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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Thirty-Seventh Annual Symposium on

Chemistry & Molecular Biology

established by M. Benton Naff
in memory of Anna S. Naff

Biochemistry at Interfaces

SPEAKERS

Georges Belfort
Ralph G. Nuzzo
Paul S. Weiss

Friday, April 8, 2011

Department of Chemistry
University of Kentucky
Lexington, KY 40506-0055

The Department of Chemistry, University of Kentucky

presents the

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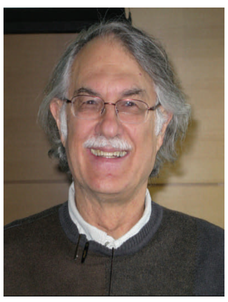
Auditorium, William T. Young Library

Biochemistry at Interfaces



Georges Belfort is the Russell Sage Endowed Professor of Chemical and Biological Engineering, Howard P. Isermann Department of Chemical and Biological Engineering, Rensselaer Polytechnic Institute

A native of South Africa, Professor Belfort joined the Rensselaer faculty in 1978 after a one-year sabbatical leave at Northwestern University and spending four years on the faculty of the School of Applied Science, Hebrew University, Jerusalem, Israel. Dr. Belfort received his Ph.D. degree in 1972 and his M.S. degree in 1969 from the University of California at Irvine in engineering, and his B.Sc. (Chemical Engineering) in 1963 from the University of Cape Town, Cape Town, South Africa. Prior to joining Rensselaer in 1978, he held the post of senior lecturer at the School of Applied Science, Hebrew University, Jerusalem, Israel from 1973 to 1977. Dr. Belfort has spent part or all of his (sabbatical) leaves at Cape Town University (1972), Northwestern University (1977-78), Yale University (1988), MIT (1988) Caltech (1988) and UC Berkeley (1996).

Georges Belfort is one of the premier academic scientists/engineers in the field of bioseparations engineering and is a leading academic chemical engineer in liquid-phase pressure-driven membrane-based processes. He has made seminal wide-ranging fundamental and applied research contributions to the understanding, design and application of pressure-driven membrane processes for the recovery of biological molecules. His research, both fundamental and developmental, is conducted in the areas of membrane-separations engineering and surface science and the behavior of proteins at interfaces. In particular, the research involves design of new membrane modules with highly efficient mass-transfer characteristics, modification of membrane surfaces for reduced fouling, and use of genetic engineering as a tool in the separation of biological molecules. Direct measurements are also made of intermolecular forces between proteins and polymeric films for application in separations and marine fouling. Recent interest has focused on the effect of solid substrates on the conformation of proteins, the development of a new molecular two-dimensional imprinting technique, the use of helical hollow fiber membranes to fractionate foreign immunoglobulins from transgenic goat milk, and the modification new polymeric surfaces for synthetic membranes using photo-induced polymerization that exhibit low attraction to proteins (biotechnology applications) and natural organic matter (environmental applications).

Ralph G. Nuzzo is the G. L. Clark Professor of Chemistry at the University of Illinois at Urbana-Champaign, a faculty he joined in 1991 and where he also holds an appointment as a Professor of Materials Science and Engineering. He received an AB degree with High Honors and Highest Distinction in Chemistry from Rutgers College in 1976 and earned a Ph.D. in Organic Chemistry from The Massachusetts Institute of Technology in 1980. He accepted the position of Member of Technical Staff in Materials Research at Bell Laboratories in Murray Hill, NJ in 1980, where he was named a Distinguished Member of the Staff in Research in 1987. He joined the Illinois faculty in 1991. He is a fellow of the American Academy of Arts and Sciences, the World Innovation Foundation, and the American Vacuum Society. He awards include the Forschungspreis of the Alexander von Humboldt Foundation in 2011, co-recipient of the George E. Smith Award of the IEEE in 2008, the Wall Street Journal Innovators Award for Semiconductors in 2006, and the Adamson Award of the American Chemical Society in 2003 for original discoveries leading to the development of self-assembled monolayers. He currently serves as a Senior Editor of Langmuir as well as a member of numerous advisory boards for both public and private entities. He is a cofounder of Semprius—a company developing new forms of high performance electronics.

Paul S. Weiss is the Director of the California NanoSystems Institute, Fred Kavli Chair in NanoSystems Sciences, and Distinguished Professor of Chemistry & Biochemistry and Materials Science & Engineering at the University of California, Los Angeles. He received his S.B. and S.M. degrees in chemistry from MIT in 1980 and his Ph.D. in chemistry from the University of California at Berkeley in 1986. He was a post-doctoral member of technical staff at Bell Laboratories from 1986-1988 and a Visiting Scientist at IBM Almaden Research Center from 1988-1989. Before coming to UCLA in 2009, he was a Distinguished Professor of Chemistry and Physics at the Pennsylvania State University, where he began his academic career as an assistant professor in 1989. His interdisciplinary research group includes chemists, physicists, biologists, materials scientists, electrical and mechanical engineers, and computer scientists. Their work focuses on the atomic-scale chemical, physical, optical, mechanical and electronic properties of surfaces and supramolecular assemblies. He and his students have developed new techniques to expand the applicability and chemical specificity of scanning probe microscopies. They have applied these and other tools to the study of catalysis, self- and directed assembly, physical models of biological systems, and molecular and nano-scale electronics. They work to advance nanofabrication down to ever smaller scales and greater chemical specificity in order to connect, to operate, and to test molecular devices, and to connect to the biological and chemical worlds. He has published over 250 papers and patents, and has given over 400 invited and plenary lectures.

For additional information, contact Professor Yuguang Cai , Department of Chemistry, ycai3@email.uky.edu.

2011 Committee: Professor Yuguang Cai (Chair, Chemistry), Professor D. Allan Butterfield (Chemistry), Professor Mark Watson (Chemistry), Professor Bruce Hinds (Chemical and Materials Engineering)

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