systems biology. This emerging field has begun to seamlessly integrate engineered devices at the atomic, molecular and macromolecular level to elucidate the workings of biological systems, and aid applications in the medical field including diagnostics and therapeutics. The existing world-class programs and facilities at UGA leverage the strengths of scientists in the biological, biomedical and agricultural sciences and have guided UGA to the forefront in the new nanotechnology era. UGA recognizes that nanotechnology and nanobiotechnology offer refinements and improvements to conventional diagnostic techniques, as well as new platform technologies that can advance human and animal health. Since the establishment of NanoSEC in 2003, many multidisciplinary collaborative nanobiotechnology research projects have been established. In general, the members of NanoSEC have formed four research areas for UGA nanobiotechnology research: biosensing and diagnostics, vaccine development and drug delivery, bioimaging, and nanobioengineering.

(1) Biosensing and diagnostics There is a significant need for a rapid and sensitive means of diagnosing infectious diseases that inflict serious disease burdens on human and animal health and to detect those agents that pose significant threats as agents for bioterrorism. A recent example is the novel swine-origin influenza H1N1 virus (S-OIV) that currently has pandemic circulation. Existing rapid viral diagnostic methods are limited in sensitivity and the approaches are cumbersome, time-consuming, and require species-specific reagents for detection. The emergence of nanotechnology holds the promise of developing biosensors that will allow for the direct, rapid, and sensitive detection of infectious agents. The bionsensing and diagnostics area is one of the most productive and active cross-disciplinary areas shared by UGA investigators from both NanoSEC and Faculty of Infectious Diseases (FID), as well as from other biomedical institutes. In this arena, the NanoSEC investigators have cross-pollinated with FID investigators to provide novel tools and means to detect pathogens. This multidisciplinary level of collaboration has successfully led to several academic advances and also the development of several start-up companies that benefit human health and our economy. The following inter-disciplinary teams are working on this area:

- Profs. Rich Dluhy from Chemistry, Ralph Tripp from Infectious Diseases, and Yiping Zhao from Physics and Astronomy: developing a surface-enhanced Raman spectroscopy (SERS) based pathogen diagnostic platform using silver nanorod array. Other collaborators include Prof. Duncan Krause from Faculty of Infectious Diseases and Prof. Yao-Wen Huang from Food Science.
- Profs. Bingqian Xu from Biological and Agricultural Engineering, Geert-Jan Boons from CCRC, and Dr. Bossoon Park from USDA Russell Lab: developing a micro/nano-cantilever based sensor platform for toxins and biomolecular detection.
- Profs. Jason Locklin from Chemistry and Faculty of Engineering and Eric Lafontaine from Faculty of Infectious Diseases: developing a new diagnostic platform for rapid

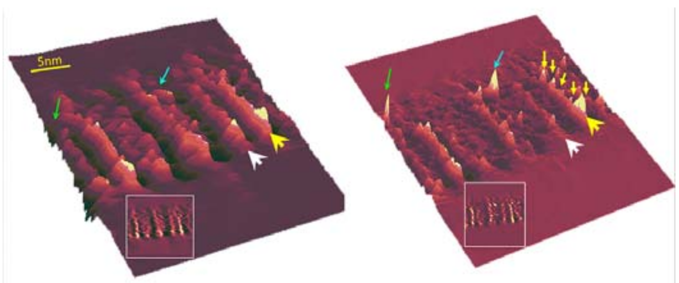
screening of adhesin binding using a surface plasmon resonance imaging technique.

- Prof. Mark Haidekker from Biological and Agricultural Engineering: developing microscale flow and shear sensors based on mechanosensitive molecular rotors for cell signaling and cell-drug interactions.

- Prof. Leidong Mao from Faculty of Engineering: using magnetic fluidic method to develop better biomolecule separation methods and micro-total analysis devices.

- Prof. Zhengwei Pan from Physics and Faculty of Engineering: developing new florescence nanomaterials for biological imaging and advanced *in vivo* diagnostic tools.

(2) Vaccine and drug delivery The potential for nanotechnological platforms that provide targeted drug delivery or facilitate drug disposition is of enormous and could result in a paradigm shift in drug treatment and delivery approaches. However, there are several major hurdles that have limited many of the current approaches to targeted delivery, include the ability to cross cell membranes, drug degradation, off-target effects, and the pharmacokinetics of drug distribution. To minimize drug degradation, reduce off-target effects, and to increase drug bioavailability, several approaches using microparticles and micelles have been investigated. There are substantial issues with these approaches, particularly prolonged circulation leading to macromolecular aggregation or passive accumulation in the liver or at other sites, potentially indicating an inability to effectively target the microparticles/micelles across cell membranes. A solution to overcoming these and related issues is the design of smart materials that are reactive to biological tissues and can release bioactive molecules by a kinetic process controlled both by the chemical and physical properties of the host matrix and the response to stimuli induced by physiological or pathological processes. Two teams at UGA NanoSEC are working on this area:



A 3D topography (left) and current (right) images of DNA duplex with Te ion modification. (Provided by Prof. Xu)

- Profs. Jason Locklin from Chemistry and Faculty of Engineering, Ralph Tripp from Infectious Diseases, and Yiping Zhao from Physics and Astronomy: designing an autonomous, highly specific drug delivery nano-vehicle.

- Prof. Yan Geng from Chemistry: using a unique self-assembled nanostructure to develop novel gene delivery systems for gene medicine.

(3) Bioimaging Advanced biomedical imaging is becoming increasingly important in combating diseases. Non-invasive studies of disease processes and their underlying biomolecular interactions are becoming the backbone of diagnostic imaging as well as in identifying new drug targets, optimizing the distribution of drug candidates, individualizing the therapy of humans, and early diagnostics of cancers. The development of novel imaging modalities of disease progression, drug biodistribution, therapeutic efficacy, and early diagnostics is therefore crucial to treatment as well as innovative drug development and testing. In parallel, nanoscience research has revolutionized the prospects of engineering customized 'vehicles' for targeting specific tissue properties by bioimaging and indeed for developing advanced therapies. The faculty members of UGA NanoSEC have a strong presence in this emerging field.

- Prof. Qun Zhao from Physics and Astronomy: improving Magnetic Resonance Imaging and Spectroscopy (MRI/MRS) tumor imaging contrast using magnetic nanoparticels.

- Prof. Mark Haidekker from Faculty of Engineering: developing laser-optical methods to rapidly scan large areas of tissue or collagen scaffolding with microscopic resolution.

- Prof. Bingqian Xu from Biological and Agricultural Engineering: developing a series of SPM-based single molecule recognition techniques for simultaneous ultrahigh-resolution (single molecule) topography and recognition imaging that is much needed in biological research.

- Prof. Peter Kner from Faculty of Engineering: developing fluorescence microscopes that use state of the art opto-electronics to push the limits of resolution and sensitivity and to improve the results of live-cell based assays and small animal model imaging.

(4) Nanobiomaterial engineering Recent developments in nanotechnology led to the paradigm shift in novel material design, and nano-objects can serve as building blocks to develop complex materials and structures with desired biomedical and physical properties. Thus, it is believed that nanotechnology will one day revolutionize the field of tissue engineering by providing smaller, efficient, and biocompatible biomaterials for use within the body, or provide better materials for tissue regeneration, and prevention of disease transmission.

We have developed various nanostructured materials towards those goals.

- Profs. William Kisaalita from Biological and Agricultural Engineering and Yiping Zhao from Physics and Astronomy: combining microfabrication/nanofabrication with cellular biology to produce porous nano-, micro- or hybrid- structures that will support 3-D cell growth and differentiation. They also collaborate with Prof. Steve Stice from Regenerative Bioscience Center to investigate how those micro and nanostructures change the growth behavior of Stem Cells.

- Prof. Steve Stice from Regenerative Bioscience Center: developing Stem Cell based cell-sensing system.

- Profs. Jason Locklin from Chemistry and Faculty of Engineering, Ralph Tripp and Mark Tompkins from Infectious Diseases: developing antiviral coatings that can kill both envelope and non-envelope viruses on contact.

- Profs. Karen K. Leonas from Textiles and Yiping Zhao from Physics and Astronomy: developing new biodegradable polymer nanofibers with antimicrobial agents for surgical sutures and woven wound dressings.

Clearly, the advances in nanobiotechnology from UGA are revolutionizing prognostic and diagnostic capacities for a range of diseases, and generating new nanomaterials that provide new opportunities and tools at the atomic, molecular and macromolecular level in nanometer range in all fields of biology including virology, bacteriology, cell biology, genomics, proteomics, molecular diagnostics and high throughput screening. Very recently, with the support of Georgia Research Alliance, OVPR, College of Arts and Sciences, and Faculty of Engineering, NanoSEC is building a core cleanroom facility at Riverbend Research South Laboratory with state-of-the-art nano-fabrication, nano-characterization, and nano-manipulation capabilities. This facility will be used to provide a platform for interdisciplinary collaboration, and development of new materials and devices with wide ranging applications from nano-medicine to national security. With the establishment of this facility and further collaborations among members of NanoSEC, I hope UGA NanoSEC will achieve a higher level of success, and establish multiple collaboration research projects and external centers.

Yiping Zhao, UGA NanoSEC Director

NanoSEC Seminar

Organizing Chair: Zhengwei Pan, e-mail: panz@uga.edu
Time: Friday, 12:00pm – 1:00pm
Location: conference room, RBS

Seminar schedule will be posted in NanoSEC website. If you are interested in giving a seminar, please contact Zhengwei.

Cleanroom Steering Committee

Yiping Zhao: zhaoy@physast.uga.edu
Jason Locklin: jlocklin@chem.uga.edu
Leidong Mao: mao@uga.edu

If you have any technical questions on how to use cleanroom and want to obtain training and permission to use the cleanroom, or if you have good suggestions on how to manage the cleanroom, please contact the committee members.

NanoSEC Advisory Committee

Ralph Tripp: ratripp@uga.edu
Zhen Fu: zhenfu@uga.edu
Jason Locklin: jlocklin@chem.uga.edu

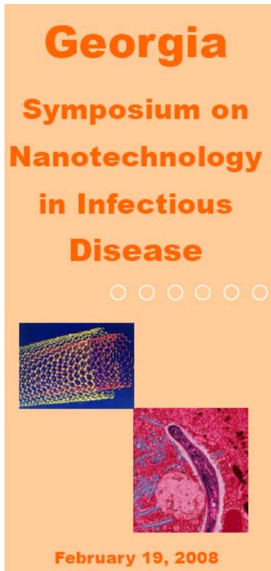
NanoSEC Director

Yiping Zhao, Associate Professor
Department of Physics and Astronomy
221 Riverbend Research South Laboratory
Tel: 706 542 7792

Welcome New Members

Marsha C. Black, Dept. of Environmental Health Science
Jeremy Driskell, Dept. of Infectious Diseases
Jianguo Fan, Center for Advanced Ultrastructural Study
Mark Haidekker, Faculty of Engineering
Qingguo Huang, Dept. of Crop and Soil Sciences
Yao-wen Huang, Dept. of Food Science and Technology
Peter Kner, Faculty of Engineering
Marcus Lay, Dept. of Chemistry
Jason Locklin, Dept. of Chemistry & Faculty of Engineering
Leidong Mao, Faculty of Engineering
Zhengwei Pan, Dept. of Physics &Faculty of Engineering
Susanne Ullrich, Dept. of Physics and Astronomy
Bingqian Xu, Dept. of Bio. & Agr. Eng.
Geng Yang, Dept. of Chemistry
Qun Zhao, Dept. of Physics and Astronomy

The **Inaugural Georgia Symposium on Nanotechnology in Infectious Disease**, co-sponsored by northeast Georgia's major research universities, was hosted by the University of Georgia on Thursday, February 19. The one-day symposium marked the start of collaboration among UGA, the Georgia Institute of Technology and Emory University to transform Georgia into a major attractor and incubator for emerging nanotechnology-based industries, with a focus on the application of nanotechnology to infectious diseases.



Dr. Shuming Nie of Emory University and Dr. Mostafa El-Sayed of the Georgia Institute of Technology were the keynote speakers. In addition to these two keynote speakers. Twelve other researchers from these three institutions contributed talks. Approximately 70 other scientists participated as attendees. Due to the strong positive response, this symposium will continue on a yearly basis, rotating among the three sponsoring institutions. The 2nd Georgia Symposium on Nanotechnology in Infectious Disease will be hosted by Emory University in 2010. Scientists from the Centers for Disease Control in Atlanta and the Medical College of Georgia in Augusta will be involved.

The organizers for this event are: Dr. Richard A Dluhy, former director of UGA NanoSEC; Dr. Duncan Krause, the director of UGA Faculty of Infectious Diseases; Dr. Larry McIntire, the Chair, and Dr. Gang Bao, Distinguished Professor, at Georgia Tech/Emory Department of Biomedical Engineering; Dr. Fred Quinn, the Chair of UGA Department of Infectious Diseases; and Dr. Bali Pulendran From Emory University Vaccine Center.

Members of **UGA NanoSEC** and the nano-task force members of Hydrogen Center from **Savannah River National Laboratory** (SRNL) held an exchange meeting at the Center for Hydrogen Research, Aikens, South Carolina on June 10, 2009. The purpose of this meeting was to establish collaborations between UGA NanoSEC and scientific staff members from SRNL, and to build a closer relationship between UGA and SRNL.

During the meeting, members of each institute have presented the following projects:

"The Applications of Nanostructures Fabrication by Dynamic Shadowing Growth" (**Yiping Zhao**, UGA)
"Creating Functional Surfaces with Polymer Brushes," (**Jason Locklin**, UGA)
"Overcoming the Diffusion Barrier: Ultra-fast Mirco-scale Mixing via Ferrofluids," (**Leidong Mao**, UGA)
"Local Probiing of Single Molecules: Electronic, Mechanical and Molecular Recognition Properties," (**Bingqian Xu**, UGA)
"Controlled Growth ZnO Nanostructures by Thermal Evaporation," (**Zhengwei Pan**, UGA)
"Nanostructured Anodes for Li-ion Rechargeable Batteries," (**Ming Au**, SRNL)
"Scanned Probe Microscopy Studies: Probing Charge Transport in Organic Semiconducting Materials," (**Luci Teague**, SRNL)
"Overview of Nano-related Research in Materials Science and Technology at SRNL," (**Marie Kane**, SRNL)
"Colloidal Plasmonic Particles for Sensing and Imaging," (**Simona Murph**, SRNL)
"Manganese-Doped Gold Nanoparticles as Positive Contrast Agents for MRI," (**Steven Serkiz**, SRNL)
"Savannah River Ecology Lab Facilities," (**Carl Bergmann**, UGA)

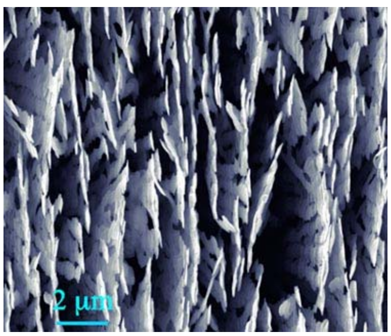
On June 7, construction began in Riverbend Research South on a **Nano-Bio cleanroom facility** for the University of Georgia campus. The cleanroom will house facilities and equipment that is specifically meant to facilitate interactions between engineering, the physical sciences, and biology. The mission of the facility is to use novel nanostructures and nanoscale devices for applications such as drug delivery, disease detection and diagnostics, renewable energy applications, etc. This cleanroom has a Device Fabrication area (Class 1000, one thousand particles per billion at 0.3 micron) and a Lithography area (Class 100, one hundred particles per billion). In terms of user-shared facilities, the cleanroom will house equipment to perform these specific functions: sputtering growth, atomic layer deposition, thermal evaporation, laser micromachining, photolithography (including MA-6 mask aligner, spin coater, photoresist processing), screen-printing, wire bonding, and thin film characterization. A bio-lab right adjacent to the cleanroom will be a Phase II project, which will host general cell growth and characterization tools.

The new facility is an example of UGA's commitment to a convergence of disciplines, bringing together diverse disciplines from the biological and physical sciences to work side by side.

Research Stories

Nanoblade array confronts hydrogen storage bottleneck

Storage is the bottleneck when it comes to using hydrogen energy for on-board vehicle applications. Magnesium hydride is one of the most promising candidates for future solid-state hydrogen storage thanks to its light weight, low cost and highly reversible hydrogen storage capacity of 7.6 mass% in MgH_2. There are obstacles to overcome though. The material's high thermodynamic stability and sluggish reaction kinetics limit its practical applications, but here, engineering magnesium into nanostructures and adding an appropriate transition metal catalyst could help. To investigate the concept, researchers at the University of Georgia, US, have designed and fabricated a vanadium-decorated magnesium nanoblade array structure (shown above) by coating a thin layer of vanadium onto the two sides of individual magnesium nanoblades. The structures were made using a dynamic shadowing growth (DSG) technique, which is based on a physical vapor deposition method and combines oblique angle deposition (OAD) with substrate manipulation and source control.

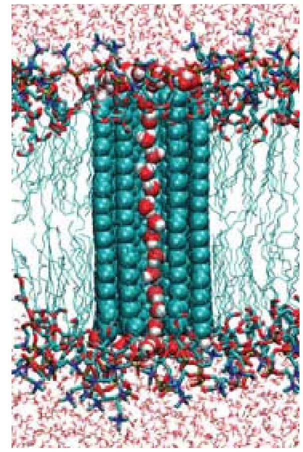


The vanadium-decorated magnesium nanoblade ar-

The catalytic role of the vanadium coating in the formation and decomposition of MgH_2 and the unique nanoblade morphology with large surface area and small hydrogen diffusion length contribute to an overall improvement in hydrogen sorption performance. Specifically, the hydrogen sorption activation energy is reduced from 120–150 kJ/mol H_2 for magnesium films or powders to ~35 kJ/mol H_2, the hydrogen uptake and release temperatures are reduced even to room temperature, and the hydrogen loading and unloading times are reduced from 50 hours to several minutes. (News highlight for **Y.-P. He** and **Y.-P. Zhao**, "*Hydrogen storage and cycling properties of Vanadium decorated Mg nanoblade array on Ti coated Si substrate*," Nanotechnology **20**, 204008 (2009).from nanotechweb.org at http://nanotechweb.org/cws/article/tech/38811)

Nanomaterials: Cellular water carriers

In recent years, carbon nanotubes have been proposed for many biological applications, such as sensing or transporting molecules. Xiaoyi Li at the Chinese Academy of Sciences, Yuliang Zhao at the National Center for Nanoscience and Technology of China, both in Beijing, and co-workers[1] have shown that a double-walled nanotube could act as an artificial channel for water flowing in and out of cells.



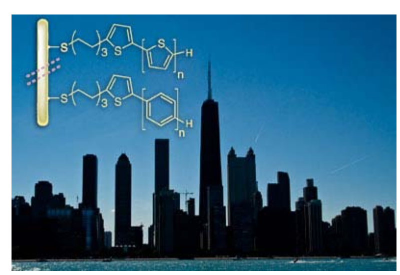
All living cells contain natural protein channels that are essential for transporting molecules across cell membranes. Nanotubes can mimic these channels because they tend to be hydrophobic, so they bind well to the lipids in cell membranes. However, the channels inside single-walled nanotubes may be adversely affected by the cell environment. The researchers realized that if they used a double-walled nanotube, the outer tube could act as a shield for the inner one. They performed molecular dynamics simulations of a double-walled tube that had its ends modified to attract water, and charged sites on the inner tube to encourage water transport.

The simulations showed that water molecules readily entered the nanotube and flowed along the channel. Moreover, the nanotube channels are fully biocompatible, and because they are relatively small they could easily move around a cell membrane without disrupting the natural diffusion of lipids. (Nature China news highlight for B. Liu, , X. Li, B. Li, , **B. Q. Xu**, and Y. Zhao, "*Carbon nanotube based artificial water channel protein: Membrane perturbation and water transportation*," Nano Lett. doi:10.1021/nl8030339 (2009). from http://www.nature.com/nchina/2009/090325/full/nchina.2009.56.html)

Skyscraper approach to nanoelectronics

Scientists based at the University of Georgia, US, have grown conjugated polymer brushes directly onto monolayers, producing films with thicknesses around 50 nanometers. This is a significant breakthrough for nanotechnology as existing techniques for creating electronics on the nanoscale are reaching their limits.

Previous attempts to grow conjugated polymers on monolayers have had limited success. Using a modified Kumada-type catalyst-transfer polycondensation, Jason Locklin and his team grew polyphenylene and polythiophene brushes, from aryl Grignard monomers, on gold monolayers. They ana-



lysed the polymer brushes using cyclic voltammetry, polarization modulation-infrared reflection-adsorption spectroscopy and atomic force microscopy. 'This surface-initiated polymerisation technique allows one to create conjugated polymer films in a controlled fashion,' Locklin comments. The technique 'allows for a high density of functional groups to be obtained in a limited area. This has been called the skyscraper approach.'

'Locklin's work represents another important addition to the synthetic toolbox for generating functional polymer brushes,' says Wilhelm Huck, an expert in macromolecular chemistry at the University of Cambridge, UK. 'I am confident that we will see a lot more work on conjugated polymer brushes and with improvements in synthesis, hopefully, improvements in device performance will follow.'

With potential applications in electroluminescent and photoelectric devices, batteries and organic electronics, it may be difficult to know which to study further. Locklin sees his polymer brushes being used for the construction of enzymatic biofuel cells for powering cochlear implants and pacemakers, and biochemical sensors. 'Individual polymer chains serve as molecular wires, facilitating efficient charge transport between a fuel cell catalyst and the electrode to are many issues that must be overcome before this technique can be applied to real-world devices.' (Chemical New highlight for S. Kyle Sontag, Nicholas Marshall and Jason Locklin, "*Formation of conjugated polymer brushes by surface-initiated catalyst-transfer polycondensation*," *Chem. Commun.*, 2009, 3354, from http://www.rsc.org/Publishing/ChemScience/Volume/2009/07/Skyscraper_nanoelectronics.asp).

New Funding

In January, Prof. **Yaowen Huang** of the Department of Food Sceince and Technology, Prof. **Yiping Zhao** of the Department of Physics and Astronomy, and Dr. Bosoon Park of USDA Russell Research Laboratory were awarded a three-year grant by USDA entitled "***Rapid Detection of Food-borne Pathogenic Bacteria Using Nanorods Array Surface Enhanced Raman Spectroscopy***." They will develop a fast and nanotechnology based sensor for forborne bacteria detection.

On July 15, Prof. **Steven Lewis** of the Department of Physics & Astronomy and his experimental collaborators at the University of Wisconsin-Milwaukee, Junhong Chen, Maria Gajdardziska-Josifovska, and Carol Hirschmugl, were awarded a three-year grant by the National Science Foundation entitled "***Collaborative Research: Engineering Miniaturized Gas Sensors with Hybrid Nanostructures***". This grant, totaling half a million dollars, supports basic and applied research on the fabrication, characterization, and theoretical understanding of a novel gas-sensing platform composed of doped tin-oxide nanocrystals adsorbed to the sidewalls of carbon nanotubes assembled in micro-arrays. Prof. Lewis will head up the theoretical component of this research team.

Miniaturized gas sensors that rapidly and accurately detect and differentiate trace amounts of chemical species are extremely attractive for environmental monitoring, medical diagnosis, and lab-on-a-chip analytical devices. The hybrid nanostructure at the heart of the novel sensor platform to be studied under this grant offers a distinctly new sensing mechanism resulting from the electronic coupling between nanocrystal and nanotube. By integrating strands decorated with differently doped nanocrystals into a large, parallel-detection sensing array, the research team hopes to realize a room-temperature device with acute sensitivity (perhaps at the single-molecule level) and broad chemical selectivity.

Profs. **Phillip Stancil** and **Michael Geller** of the Department of Physics & Astronomy, Prof. **Andrew Sornborger** of the Department of Mathmatics and Faculty of Engineering, and Prof. John Martinis from the University of California, Santa Barbara, have been awarded a one-year EAGER grant from the National Science Foundation entitled "***Theoretical Development of a General Purpose Molecular Collision Simulator***". The investigators will explore the design of a first-generation general purpose quantum simulator or Schrodinger equation solver built from low-temperature superconducting electrical circuits, and its use in simulating molecular collisions. The EAGER program (EArly-concept Grants for Exploratory Research) supports high-risk, exploratory and potentially transformative research.

In May, Prof. **Marcus Lay** of the Department of Chemistry was awarded a four-year grant by National Science Foundation entitled "***Macroscopic Electronic and Electrochemical Properties of Networks of Purified SWNTs***". He will explore a novel method for deposition of large-scale ordered arrays of single-walled carbon nanotubes (SWNTs). The aim is to enhance current understanding of the properties of nanomaterials by investigating a mild technique for purification of SWNTs, investigating the electrical applications of SWNT networks, and studying the effect of SWNT density on electrochemical responses.

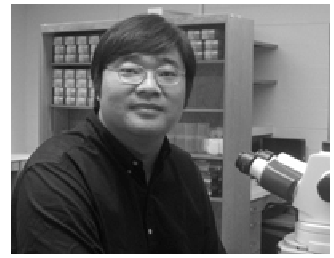
Peter Kner arrived at the University of Georgia in January, 2009, from the University of California, San Francisco, Department of Biochemistry and Biophysics, where his research in the labs of John Sedat and Mats Gustafsson was on building novel microscopy systems for studying cellular sub-structure. In work recently published in *Nature Methods* ("Super-resolution video microscopy of live cells by structured illumination," May 2009), Kner extended the super-resolution fluorescence microscopy technique, Structured Illumination Microscopy, to live imaging. Structured Illumination which provides a resolution of 120nm, about twice the resolution of a conventional microscope, previously had been too slow to image dynamic events in living cells. Kner et al. demonstrated imaging at 11Hz, fast enough to capture the molecular motor, kinesin, moving along microtubules.

Dr. Kner's research at UGA will focus on developing methods to improve imaging for biomedical applications using the latest developments in optical technology. In a representative project that he will be continuing at UGA, Dr. Kner is using adaptive optics, originally developed to reduce aberrations caused by the earth's atmosphere in astronomy, to correct for the aberrations that arise when imaging deep into biological samples. Currently aberrations limit the depth of imaging to a few tens of microns in many biological samples. Allowing imaging up to a depth of several hundred microns or greater could pave the way for new discoveries in many areas of biomedical research.

Dr. Kner's multidisciplinary research and background in optical physics fit in nicely with the goals of NanoSEC. He is always looking for collaborators and looks forward to interacting with the members of NanoSEC.

Microfluidics is an important branch of Micro-Electro-Mechanical Systems (MEMS) that manipulates very small amounts of liquids using micro-scale channels. With the potential to revolutionize biological and biomedical research, as well as a host of product categories, this micro-scale technology is the next leading edge research area to distinguish UGA engineering as Dr. **Leidong Mao** joined its faculty last fall.

Dr. Mao comes to UGA from Yale University, where his Ph. D research in magnetic nanoparticles' applications on biomedical and microTAS (micro total analysis systems) areas led him to an interest in microfluidics. His goal is developing enhanced research tool, a "lab-on-a-chip", where researchers can plug a microchip into a portable device that can purify, separate, mix and detect a substance in liquid form within minutes. Lowering the expense and time lags and improving detection sensitivities will provide for a sort of toolbox for scientists and engineers in chemistry and the biological sciences to decrease laboratory bottlenecks that inhibit the pace of research.



Such a highly collaborative field, especially toward biomedical research, is one of the reasons Dr. Mao was attracted to UGA. "UGA has a wonderful biological science program, so I look forward to finding collaborators to target potential problems in their research," he said. Dr. Mao joins a formidable cadre of Nano-physicists and engineers at the Nano-scale Science and Engineering Center (NanoSEC), a growing investment in the future of science that demonstrates the university's commitment to research frontiers and the people who will make them possible.

For more information on Dr. Mao's research merging biotechnology with MEMS, see http://www.micronano.engr.uga.edu/

Qingguo Huang is an assistant professor in Environmental Water Chemistry at the University of Georgia, having near twenty years of research experience in environmental chemistry and engineering focusing on the environmental transport, transformation, and fate of organic contaminants and related remediation technologies.

Dr. Huang's research interests in environmental nanotechonology are involved in i) the environmental behavior and potential health impact of nanomaterials and ii) the application of nano technology in pollution control and water/wastewater treatment. Dr. Huang is presently the PI and co-PI of three major research projects relating to the environmental behaviors of nanomaterials, with an emphasis on carbon nanomaterials. These projects are i) Environmental Behaviors of Solubilized Carbon Nanotubes in Aquatic Systems: Transformation, Sorption, and Toxicity Exposure, (PI) EPA STAR grant program, ii) Carbon Nanotubes: Environmental Dispersion States, Transport, Fate, and Bioavailability, (co-PI) EPA STAR grant program; and iii) Nanomaterials in the Aquatic Environment: Ecological Uptake and Toxicology, (co-PI) Graham Environmental Sustainability Institute.