Schedule for the 9th Mid-Atlantic Soft Matter workshop, July 20, 2012

The University of Maryland, College Park.

8:15 am

Registration and Breakfast

8:50 am

Opening Remarks

9:00 am

Gregory Payne (UMD) *Biofabricating a Soft Bio-Device Interface Using Biological Materials and Mechanisms*

9:40 am

Sound-bite Session I

10:20 am

Coffee Break

10:40 am

Xinqiao Jia (U. Del) *Hydrogels Crosslinked by Soft Particles*

11:20 am

Sound-bite Session II

12:00 pm

Lunch

1:20 pm

Tobias Baumgart (U. Penn.): *Biophysics and Lipid and Protein Interactions Modulated by Membrane Curvature*

2:00 pm

Sound-bite Session III

2:40 pm

Break

3:00 pm

Ralph Colby (Penn State): *Ion-Conducting Energy Materials*

3:40 pm

Sound-bite Session IV

4:20 pm

Break

4:40 pm

David Gracias (Hopkins): *Self Folding Soft Materials*

Gregory Payne, Bioeng., U. Maryland
Biofabricating a Soft Bio-Device Interface Using Biological Materials and Mechanisms

Integrated circuits transformed our lives during the last half century and the potential for integrating biology with devices promises even greater transformations. Two key challenges to integrating biology with electronic systems are; construction of a bio-device interface that preserves the activity of labile biological components, and communication across this interface. Our approach to the construction challenge is to "biofabricate" the biology-device interface using biological materials and mechanisms. Specifically, we focus on three biofabrication approaches: (i) the use of stimuli-responsive materials to recognize device-imposed electrical inputs to direct- the-assembly of (i.e., to electrodeposit) hydrogels; (ii) the use of enzymes to build macromolecular structure by catalyzing conjugation and crosslinking reactions; and (iii) the use of genetic techniques to engineer proteins for assembly. Our approach to the communication challenge is to biofabricate redox-active interfaces that can transduce biological information into electronic currents. We anticipate that biofabrication will allow synergies to be realized between biological and technological systems and provide broad opportunities to couple the power of electronics to the versatility of biology.

Xinqiao Jia, Materials Sci., U. Delaware
Hydrogels Crosslinked by Soft Particles

Hydrogel materials have attracted a great deal of attention from biomedical fields due to their high water content, tissue-like viscoelasticity, and stimuli-responsive properties. Traditional hydrogels are derived from molecularly-dispersed, soluble precursors (monomers and multifunctional crosslinkers or macromers) that are randomly interconnected, lacking the structural complexity, mechanical integrity and functional diversity seen in the natural extracellular matrices. Using hydrogel particles (HGPs) or block copolymer micelles (BCMs) as the microscopic crosslinkers, we have created a novel class of hybrid hydrogels that overcome the limitations associated with the tradition hydrogels. Specifically, we have synthesized hyaluronic acid (HA)-based doubly crosslinked networks (DXNs) with densely crosslinked, nanoporous HA HGPs covalently interconnected by a loose secondary network that is also HA-based. These HA-based DXNs exhibit tunable viscoelasticity and are effective in controlling cellular functions through the spatial and temporal presentation of defined biological cues. Separately, a poly(acrylamide) gels were prepared by radical polymerization of acrylamide in the presence of mono-disperse spherical nanoparticles assembled from amphiphilic block copolymers consisting of a hydrophobic, rubbery block and a hydrophilic, stealth segment partially decorated with reactive acrylates. Cross-sectional TEM analysis showed that macroscopic deformation exerted on the hydrogels was effectively transmitted to the immobilized micelles, causing a significant micelle deformation without compromising the mechanical integrity of the hydrogels. The entrapped micelles return to their original shape after the force is removed. Force-induced micelle deformation was further utilized for the step-wise release of pyrene that was loaded into the hydrophobic core of BCMs prior to gelation, under the control of external stretching. Overall, HGP- or BCM-crosslinked hydrogels are potentially useful tissue engineering scaffolds or drug release devices.

Tobias Baumgart, Chemistry, U. Penn
Biophysics and Lipid and Protein Interactions Modulated by Membrane Curvature

Biological membranes consist of a lipid double layer containing proteins and other macromolecules. Such membranes surround biological cells and the organelles that cells contain. Biomembranes often show lateral structure and complex shapes. Importantly, membrane shape and local composition have been found to couple in important functional aspects involved in cell signaling, membrane component sorting and membrane trafficking. The mechanisms of such phenomena currently are not well understood.

Here we investigate the interrelation of membrane curvature generation, curvature sorting, and membrane binding of various peripheral membrane proteins. We use giant unilamellar vesicles in combination with various fluorescence and mechanical manipulation methods to study aspects of the biophysical mechanisms underlying the function of these proteins. We also introduce a solid supported membrane platform that offers a robust approach to curvature mediated sorting experiments.

Ralph Colby, Materials Sci., Penn State
Ionomer Design Principles for Ion-Conducting Energy Materials

We synthesize single-ion conducting ionomers with low glass transition temperatures to prepare ion conducting membranes for actuators and lithium battery separators. We use dielectric spectroscopy to determine the number density of conducting ions and their mobility from electrode polarization (using the 1953 Macdonald model) and the number density of ion pairs from measured dielectric constant (using the 1936 Onsager model). This experimental work concludes that the number density of conducting ions is tiny, and we discuss ways to boost that using more polar polymers with weak-binding anions attached to the chain.

We use ab initio quantum chemistry calculations at 0 K in vacuum to characterize ion interactions and ion solvation by various functional groups on ion-containing polymers. Simple ideas for estimating the ion interactions and solvation at practical temperatures and dielectric constants are presented that indicate the rank ordering observed at 0 K in vacuum should be preserved. Hence, such ab initio calculations are useful for screening the plethora of combinations of polymer-ion, counterion and polar functional groups, to decide which are worthy of synthesis for new ionomers. The results provide estimates of parameters for a simple four-state model for counterions in ion-containing polymers: free ions, isolated ion pairs, triple ions and quadrupoles. We show some examples of how ab initio calculations can be used to understand experimental observations of dielectric constant, glass transition temperature and conductivity of polymerized ionic liquids with either lithium or ionic liquid counterions. In particular, recent calculations provide some important insight as to why poly(ethylene oxide) is able to raise the dielectric constant to boost ion transport.

David Gracias, Chem Eng., Johns Hopkins
Self Folding Soft Materials
There are many structures in nature such as leaves and tissues that self-assemble in curved and folded geometries. I will describe synthetic strategies to pattern and engineer differential stress in polymers and gels so that they self-fold into three dimensional structures such as non-spherical capsules, curved microfluidic networks and anatomically relevant tissue scaffolds. The highlight of our approach is that it transforms the precision of planar lithographic patterning and integration to the third dimension and enables the structuring of polymeric materials and devices for applications in drug delivery, tissue engineering and microsurgery.

Soundbite Talks: *MASM9*

Session I

1. Sara Johnson (University of Maryland)
   AFM Nano-mechanical Stimulus for Silk-Elastin-like Protein Self-Assembly

2. Henry W. Haslach, Jr. (University of Maryland)
   Mechanical Damage in Rat Brain Tissue and Mild Traumatic Brain Injury

3. Yi Liu (University of Maryland)
   Salt Effects on Chitosan Electrodeposition

4. Jefferson Taylor (University of Maryland)
   Interaction of a Bi-Molecular Liquid Crystal Film and Thicker Films with Functionalized Nanoparticles

5. Zengjiang WEI (Department of chemistry and biochemisty, University of Maryland College Park)
   Programmable shape transformation generated from alternant chemical gel and physical gel

6. Helen DeCelles-Zwerneman (Georgetown University)
   Local Deformation of Microtubule Networks with Optical Tweezers

7. Luz J Martinez-Miranda (University of Maryland, College Park, MD)
   Structural and Electrical Properties of Smectic Liquid CrystalNanocomposites for Potential Photovoltaic Applications

8. Slavica Grdanovska (University of Maryland)
   Radiolytic Synthesis of Magnetic Nanocomposites

9. Xiaowei Yang (Materials science and engineering department, University of Delaware)
   Photo-Crosslinked Functional Polyester Elastomer

10. Amit Vaish (NIST/UMD)
    Determination of Structure-Function Relationship of G-Protein-Coupled Receptors using Functionalized Surfaces

11. Peng Zhang (University of Maryland, College Park)
    Biphasic synthesis of polymer/inorganic hybrid nanoparticles

12. Brian Rost (Georgetown University)
    Simulating motion of rigid helices in shear flow using Dissipative Particle Dynamics

Session II

1. Matthew Lohr (University of Pennsylvania)
   Vibrational Density of States of Quasi-2D Attractive Colloidal Suspensions

2. Marcus Cicerone (NIST)
   Two-State Dynamic Heterogeneity in Molecular Liquids and Glasses

3. Renee Hood (University of Maryland College Park)
   PharmacyonaChip: Microfluidic Liposome Formation

4. Justin Stimatze (Georgetown University)
   Simulating fiber motion in shear flow using Dissipative Particle Dynamics

5. Ye Xu (University of Pennsylvania)
   Imaging stress and strain in the fracture of colloidal films

6. Xiangyun Qiu (George Washington University)
   Structure and Interaction of Macromolecular Complexes

7. Richard Arevalo (Georgetown University)
   Stress Transfer Through Branched Collagen Fiber Networks

8. Marcin P. Walkiewicz (National Cancer Institute / National Institutes of Health)
   Target Recognition by Atomic Force Microscopy using Antibody-conjugated Quantum Dots. (TRAQ-DOTS)

9. Pramukta Kumar (Georgetown University)
   3D/2D Sheared Colloidal Fibers

10. Anindita Basu (University of Pennsylvania)
    Rheology of Soft Colloids Near the Jamming Transition

11. Armstrong Mbi (Georgetown University)
    Shear banding in binary colloidal glasses

12. Patricia Inamura (University of Maryland)
    Radiation induced Grafting of Polyethylene glycol on Gelatin Nanoparticles

Session III

1. Marguerite Brown (Georgetown University)
   Ordering and Deformation of Microtubules under Confinement

2. Eddy Salgado (University of Maryland)
   Functionalized gold nanoparticles for packaging and delivery of DNA

3. Xiaoyu Sun (University of Maryland, College Park)
   Fabrication of Nano-scale Topographies with Multi-photon Absorption Polymerization for Directional Cell Migration

4. Xin Zhang (University of Maryland)
   Large scale block copolymer templated gold nanoparticle arrays

5. Jana Dodson (Georgetown University)
   Oil-in-Water Emulsions Stabilized with Colloidal Microrods

6. Wolfgang Losert (University of Maryland)
   Shape Dynamics of Cells: From Waves to Migration

7. Sarah Mburu (Cornell University)
   Non-linear Elasticity of Semiflexible biopolymers: Collagen
8. Steven Slotterback (University of Maryland: College Park)
   3D Imaging of Dense Granular Flows Subject to Cyclic Shearing
9. Matt Harrington (University of Maryland)
   Three dimensional imaging of slow shear-driven segregation of a dense granular material
10. Raman Ganti (University of Pennsylvania)
    Determining Steady State Position of Particles at the Edge of Drying Drops
11. Tim Still (University of Pennsylvania)
    Elastic Properties of Quasi-Two-Dimensional Colloidal Model Systems
12. Charles Kuo (University of Maryland)
    Liposome-based nanoprobe for targeting and imaging of head and neck cancer cells

Session IV

1. Yijing Liu (university of maryland college park)
   Self-assembly of Inorganic Nanoparticle Vesicles and Tubules Driven by Tethered Linear Block Copolymers
2. Ruiliang Bai (University of Maryland)
   Quantitatively Detecting and Understanding Nerve Excitability by Combining Different MRI Modalities
3. WONSEOK HWANG (University of Maryland, College Park)
   Structure-Property Relationships of Semicrystalline Polyolefins
4. Laura Hyland (University of Maryland)
   Chirality-Mediated Mechanical and Structural Properties of Oligopeptide Hydrogels
5. Kevin Diehn (University of Maryland)
   Insight into Slow vs. Instant Gelation of Organic Solvents by Self-Assembly of an Organogelator via Hansen Solubility Parameters
6. Xiaowei Yang (Materials Science and Engineering Department, University of Delaware)
   Synthesis and Characterization of Functional Polyester Elastomers
7. Nestor E. Valadez (NIST Center for Neutron Research)
   Effect of a Weak Long-ranged Repulsion on the Phase Diagram of Short-ranged Attractive Colloidal System
8. Pasha Tabatabai (Georgetown)
   Silk Electro-Gelation
9. Beatriz Burrola Gabilondo (Georgetown University)
   Shearing microtubule networks
10. Stephen Banik (University of Maryland–College Park)
    Creating Polymer Hydrogel "Hybrids" Combining Gels of Distinct Properties
11. Amy Lee (University of Maryland, College Park)
    Direct Measurements of Mechanical Properties of Condensed DNA using Optical Tweezers