Nanotechnology Seminars

Chem 560A and Bioeng 599F
TIME: Tuesdays12:30 - 1:20 PM
LOCATION: Bagley Hall Room 260
(On the 2nd floor, near the stairwell closest to the loading dock and Benson Hall)

10/1/01
AUTUMN QUARTER 2001 STARTS

10/2/01
Hongkun Park Asst. Prof. Harvard University
Transport and Scanned Probe Investigations of One-Dimensional Nanostructures

Host: Daniel Chiu, Asst. Prof. Dept. of Chemistry

I will present transport and scanned probe investigations of single-walled carbon nanotubes and ferroelectric nanowires in this talk. In the first major part of the talk, I will discuss coupled scanned probe and transport measurements on individual single-walled carbon nanotubes, which allowed us to investigate (1) Fabry-Perot interference between electron waves traveling along the nanotube, (2) electronic shell filling and exchange coupling in metallic nanotubes, and (3) resonant electron scattering from individual structural defects. In the second part of the talk, I will discuss the synthesis and characterization of ferroelectric nanowires.

10/9/01
James M. Tour, Professor Rice University - Center for Nanoscale Science and

Molecular Computers

Host: Younan Xia, Assistant Professor

Research efforts directed toward constructing a molecular computer will be described. Routes will be outlined from the synthesis of the basic building blocks such as wires and alligator clips, to the assembly of the entire CPU. Specific achievements include: (1) isolation of single molecules in alkane thiolate self-assembled monolayers and addressing them with an STM probe, (2) single molecule conductance measurements using a mechanically controllable break junction, (3) 30 nm bundles, approximately 1000 molecules, of precisely tailored molecular structures showing negative differential resistance with peak-to-valley responses far exceeding those for solid state devices, (4) dynamic random access

memories (DRAMs) constructed from 1000 molecule units that possess 10 minute information hold times at room temperature, (5) demonstration of single-molecule switching events and (6) initial assemblies and programming of molecular CPUs in a Nanocell configuration.

10/16/01

Marya Lieberman Assistant Professor University of Notre Dame in South Bend, Indiana

Quantum Dot Cellular Automata

Host: Prof. Jim Mayer

Do molecular electronic devices have to mimic solid-state transistors, diodes, and wires? The quantum-dot cellular automata (QCA) paradigm for computing describes how information can be transmitted and processed by Coulomb interactions between structures that contain electrical charge. QCA wires, logic gates, memories, etc. have been demonstrated at the micrometer scale in a prototype system based on lithographically fabricated metal dots.[1] Advantages of QCA include extremely low power dissipation, true power gain, and an architecture that is suitable for self-assembly at the molecular level. A large research effort is underway at Notre Dame to translate this paradigm to the smallest possible size scale, that of individual molecules. This talk will describe our design criteria for molecular QCA cells, explain how these molecules would fit into QCA devices, and focus on experimental measurements on a series of binuclear and tetranuclear mixed-valence compounds that we believe will act as molecular QCA cells. In these compounds, inorganic redox centers serve as "quantum dots," and organic linkers act as tunnelling barriers between the "dots". We have found it advantageous to create mixed-valence compounds with low net charge, and both the rationale for this decision and its impact on the electronic properties of the resulting compounds will be described.

10/23/01

Brian S. Mitchell, Associate Professor Chemical Engn. - Tulane University, New Orleans

Nanostructured Materials: To Buildup or To Breakdown.

Host: Guozhong Cao, Assistant Professor; Dept of Mat. Sci. and Engineering

Many nanostructured materials are produced by a build-up process from the atomic scale. Self- assembled systems, sol-gel derived materials, and templated materials are a few examples. But nanoscale structures can also be formed by a reduction in the scale of a material structure. In this talk, I will give an example of each approach. In this first case, the formation of nanocrystalline SiC from polymeric precursors will be described. The applicability of nucleation and growth kinetics to the formation of nanocrystalline materials will also be discussed. In the second example, the formation of nanocrystalline powders by high energy ball milling (mechanical attrition) will be described. Implications of the nanoscale structure of these powders to the formation of nanostructured aluminum/mullite composites will be addressed.

10/30/01

Susan M. Kauzlarich, Professor University of California

The Novel Synthesis of Silicon and Germanium Clusters and Nanoclusters

Host: Daniel R. Gamelin, Asst. Prof. - Dept. of Chemistry

Interest in the synthesis of semiconductor nanoparticles has been generated by their unusual optical and electronic properties arising from quantum confinement effects. We have synthesized Silicon and Germanium nanoclusters by reacting Zintl phase precursors with either silicon or germanium tetrachloride in various solvents. Strategies have been investigated to stabilize the surface, including reactions with RLi and MgBrR (R = alkyl). This synthetic method produces group IV nanocrystals with passivated surfaces. These

particles have been characterized using HRTEM, FTIR, UV-Vis, solid state NMR, and fluorescence and have been shown to have efficient blue, green, or red luminescence. While there is a great deal of interest in Si and Ge nanoparticles, all the reaction routes published to date produce these nanoparticles in low yield. We are investigating solution routes to these nanoparticles, both reduction of SiCl4 or organosilanes, and oxidation of Zintl salts. We are also functionalizing the surface of the Ge nanoclusters with an aim towards preparing organized arrays. I will briefly present work to date and some new directions in synthesis.

11/6/01

William E. Buhro, Asst. Prof, Washington University - St. Louis, MO

Monodisperse Metallic Nanoparticles as Catalysts for Semiconductor Quantum-Wire Growth

Host: Daniel R. Gamelin, Asst. Prof. - Dept. of Chemistry

Quantum wires possess quantum confinement in two dimensions, and resemble whiskers, being nanocrystals that are small in two geometric dimensions and larger in the third. Less is known about quantum wires than about quantum dots or quantum wells, and methods to fabricate or synthesize them have begun to emerge only recently. Several years ago, we learned that the growth of III-V semiconductor nanowhiskers in solution was catalyzed by nanometer-sized particles of low-melting metals, such as indium [1].

We have now developed a method – heterogeneous seeded growth – for preparing monodisperse nanoparticles, having predetermined, rationally controlled sizes, of the low-melting metals In, Bi, and Sn [2]. This strategy, which has the potential to become a general method for synthesis of metallic nanoparticles, will be one emphasis of the seminar. Semiconductor quantum wires that exhibit small diameters and narrow diameter distributions have been successfully grown from these size-controlled, monodispersed catalyst nanoparticles. The synthesis and preliminary spectroscopic characterization of these III-V quantum wires will form the second emphasis of the lecture.

11/13/01

Tom Russell, Polymer Science and Engineering Department University of Massachusetts

Thin Film Scaffolds and Templates for Nanostructures from Block Copolymers

Host: Lixin Zheng, Graduate, Materials Science & Engr
Visit the UMass MRSEC website at http://www.pse.umass.edu/mrsec/

Manipulating the spatial orientation of homopolymer and block copolymers in thin films requires control of the interfacial energies the use of external fields. Electric fields have proven to be an effective means of achieving this end in thin films. Low voltages across a thin film produces high field strengths. Fields applied normal to the film surface can simply produce ordered arrays of nanostructures with lateral densities in excess of 1011/cm2. Standard lithographic processes can be used to produce arrays of nanopores that act either as a scaffold in which to grow nanoscopic structures or as a template for transferring the pattern into the substrate.

11/20/01

Prof. Kannan M. Krishnan, University of Washington Department of Materials Science & Engineering

Magnetic Small Particles and Nanostructures

Size-dependent scaling laws and the magnetic behavior of small particles and nanostructured assemblies, as a function of size, dimensionality and inter-particle interactions, is increasingly attracting both fundamental and technological interest. Our work in this field is multi-disciplinary, involving three complementary synthesis methods (metallurgy, chemical routes & lithography) and addressing a range of fundamental and technological questions.

Our method is to test the applicability of "Browns paradox" and understand coercivity limits/mechanisms in such nanocomposite systems [1]. Complementing the research, we are also pursuing the synthesis of monodisperse, metallic, passivated nanocrystals with good size/shape control [2] and their large area assembly by entropy-driven or template-assisted organization methods. Our goal is the understanding, prediction and control of cooperative magnetic phenomena over different length scales and time signatures in such artificially tailored solids. Novel phenomena such as the existence of a "dipolar ferromagnet" without exchange interactions at elevated temperatures and applications in bioengineering using these nanocrystalas and their arrays are also being explored. Finally, our recent work [3] on a different approach to lithography, i.e. ion-beam modification through a stencil mask, to create ordered arrays of magnetic elements in the context of future patterned magnetic recording architecture will also be presented.

11/27/01

Prof. Shirley Chiang University of California Dept. of Physics

Studies of Oxygen Adsorbed on Cu(100) and on W(110) by Low Energy Electron Microscopy and Scanning Tunneling Microscopy

Host: Jason Donev, NSA - PNNL Liason

Discussion will be on low energy electron microscopy (LEEM) used to perform a detailed study of three phases of oxygen on the Cu(100) surface, including two new phases heated above 600 degrees C.

12/4/01

Jess Wilcoxons Sandia National Nanostructures and Adv. Materials

Optical and catalytic properties of metal and semiconductor nanoclusters, alloys, and cluster arrays

Host: Prof. J. Michael Schurr

The size-dependence of the optical absorbance of individual clusters of noble metals is one of the oldest problems in colloid science yet many issues still remain unresolved. Recent improvements in both chemical synthesis methods and novel separation approaches allow us to investigate issues such as the size dependence of the optical plasmon absorbance resonance and its damping (width) with great precision. In particular, the ability to size select, chemically purify, and identify sizes with 1-2 Å resolution over the size range from 1.2 to 10 nm using size exclusion chromatography (SEC) has demonstrated a true intrinsic blue shift of the plasmon peak in Au but a red shift over a comparable size range in Ag. Extreme broadening of the plasmon peak was observed with decreasing size-molecular-like features being observed in the smallest clusters. Using heterogeneous growth from monodisperse seed nanocrystals we have also synthesized core/shell particles of Au/Ag and Ag/Au. Alloys were also grown by co-reduction. The optical properties of these two classes of materials are strikingly different for identical composition and size.

12/11/01

Arthur Nozik, Ph.D. National Renewable Energy Laboratory

Carrier Dynamics in Quantum Dots and Quantum Dot Arrays and Applications for Photon Conversion

Host: Pavle Radovanovic, NSA Academic Speaker Series Coordinator

The dynamics of photogenerated carrier relaxation, transport, and interfacial transfer are modified profoundly by quantum confinement in semiconductor quantum dots. These effects have potential applications in novel quantum dot structures for highly efficient photon conversion to electricity or stored chemical free energy. Studies of the fundamental properties (optical properties, magnetic resonance spectrosscopy, electron relaxation and electron transfer dynamics, inter-dot electronic coupling, and pressure effects) of III-V quantum dots and quantum dot arrays will be presented, as well as a discussion of their application in quantum dot solar cells that have the potential to exhibit very high photon

conversion efficiencies.

1/7/02
WINTER QUARTER 2002 STARTS

1/8/02
Norm Dovichi, Professor Department of Chemistry, University of Washington

The single cell proteome project

The proteome is the complement of proteins within an organism,tissue, or cell. Unlike the genome, which is static, the proteome is dynamic, changing with development and in response to illness. We are developing technology to monitor the proteome of a single cancer cell by use of comprehensive two-dimensional capillary electrophoresis to separate proteins into components and laser-induced fluorescence to detect the proteins. Our goals are to provide protein fingerprints as a prognositic indicator of cancer, as well as providing a tool to monitor changes in protein expression during development and to study the expression of selected regulatory proteins at the lowest possible levels.

1/15/02
Prof. Sigurd Wagner, Department of Electrical Engineering Princeton University

Large Area Electronics: Prospects and Materials

Host: Professor Karl F. Bohringer, Electrical Engineering

Large area electronics are integrated circuits bigger than the single crystal wafers used in microelectronics. Macroelectronics began with thin film solar cells, grew into a large industry with liquid crystal displays, and now is branching out to sensitive skin, mechatronic materials, and e-textiles. The basic circuit combines backplane transistors and frontplane function in a cell, or pixel, which is repeated many times. The cell functions that one might deploy are only beginning to be explored. Light emitters, sensors, and actuators are under consideration, and a number of functions are bound to depend on nanostructures. Today's macroelectronic circuits are made on glass plates. Advanced concepts combine silicon and organic device materials, ceramics, steel, and plastic in structures that can be flexed, bent, shaped or draped. Using my research on transistors on flexible foil substrates I will illustrate the panoply of devices, materials and geometries under study for large area electronics.

1/22/02
Tejal Ashwin Desai, Ph.D. University of Illinois at Chicago Department of Bioengineering

Micro- and Nanofabricated Therapeutic Constructs: From Concept to Clinic

Host: Karl Bohringer, Asst. Prof. - Department of Electrical Engineering

Microfabrication techniques, which permit the creation of multifunctional platforms that possess a combination of structural, mechanical, and electronic features, may surmount several challenges associated with the conventional delivery of therapy. In this talk, in vivo delivery concepts are presented which capitalize on the strengths of micro and nanofabrication. Current work on micromachined nanoporous implantable biocapsules for the immunoisolation of pancreatic islet cells – as a possible treatment for diabetes -- and the sustained release of injectable drugs, will be described. Such microengineered interfaces may be optimized for biomolecular permselectivity and surface bioactivity. In addition, asymmetrical, reservoir-containing microfabricated particles and arrays with specific biorecognition ligands will be discussed for improving the oral delivery of peptides and drugs. With the capability to design components spanning from the millimeter down to the nanometer range, few other engineering technologies can so closely parallel the multidimensional size scale of the living cells and tissues, with control and reproducibility, in

the same fabrication process. Micro/Nanotechnology can add flexibility to current practices while becoming an enabling technology leading not just to new therapies and laboratory techniques, but also to new models for delivering healthcare to the patient.

1/29/02

Henry Hess, PhD, Dept. of Bioengineering University of Washington

Molecular shuttles based on motor proteins: Active transport in synthetic environments

Active transport in cells, utilizing molecular motors like kinesin and myosin, provides the inspiration for the integration of active transport into synthetic devices. Hybrid devices, employing motor proteins in a synthetic environment, are the first prototypes of molecular shuttles, until the development of superior synthetic motors succeeds. Here the basic characteristics of motor proteins are discussed from an engineering point of view, and the experiments aimed at incorporating motor proteins such as myosins and kinesins into devices are reviewed. The key problems for the construction of a molecular shuttle are guiding the direction of the motion, controlling the speed, and loading and unloading of cargo. Various techniques, relying on surface topography and chemistry as well as flow fields and electric fields, have been developed to guide the movement of molecular shuttles on surfaces. The control of ATP concentration, acting as fuel supply, can serve as a means to control the speed of movement. The loading process requires the coupling of cargo to the shuttle, ideally by a strong and specific link. Applications of molecular shuttles can be envisioned e.g. in the field of Nano-Electro-Mechanical-Systems (NEMS), where scaling laws favor active transport over fluid flow, and in the bottom-up assembly of novel materials.

2/5/02

Scott Chambers The Pacific Northwest National Laboratory

Ferromagnetic Oxide Semiconductors and Their Role In Spintronics

Host: Pavle Radovanovic

In electronics, device dimensions continue to reduce in size in order to achieve higher speeds. However, power dissipation and localized heating caused by the use of bundles of charge to carry signals become limiting issues as this shrinkage occurs. Even with short-term innovation, conventional field effect transistors (FET) will eventually hit a natural performance limit that cannot be surmounted without radical departures from our current methods for designing and building such devices. Several long-term, alternative concepts are being investigated that would reduce device size and power consumption. One concept is to use spin, rather than charge, to gain new functionality in both analog and digital electronics. There are numerous device concepts that can be envisaged based on spin. These range in complexity from spin-based light emitting diodes (spin-LEDs), resonant tunneling diodes (spin-RTDs), and field effect transistors (spin-FETs), to spin-based single electron devices based on quantum dot arrays. The latter class of devices might allow large-scale quantum computation to become a reality...

2/12/02

Professor David J. Beebe Dept. of Biomedical Engineering, UW-Madison

Alternative organic approaches to microfluidic system design, fabrication and operation

Host: Albert Folch, Assistant Professor, Bioengineering

Many approaches to the construction of microfluidic systems have appeared in the last few years including glass and silicon etching and bonding, laser machining, micromolding and others. None have emerged as a clear “winner.” Each has advantages and disadvantages for a given application. The cost of manufacturing for most approaches is still relatively expensive when compared to a more standard manufacturing method such as injection molding. Injection molding is of limited use for microfluidic applications due to limited resolution (although this is continually improving) and functionality (typically only passive, inflexible materials are used). Here we present an alternative approach to the design, construction and

operation of microfluidic systems that we call μfluidic tectonics (μFT) that compares to injection molding in cost, but allows for a wide variety of functionality. μFluidic Tectonics utilizes liquid phase photopolymerization and responsive materials to achieve elegant yet functional designs. The approach allows for the design, fabrication and operation of complete microfluidic devices within a few minutes. Ultra rapid microchannel fabrication is demonstrated. Filtering, flow control, readout and mixing components are demonstrated...

2/19/02

Prof. Stacey Bent, Dept. of Chemical Engineering Stanford University

Using Chemistry to Modify the Semiconductor Interface

Host: Professor Charles T. Campbell, Department of Chemistry

Molecular scale engineering has the potential to contribute to the generation of many new materials, and the knowledge of how to build a material one molecular layer at a time will be invaluable. I will describe our studies of organic modification of semiconductor surfaces, in which organic molecules are chemically attached to the surface in vacuum. The growing importance of organic materials in electronic and optical technologies, including their role in nanotechnology, motivates the development of new attachment chemistries for joining organic layers with inorganic semiconductors. A number of different chemical strategies will be described, including cycloaddition chemistry of alkenes and dienes, dissociative adsorption of amines, and reactions of carbonyls. The potential for these different classes of attachment reactions to impact future applications will be discussed.

2/26/02

Mehmet Toner, Associate Professor of Surgery Center for Engineering in Medicine - Boston

The Coming Merger of Living Cells and Microdevices

Host: Albert Folch, Assistant Professor, Bioengineering

Biomedical applications of microfabricated devices is no longer limited to non-living systems as genes-on-a-chip or lab-on-a-chip, recent advances in the understanding of cellular behavior in micro-environments have started to pave the way toward living micro-devices. These emerging devices are expected to become key technologies in the 21st century of medicine with a broad range of applications varying from diagnostic, tissue engineered products, cell-based drug screening tools, and basic molecular biology tools. They will also include multiple cell types and/or genetically engineered cells to investigate complex interactions between cells from different tissues. These sophisticated devices will contain micro-engineered tissue units coupled to each other by complex microfluidic handling network. Microfluidic mixing systems will also precisely regulate the composition and concentration of drugs to be tested. This presentation will briefly review the early historical literature on the use of microtechnologies in cellular systems and then focus on fundamental aspects of integrating cells into micro-devices. Several emerging areas of applications will also be discussed including liver and skin tissue engineering using microfabrication, the use of dielectropheresis to create cellular arrays for rapid screening, and microfluidic cellular chemotaxis assays.

3/5/02

Professor Geoffrey F. Strouse, Materials/Analytical Chemistry U.C. Santa Barbara

Nano-Material Surfaces, Defects, and Composite Structures

Host: Assistant Professor, Daniel Gamelin

Since the first demonstration of quantum confinement effects in semiconductor quantum wells, materials scientists, engineers, physicists and chemists have pursued the promise of novel optical and transport properties in these structures. At the nanoscale changes in the

allowed electron distributions and changes in critical electron transport length scales can result in profound changes in the microscopic electronic interactions between ions in the lattice and the macroscopic optical behavior of these materials. This corresponds with quantization of the electronic levels of the materials as the particle size approaches the natural exciton width in the semiconductor. The trend, particularly in chemically-synthesized systems, has been the development of smaller, lower-dimensionality materials (quantum dots) where the quantum confinement effects are large....

3/7/02

Paul Alivasatos UC Berkeley

Inorganic Nanorods: Synthesis, Properties, and Applications

Time: Thursday, March 7, 2000, 3:30-4:30
Place: Bagley 131
A Social Hour follows the lecture.

The speaker was chosen and invited by the Graduate student Colloquium Committee. To suggest future speakers (please do!), contact jschuman@u.washington.edu

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3/12/02

Prof. Hannes Jonsson Department of Chemistry University of Washington

Method for simulating long-time scale evolution of nano-structures: Application to crystal growth and clusterformation/Break-up

A method for simulating the long time-scale evolution in atomic systems will be presented. By using the dimer method [1] to find the mechanism and rate of transition that can occur in the system, the kinetic Monte Carlo method can be used without having to specify a predefined event table and assign atoms to lattice sites, thereby extending the applicability of the method to complex systems [2]. Applications to the growth of metal crystal surfaces will be presented. There, empirical many-body potential energy functions of the EAM type were used to represent the interaction between the atoms. Also, an application to boron cluster formation and evaporation in silicon will be presented. In that case, the energy and atomic forces are obtained directly from density functional theory. This new simulation algorithm is ideally suited for parallel and distributed computing. Software for carrying out these calculations through a screensaver on Windows machines has been developed and is being used on a couple of hundred computers at UW. More cycles would be welcome. Information about downloading the screensaver and project statistics are available at http://eon.chem.washington.edu

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4/1/02

SPRING QUARTER 2002 STARTS

4/2/02

Dong Qin, Ph.D. Center for NanoTechnology University of Washington

Building and Mapping Nano-Architecture at UW Campus

The presentation will provide scientific community a virtue tour to Nanotech User Facility (NUF) with an emphasis on approaches deliberated for building nanostructures and tools designed for mapping structures at nanometer scale. NUF has served as core facility to Nanotech research groups for imaging engineered surface at nano-scale over past three years. Recently, we have established a set of nano-lithographic tools for building complex nano-patterns and structures as small as 20 nm. In the talk, we will introduce nanofabrication in depth and shed light on the applications of these nano-architectures for current research projects at NUF. This talk will open a forum to those who are seeking opportunities to persist their research in the area of Nanoscicene and NanoTehcnology at UW campus.

4/9/02

Professor Zhong Lin (ZL) Wang, Center for Nanoscience and

Nanotechnology Georgia Institute of Technology

Semiconducting Oxide Nanobelts – structure, property and devices

Host: Younan Xia, Department of Chemistry

Searching for one-dimensional-like nanostructures is essential for interconnects and devices in nanoelectronics. Binary semiconducting oxides, such as ZnO, SnO_2, In_2O_3 and CdO, are now widely used as transparent conducting oxide (TCO) materials and gas sensors due to their various unique properties. SnO_2 nanoparticles are regarded as one of the most important sensor materials for detecting leakage of several inflammable gases owing to its high sensitivity to low gas concentrations. In our lab, ultra-long belt-like, quasi-one-dimensional nanostructures (so called nanobelts or nanoribbons) have been successfully synthesized for semiconducting oxides of zinc, tin, indium, cadmium and gallium, by simply evaporating the desired commercial metal oxide powders at high temperatures. The as-synthesized oxide nanobelts are pure, structurally uniform, single crystalline and most of them free from defects and dislocations; they have a rectangular-like cross-section with typical widths of 30-300 nm, width-to-thickness ratios of 5-10 and lengths of up to a few millimeters. The belt-like morphology appears to be a unique and common structural characteristic for the family of semiconducting oxides with cations of different valence states and materials of distinct crystallographic structures.

4/16/02

Prof. Gabriel Lopez University of New Mexico Chem. & Nuclear Engineering

Nanostructured and Smart Materials for BioMEMS Devices and Fluorescence Based High Throughput Screening

Host: David G. Castner

This talk will present an overview of multidisciplinary research at the University of New Mexico that has developed molecular assemblies, materials, methods and instrumentation that enable direct transduction of affinity interactions in biosensors and high throughput screening formats. Specific advances have included: (1) the development of molecular assemblies for direct fluorescence of immuno interactions; (2) the development of biomimetic nanostructured beads as receptor display systems; (3) the development of optical instrumentation (based on flow cytometry and time-resolved fluorescence spectroscopy) for monitoring of biosensor arrays and high throughput screening; and (4) the development of highly sensitive nanofluidic biosensor array systems with associated detection instrumentation based on new methods for fluorescence lifetime spectroscopy that allow unprecedented levels of sensitivity to changes in excited state lifetimes through simple, inexpensive instrumentation.

4/23/02

Heiner Linke, Assistant Professor Physics Department, University of Oregon

Ratchets: Muscles, Molecules and a Quantum version of Maxwells Demon.

Host: Henry Hess

Over the last decade or so it has been realized that a number of biological processes, for instance the contraction of muscles and intracellular transport, may make use of a fascinating physical principle: In periodic, asymmetric potentials the random motion of Brownian particles can be put to use by extracting energy from nonequilibrium processes. Such systems are called ratchets or Brownian motors.

I will introduce the ratchet concept and briefly describe a number of applications and experiments ranging from molecular separation techniques to microfluid control. Some of our own experimental research focuses on realizations of so-called "quantum ratchets" using

mesoscopic nano-devices. An experimental tunnelling ratchet turns out to have the intriguing feature to be able to sort electrons by energy. I will also present some theoretical work looking at the fundamental thermodynamic limits of the efficiency of such quantum heat engines.

4/30/02

Asst. Prof. Christopher S. Chen Johns Hopkins School of Medicine

Programming cellular functions with soft lithographic interfaces

Host: Albert Folch, Assistant Professor, Bioengineering

The binding interactions between cell surface receptors and local bioactive ligands serves as the principal mechanism by which cells survey their microenvironment and accordingly modulate their behaviors, such as proliferation, differentiation, migration, and suicide. Using microfabrication approaches to engineer cellular microenvironments, we are examining how different cues can be used to program cellular functions. We are investigating the interactions between signals from the extracellular matrix, growth factors, intercellular adhesions, and mechanical forces in endothelial cells to understand how environmental signals integrate to regulate cell function. We will discuss our approaches to control compositional chemistry, mechanical properties, architecture, and geometry of surfaces, and how these factors regulate cells. We hope to use these results to improve the interconnect between artificial surfaces with living cells.

5/7/02

Professor Richard McCullough, Dept. of Chemistry Carnegie Mellon Univ.

Self-Assembly of Block Co-Polymers and Amphiphilic Polythiophenes into Conducting Nanowires

Host: Samson A. Jenekhe

Regioregular, head-to-tail coupled, alternating copolymers of thiophenes can drive a self-assembly in polythiophenes at the nanoscale through polymer phase-separation. These new polymers have allowed us to create not only highly conductive polymers, but also conducting polymer nanowires. In addition, amphiphilic regioregular polythiophenes and polythiophene polyelectrolytes have been assembled at surfaces by layer-by-layer assembly or as SAMs to create nanoscale conductors.

5/14/02

Andreas Stein, Professor University of Minnesota

Colloidal Crystal Templating of Macroporous Materials

Host: Guangtao Zhang, Coordinator of NSA

Colloidal crystal templating is a versatile method to synthesize porous solids with periodic, three-dimensional arrays of interconnected void spaces, typically a few hundred nanometers in diameter. The templated synthesis can be employed to produce three-dimensionally ordered macroporous (3DOM) structures with walls composed of oxides, metals, semiconductors, polymers, and hybrid structures. The periodic porous structures impart the materials with interesting optical properties, highly accessible internal surfaces, and the ability to trap and stabilize relatively large guest species. This talk highlights recent synthetic approaches to colloidal crystal templating, as well as applications of 3DOM solids in optics, catalysis, battery materials, and biomaterials. An emphasis will be placed on phase, grain size, and structural control of the inorganic wall skeleton.

5/21/02

Jeffrey R. Long, Department of Chemistry University of California, Berkeley

Toward Molecular Data Storage: Directed Assembly of High-Spin Metal-Cyanide Clusters

Host: Brian T Mayers

The discovery of magnetic bistability in certain metal-oxo clusters has raised the tantalizing prospect of one day storing information at a molecular scale. However, to realize practical storage temperatures and durations with such media, it is necessary to synthesize new clusters possessing the requisite magnetic anisotropy, D, and a very large ground state spin, S. We submit that the relative simplicity of the structures and magnetic exchange pathways obtained in metal-cyanide systems will make them more amenable to the design of improved cluster magnets than previously studied metal-oxo systems. In reactions paralleling the synthesis of Prussian blue, 1,4,7-triazacyclononane (tacn) has been employed as a capping ligand to generate cubic clusters of formula $[(tacn)_8M_4M'_4(CN)_{12}]x+$. In order to access molecules with ground states of total spin higher than the maximum of S = 10 attainable with this geometry, we are now exploring reactions intended to produce higher-nuclearity clusters. The synthesis and magnetic properties of $[(Me_3tacn)_8Cr_8Ni_6(CN)_{24}]^{12+}$ and related clusters featuring as many as 27 metal centers will be presented.

5/28/02

Prof. Shaowei Chen, Dept of Chem Southern Illinois University

Gold Nanoparticle Organized Assemblies: Rectified Quantized Charging in Aqueoius Media

Host: Younan Xia, Department of Chemistry

Ion-induced rectification of the quantized capacitance charging of gold nanoparticle organized ensembles in aqueous media was reported. The particle surface assemblies were constructed either by self-assembly or transition metal ion complexation interactions with chelating moieties. The rectified charging features were interpreted on the basis of a Randles equivalent circuit where the binding of hydrophobic electrolyte ions to surface-confined particle molecules led to the manipulation of the electrode interfacial capacitance. It was found that the rectification effects were directly related to the ion hydrophobicity, manifested by the cathodic (anodic) shift of the onset potential with anions (cations) of increasing hydrophobicity. Additionally, the voltammetric responses evolved from those similar to conventional molecular diodes to those of quantized charging rectifiers with increasing anion hydrophobicity. Electron-transfer kinetics was also evaluated by varying the nanoparticle chemical structures and solution properties.

6/4/02

Peidong Yang, Assistant Professor Department of Chemistry, University of California

Recent progress on Heterostructured 1-dimensional Nanostructures

Host: Younan Xia, Department of Chemistry

Nanowires are of both fundamental and technological interest. They represent the critical components in the potential nanoscale electronic and photonic device applications. In this talk, I will introduce the vapor-liquid-solid crystal growth mechanism for the general synthesis of nanowires of different compositions, sizes, orientation and doping profile. Particularly, synthesis and organization of different types of heterostructured nanowires will be discussed. I will also discuss some of the unique linear and nonlinear optical properties of the nanowires and their potential applications including nanolaser, nanosensor and optical switch.

9/30/02

AUTUMN QUARTER 2002 STARTS

10/1/02

Dr. John Rogers, Director Condensed Matter Physics Research Bell

Laboratories, Lucent Technologies
Dr. John Rogers, Director

Host: Assoc. Prof. Younan Xia Department of Chemistry

10/8/02
TBA - OPEN

10/15/02
Jackie Y. Ying, Assoc. Prof., Dept. of Chemical Engineering MIT
Jackie Y. Ying

Host: Assoc. Prof. Younan Xia Department of Chemistry

10/22/02
Prof, Dan Branton, Department of Molecular and Cellular Biology
Harvard University
Professor, Dan Branton

Host: Bingyun Sun, Nanotechnology Student Association

10/29/02
Prof. Daniel Feldheim, Department of Chemistry North Carolina State
Prof. Daniel Feldheim

Host: Assoc. Prof. Younan Xia Department of Chemistry

11/5/02
TBA - OPEN

11/12/02
TBA - OPEN

11/19/02
TBA - OPEN

11/26/02
TBA - OPEN

12/3/02
TBA - OPEN

12/10/02
TBA - OPEN

1/6/03
WINTER QUARTER 2002 STARTS

1/7/03
OPEN - TBA

1/14/03
OPEN - TBA

1/21/03
OPEN - TBA

1/28/03
OPEN - TBA

2/4/03
OPEN - TBA

2/11/03
OPEN - TBA

2/18/03
OPEN - TBA

2/25/03
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3/4/03
OPEN - TBA

3/31/03
SPRING QUARTER 2002 STARTS

4/1/03
OPEN - TBA

4/8/03
OPEN - TBA

4/15/03
OPEN - TBA

4/22/03
OPEN - TBA

4/29/03
OPEN - TBA

5/6/03
OPEN - TBA

5/13/03
OPEN - TBA

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