2011 PROGRAM

8:00 a.m. Registration & Continental Breakfast
Keeneland Room, W.T. Young Library
8:50 a.m. Welcome by Dr. James Tracy
Vice President for
Research at University of Kentucky
9:00 a.m. Dr. Georges Belfort
Rensselaer Polytechnic Institute
Proteins and Interfaces: Stability and Function

Proteins are exposed to a multitude of different surfaces and chemistries in vivo and yet, they must retain their stability in order to function. However, conversion of soluble native proteins into β-sheet-rich structured aggregates, such as amyloid and prion deposits can occur at interfaces. Protein stability and activity is also essential for use in various medical and analytical devices, such as biosensors, biocatalytic chips, biocompatible materials for implants, drug delivery vehicles, tissue engineering and beads or membranes for bioseparations. Although a vast experimental literature exists on the adsorption of specific proteins to various solid substrates under defined conditions, difficulties in determining the underlying reasons for the loss of stability and function remain. Many researchers have addressed particular aspects of protein behavior at interfaces through experiment, theory and molecular simulation. Here, we review recent results on protein stability and activity on solid heterogeneous and homogeneous substrates, demonstrate the effect of surface chemistry and roughness on protein aggregation, describe a novel method to probe unfolding of a monolayer of tethered proteins and introduce new NMR titration results with chromatographic data in order to study the nature of protein adsorption in multimodal chromatography. We also mention the use of single molecule force spectroscopy to determine molecular interactions in the nuclear pore complex (NPC). Tethered fibril-like proteins that contain intrinsically disordered domains interact with carrier proteins that determine selectivity. Finally, we introduce a new high-throughput synthesis and screening method to identify protein resistant surfaces.

10:00 a.m. Break (refreshments available)
10:10 a.m. Dr. Ralph G. Nuzzo
University of Illinois, Urbana-Champaign
Devices, Fabrication Methods, and Functional Materials for Discovery in Biological and Bioanalytical Chemistry

The fabrication of high performance integrated circuits provides examples of the most sophisticated materials fabrication methods, as well as the most high performance materials, used in any area of modern technology. The advanced functional systems they provide are ones that are generally characterized by a massive integration of circuit elements within compact, rigid and essentially planar device form factor devices. Such features, while well suited to the requirements of electronics, are less enabling for the classes of devices and modes of operation that enable the study and manipulation of biological systems. For the latter, the design rules and forms of materials integration involve numerous interesting but generally difficult to realize attributes. These include: the ability to accommodate living system—cells or microorganisms—as well as highly functional/chemically complex materials; to sustain or manipulate fluid flows; enable dynamic molecular patterning that is elicited both temporally and spatially; embed complex multiscale, non-planar/curvalinear and 3D structural forms; and provide capacities for enabling useful forms of mechanics—flexure, folding, and actuation as examples. New materials and enabling means of fabrication are beginning to provide approaches to construct devices with properties of this type along with capacities for high performance. In this lecture I will describe a number of examples related to recently developed 3D materials platforms and microfluidic devices possessing utility to drive discovery in biological and bioanalytical chemistry. Of particular interest will be examples taken from our recent work involving integrated 3D fluidic platforms for sustaining and manipulating complex 3D cellular microcultures of neurons and novel integrated tools for chemical analysis that can be used to characterize both them and biologically relevant samples more generally. I will provide an overview of the rapidly developing fields of soft and direct write fabrication methods that can be used to construct these devices and suggest opportunities as well as needs for future progress.

11:10 a.m. Poster Session, Gallery, Young Library
12:30 p.m. Lunch
2:00 p.m. Dr. Paul S. Weiss
University of California, Los Angeles
New Dimensions in Patterning: Placement and Metrology of Chemical Functionality at All Scales

Chemists have a desire to construct materials atom-by-atom and molecule-by-molecule, and through the development of modern polymer chemistry, coordination chemistry, and crystal engineering. They have become moderately proficient at realizing target structures. Some researchers draw the analogy between atoms and nanoparticles, yet as chemists, we are just beginning to realize the nanoparticle equivalents of molecules and extended materials. One of the fundamental challenges facing nanotechnology researchers in this area is the development of a method to programmably assemble these nanoparticles into complex 1-, 2-, and 3-dimensional structures. The ability to create these nanoscale architectures would provide a means to increase sensitivity, speed, and functionality in electronic, therapeutic, and diagnostic devices relative to current benchmarks, as achieving such a feat would allow for the synthesis of designer materials, wherein the physical properties of a material could be predicted and controlled a priori. Our group has taken the initial steps towards this goal and developed a means of creating tailorable assembly environments using DNA-nanoparticle conjugates. These nanobioconjugates combine the discrete plasmon resonances of gold nanoparticles with the synthetically controllable and highly selective recognition properties of DNA, making them both useful nanoscale building blocks and beneficial materials in their own right. This talk will focus on the history of these conjugates, as well as recent advances and potential applications of both the conjugates and their assemblies in medical research, gene regulation, therapeutics, and diagnostics.

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in memory of Anna S. Naff

Biochemistry at Interfaces

SPEAKERS

Georges Belfort
Ralph G. Nuzzo
Paul S. Weiss

Friday, April 8, 2011

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