SCHOOL OF ENGINEERING

NANOTECHNOLOGY
RESEARCH FORUM

March 5th, 2008

1:00 - 4:00 p.m.

4:00 - 5:00 p.m. Reception

Konover Auditorium
Thomas J. Dodd Research Center
Storrs, Connecticut

University of Connecticut
School of Engineering
www. engr.uconn.edu
**Agenda:**

1:00 Welcome – Mun Choi, Dean, School of Engineering
1:00 Greg Anderson, Vice Provost Research and Graduate Education
1:00 Harris Marcus, Director, Institute of Material Science
1:05 Stephen Andrade, OWC: Overview of State Nano Activities
1:15 Elliot Ginsberg, President & CEO, CCAT: Nanotechnology Initiatives at CCAT
1:25 Louis Manzione, Dean, CETA, University of Hartford

**Technical Session**

1:40 Nejat Olgac: Rotational Oscillatory Micro-Drill (Ros-Drill ©): A New Technology for Intracytoplasmic Sperm Injection (ICSI)
1:45 Rainer Hebert et al.: Deformation-induced Synthesis of Nanostructured Metallic Materials
1:55 Sanguthevar Rajasekaran et al.: Algorithms and Architectures for Nanocomputing
2:00 C. Barry Carter et al.: Complementary Microscopy Techniques for Characterizing Nanostructures (*in situ* Microscopy: A Tool to Understand Mechanisms)
2:05 Richard Parnas et al.: Imaging and Thermal Studies of Wheat Gluten Composites
2:10 Baikun Li & Ross Bagtzoglou: Environmental Challenges of Nanoparticles and Research Opportunities
2:15 Puxian Gao: Hierarchical Assembly of Low-dimensional Nanostructures for Energy, Environment and Sensing Applications
2:20 Ali Gokirmak et al.: High-Resolution Charge Density and Transport Measurement on Nanoscale Transistors Utilizing Ambient Noise
2:25 Bryan Huey: Nanoscale Property Measurements and Mapping
2:30 Faquir Jain et al.: Quantum Dot Gate FETs and Nonvolatile Memory Devices: Modeling and Processing for Nanochannels
2:40 Yu Lei: Nanomaterials and their Application in Sensors/Biosensors
2:45 Wilson K.S. Chiu et al.: Growth and Modeling of Carbon Nanotubes by Open-Air Chemical Vapor Deposition
2:50 Robert Magnusson: Nanostructured Resonant Leaky-Mode Photonic Devices
2:55 Ion Mandoiu: Rational DNA Sequence Design for Molecular Nanotechnology
3:00 Reda Ammar et al.: High Performance Modeling and Simulation of Nanoscience and Nanotechnology
3:05 Leon L. Shaw: Nano-Engineering for Hydrogen Storage Applications
3:10 Helena Silva et al.: Crystallization of Nanocrystalline Silicon Nanowires through Self-Heating
3:15 Geoff W. Taylor: Integrated Nano-OptoElectronics
3:20 Lei Wang et al.: Information-Theoretic Analysis of Defect Tolerance in Nanocomputing Systems
3:25 Yong Wang: RNA Nanostructures for Imaging and Therapy
3:30 Montgomery Shaw: Fast-acting Detectors Based on Organized Nanoparticles
3:45 Bi Zhang: Micromachine Design for Nanomanufacturing and Micromanipulation
3:50 Ali Gokirmak et al.: Accumulated Body Si Field Effect Transistor
3:55 C. Barry Carter et al.: Chemical Characterization of Nanomaterials at High Spatial Resolution
4:00 Reception
List of Abstracts

4. High Performance Modeling and Simulation of Nanoscience and Nanotechnology
5. Complementary Microscopy Techniques for Characterizing Nanostructures
6. In situ Microscopy: A Tool to Understand Mechanisms
7. Imaging and Thermal Studies of Wheat Gluten Composites
8. Hierarchical Assembly of Low-dimensional Nanostructures for Energy, Environment and Sensing Applications
9. High-resolution Charge Density and Transport Measurement on Nanoscale Transistors Utilizing Ambient Noise
10. Accumulated Body Si Field Effect Transistor
11. Nanoscale Property Measurements and Mapping
12. Quantum Dot Gate FETs and Nonvolatile Memory Devices: Modeling and Processing for Nanoarchitectures
14. Nanomaterials and their Application in Sensors/Biosensors
15. Environmental Challenges of Nanoparticles and Research Opportunities
16. Growth and Modeling of Carbon Nanotubes by Open-Air Chemical Vapor Deposition
17. Deformation-Induced Synthesis of Nanostructured Metallic Materials
18. Nanostructured Resonant Leaky-Mode Photonic Devices
19. Rational DNA Sequence Design for Molecular Nanotechnology
21. Algorithms and Architectures for Nanocomputing
22. Nano-Engineering for Hydrogen Storage Applications
23. Fast-acting Detectors Based on Organized Nanoparticles
24. Crystallization of Nanocrystalline Silicon Nanowires through Self-Heating
25. Integrated Nano-OptoElectronics
26. Information-Theoretic Analysis of Defect Tolerance in Nanocomputing Systems
27. RNA Nanostructures for Imaging and Therapy
28. Chemical Characterization of Nanomaterials at High Spatial Resolution
29. Micromachine Design for Nanomanufacturing and Micromanipulation
Selectivity in Catalysis: Catalyst Design, Unique Activation, and Kinetic Studies

Steven L. Suib
Chemistry Department, University of Connecticut, Storrs

Abstract: Selectivity to produce desired products in catalytic reactions is the focus of our research. Several examples of the design of catalysts to drive various reactions will be discussed. These catalysts are nano-size and designed via molecular control. The role of redox chemistry in preparation and use of such catalysts will be discussed. Catalysts for selective oxidations, production of acrolein, and activation of CO₂ are of current interest in our group. Novel methods of catalyst preparation such as in situ mixing nozzle microwave methods will be mentioned. Catalysts that are porous oxides and mixed metal oxides are used in these reactions. Effects of morphology and particle size on rates of reaction have been observed. In situ soft XPS studies of oxygenates at metal oxide surfaces have led to understanding of surface species present in oxidation reactions. Dynamic Enhancement of Catalytic Activity at the Nanoscale (DECAN) experiments can be used to selectively activate molecules and enhance yields of catalytic processes by the polarization of catalytic interfaces under certain conditions. Relationships among catalysts, preparation methods, surface species and catalytic activity and selectivity will be discussed.

Developing Energy and Sensor Technologies with Microbes, Nature’s First Nanotechnologists

Ismael I. Nieves¹, Ranjan Srivastava² and Kenneth M. Noll³
¹ Department of Civil and Environmental Engineering, University of Connecticut, now in the Department of Microbiology and Cell Science, University of Florida
² Department of Chemical, Materials and Biomolecular Engineering, University of Connecticut
³ Department of Molecular and Cell Biology, University of Connecticut

Abstract: Microorganisms have been using nanoscale electrical circuits, nanoparticle catalysts and nanomachines for billions of years. We are tapping into their technologies by designing microbes that are more efficient producers of electrical current for applications in fuel cells and sensors. We have identified the electrical pathways in cells that we can optimize to provide complex cellular catalysts for conversion of organic fuels to electricity. The same technology holds promise for the production of alternative fuels from similar feedstocks.
Dielectric, Pyroelectric and Piezoelectric Response of Ultra-Thin Films of Functional Oxides

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Materials Science and Engineering Program
CMBE Department, University of Connecticut, Storrs, CT 06269

Abstract: Multilayer heterostructures of functional oxides have received great interest as active elements in tunable microwave devices, pyroelectric detectors, and piezoelectric actuators/sensors. The fundamental problem that limits their use is that these materials have usually inferior properties in thin film form compared to their bulk counterparts. For example, there may be an order of magnitude difference in the electrical and electromechanical responses of a bulk and thin film ferroelectric. This reduction is attributed to compositional/microstructural inhomogeneities, defects, and internal stresses. We will discuss how the properties of such materials can be improved dramatically by engineering the strain state and the microstructure.

High Performance Modeling and Simulation of Nanoscience and Nanotechnology

Reda Ammar, S. Rajasekaran and Ian Greenshields
Computer Science and Engineering, University of Connecticut, Storrs

Abstract: A commercial enterprise usually does not commit to large-scale manufacture of a product unless it can understand its scientific phenomena and can control the process to make it with a great chance of success. Modeling and simulation have always been key enabling technologies for making fundamental advances in science but also helping commercial enterprises making technology a practical reality. Due to the inherent complexity of nanostructures, computational models will be inevitable. Computer simulations of complex systems such as nanosystems will involve intensive computation, requiring sophisticated algorithms and software running on state-of-the-art parallel computers. The investigators have extensive experience in the design of high performance parallel and distributed algorithms for large simulation of varied computational applications. It is also necessary to develop innovative data and image mining approaches utilizing the expected large volume of data collected from the developed model and simulation to test and validate observations, and to predict new phenomena in nanoscience and nanotechnology.

Complementary Microscopy Techniques for Characterizing Nanostructures

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*Physical Metallurgy Division, Indira Gandhi Centre for Atomic Research, Kalpakkam-603102, TN, India
#Materials Research Centre, Indian Institute of Science, Bangalore-560012, India

Abstract: With the growing importance of nanotechnology in materials science, the length scale has been reduced by several orders of magnitude while the complexity of
the structures and the morphology of the materials has grown correspondingly other
information needed to understand processes occurring has also greatly increased.
Though there are several imaging and analytical techniques available today, each has
limitations and may introduce large errors when used to characterize materials at these
small length scales. This presentation will illustrate examples of the advantage of using
several complementary techniques.

**In situ Microscopy: A Tool to Understand Mechanisms**

C. Barry Carter, Joysurya Basu, R. Divakar*, Jonathan P. Winterstein, N. Ravishankar#
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#Materials Research Centre, Indian Institute of Science, Bangalore-560012, India

Abstract: Over the last two decades materials science has undergone a paradigm shift,
which has made microscopy an indispensable tool in materials research. *In situ*
techniques help in observing a process in atomic scale while in progress and
understanding the mechanism involved. *In situ* heating studies of ZnSe nanowires
clearly shows that growth of nanowires is possible while the catalyst particle is in the
solid state. Dewetting of thin films on reconstructed surfaces and electron-beam-induced
deposition of metallic nanoparticles on a substrate can be observed *in situ* to study the
kinetics of deposition and other related mechanisms. Such observations can be related
directly to the parameters for further thermodynamic and kinetic studies. Recent
developments for drift correction in the TEM facilitate high-temperature experiments at a
relatively high magnification. The speed of computer processors is often the limiting
factor. The future of *in situ* microscopy lies in combining the analytical data with the
conventional data.

**Imaging and Thermal Studies of Wheat Gluten Composites**

Jing Dong 1, Richard Parnas 1,3, Alexandru Asanedi 2,3
1 Department of Chemical, Materials and Biomolecular Engineering,
2 Department of Chemistry,
3 Institute of Materials Science, Polymer Program, University of Connecticut, Storrs, CT,
USA

Abstract: Plastics derived from wheat gluten (WG) are a potential substitute for
petroleum-based materials because of its non-toxic, biodegradable and environmentally
friendly properties. However, WG also has important mechanical property limitations
(e.g. brittleness) and readily absorbs water after being processed. A novel additive
thiolated poly(vinyl alcohol) (TPVA) was synthesized and blended with WG. This
approach appears effective for improving the properties of molded WG plastics through
the interaction of TPVA with the disulfide bonds between the WG subunits. We are
investigating herein the morphological characterization of WG/TPVA blend by AFM, TEM
as well as by modulated dynamic scanning calorimetry (MDSC).
Hierarchical Assembly of Low-dimensional Nanostructures for Energy, Environment and Sensing Applications

Pu-Xian Gao
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Abstract: Our research concentrates on the synthesis, characterization, manipulations and applications of low dimensional nanomaterials such as semiconductor nanorods, nanowires, nanobelts and nanotubes. Our research objective is to improve and better bridge the gap between the nanoscience exploration and nanotechnology innovation. Specifically, we are looking for a better understanding on the physical, chemical and biological phenomena involved in nanoscale materials systems. In the meantime, we are exploring novel nanomaterials design and synthesis, and specifically suited nanotechnology innovations in conjunction with biotechnology, energy and environment related applications, such as nanoscale sensors, actuators, power sources and environment-beneficial nano-catalysts.

High-resolution charge density and transport measurement on nanoscale transistors utilizing ambient noise

Ali Gokirmak, Hazer Inaltekin2, Sandip Tiwari2
Electrical and Computer Engineering, University of Connecticut, Storrs
2Department of Electrical and Computer Engineering, Cornell University, Ithaca, NY 14853, USA

Abstract: The speed at which electrical carriers can be moved, effective carrier mobility ($\mu_{eff}$), is critically important for performance of electronics. Nanometer scale devices such as nanowire and nanotube field-effect transistors (FETs) are reported to have higher $m_{eff}$ compared to bulk materials. Knowledge of resistance, obtained from current-voltage (I-V) measurements, and number of carriers, calculated from the capacitance-voltage (C-V) characteristics on the same FET is required to calculate $\mu_{eff}$ accurately. A high resolution C-V characterization technique for nanometer scale FETs, utilizing random fluctuations and non-linearities will be presented. Minimum noise level required for achieving sub-aF ($10^{-18}$ F) resolution, optimum noise level -stochastic resonance-, and the effect of higher levels of noise will be discussed.

Accumulated Body Si Field Effect Transistor

Ali Gokirmak, Sandip Tiwari1
Electrical and Computer Engineering, University of Connecticut, Storrs
1Department of Electrical and Computer Engineering, Cornell University, Ithaca, NY 14853, USA

Abstract: A side-gated narrow channel Si nMOSFET allows extremely low leakage levels and electrostatic threshold voltage ($V_t$) tunability. These MOSFETs are built on bulk Si and utilize an additional gate for electrostatic doping of the channel and the side interfaces. An ultra narrow inversion layer is formed on the top interface controlled by the
top-gate while the side interfaces and body of the device are accumulated by holes controlled by the negatively biased side-gates. The hole density in the body can be increased to $10^{19}$ cm$^{-3}$, resulting in more than 3 V increase in $V_t$ for ultra narrow channel devices. The accumulation also suppresses off-state leakage currents and short channel effects. This device structure is likely to be useful in analog and digital applications requiring low-power, ultra-short dimensions with low off-currents.

**Nanoscale Property Measurements and Mapping**

Bryan Huey  
Department of Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs

Abstract: The IMS NanoMeasurement Labs provides atomic force microscopy (AFM) imaging and expertise for the campus community. This includes several capabilities unique to our group, including simultaneous topographic, mechanical, electric field, and/or optical probing/imaging. Certain applications are also amenable to our newly developed high speed scanning property mapping, with a >100x enhancement in imaging speeds over standard AFM but with equivalent resolution. Novel studies of surface dynamics are therefore possible as illustrated for ferroelectrics, though the methods are also applicable to semiconductors, MEMS/NEMS devices, photovoltaics, etc. Future partnerships to study new systems and for continued technique development (still faster imaging) are foreseen.

**Quantum Dot Gate FETs and Nonvolatile Memory Devices: Modeling and Processing for Nanoarchitectures**

F. Jain\textsuperscript{1}, J. Chandy\textsuperscript{1}, L. Wang\textsuperscript{1}, F. Papadimitrakopoulos\textsuperscript{2}  
\textsuperscript{1} Electrical and Computer Engineering, University of Connecticut, Storrs  
\textsuperscript{2} Chemistry Department & Institute of Material Science, University of Connecticut, Storrs

Abstract: This presentation will describe novel quantum dot gate FETs and nonvolatile memories. The emphasis will be on their device, circuit and architectural modeling, as well as fabrication using site-specific self-assembly.

**Bio-Nano-Machines: Rational Design of Mechanisms and Robots from Protein Peptide Chains**

Kazem Kazerounian  
Mechanical Engineering, University of Connecticut, Storrs

Abstract: Proteins are evolution’s mechanisms of choice. The study of functional nano-mechanical systems must encompass an understanding of the geometry and
conformation of protein molecules. Proteins are open or closed loop kinematic chains of miniature rigid bodies connected by revolute joints. The Kinematics and robotics community is in a unique position to extend the boundaries of knowledge in nano-bio-mechanical systems.

We have undertaken a multi-disciplinary project aimed at the rational, first-principles-based, realistic design, manufacture, and manipulation of artificial bio-nano-devices using biological polypeptide chains. We started with developing a comprehensive methodology for kinematics notation and direct kinematics for protein molecules. These methods utilize the Zero-Position Analysis Method and draws upon other recent advances in robot manipulation theories.

The kinematic developments are then followed by an efficient and novel computational protein prediction methodology called Kineto-Static Compliance Method. This methodology is implemented in a computer software package named ProtoFold. We have used Protofold to predict the final conformation of several protein chains from a denatured configuration. ProtoFold is also used to develop very valuable information on protein structures including accurate bond length and angles, dihedral and rotomer angles, as well as identifying flexible and rigid domains. ProtoFold is currently being utilized to design, and simulate several nano robotic and mechanism devices.

Nanomaterials and their Application in Sensors/Biosensors

Yu Lei
Department of Chemical, Materials and Biomolecular Engineering

Abstract: Many areas of medicine, the environment, and food and agriculture - ranging from the diagnosis of disease to new drug discovery, screening and food safety, as well as pollutant monitoring - involve the detection of biological and chemical species. This research is aimed at development of novel, simple, and ultrasensitive sensor/biosensor platforms for the detection of biological and chemical species using different nanomaterials, such as nanotubes, nanospheres, and nanofibers.

Environmental Challenges of Nanoparticles and Research Opportunities

Baikun Li and Ross Bagtzoglou
Department of Civil & Environmental Engineering, University of Connecticut, Storrs

Abstract: It is becoming increasingly recognized that the introduction and exponentially increasing utilization of nano-particles for a variety of applications may (in the near future) present an environmental problem of very serious proportions. We discuss some of our current work with nano-particles and present areas of potential research in the fields of energy production, enhanced remediation, and modeling of fate and transport for nano-particles.
Growth and Modeling of Carbon Nanotubes by Open-Air Chemical Vapor Deposition

Andrew C. Lysaght and Wilson K. S. Chiu
Department of Mechanical Engineering, University of Connecticut
Storrs, CT 06269-3139

Abstract: A 2-D reactor-scale model has been constructed in order to understand the multicomponent transport phenomena and limiting reaction steps associated with a novel open-air carbon nanotube (CNT) growth process developed in our lab. The model utilizes the COMSOL Multiphysics environment to calculate CNT growth by chemical vapor deposition (CVD) due to chemical interaction of multiple hydrocarbon and carrier gas species. Pyrolytic gas phase decomposition as well as nanoparticle catalyzed surface chemical interactions are controlled by a 20-step reaction mechanism governed by coupled conservation of mass, momentum, energy, and species equations. This work assists in the optimization of reactor inlet and feed-stream conditions. Nanotubes grown by this process can be used in biological, energy and materials applications.

Deformation-Induced Synthesis of Nanostructured Metallic Materials

D. Maddala, A. Mubarok, J. Suri, G. Marathe, R. Hebert
University of Connecticut, Storrs, Materials Science and Engineering Program, Chemical, Materials, and Biomolecular Engineering Department

Abstract: Several examples have emerged recently of microstructural changes and phase transformations that occur during intense deformation at ambient temperatures. Examples such as deformation-induced crystallization reactions in amorphous alloys, dissolution reactions or cyclic phase transformations signify novel opportunities to control microstructures beyond traditional thermal or thermomechanical processing. The underlying mechanisms have not yet been completely rationalized, but theoretical approaches, for example, the theory of driven alloying, offer insight into the competing effects of thermally activated processes and intense deformation. Opportunities and challenges will be highlighted for deformation-synthesized bulk nanolaminate materials as well as nanocrystal/amorphous alloys.

Nanostructured Resonant Leaky-Mode Photonic Devices

Robert Magnuson
Nanophotonics Device Group, Electrical & Computer Engineering
University of Connecticut, Storrs

Abstract: The objective of our research is to realize the potential of a new class of nanophotonic devices. Thus, we conduct analysis, design, fabrication, and characterization of subwavelength periodic lattices and layers that exhibit strong resonance effects originating in quasi-guided, or leaky, waveguide modes. These compact elements yield versatile photonic spectra and surface-localized energy states with controllable Q factors. We have shown that a single periodic layer with one-
dimensional periodicity enables narrow-line filters, polarizers, and reflectors. Additional applications include bandpass and bandstop filters, laser mirrors, ultrasensitive biosensors, absorption enhancement in solar cells, security devices, tunable filters, and nanoelectromechanical display pixels.

**Rational DNA Sequence Design for Molecular Nanotechnology**

Ion Mandoiu  
Computer Science and Engineering, University of Connecticut, Storrs

Abstract: DNA is emerging as an ideal molecule for molecular nanotechnology due to its stability under a wide range of conditions and an incredible information density of about 1 bit per nm^3. Nanotechnology applications of DNA -- such as high sensitivity molecular detection and DNA-mediated assembly of carbon nanotubes -- exploit its ability to recognize and bind with high affinity to complementary strands. In this talk I will briefly review principles of rational DNA sequence design and present recent algorithmic advances and future challenges and opportunities in this area.

**Rotational Oscillatory Micro-Drill (Ros-Drill ©): A New Technology for Intra-Cytoplasmic Sperm Injection (ICSI)**

Nejat Olgac  
Mechanical Engineering Department, University of Connecticut, Storrs

Abstract: ICSI (intracytoplasmic sperm injection) is an important assisted reproductive technology (ART). Due to deployment difficulties and low efficiency of the conventional version of ICSI, piezo-assisted ICSI technique had evolved as a popular ART methodology in recent years. An important and remaining problem with this technique, however, is that it requires small amounts of mercury to stabilize the pipette tip when piezoelectric force pulses are applied. To eliminate this problem we developed and tested a completely different and mercury-free technology, called the “Ros-Drill©” (rotationally oscillating drill). The technique uses microprocessor-controlled rotational oscillations on a spiked micropipette (with 1-10 micron diameter) without mercury or piezo. Preliminary experimental results show that this new microinjection technology gives high survival rate (>70% of the injected oocytes) and fertilization rate (> 80% of the survived oocytes), and blastocyst formation rates in early trials (~ 50% of the survived oocytes). Blastocysts created by Ros-Drill© ICSI were transferred into the uteruses of pseudopregnant surrogate mothers and healthy pups were born and weaned. The Ros-Drill ICSI technique is automated therefore it requires a very short preliminary training for the specialists, as evidenced in many successful biological trials. These advantages of Ros-Drill ICSI over conventional and piezo-assisted ICSI are clearly demonstrated and it appears to have resolved an important problem in cellular biology. There are other foreseeable transformative impact from this development in the areas of drug development, artificial insemination, cloning, fly research (i.e., on the drasophila oocytes) and stem-cells.
Algorithms and Architectures for Nanocomputing

Rajasekaran, Ammar, Greenshields, Kim, Mandoiu, Shi, Wu
Computer Science and Engineering, University of Connecticut, Storrs

Abstract: Nanocomputing is an area that is being currently pursued extensively owing to the promise of decreasing the size and gate propagation delays by 2-3 orders of magnitude compared to semiconductor based computers. Several aspects of nanocomputing are of interest to scientists. For instance, effort is on to synthesize DNA molecules that can function as diodes. From these building blocks one could construct complex bio-circuits. As another example, protein molecules that can serve as associative memory elements have been identified. Computing models inspired by the way biological cells function have also been conceived of. One such model is the P-systems.

In all of these variants of biocomputing, two important problems are to develop appropriate architectures (both sequential and parallel) and to devise efficient algorithms that can exploit the technological advances. Our research is centered around these crucial issues. We anticipate that more investigators (from the School of Engineering, Dept. of Biology, UCHC, etc.) will join this team.

Nano-Engineering for Hydrogen Storage Applications

Leon L. Shaw
Department of Chemical, Materials and Biomolecular Engineering
University of Connecticut, Storrs

Abstract: One of the key components for the hydrogen economy is fuel-cell-powered vehicles which, in turn, depend critically on the advanced hydrogen storage materials that can store hydrogen on board with high gravimetric and volumetric densities. This presentation discusses the role of nano-engineering in reversible hydrogen storage materials such as the lithium amide (LiNH₂) plus lithium hydride (LiH) mixtures. The implication of nano-engineering, in conjunction with advanced catalysts and thermodynamic destabilization, for enhancing hydrogen uptake and release kinetics is discussed. Challenges for further improvements will also be highlighted.

Fast-acting detectors based on organized nanoparticles

Montgomery Shaw, UConn
Chemical, Materials and Biomolecular Engineering, University of Connecticut, Storrs

Abstract: Gel-like polymers are able to transport chemicals at high rates because of their high level of molecular motion. Unlike liquids, they are able to maintain morphology and shape indefinitely. Conducting particles in such gels can be aligned into a percolating arrangement at low particle concentration, keeping the permeability at high levels. Swelling can drop the conductivity of such a composite by 7 orders of magnitude. By making the films even thinner, i.e., by using nanoparticles, the response time can be
decreased even further. We are currently working on aligning 20-nm carbon-coated iron particles in both crosslinked and uncrosslinked matrices.

**Crystallization of Nanocrystalline Silicon Nanowires through Self-Heating**

H. Silva, G. Bakan, C. Boztug, M. Akbulut, N. Henry, A. Gokirmak
Electrical and Computer Engineering, University of Connecticut, Storrs

**Abstract:** Improved large area electronics - e.g. solar cells, displays - and high performance electronics on arbitrary substrates require a process to obtain single crystal silicon at low temperatures. Our approach involves local self-heating of lithographically defined amorphous or nanocrystalline silicon nanowires through Joule heating. Short, high amplitude electrical pulses applied across the wires result in significant structural and electrical changes and Scanning Electron Microscope (SEM) analysis suggests formation of single crystal silicon. Our results also show clear asymmetries in the self-heating process of the silicon wires indicating significant convective electronic heat transport (Thomson heat) at these dimensions and current densities.

**Integrated Nano-OptoElectronics**

G. W. Taylor
Electrical and Computer Engineering, University of Connecticut, Storrs

**Abstract:** Integration of nano-electronic and nano-optical components is an area of sustained interest in both defense and commercial sectors. This research is developing a family of submicron devices based on modulation-doped heterostructures in GaAs epitaxial materials that enables the single chip integration of electronic digital and analog functions together with optical sources, detectors, modulators and switches. The optical wavelength bands of interest include the visible, NIR, MWIR, LWIR and VLWIR. Specific applications being addressed include optoelectronic oscillators for VCO's as part of optical transceivers, optical clock sources, high efficiency power amplifiers, microwave photonic filters, AD converters, infrared detection/generation and THz sources.

**Information-Theoretic Analysis of Defect Tolerance in Nanocomputing Systems**

Lei Wang and Faquir Jain
Department of Electrical and Computer Engineering, University of Connecticut

**Abstract:** Molecular electronics such as silicon nanowires (NW) and carbon nanotubes (CNT) demonstrate great potential for continuing the technology advances towards future nanocomputing paradigm. However, excessive faults/defects from bottom-up stochastic assembly have emerged as a fundamental obstacle for achieving reliable system integration. In this talk, we present an information-theoretic approach to investigate the intrinsic relationship between defect tolerance and inherence redundancy.
in nanocomputing systems. By modeling defect-prone nanocomputing systems as non-ideal information processing media, we derive the information transfer capacity, which can be interpreted as the bound on reliability that a nanocomputing system can achieve. Employing this method, we determine the gap of reliability between redundancy-based defect tolerance and ideal defect-free systems. The ability to determine this gap has significant implications to design optimization of nano/molecular computing systems.

(This research was supported by NSF under grant CCF-0621947 and University of Connecticut Faculty Research Grant 446751. An early version of this work appeared in the Proceedings of the IEEE/ACM International Symposium on Nanoscale Architectures, October, 2007)

**RNA nanostructures for imaging and therapy**

Dr. Yong Wang  
Department of Chemical, Materials and Biomolecular Engineering  
University of Connecticut, Storrs

Abstract: Nanobiotechnology for biological and biomedical applications is explored. Specifically, our research objectives are to engineer nanostructures with biomolecules, aiming to design nanomaterials for regenerative medicine, novel nanomedicines for therapy, and nanoprobes for clinical testing. To this end, we are using RNA oligonucleotides to form nanostructures to interact with target molecules. RNA oligonucleotides can be integrated into many existing systems to improve their functionalities.

**Chemical Characterization of Nanomaterials at High Spatial Resolution**

Jonathan P. Winterstein, Joysurya Basu and C. Barry Carter  
Chemical, Materials and Biomolecular Engineering. University of Connecticut, Storrs

Abstract: Many current and developing energy technologies such as catalysis, fuel cells, hydrogen storage and hydrogen production rely on control of nanoscale materials chemistry. Transmission electron microscopy (TEM) with energy-loss spectroscopy is a critical tool for understanding chemical and structural changes at nanoscale dimensions. Cerium oxide nanoparticles doped with various cation dopants have been produced and investigated using TEM imaging and electron energy-loss spectroscopy (EELS) to understand both structure and chemistry. Dopant distributions and oxidation state changes of the cerium ions have been studied. Research to understand reduction kinetics and the relationship between particle morphology and processing is ongoing.

**Micromachine Design for Nanomanufacturing and Micromanipulation**

Bi Zhang  
Mechanical Engineering, University of Connecticut, Storrs

Abstract: Because there does not exist a rotary bearing that can provide rotational motions at the subnanometer or nanometer accuracy level, which inevitably becomes
the bottle neck to the three-dimensional (3-D) nanomanufacturing and micromanipulation. To realize the 3-D nanomanufacturing and micromanipulation, it is necessary to design a bearing that is capable of achieving the rotational accuracies at the nanometer level. This study proposes a novel design of a rotary flexural micro-bearing capable of achieving rotational/ oscillational accuracies at the nanometer level and a design methodology for such a bearing. The long-term goal is to realize true 3-D nano-manufacturing and micromanipulation through the application of the micro-bearing.