

Aug 23, 2010
10:40 AM
EB1, Room 1011

Dr. Nancy Allbritton
Department of Biomedical Engineering, UNC-CH/NC State

Analysis and Separation of Cells using Microfabricated Devices

The separation of single or small groups of cells from within a heterogeneous population is a fundamental need in almost all areas of biomedical research. Despite recent technological advances, selection and isolation of individual or small groups of live cells from a population remains a significant challenge.

A microfabricated cell array platform composed of releasable elements in combination with an integrated laser microscope system has been developed for analyzing, sorting and collecting viable cells from a mixed population while the cells remain adherent to their growth surface. The individual polymeric elements containing single cells or colonies can be released and collected with minimal perturbation.

Studies have shown that adherent cells cultured on the array can be analyzed and selected using standard imaging methods. Furthermore, target cells can then be collected with high viability and efficiently cloned.

Mating of the technique with image cytometry can be expected to provide a high-throughput tool for selection and isolation of adherent cells for biomedical and pharmaceutical applications.

Aug 30, 2010
10:40 AM
1011 EB1

Dr. Paul F. Nealey
University of Wisconsin

Directed assembly of block copolymers on chemically nanopatterned substrates

Through fundamental understanding of the physics and chemistry of interfacial phenomena associated with equilibrating block copolymer materials in the presence of lithographically defined chemically nanopatterned substrates, we seek to synthesize and assemble such materials to enable fabrication at length scales (3-20 nm) not possible with current materials and processes. Essential attributes of existing manufacturing practices must be retained, depending on the application, and may include pattern perfection, registration and overlay, and the ability to pattern device-oriented geometries.

Here we experimentally and theoretically investigate the structure of the block copolymer film as a function of the interfacial energy between the blocks of the copolymer film and the regions of the lithographically-defined chemical pre-patterns. In all cases, assembly is undertaken under conditions in which the density of features in the domain structure of the film is greater than that of the chemical pre-pattern.

Finally, we report an approach for replicating geometrically complex patterns over macroscopic areas with feature dimensions below 15 nm, and the ability to replicate the same pattern, including those defined lithographically, multiple times. The technique, called molecular transfer printing (MTP), takes advantage of presenting patterns in the domain structure at the surface of block copolymer films, and transfers those patterns with high fidelity and degrees of perfection to substrates placed in contact with the copolymer film.

Sep 13, 2010
10:40 AM
1011 EB1

Dr. Thomas Meyer
Department of Chemistry - UNC-CH

Solar Fuels from Sunlight

Because of its intermittency, solar energy cannot be a primary energy source in a new energy future without energy storage on a massive scale. The only reasonable approach is chemistry and production of solar fuels with sunlight used to drive critical reactions such as water splitting into hydrogen and oxygen, and water reduction of CO₂ to reduced carbon, ultimately as a source of transportation fuels.

The critical elements in solar fuels production by natural and artificial photosynthesis are understood. Light absorption, excited state electron transfer, vectorial electron-energy-proton transfer through free energy gradients, electron transfer activation of catalysis, and rapid catalysis of target half reactions.

All of these elements are available in Dye Sensitized Photoelectrochemical Synthesis Cells (DSPEC) driven by excited state electron or hole injection at semiconductor surfaces based on a "modular" approach.

Sep 20, 2010
10:40 AM
1011 EB1

Dr. Stefan Franzen
Department of Chemistry - NC State

Plant Virus Biotechnology

The seminar topic will provide a brief overview of plant viruses and then focus on specific applications to imaging and cell targeting for biomedical applications.

The Red clover necrotic mosaic virus provides a unique scaffold for loading molecules in the interior and for attaching targeting groups on the exterior. These applications will be described with extensive data from both in vitro and in vivo testing.

Sep 27, 2010
10:40 AM
1011 EB1

Dr. William Bentley
University of Maryland College Park

Biofabrication for Interrogating and Modulating Biological Signaling

The biological signal transduction process is the means by which external signals are incorporated into information that directly or indirectly alters gene expression and ultimately, phenotype. As microbial communities occupy a confined space over time, concentrations of extracellular signaling molecules accumulate, providing stimulus for unique and varied cellular responses as well as protection from competing microbial communities. Referred to as “quorum sensing” (QS) for its often reported and coincident dependence on high population density, extracellular signaling provides a new basis for control over molecular and cellular processes as well as population behavior, perhaps in a manner more consistent with that of native machinery.

Our laboratory has uncovered many of the molecular features of the QS autoinducer-2 system using traditional methods that probe bacterial physiology and we have developed new methods that enable on-chip analysis. This presentation will describe the features of this system that make it particularly amenable to modification and abstraction for recognizing various signals and for modulating biochemical pathways.

We have constructed bioMEMS systems for elucidating pathway behavior and understanding signal transduction. We have also created a novel protein expression system based on autoinduction. These and other issues and applications will be described.

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Oct 4, 2010
10:40 AM
1011 EB1

Dr. Huimin Zhao
University of Illinois at Urbana-Champaign

Microbial Synthesis of Drugs and Fuels via Synthetic Biology

Synthetic biology is the deliberate design of novel biological systems and organisms that draws on principles elucidated by biologists, chemists, physicists, and engineers. It is a rapidly growing area with broad applications in medical, chemical, food, and agricultural industries.

In this talk, I will discuss our recent work on the development and application of new synthetic biology tools. Specifically, I will discuss:

- (1) development of a new tool for rapid assembly of large DNA molecules for pathway engineering and discovery of novel natural products,
- (2) discovery, characterization, and engineering of the antimalarial drug FR900098 biosynthetic pathway, and
- (3) engineering of recombinant yeast strains that can efficiently utilize lignocellulose raw materials.

Oct 18, 2010
10:40 AM
1011 EB1

Dr. Thomas Epps
Department of Chemical Engineering - University of Delaware

Using Interfacial Manipulations to Generate Functional Materials from Nanostructured Polymers

As future technological progress necessitates the design and control of nanoscale devices, new methods for the facile creation of smaller features must be discovered. One sub-class of soft material, block copolymers, provides the opportunity to design materials with attractive chemical and mechanical properties based on the ability to assemble into periodic structures with nanoscale domain spacings.

To employ block copolymers in many applications, it is essential to understand how interfacial energetics influence copolymer morphologies. Two areas of recent research in the group involve: (1) probing the effects of interfacial composition on block copolymer self-assembly using tapered block copolymers, and (2) generating gradient substrate and “free” surfaces for thin films block copolymer studies.

In the first area, we are manipulating the interfacial region between blocks to control ordering transitions in tapered diblock copolymers and triblock copolymers.

In the second area, we are manipulating polymer thin film interfacial interactions using discrete gradient methods to control the free surface interactions, and gradient arrays of assembled monolayers to influence the substrate surface interactions. In particular, our chlorosilane monolayer gradients permit rapid screening of the substrate/polymer interactions necessary to induce the desired nanostructure orientations in many block copolymer systems.

Oct 29, 2010
10:40 AM
1231 EB2

Dr. Sanjeev Mukerjee
Northeastern University

Finally Unplugged: New Revolution in Energy Conversion

Mankind is at the helm of a perfect storm of environmental repercussions of our enhanced carbon emissions and the rapid rise of energy prices together with its unfortunate global political consequences. In addition there is a rapid change in lifestyle which is more mobile and free of locational consideration.

This presentation will provide an introduction to the emerging technology of electrochemical energy conversion and storage using low- and medium-temperature fuel cells and Li-Air batteries which promises to finally un-tether us in all our daily pursuits.

Materials challenges as it pertains to charge transfer at an electrochemical interface will be showcased in light of the oxygen reduction reaction and direct oxidation of organic fuels. New insights on structure-property correlation for both electrocatalysts and electrolytes in light of novel more complex materials will be presented.

Investigations on the role of the reaction center will be presented in light of new data from synchrotron-based in situ X-ray absorption spectroscopy measurements which are more specifically tailored towards elucidation of surface adsorption modes.

Nov 1, 2010
10:40 AM
1011 EB1

Professor Alptekin Aksan
University of Minnesota

Molecular-Level Phenomena in Preservation of Biospecimens

Biospecimens contain very valuable information on the state of health or disease of an individual. For example, most biofluid biospecimens (e.g. urine, bronchoalveolar lavage fluid, saliva, blood, etc.) contain exfoliated cancer cells and/or sub-cellular macromolecular fragments that can be used to diagnose disease, monitor response to treatment or discover biomarkers.

In almost all of the biorepositories, biospecimens are stored by freezing without following any preservation protocol (the samples are directly placed in freezers, in the absence of any cryoprotectant, where they experience very slow cooling at 1-2oC/min). It is well-known that these conditions impose very harsh chemical, physical and thermodynamic stresses on macromolecules, and cells altering their characteristics (structure, activity, etc.), often irreversibly.

In this presentation we focus on exploring the molecular level phenomena dictating the freeze/thaw responses of protein and cell solutions. We mainly utilize FTIR and Raman Microspectroscopy to construct chemical maps of frozen biological systems to understand their interactions with the surrounding medium during thermal/osmotic interventions.

Nov 3, 2010
10:45 AM
135 BTEC

Professor K. Dane Wittrup
MIT - Dept of Chemical Engineering and Biological Engineering

Applications of Protein Engineering and Kinetic Modeling to Cancer Pharmacology

Nov 4, 2010
10:00 AM
135 BTEC

Professor Michael Danquah
Monash University, Victoria, Australia

Plasmid Bioprocessing: The Chemical Engineer's Perspective

The recognition of the potential efficacy of plasmid molecules as vectors in the treatment and prevention of emerging diseases has triggered the confidence to fight global pandemics. This is mainly due to the close-to-zero safety concern associated with plasmid vectors compared to viral systems in cell transfection and targeting.

Consequently, well in excess of 100 plasmid gene therapies, cancer and prophylactic vaccines clinical trial have been initiated. This increasing evolution has resulted in some encouraging results, and thus requires the bioprocess technology to produce large quantities of plasmid molecules to meet the growing demand.

The structural dynamics of plasmid molecules, their high sensitivity to shearing, susceptibility to cleavage by endonucleases, and the stringent FDA standards which negate the use of toxic chemicals, avian or bovine sourced components are amongst the many hurdles that pose huge bioprocess challenges to large-scale production of plasmid molecules.

This talk will cover some of the work we have done in the development of a scalable and commercially-viable technique for high throughput rapid production of plasmid molecules.

Nov 15, 2010
10:40 AM
1011 EB1

Dr. Maurizio Fermeglia
University of Trieste, Trieste, Italy

A Tool for Design of Organic/Inorganic Nano Structured Materials

A current challenge of physical, chemical and engineering sciences is to develop theoretical tools for predicting structure and physical properties of complex nano structured materials. However, despite all efforts, progress in the prediction of macroscopic physical properties from structure has been slow.

Major difficulties relate to the fact that the final properties of the material strongly depend on the nanostructure of the matrix and the interactions of the nano fillers with the matrix. The investigation of the nanostructure via computer simulation is not straightforward and cannot be done using one single tool: in principle the structure could be described by atomistic simulation, but we do not have enough computer power to do that for complex systems such as nanocomposites.

In this seminar, focus will be given to the development of a multiscale molecular simulation framework, with the ultimate goal of developing a computationally-based nanocomposite designing tool specific for hybrid organic/inorganic systems (H-O/I). Many examples of the application of this recipe to PCNs and other H-O/I materials will be presented and discussed. The global perspective of the seminar is the complete integration of all available simulation scales, in a hierarchical procedure to provide an efficient and robust simulation protocol for the successful design of H-O/I systems of industrial interest and the prediction of their final performance.

Nov 19, 2010
10:40 AM
1231 EB2

Professor Gerardine G. Botte
Center for Electrochemical Engineering Research, Ohio University

Recovery of Energy from Ammonia Effluents

Ammonia is considered a threat to environmental quality because of its contribution to impaired air quality, surface-water eutrophication, and nitrate contamination of ground water. Also, ammonia emissions to the atmosphere play a significant role in the formation of fine particulate matter, which has been shown to cause respiratory problems in humans and contribute to haze and poor visibility.

Major sources of ammonia emissions include livestock operations, fertilizer use, waste management, mobile sources, industrial point sources, and various biological sources including human respiration, wild animals, and soil microbial processes. Current technologies for the removal of ammonia from waste require an extensive amount of energy, and the technologies most commonly used are not portable.

Therefore, treatment of ammonia emissions from non-point sources, such as ammonia emissions from livestock and fertilizer use are difficult to control because of the costs and the inherent complexities associated with the installation of waste water treatment units on every farm.

Our research group at Ohio University has developed a new technology, "Ammonia Electrolysis" that allows the oxidation of ammonia to nitrogen with cogeneration of hydrogen. The resulting hydrogen can be used for heat and power generation. In this talk, a technical and economical analysis will be presented on the use of ammonia electrolysis as a wastewater treatment process for different applications.

Nov 22, 2010
10:40 AM
1011 EB1

James A. Trainham
RTI International, North Carolina State University

Birthing The Research Triangle Solar Fuels Institute

The Research Triangle Solar Fuels Institute was formed to provide a framework for integrating the strengths of partnering institutions to make the Triangle area the leader in producing science and technology that would lead to the pre-commercial demonstration of clean, low-cost fuels using water (H₂O), carbon dioxide (CO₂) and sunlight. The four institutions, NC State, UNC-Chapel Hill, Duke and RTI International, came together to create the Institute.

Solar fuels technology is inspired by photosynthesis, when plants convert sunlight, CO₂, and water into chemical energy. The technology behind solar fuels is analogous in concept to photosynthesis, but the technology is similar to that deployed in more conventional chemical processes, and NCSU's direct bandgap semiconductor photo-electrochemical work is the inspiration for one of the pathways RTSFI is pursuing.

The Solar Fuels Institute will encourage innovation with programs and incentives to benefit all partner institutions, and the Institute vision is to develop and demonstrate solar fuels technology by the end of the decade to produce Sunthetic Fuels that will effect a permanent shift in the world's energy supply.

There is no suitable replacement fuel for oil now, and there are presently no long term acceptable ways to create sustainable liquid fuels to run our planes, trains, trucks, tractors and cars. The Research Triangle Solar Fuels Institute sees the sun as the answer and technology as the solution.

Nov 29, 2010

10:40 AM

1011 EB1

Jonathan S. Lindsey

Department of Chemistry - NC State

Some Chemistry in Darwin's Warm Little Pond

The question of how life originated in the vast chemical reactor known as the early Earth is central to our understanding of evolution, yet has remained largely obscure. Oparin and Haldane, two early proponents (ca. 1930s) of a chemical origin of life, proposed that the earliest cells were chemotrophs rather than phototrophs, chiefly because they viewed photosynthesis as exceedingly complex.

The failure to identify a plausibly prebiotic pathway to tetrapyrrole macrocycles only accentuated focus on non-photochemical origins: indeed, the theory du jour heralds a chemolithotropic origin of life at or near (hydrothermal) deep sea vents. A philosophical line of reasoning about the origin of tetrapyrrole macrocycles is that the modern biosynthetic pathway (which is believed to be universal) recapitulates the prebiotic pathway and thus provides a window on evolution.

In June 2010, we discovered a pathway that differs slightly from the modern biosynthesis of tetrapyrrole macrocycles. The reaction is robust, structure-directed (i.e., does not require external catalysts), and with analogous substrates can afford other macrocycles that are more advanced on the biosynthetic pathway. Such results raise questions about the origin of biosynthetic pathways: in particular, how and when did structure-directed pathways in proto-metabolism give way to catalytic pathways resembling modern biosynthesis?

We are currently extending this discovery to a systematic investigation of the spontaneous de novo emergence of proto-photosynthesis.