CENTER FOR NANOSCALE SCIENCE AND TECHNOLOGY
University of Illinois at Urbana-Champaign

PAPER ABSTRACTS

AND

LIST OF POSTERS

INDUSTRY AND RESEARCH

May 9, 2003

CENTER FOR NANOSCALE SCIENCE AND TECHNOLOGY

Nanotechnology Industry Workshop

Levis Faculty Center

University of Illinois at Urbana-Champaign

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PREMISE

Nanotechnology research and development will lead to fundamental changes in how we live and interact with our environment. To harness the full potential of nanotechnology, fundamental research is needed to understand self-organizing molecular phenomenon and subcellular interactions among complex biological systems. Development efforts are needed to commercialize patentable ideas, processes, and products. This can be done through collaborative efforts among academia, industry, and policy makers. To advance these objectives, the Center for Nanoscale Science and Technology (CNST) was created as a campus-wide initiative of the College of Engineering, University of Illinois.

CNST campus-wide multidisciplinary initiatives span the Colleges of Engineering; Agricultural Consumer and Environmental Sciences; Liberal Arts and Sciences; Medicine, and Veterinary Medicine; with 75 faculty working on joint initiatives in the area of nanotechnology. The devised research strategy for the CNST includes identification of five research focus areas for nanotechnology applications: Agriculture and Food; Atmospheric and Environmental, Communications and Electronics, Computational, and Medical and Pharmaceutical.

CNST Nanotechnology Industry Workshop is envisioned to foster a multidisciplinary collaboratory environment that will support the development and application of new nanoscale technologies in the formation, fabrication, and characterization of nanoscale materials for applications in agricultural and medical biotechnology, electronics, and optics.

OBJECTIVES

The overall objective of the workshop is to:

- provide an introduction to CNST and its interdisciplinary approach to nanotechnology research- from materials to devices to systems;
- provide a forum for faculty and industry interactions and collaborations

INDUSTRY PARTNERS

At CNST we firmly believe in the value of partnerships, which it brings to advance the mission of the University of Illinois. By establishing linkages with industrial partners we commit ourselves to deliver quality education, bleeding-edge research synergistically with the industry in creating intellectual property resulting in technologies and products, which positively affect the lives of our fellow citizens.

Avenues for Industry to Partner with CNST

- **Affiliate programs**. Industry Partners participating in CNST's affiliate program interact closely with university faculty in specific research areas. The nature and mode of participation can be informal visits to research laboratories, or formally at annual workshops or campus symposia.

- **Consulting**. CNST faculty members consult on a private basis with Industry Partners. These contacts occur through the individual faculty, not CNST directly.

- **Leveraging existing research**. Industry Partners may leverage ongoing research at CNST.

- **Licensing**. Industry Partners can license intellectual property, such as hardware, technology process, or software from CNST. Industry Partners that support the research have the opportunity to negotiate beneficial licensing terms through the Office of Technology Management.

- **Long-term research gifts**. Industry Partners also make long-term gifts dedicated to an area of research.

- **Personnel placement**. Industry Partners sometimes place their own personnel at CNST for a limited time.

- **Research center funding**. Some Industry Partners fund a research center, which can provide significant impetus to the Industry Partner's research direction. Funding a center entails developing a pool of talented students whose expertise can be leveraged by the Industry Partner through direct hire.

- **Research contracts**. Some Industry Partners contract for goal-oriented research, which targets a specific research area.

- **Research visitor program**. Provides a chance for researchers from academia and industry to interact with CNST faculty and students on novel, innovative, interdisciplinary research topics for an extended period.

- **Student interns and fellowships**. Industry Partners hire student interns as a way to meet short-term needs and recruit future employees. They also offer fellowships to support students' research.

Contact us to establish a partnership.

Phone: 217-333-3097 nano@cnst.uiuc.edu www.cnst.uiuc.edu

PAPER ABSTRACTS*

The Many Nanotechnology Initiatives: Assessment, Strategy and Opportunities

Dr. James S. Murday

Executive Secretary, Nanoscale Science, Engineering and Technology

Chief Scientist, Acting, Office of Naval Research

Investment in the science, engineering and technology of nanometer scale structures has grown significantly worldwide - in part due to the prospects for science discovery, in larger part to the potential economic impact. The U.S. nanotechnology initiative is entering its third year. A National Academy of Sciences assessment, "Small Wonders, Endless Frontiers: Review of the National Nanotechnology Initiative," has suggested some ways to improve the initiative. This talk will present: a) metrics for assessing the initiative impact; b) the high value return on present science and technology investment at the nanoscale; c) modifications to the US initiative designed to accelerate the already impressive rate of progress; and d) opportunities for science discovery with likelihood of transition into innovative technology.

Nanotechnology: From Material Science to Commercial Applications

Judith Stein, GE

At the beginning of 2002, GE Global Research initiated a new funding scheme in which in addition to research that can impact the GE businesses in the 3-5 year time frame, investment was also made in areas with long-term impact. These research programs are in the areas of:

- Nanotechnology
- Light Energy Conversion
- Photonics
- Biotechnology
- Advanced Propulsion
- Hydrogen Storage

The Nanotechnology team is composed of 5 thrust areas:

- Nanotubes and nanowires
- Magnetic nanoparticles
- Nanostructures in metals and ceramics
- Hybrid materials
- Hierarchical ceramics platform

The overall challenge of the Nanotechnology team is the control of nanostructures through techniques such as self-assembly, guided self-assembly, templating, etc. These materials will then be used in a variety of applications that support GE businesses such as GE Medical Systems and GE Power Systems.

In this presentation we will discuss our latest developments in the area of nanotechnology as well as describe methods for strategic benchmarking of the program and application strategy. The results will be framed in the context of the 100 + years of innovation at GE.

Opportunities at the Nanoscale in the Heavy Equipment Industry

Mark J. Andrews, *Ph.D.*
Advanced Materials Technology, **Caterpillar, Inc.**

Caterpillar, Inc. is a world leader in the manufacture of both large and small machines used for the building of global infrastructures, and for diesel and natural gas engines used in the transportation and electrical generation industries. The presentation will illustrate some of Caterpillar's involvement in technologies at the nanometer scale, as well as the Company's interest in future technologies in this regime.

DIRECTED ASSEMBLY OF 3-D PERIODIC STRUCTURES

Jennifer A. Lewis
Department of Materials Science and Engineering
University of Illinois at Urbana-Champaign

Three-dimensional (3-D) periodic structures may find potential application as photonic band gap materials, composites, microfluidic devices, and, even, tissue engineering scaffolds. These structures can be assembled directly from colloidal, nanoparticle and organic building blocks. This talk will feature examples from our recent efforts in engineering such assemblies. First, the role of highly charged nanoparticle species in regulating the behavior of binary colloidal microsphere-nanoparticle mixtures is highlighted. Second, the creation of 3-D periodic structures via robotic deposition of novel inks is described. Concentrated gel-based inks with tailored viscoelastic properties were designed to produce 3-D structures with self-supporting features. The inks were robotically deposited in a layerwise build sequence to directly write the desired 3-D pattern. 3-D periodic structures with spanning features that vary between ~ 100 mm and 1 mm were created from a broad array of ink designs. The myriad of materials systems and assembly techniques under development offers the potential to architect complex 3-D structures needed for a wide variety of applications

Using Simple Theoretical Tools in the Interpretation of Electron Conductance in Molecular Bridges

Carlos Gonzalez
Computational Chemistry Group, **National Institute of Standards and Technology**, Gaithersburg, MD. 20899

Recent advances in the development of robust theoretical methodologies for the proper treatment of electron transport through molecular bridges attached to metallic electrodes has led to the implementation of a series of computational tools that enable the scientist to complement the experimental observations obtained in the lab. In particular, current-voltage (I-V) curves can now be calculated on single molecules over a wide range of voltages and the results correlated with the experimental I-V curves, providing significant insight on the mechanism governing the transport process. In this talk a brief overview of the current methods will be presented. In addition, the use of some of these methods to study systems known to exhibit asymmetric I-V curves of the type called negative differential resistance (NDR) will be discussed. Although very few measurements have appeared in the open literature and there seems to be a controversy regarding the existence of the NDR phenomenon in molecules, the prospects of building such systems have attracted significant attention. In this work, a model based on DFT calculations of the electronic structure of the 2'-amino-4,4'-di(ethynylphenyl)-5'-nitro-1-benzenethiolate molecule (previously reported to exhibit NDR behavior) in a capacitor-like electric field that mimics the potential spatial profile of the junction is used. Our results suggest that in these systems, there seems to be a correlation between a substantial charge density rearrangement of the neutral bridge at a threshold voltage and NDR behavior. Our results highlight the importance of both field *and* geometry optimization in the study of electrified interfaces. We have applied this model to other substituted conjugated di-ethynylphenyl molecule, and these calculations predict similar behavior. Results based on extended system calculations including the electrode-molecule interactions confirm the validity of the model based on the isolated molecule, and suggest the use of these simple models to rationally design molecular devices with similar switching characteristics.

Silicon Nano-biotechnology

G. Timp
Department of Electrical and Computer Engineering, **University of Illinois at Urbana-Champaign**

Silicon nanotechnology can now manufacture logic that incorporates more than 43 million Metal-Oxide-Semiconductor Field Effect Transistors (MOSFETs) into a monolithic integrated circuit (IC). Some of these MOSFETs have a gate or control electrode that is only 130nm long with a gate oxide that insulates the control electrode from the current-carrying channel that is as thin as 1.7nm. Moreover, we have recently shown that further miniaturization is practical. We have produced nanometer-scale MOSFETs or nano-transistors with a gate electrode as shorter than 40nm and a gate oxide thinner 1nm. Inexorably, within the next ten years (according to the ITRS roadmap) the electronics industry is expected to integrate over a billion nanotransistors into a ~3-10cm^2 area chip, packing about 5-10 nano-transistors/□m^2. Integration on this scale, along with the facility for nanofabrication, will enabled new types of ICs. For example, we will show that it is now possible to fabricate ICs so small that *they could inserted inside a living cell.* Since the cell is the key to biology, this chip could provide unprecedented access to it. We will also show how silicon nanofabrication technology can be used to produce nanometer-scale pores (~2nm in diameter) in an ultra-thin glass membrane (~2nm thick) that function like ion channels in the membrane of a living cell. Such devices may ultimately be used in proteomics or for rapid sequencing of minute amounts of DNA to discover the genetic origin of a disease.

Nanocapillary Arrays for Neurotoxin Detection

Donald M. Cannon, Jr., Tzu-Chi Kuo, Joseph J. Tulock, Carla B. Swearingen,
Mark A. Shannon, Jonathan V. Sweedler and Paul W. Bohn
University of Illinois at Urbana-Champaign

Hybrid nanofluidic / microfluidic chips have been developed in our laboratories with characteristic linear dimensions of nanometers and volumes as small as tens of attoliters, specifically designed to manipulate species which must be handled at extremely low masses, *e.g.*, the potent neurotoxins encountered in biological warfare agents. These sensor systems rely on nanocapillary arrays with active areas not much larger than transistors in microprocessors to actively control (via electrokinetics) fluidic transport between distinct microfluidic channels of a multilayer microchip. Polycarbonate nuclear track-etched membranes, with nanometer diameter channels capable of sustaining flow across the relatively large (~10 um) membrane thickness, serve as the critical interconnect component. Controlling the chemical and physical properties of the nanocapillary array provides for a highly selective, yet flexible, molecular transport mechanism. Because of the nanofluidic nature, the transfer can even depend on the properties of the analyte, such as the molecular size. Nanocapillary array transport incorporated into multilayer microfluidic systems digitizes fluidic operations, such as analyte injection, mixing, and collection, thereby achieving integrated fluidic analyses. As digitizing electronics has permitted complex operations to be processed, digitizing molecular fluid flow can potentially solve the daunting challenges posed by trace levels of extraordinarily lethal toxins.

Microfluidic Technology for Assisted Reproduction

Matthew B. Wheeler
Department of Animal Sciences and Beckman
Institute for Advanced Science and Technology
University of Illinois at Urbana-Champaign

In the last decade the use of *in vitro* production of mammalian embryos and the utilization of assisted reproductive technologies such as embryo transfer, cryopreservation, and cloning are being used to produce genetically superior livestock. However, efficiencies of these assisted reproductive technologies (ART's) are low. For these ART's to become more commercially viable, the efficiencies must improve. Despite this importance of reproduction for the livestock industry, little progress in decreasing embryonic mortality has been made. The livestock industry has succeeded in achieving large increases in average milk production of dairy cattle, growth rate in beef cattle and leanness in swine but reproductive efficiency has actually decreased. For example, research has provided little progress toward developing an objective method to examine viability of a single living embryo.

At the same time, the growth of miniaturization technologies beyond integrated circuits and towards small mechanical systems has created opportunities for fresh examination of a wide range of existing problems. While the investigation and application of miniaturization technologies to medicine and biology is progressing rapidly, there has been limited exploration of microfabricated systems in the area of embryo production. We have taken a major step in demonstrating microfluidic systems for embryo manipulation and analysis.

Manipulating and Sorting Carbon Nanotubes using Selective Recognition by Polypeptides and ss-DNA

Timothy Gierke, DuPont

We (Dupont) have been interested in using molecular biology and biochemistry to assist in the manipulations of matter at nanometer scales. One material of particular interest in the electronics industry is single walled carbon nanotubes (SWCNT). We have found that we can identify both peptides and single stranded DNA that have specific recognition for SWCNT's. We will discuss our work in discovering these biomolecules with selective recognition and demonstrate preliminary results in using this technology to disperse, sort and place carbon nanotubes.

Nanotechnology for Cracking the Problems of Membrane Proteins

Stephen G. Sligar
Departments of Biochemistry, Chemistry and the College of Medicine
University of Illinois at Urbana-Champaign and Nanodisc LLC, Urbana, Ilinois 61801

Nanobiotechnology is the marriage of biology with the nanotechnological advances in materials, instrumentation and processing in order to realize a fundamentally new understanding of biological function as well as to visualize and manipulate hierarchical supramolecular assemblies. An important goal is the development and execution of methodologies for the determination of biological structure and function in the 5 nm - 500 nm 'mesoscale' size range, thus providing the important architectural information of specific aggregates of nucleic acids, lipids and proteins which constitute important cellular machinery. We have utilized genetically engineered lipid-protein complexes to understand the reactivity of lipoproteins on surfaces and to stabilize and incorporate single membrane proteins in nanostructured phospholipid bilayers. These resultant supramolecular architectures, termed Nanodiscs™, allow the direct visualization of individual membrane protein structures and measurement of physical properties on single molecules. The ability to directly probe the function of single membrane proteins incorporated into mimics of the natural cellular environment can have an enormous impact on the understanding and control of biological signaling, receptor mediated growth control processes and high throughput screening.

New Concepts in Droplet-Nanoengineering and Nanoencapsulation

Manuel Marquez

Group leader of the NanoteK Consortium sponsored by Kraft Foods R&D.

Herein we describe two approaches for nanoengineered complex droplets and their use as templates for micro- and nanoencapsulation. We will discuss the use of microfluidic devices for the preparation of inverse emulsions of water droplets in oil with a very narrow size distribution. In addition, the application of an electric field has allowed for the generation of submicron emulsions by electrospray inside the channels.

***Concept #1*: Micro/Nano Encapsulation via Electrified Coaxial Liquid Jets:** We report a method to generate steady coaxial jets of immiscible liquids with diameters in the range of micrometer/nanometer size. This compound jet is generated by the action of electro-hydrodynamic (EHD) forces with a diameter that ranges from tens of nanometers to tens of micrometers. The eventual jet breakup results in an aerosol of monodisperse compound droplets with the outer liquid surrounding or encapsulating the inner one. Following this approach, we have produced monodisperse capsules with diameters varying between 0.05 and 10 micrometers, depending on the running parameters.

***Concept #2:* Colloidosomes: Selectively Permeable Capsules Composed of Colloidal Particles:** We present an approach to fabricate solid capsules with precise control of size, permeability, mechanical strength, and compatibility. The capsules are fabricated by the self-assembly of colloidal particles onto the interface of emulsion droplets. After the particles are locked together to form elastic shells, the emulsion droplets are transferred to a fresh continuous-phase fluid that is the same as that inside the droplets. The resultant structures, which we call "colloidosomes," are hollow, elastic shells whose permeability and elasticity can be precisely controlled. The generality and robustness of these structures and their potential for cellular immunoisolation are demonstrated by the use of a variety of solvents, particles, and contents.

Silicon Nanoparticle: A New Generation of Biomedical Markers

Munir H. Nayfeh, Thomas E. Eurell, Paul V. Braun, and Sahraoui Chaieb

Departments of Physics, Veterinary Biosciences, Material Science and Engineering, and
Theoretical and Applied Mechanics
University of Illinois at Urbana-Champaign

Weiming Yu
Department of Medicine
Indiana University
Indianapolis, IN 46202

Tags that fluoresce under illumination are ubiquitous in medicine and biology—used in everything from HIV tests to imaging the inner functions of cells. But the dye molecular fluorescent tags that are relied on today have serious drawbacks. They periodically dim (blink), and are not photostable, introducing uncertainty in measurements. The ambitious goal of developing treatment procedures that require only minimal numbers of cells from living patients requires the development of a new generation of highly improved markers having superior detection sensitivity and spatial resolution. We have synthesized ultrasmall silicon nanoparticle markers that are brighter, safer, less fragile, and potentially more practical than dyes, or compound semiconductor tags. The objective is to transform this scientific potential at the cutting edge of technology into a viable biophotonics technology.

We will discuss the physical, material, chemical, and optical properties of the particles. We will also discuss how we functionalize them to produce "smart" tags that are able to seek out specific biological targets—for imaging, targeted drug delivery, or destruction of a pathogenic invader. We will finally discuss preliminary results on staining stem and kidney cells.

Technology Commercialization and Economic Growth: A System of Partnerships

David Chicoine
Economic Development and Corporate Relations
University of Illinois at Urbana-Champaign

A key requirement for the realization of economic benefits from the technologies developed in our research universities is *civic entrepreneurial leadership* provided by a collaborative partnership of leaders in academia, business and government. These leaders are characterized as catalysts with long-term commitment to community/regional/state economic development, team builders, motivators, visionary, passionate, and energetic; they motivate and bring out the best in others. A successful program for economic development combines strong civic entrepreneurial leadership with world class scientists and research facilities, long term State investment in enabling infrastructure for research and technology commercialization, collaborative State and community agencies and R&D entities, and engaged corporate, financial and services sectors.

Research Park and Incubator

John Parks
University Research Park

Opened in 2001, the Research Park at the University of Illinois provides a home for scientific and technology-based businesses. It will eventually cover nearly 200 acres with more than two million square feet of high tech office space. The facility promotes an environment where research-based businesses can work with students and graduates of a premier research institution to take advantage of multiple opportunities for collaborative work with a world-class research faculty. 26 companies and research centers employing over 630 people in high technology careers are housed at the Research Park; current occupants include Motorola, Caterpillar, and Science Applications International Corporation (SAIC). The vision of the Research Park is to create a symbiotic relationship between technology, commerce, and community.

EnterpriseWorks @ Illinois (incubator program) aids in the development of start-up companies, providing a low-cost high-tech environment including business planning assistance, market research, and access to capital. In addition, start-up companies have access to an extensive internship and mentoring network. As many as 30 companies will be housed in the new 43,000-square foot facility with state-of-the-art laboratory space beginning in April 2003.

A Colorimetric Electronic Nose

Kenneth S. Suslick*, Margaret A. Kosal, William B. McNamara III**, Avijit Sen****
***University of Illinois at Urbana-Champaign**
****ChemSensing, Inc.**, 505 S. Mathews Av., Urbana, IL 61801
http://chemsensing.com

Array based vapor sensing has emerged as a powerful approach toward the detection of chemically diverse analytes. We have developed a unique chemical detection technology in which colorimetric changes in an array of dyes constitute a signal much like that generated by the mammalian olfaction system; each dye is a cross-responsive sensor. This technology uses a disposable two-dimensional array of chemoresponsive dyes as the primary sensor elements, making it particularly suitable for detecting many of the most odiferous compounds. Striking visual identification of a wide range of VOC's are easily made at part per billion (ppb) levels, for example to hydrogen sulfide, methylsulfide, formic acid, acetic acid, ammonia, and hexylamine (i.e., sensitivities comparable to or better than GC-FID or GC-MS detection).

Nano Business in Illinois: Atomworks Perspectives

Sean Murdock
Atomworks

Nanotechnology has vast potential to affect the world around us. In time, it will have a dramatic impact upon the world around us. The University of Illinois, and the state of Illinois and Midwest more broadly, are leading the way. Our exceptional research, coupled with our diverse economy and the strengthening entrepreneurial culture, positions us well to be world leaders in the commercialization of nanotechnology going forward.

NOON – 2:00PM LUNCH AND POSTER SESSION- LEVIS SECOND FLOOR

Lunch Courtesy: Brinks, Hofer, Gilson & Lione

POSTERS BY CNST ASSOCIATED FACULTY, GRADUATE STUDENTS, CAMPUS UNITS, INDUSTRY, AND LOCAL TECHCOMMUNITY-EDC *

P#	Title	Presenter	Co-Presenter(s)	Affiliation
1	Nanotechnology Research and Resources at University of Illinois	Irfan Ahmad	Kathy Harper, Ilesanmi Adesida	Center for Nanoscale Science and Technology
2	On the Growth Kinetics of Nano-Clusters on a Desorbing Buffer	Arshad Bhatti	V. Antonov, J. Palmer, J. Weaver	Materials Science & Engineering
3	The Bending Stiffness of a Film made of Silicon Nanoparticles	Sahraoui Chaieb		Theoretical & Applied Mechanics
4	A Novel Integrated In Vitro Maturation and In Vitro Fertilization System for Swine	Sherrie Clark	E. Walters, D.Beebe*, M. Wheeler	Animal Sciences, Beckman Institute, and *University of Wisconsin
5	In Vitro Fertilization of Porcine Oocytes in Polydimethylsiloxane (PDMS)-Glass Microchannels	Sherrie Clark	E. Walters, D. Beebe*, M. Wheeler	Animal Sciences, Beckman Institute, and *University of Wisconsin
6	Diffusion on Amorphous Semiconductors as a Means to Form Nanostructures	Andrew Dalton	Edmund Seebauer	Chemical and Biomolecular Engineering
7	Multi-Scale Simulations of Nanofabricated Structures: Application to Copper Electrodeposition for Applications in Electronic Devices	Tim Drews	Richard Alkire, Richard Braatz	Chemical & Biomolecular Engineering
8	Nano-Complexes of Polymer and DNA: "Artificial Viruses"	M. Laird Forrest	Daniel Pack	Chemical & Biomolecular Engineering
9	Nanotechnology in Photonic Devices	Dan Grasso	Aaron Danner, Kent Choquette	Electrical & Computer Engineering, and Micro & Nanotechnology Lab.
10	Nanosystems Engineering Applied to Transient-enhanced Diffusion Modeling	Rudiyanto Gunawan	Michael Jung, Edmund Seebauer, Richard Braatz	Chemical & Biomolecular Engineering
11	Applying Micro Electromechanical Systems (MEMS) for Nanotechnology Applications (M4N)	Chang Liu		Electrical & Computer Engineering, and Micro & Nanotechnology Lab.

12	High Performance Micro Fluid Platforms for Rapid DNA Identification	Chang Liu		Electrical & Computer Engineering, and Micro & Nanotechnology Lab.
13	New Colorimetric Biosensors for Metals and Organic Molecules Based on Catalytic DNA-directed Assembly of Gold Nanoparticles	Yi Lu	Juewen Liu, Daryl Wernette	Chemistry, Biochemistry, and Beckman Institute
14	Metalloporphyrin Nanoporous Solids	Dennis Smithenry	Kenneth Suslick	Materials Chemistry
15	Nanotechnology and Future of Architecture	Nitin Narang	George Elvin	School of Architecture
16	Dynamic Non-fluorescent Nanoparticle Optical Contrast Agents	Amy Oldenburg	Farah Jean-Jacques Toublan, Jillian Gunther, Tin Man Lee, Kenneth Suslick, Stephen Boppart	Electrical & Computer Engineering, and Beckman Institute
17	Nanofluidics: From Anomalous Behavior to Multiscale Methods	Rui Qiao	Sony Joseph, N. Aluru	General Engineering, and Beckman Institute
18	Nonlinear Feedforward-Feedback Control of a Stochastic Multiscale Code for Simulating Thin Films and Trenches	Effendi Rusli	Richard Braatz, Richard Alkire	Chemical & Biomolecular Engineering
19	Nano Wires by Self Assembly	Taher Saif	Erdem Alaca, Huseyin Sehitoglu	Mechanical & Industrial Engineering
20	Hybrid-Integrated Semiconductors through Wafer Bonding Technology: Nanostructure, Electrical, Optical, and Mechanical Properties	Frank Shi	K. C. Hsieh	Electrical & Computer Engineering, and Micro & Nanotechnology Lab.
21	Three-Dimensional Microvascular Networks for Microfluidics	Daniel Therriault*	Scott White*, Jennifer Lewis**	* Aerospace Engineering, ** Materials Science & Engineering
22	Silicon Nanoparticles: New Generation of Biomedical Markers	Joel Therrien	Elena Rogozhina, Gennadey Belomoin, Satish Rao, Adam Smith, Munir Nayfeh	Physics
23	Microfluidics with Incorporated Nanofluidic Interconnects for Three-Dimensional Molecular Transport and Sample Manipulation	Joe Tulock	Paul Bohn	Beckman Institute
24	In Vitro Maturation of Pig Oocytes in Polydimethylsiloxane (PDMS) and Silicon Microfluidic Devices (IETS 2001)	Eric Walters	Matthew Wheeler	Animal Sciences, and Beckman Institute
25	Production of Live Piglets Following In Vitro Embryo Culture in a Microfluidic Environment (IETS 2003)	Eric Walters	Matthew Wheeler	Animal Sciences
26	Characterization of Airflow in Aircraft Cabins	Aijun Wang	Yuanhui Zhang	Agricultural Engineering
27	Structure of Zein Layers at Protein-lipid Interfaces	Qin Wang	Graciela Padua	Food Science & Human Nutrition
28	Optical Properties and Morphology of Porous GaN	Todd Williamson	Paul Bohn	Chemistry
29	Nanoporous Optoelectronic Materials	Todd Williamson	Diego Diaz	Chemistry

30	Electron Beam Nanolithography	Michael Word	Ilesanmi Adesida	Electrical & Computer Engineering, and Micro & Nanotechnology Lab.
31	Dynamics, Equilibrium Morphologies, and Monte Carlo Modeling of Cl-Si(100)-(2x1)	Guangjun Xu	G. Xu , K . Nakayama, B. Trenhaile, C. Aldao, J. Weaver	Materials Science & Engineering
32	Sub 10 nm Nanoindentation Mechanical Property Measurements Using a Very Sharp FIBed Diamond Indenter	Ning Yu	Andreas Polycarpou	Mechanical & Industrial Engineering
33	Midwest Breast Research Institute Initiative	Lynne Barnes	Kathy Emanuel, Edra Scofield	Carle, and Federal Initiatives Group of Urbana-Champaign
34	Intellectual Property	Jasper Dockrey	Anthony Curtis, William Prendergast	Brinks, Hofer, Gilson & Lione
35	UIUC-- Technology Research, Education, Commercialization Center (TRECC)	EJ Grabert	Nancy Komlanc	UIUC, NCSA— Technology Research, Education, Commercialization Center (TRECC)
36	The Office of Technology Management: Facilitating Real-World Applications for Intellectual Innovation	Lesley Millar	Roger VanHoy and Mark Kaczor	Office of Technology Management
37	SUN-FARM	Jeremy Ross		SAIC, and Federal Initiatives Group of Urbana-Champaign
38	Technology Entrepreneur Center	Brenda Tyler	Ikhlaq Sidhu	Technology Entrepreneur Center, and General Engineering
39	Instruments for Near-field Optical Microscopy, Micro-Raman Spectroscopy, and Atomic Force Microscopy	Jeff White		WITec Instruments Corp.
40	Anomolous immobilization of water by confinement in carbon nanotubes: Implications for design of proton-conducting nanoscale semiconductors	Jay Mashl	Sony Joseph, Narayan Aluru, Eric Jakobsson	Molecular and Integrative Physiology, Biochemistry, Beckman

** Abstracts and poster list includes only those submitted until the time of printing.* http://www.cnst.uiuc.edu/NanoWorkshop.htm

For More Information or Technical Collaboration Contact:

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