Aug 26, 2013 10:40 AM Room 1011 EB1	**Dr. Brian Pfleger** University of Wisconsin – Madison

Sustainability via Synthetic Biology: A Growing Role for Biotechnology in the Chemical Industry

Finding a sustainable alternative for today's petrochemical industry is a major challenge facing chemical engineers and society at large. To be sustainable, routes for converting carbon dioxide and light into organic compounds for use as both fuels and chemical building blocks must be identified, understood, and engineered.

Advances in synthetic biology and other biological engineering disciplines have expanded the scope of what can be produced in a living organism. As in other engineering disciplines, synthetic biologists want to apply a general understanding of science (e.g. biology and biochemistry) to construct complex systems from well-characterized parts (e.g. DNA and protein).

Once novel synthetic biological systems (e.g. enzymes for biofuel synthesis) are constructed, they must be engineered to function inside evolving cells without negatively impacting the host's physiology. In most cases first generation systems fail to meet this goal.

One of the largest barriers to producing chemicals from biomass is the deconstruction step where sugar polymers are broken down into functional intermediates that can be consumed by engineered microbes.

In this talk, I will present a novel, sustainable method of deconstructing biomass into fermentable sugars that does not require degradative enzymes. I will then describe work to develop strains of bacteria for producing chemical building blocks such as fatty acids, alpha-olefins, fatty alcohols, and bioplastics.

Sep 9, 2013 10:40 AM Room 1011 EB1	**Dr. Zhen Gu** NCSU/UNC Chapel Hill

Smart Protein Gels

Proteins are the engines of life, taking part in all vital processes in the body. From a therapeutic perspective, delivery of bioactive proteins to specific cells and organs is of tremendous interest in the fields of cancer therapy, vaccination, regenerative medicine and treatment for loss-of-function genetic diseases. From a diagnostic perspective, protein biochips with well-controlled micro or nano-scale features hold great promise in drug screening, identification of protein-protein interactions, cell manipulation and cell separation.

However, the successful application of the target protein always depends on the ability to effectively stabilize the functional component in an unnatural environment. Hydrogels or gels with porous and crosslinked networks can hold water and simulate natural environment for proteins.

In this seminar, we will first discuss a unique nanogel-based strategy for intracellular delivery of various protein targets. The nanogels consist of a protein core and a thin cell-permeable polymeric shell that is capable of releasing the payload upon highly specific, bio-inspired triggers.

Next, I will introduce our recent work on engineering synthetic closed loop systems for biomimetic delivery of insulin. Three distinct injectable gel-based formulations have been developed and their glucose-responsive properties have been validated.

Finally, I will briefly highlight two methods of forming protein micro- or nanopatterns onto gel substrates for diagnostics. Magnetic electric lithography can generate heterogeneous protein nanopatterns over a large area; while enzyme-assisted photolithography can simultaneously form topographical features and bioconjugation sites within gel scaffolds.

Sep 16, 2013 **10:40 AM** **Room 1011 EB1**	**Dr. Jason Hattrick-Simpers** University of South Carolina

New High-Temperature Materials via PVD Modeling, Experimentation and Big Data

The identification of new materials and their engineering optimization is a time-intensive process. Although the development of high-throughput experimental methods originally offered the possibility for revolutionizing novel material exploration, researchers encountered several new problems.

A lack of off-the-shelf characterization techniques necessitated the validation of new rapid screening techniques, which generated terabytes of data to be analyzed and compared systematically. This issue is exacerbated in the field of high-temperature materials where sub-atomic compositional control is required and material functionality can be degraded over time.

Here we use the Ni-Al binary alloy system to demonstrate a comprehensive modeling-experimental-data minimization methodology for the combinatorial exploration of novel high-temperature alloys. Modeling of the physical vapor deposition process is used to minimize the trial-and-error efforts associated with the identification of composition regions that maximize usage of sample real-estate, avoiding low temperature liquidus regions and undesirable phases.

A suite of diffraction and spectroscopy techniques are then implemented to monitor the initial phase of the base metal and oxide and their phase evolution in time during oxidation treatments at 1373 K. The resulting data sets are mined using a modified version of the CombiView platform and compared to determine prevailing trends.

Finally, time dependent phase diagrams of metal oxidation are created, permitting compositional trends to be evaluated and new materials to be identified.

Sep 17, 2013 **3:00 PM** **EB1 - Room 2018**	**Dr. Antonio Guerrero** University of Seville, Spain

Interfacial Rheology of Protein-Adsorbed Interfacial Layers

A comparison of the most sensitive techniques currently used for the characterization of dilatational and shear interfacial rheological properties of air/water or oil/water interfacial layers stabilized by protein will be outlined in this presentation. Interfacial tension properties from compression-expansion cycles and pendant drop tensiometry are also used in this study.

The analysis mainly deals with the use of a protein isolate extracted from crayfish (CFPI). The influence of protein concentration and pH on the interfacial rheological behavior of CFPI-adsorbed interfacial layers under small amplitude oscillatory dilatational and shear techniques is analyzed. In addition, the contribution of a polysaccharide such as chitosan to interfacial properties is also considered.

The usefulness of interfacial rheological properties to predict the stability behaviour of CFPI-stabilised O/W emulsions is eventually illustrated.

Sep 23, 2013 10:40 AM Room 1011 EB1	**Dr. Chang-Jin Kim** UCLA

Surface Tension Is Fair Game in Micro-Engineering: Let´s Play!

Unlike in regular scale, where containers and pipes are needed to manipulate liquids, in submillimeter scale liquids can be handled as discrete objects using the liquid-air interface as virtual walls. This unusual option is a consequence of surface tension dominating other mechanical forces in microscale.

Presented will be a series of engineering applications where the main design concepts are based on such unique microscale effects. The application examples include satellite-free inkjet printing; micro RF switches using liquid-metal droplets; and active micro fuel cells with no mechanical components. Furthermore, droplets can be actively and individually manipulated by voltages using the electrowetting-on-dielectric (EWOD) mechanism, which ushered the new field of digital microfluidics.

Demonstrated to manipulate mostly aqueous droplets in air, EWOD-based microfluidics has accomplished many manipulative functions (e.g., creating and moving droplets, mixing and separating droplets, separating particles in a droplet) and developed several applications (e.g., sample preparation for MALDI-MS, radiosynthesis of tracers for PET scan). To demonstrate how EWOD microfluidics simplifies eventual lab-on-a-chip product, we showcase stand-alone handheld systems. Although based on microscale physics, the surface-tension engineering can be applied to large-scale systems as well.

Finding the solutions in microscale details, we have developed superhydrophobic (SHPo) surfaces that can stay SHPo indefinitely even 70 meters deep underwater and reduce the drag of water flows significantly. Most recently we have obtained a drag reduction over 75% in turbulent-boundary-layer flows, which represent water vehicles.

Sep 27, 2013 2:00 PM Room 1010 EB1	**Dr. Michal Banaszak** Adam Mickiewicz University, Poland

Ionic Block Copolymers Studied by a Minimal Lattice Model

We present the results of Monte Carlo lattice simulations of model systems composed of either a compositionally symmetric or asymmetric diblock copolymer wherein a fraction of segments in one block, p, corresponds to ionic species, and the other block remains nonionic.

Such materials are of considerable interest in the development of membranes for use in molecular separations and fuel cells. We use experimentally determined values of the Flory−Huggins interaction parameter, χ, to quantify the interactions between ionic and nonionic species. Analysis of experimental data indicates that χ between poly(styrene sulfonate) and polystyrene is about 5, a value that is several orders of magnitude larger than that obtained in mixtures of nonionic polymers.

Our model predicts that the clustering of ionic monomers in the disordered state results in stabilization of the disordered phase so that the product p2χN is well above the mean-field value of 10.5 at the order−disorder transition (N is the total number of statistical units per chain) for the case of a symmetric copolymer.

Network morphologies and hexagonally-packed cylinders are observed in the ordered state at large p values, whereas more traditional lamellar phases are found to occur at small values of p. In the case of asymmetric copolymers, we find that the lamellar phase is stable and more pronounced for values of p corresponding to experimental systems.

Sep 30, 2013 10:04 AM Room 1011 EB1	**Dr. Christopher Rao** University of Illinois at Urbana-Champaign

Systems for Synthetic Biology

We now possess the ability to read and write DNA. These tools are not only revolutionizing biotechnology but also the basic life sciences as well. The challenge is that we are still learning the grammar. In other words, we often do not know which genetic perturbations to make in order to alter the behavior of an organism. As a result, synthetic biology still involves much trial and error. Moreover, we are still far from the point where we can engineer new organisms from scratch rather, we need to alter the physiology of existing ones. Even then, we still need to understand how these organisms function in an integrated manner.

In this talk, I will discuss the application systems biology to synthetic biology as a general strategy for overcoming many of these challenges. I will first review some of our previous work applying comparative genomics to inform biological design. I will then discuss our work applying systems biology approaches to improve organisms for fuel and chemical production. I will conclude by discussing our recent work developing tools for engineering non-model organisms with unique properties.

Oct 7, 2013 10:40 AM Room 1011 EB1	**Dr. Sharon Glotzer** University of Michigan

Directional Entropic Forces in Colloids: New Design Principles for Self Assembly of Patchy Particles

Ordered assemblies formed spontaneously from colloidal building blocks of nanometer to micron size are highly desired for their potentially novel properties. They are prevalent in natural, biological, and synthetic systems, and can exhibit great complexity, including hierarchical structure.

Two inter-related "holy grails" in materials design are (1) the prediction of crystal and other ordered structures from knowledge of the constituent building blocks, and (2) the inverse design of the optimal building block for self assembly into a target structure. Much progress has been made on these fronts by considering "anisotropy dimensions" for building blocks that allow for the systematic study of how the forces between building blocks dictate preferred structures.

Among the many forces responsible for the formation of highly organized structures, entropy stands apart as a statistical "force" that can drive systems toward both order and disorder. In particular, entropic forces that emerge upon crowding due to steric interactions can drive transitions to highly ordered structures, including complex, large unit cell crystals and quasicrystals, liquid crystals, and rotator crystals. Entropic forces are of particular importance in colloidal assembly, where they can be as large as several kT at the onset of ordering, competing with van der Waals, electrostatic, and other interactions. Through shape, these entropic forces become directional, creating an entropic "valence" capable of dictating bulk crystal structures.

We discuss the implications of emergent directional entropic forces for colloidal assembly and materials design.

Oct 14, 2013 10:40 AM Room 1011 EB1	**Dr. Keith Chadwick** Purdue University

Designing Heterogeneous Surfaces for Controlling Crystal Nucleation

The ability to design crystalline materials with desired properties is an outstanding problem in manufacturing. This is due to many industrial products such as explosives, fine chemicals, foods, pharmaceuticals and semiconductors containing one or more crystalline component. The development of such materials requires careful control of the nucleation and crystal growth steps that govern crystallization.

One rapidly growing area of research is the engineering of heterogeneous surfaces to control nucleation. Therefore it is necessary to understand, at the molecular level, the mechanisms controlling heterogeneous nucleation.

In this seminar I will discuss the importance of the molecular functionality and structure of crystalline and polymer heterogeneous surfaces on the nucleation kinetics, polymorphism and location of nucleation for small organic compounds. Our results suggest that the hydrogen bonding ability of a crystalline hetero-surface is more important than a crystallographic lattice match for enhancing nucleation kinetics.

I will also discuss how a greater understanding of heterogeneous nucleation mechanisms has been used to select crystalline heteronuclei for obtaining a kinetically unfavorable metastable polymorph from conditions that favor the nucleation and growth of the stable crystal form.

Finally, I shall discuss the synthesis of a porous 3D polymer matrix for confined heterogeneous nucleation.

Oct 21, 2013 10:40 AM Room 1011 EB1	**Dr. Martha Grover** Georgia Institute of Technology

Prediction and Design in Chemical Evolution and Origins of Life Chemistry

Life is a complicated process. In this presentation, computational approaches provide a unifying system-level framework, to quantify tradeoffs among the many competing factors governing the transition from chemistry to biology on the early Earth. Reaction and diffusion events may be parameterized using targeted experimental studies, or conversely the parameter space may be explored using the model, to identify promising regions for experimentation. Here the system-level objective is to generate and sustain chemical diversity to enable open-ended evolution.

Diversity is necessary for selection and evolution, yet many theoretical models of minimal life predict the dominance of a single sequence. We propose a model for the early chemistry prior to evolution in which sequence diversity may be generated and sustained. The model is based on chemical kinetics and Fickian diffusion, so that it can be used to design chemical systems.

The replication rate constant is sequence-independent, with replication rate depending only on the local concentration of monomer. New sequences are generated randomly, and then compete for a finite monomer resource that is recycled via reversible polymerization. Stochastic simulations show that a diverse sequence pool is sustained over a broad range of rate constants and diffusivities. The later emergence of a monomer replicase in the system extends the lifetime not only of the functional replicase sequence, but also the local community of nonfunctional sequences.

Oct 28, 2013 **10:40 AM** **Room 1011 EB1**	**Dr. Tim Fornes, Dr. Stewart Witzeman, Dr. Elaine Cohen Hubal, Dr. Celia Ponder** Lord Corporation, Eastman, Environmental Protection Agency, GlaxoSmithKline

Career Opportunities in Industry: an Interactive Panel of Industrial PhD's

Are you considering industrial positions after graduating but are unsure what PhD's do in industry or how to apply? Four panel members from different industries and professional roles will give their perspective on being a PhD in industry, how they originally obtained a position, and what you can do to prepare. There also will be ample time for questions from students. Please prepare questions in advance and submit them to Prof. Chase Beisel (cbeisel@ncsu.edu), who will be moderating the panel.

Nov 11, 2013 **10:40 AM** **Room 1011 EB1**	**Dr. Alan Weimer** University of Colorado – Boulder

Functionalization & Application of Fine Particles Coated by Atomic/Molecular Layer Deposition (ALD/MLD)

The functionalization of fine primary particles, including nanoparticles and nanotubes, is easily carried out using sequential self-limiting surface reactions. The self-limiting reactions result in the deposition of atomic or molecular layers, i.e. ALD or MLD.

This functionalization process, referred to as Particle ALD/MLD, can be used to deposit conformal and pinhole-free films of refractory oxides, non-oxides, metals, and hybrid polymer-based materials, among others. Fluidized bed reactors are well suited for large scale operations.

In this process, the particles are normally fluidized under reduced pressure conditions using an inert gas. Precursor doses can be delivered to the bed of particles sequentially and, in most cases, can be utilized at nearly 100% efficiency without precursor breakthrough and loss. Also, the progress of the coating process can be monitored continuously using an in-line downstream mass spectrometer.

Particle ALD/MLD has been demonstrated to place films on primary nanoparticles as small as 10 nm as well as on nanotubes having surface areas approaching 1000 m2/g and within the porous structure of polymeric materials having porosity near > 90%. Physical, optical, electrical, and magnetic properties of the particles can be controlled in order to passivate, activate, or in some manner functionalize the particles.

Nov 18, 2013 10:40 AM Room 1011 EB1	**Dr. Michael Rubinstein** UNC Chapel Hill
Airway Surface Brush Sweeps Lungs Clean: Polymer Physics Helps Us Breathe Easier	
The classical view of the airway surface liquid (ASL) is that it consists of two layers; mucus and the periciliary layer (PCL). The mucus layer is propelled by cilia and rides on the top of the PCL, which is assumed to be a low viscosity dilute liquid. This model of the ASL does not explain what stabilizes the mucus layer and prevents it from penetrating the PCL. I propose a different model of the ASL in which the PCL consists of a dense brush of mucins attached to cilia. This brush stabilizes the mucus layer and prevents its penetration into the PCL, while providing lubrication and elastic coupling between beating cilia. Both physical and biological implications of the new model will be discussed.	

Nov 25, 2013 10:40 AM Room 1011 EB1	**Dr. Leslie Sombers** NCSU
Disambiguating the Complex Chemical Mechanisms Underlying Basic Brain Function using Microelectrochemistry	
The Sombers lab is using the power of carbon-fiber microelectrochemistry to develop electrochemical methods that push the limits of neurochemical measurements. Over the past decade, advances in voltammetry have considerably expanded the scope of neurochemical studies by enabling selective quantification of subsecond fluctuations of electroactive molecules such as dopamine, a neurotransmitter that is important in movement and reward processes. However, information associated with rapid fluctuations of countless molecules in the brain remains obscure. The broad research goal of the Sombers Lab is to look beyond DA in disambiguating the complex chemical mechanisms underlying basic brain function. The seminar will demonstrate new electrochemical detection strategies and how they are being used to target new molecules, providing insight into the fundamental way in which information is conveyed between neurons, the mechanisms that regulate it, and the functional implications of this chemistry.	

Dec 2, 2013 10:40 AM Room 1011 EB1	**Dr. Arup Chakraborty** MIT

Ollis Lecture: How to Hit HIV Where It Hurts

HIV continues to wreak havoc around the world, especially in poor countries. A vaccine is urgently needed to overcome this major global health challenge. I will describe key challenges that must be confronted to achieve this goal. I will then focus on some work that aims to address a part of these challenges by bringing together theory and computation (rooted in statistical physics), consideration of structures of multi-protein assemblies, basic immunology, and human clinical data. The results of these studies suggest the design of immunogens that could be components of vaccines that might elicit immune responses which might be able to hit HIV where it hurts upon natural infection. I shall also briefly touch upon some potentially generic features of viral evolution, which are superficially reminiscent of Hopfield dynamics and scaling.