MASM, the **M**id-**A**tlantic **S**oft **M**atter workshop
Georgetown University, November 30, 2007
Schedule

· 8:00 - 8:55 am
Registration and Breakfast (Reiss Science Center)

· 8:55 - 9:00 am
Dr. Timothy Barbari (Georgetown University; Copley Formal Lounge)

· 9:00 - 9:45
Prof. Srinivasa Raghavan (University of Maryland)

· 9:45 - 10:30
Prof. Kathleen Stebe (Johns Hopkins University)

· 10:30 - 10:50
Coffee Break (Copley Formal Lounge)

· 10:50 - 12:00
Sound-bite Session I

· 12:00 - 1:30
Lunch (O'Donovan Dining Hall)

· 1:30 - 2:15
Prof. Paul Janmey (University of Pennsylvania)

· 2:15 - 3:15
Sound-bite Session II

· 3:15 - 3:35
Coffee Break (Copley Formal Lounge)

· 3:35 - 4:15
Sound-bite Session III

· 4:15 - 5:00
Prof. Eric Furst (University of Delaware)

Invited Speakers

Srinivasa R. Raghavan, University of Maryland

"From Jello to mayonnaise to silly putty to biological cells, our world is replete with soft matter materials that behave as soft, deformable solids or highly viscoelastic liquids. One of the joys of working with soft matter is that it is conducive to tabletop experiments, where interesting phenomena occur in front of your eyes. Moreover, it is often possible to create new forms of soft matter simply by mixing existing molecules in new or different ways this will be illustrated by recent examples from our lab.

Three systems will be described, all based on self-assembly in mixtures of amphiphilic molecules. In one case, we have created a temperature-sensitive fluid that undergoes a 1000 fold increase in viscosity with increasing temperature (JACS, 2006. 128, 6669). Second, we have devised a light-sensitive material that can be transformed from gel-like to water-like upon illumination with UV light (JACS, 2007. 129, 1553). Lastly, we have demonstrated that the addition of a certain biopolymer transforms a solution of vesicles or biological cells into a gel (Langmuir, 2005. 21, 26). Applications for these systems could range from microfluidic valves to controlled release to hemostasis and wound healing."

Kathleen Stebe, Johns Hopkins University

"Ordered aggregates of particles have a wide range of potential applications; examples include novel optical, sensing and data recording platforms, and templates for microporous or nanoporous materials. One means of creating the assemblies is evaporative deposition, in which particles are directed to desired locations by a flow field, and then drawn into order by evaporation of capillary bridges between the particles. In this work, the spontaneous deposition of particles in ordered structures is studied experimentally on energetically homogeneous surfaces, on energetically heterogeneous surfaces, and in the presence of surfactants. Another means of creating assemblies exploits capillary interactions between partially wet particles at fluid interfaces. We focus on interactions between anisotropic particles which drive orientations, rotation and assembly."

Paul Janmey, University of Pennsylvania

"Networks formed by filamentous biopolymers like collagen and fibrin have viscoelastic properties that are very different from those of rubberlike elastomers or hydrogels formed by flexible polymers. Compared to flexible polymer gels, filamentous biopolymer networks generally have much higher shear moduli, they often exhibit a striking increase in elastic modulus with increasing strain, and they show a pronounced negative normal stress when deformed in simple shear. Several different theories have been proposed to explain these unusual features. One approach extends concepts of entropic elasticity to a regime where the polymer chains are already significantly extended in the absence of external forces because of their finite bending stiffness. Others consider the balance between bending and stretching of filaments. The theories that relate microscopic structural parameters such as persistence length and mesh size of biopolymer gels to their macroscopic rheology make different predictions about

whether the deformation of these materials is affine: that is, whether the macroscopic strain of the bulk material is equal to the local strain within the material at each point. The validity of this assumption for the dilute open meshworks biopolymer gels is experimentally tested by embedding micron diameter fluorescent beads within networks and quantifying their displacements as the macroscopic samples are deformed in a rheometer. In some cases individual polymer chains can be imaged within the strained network to relate molecular deformation to macroscopic material properties. For homogenous networks of thin fibers such as fibrin protofilaments, nonaffinity measures are low and do not change as the material stiffens. As fiber diameter and mesh size increase, non-affinity also increases and becomes strain dependent. Correlation of nonaffine deformation and strain stiffening can help differentiate between different theoretical models."

Eric Furst, University of Delaware

"Hydrogel networks offer exciting possibilities for the rational design of novel materials. Properties specific to tissue engineering, such as biocompatibility, biodegradability and remodeling characteristics, are dependent on the environmental responsiveness of the material. Thus, recent research has focused on using small peptide sequences that assemble or even self-assemble into materials. Peptides can be engineered such that the formation and final properties display responsive behavior.

In this talk, I will discuss the gelation kinetics of self-assembled hydrogels consisting of a beta-hairpin peptide. These materials are investigated using microrheology and far-UV circular dichroism (CD) spectroscopy. The intramolecular folding of this peptide is engineered to control its self-assembly into beta-sheet rich hydrogels. When the peptide is unfolded, it does not self-assemble, and aqueous solutions have the viscosity of water. Folding and consequent self-assembly are triggered by changes in pH, temperature or ionic strength. This folding and self-assembly mechanism allows temporal control of the material formation. CD spectroscopy shows that the kinetics of beta-sheet structure formation occurs in a concentration-dependent manner, but does not provide information on the kinetics of network assembly. Multiple particle tracking microrheology is used to define exact gelation times as a function of peptide concentration. The principles of time-cure superposition are used rescale the mean-squared displacement of probe particles onto a single master curve. A time shift factor accounts for divergence of the longest relaxation time as the gel point is approached, and a second shift factor characterizes the decrease in compliance as the gel network forms and becomes more elastic. By analyzing the shift factors based on scaling relationships near the liquid-solid transition, we are able to accurately determine both the gel time and critical exponents of the incipient gel. The gel point provides a key reference from which to define the kinetics of gelation, while the critical exponents provide insight into the gel connectivity. Overall, this enables an empirical relationship to be established between the rheologically-defined gelation time and the onset of beta-sheet formation as measured by CD."

Sound bite session I

1. Daniel Chen, Penn; "Gelation of Carbon Nanotube Networks"
2. Andras Libal, Hopkins; "Colloidal Ratchets"
3. Andrzej Latka, St. Josheph's; "Particle dynamics in the attractive liquid region of the reentrant glass transition"
4. Indira Sriram, Delaware; "Laser Tweezer Microrheology"
5. Jeetain Mittal, NIH; "Clarifying some basic consequences of confinement for fluids"
6. Erin Rericha, Maryland; "Relaxation of actin networks due to local, micron scale perturbations"
7. Paul Roepe, Georgetown; "Sound Bite Title: Controlling heme aggregation vs crystallization can cure malaria"
8. Anindita Basu, Penn; "Shear deformation in polymer network"
9. Clayton Lapointe, Hopkins; "Manipulation of nanowires in a liquid crystal"
10. John Singh, Delaware; "Behavior of colloidal particles in Electric field"
11. Dan Sisan, Georgetown; "Sound Bite Title: Spatially resolved FCS using a spinning disk confocal microscope"
12. Florian Rehfeldt, Penn; "Hydrogels as echanically tunable and well-defined microenvironments for adult stem cells"
13. Bum Jun Park, Delaware; "Interactions between colloidal particles at oil-water interfaces"
14. Ralph Nossal, NIH; "Physical Aspects of Clathrin Basket Assembly"
15. Steven Slotterback, Maryland; "Analysis of 3D Particle Motions in Granular Media"
16. Alexander Lobkovsky, Georgetown; "Fluid flow through polymer gels"
17. Wouter Ellenbroek, Penn; "A diverging length scale in the response of granular media near unjamming"
18. Jiyeon Huh, Delaware; "Sound Bite Title: Collapse of depletion-induced vesicle gels"
19. Tao Yu, Georgetown; "Reversible, Room-Temperature, Chiral Ionic Liquids"

Sound Bite Session II

1. Elisabetta Matsumoto, Penn ; "Smectic Defects with Riemann Reason"
2. Edward Banigan, Penn; "Dynamical Analysis of a Sheared Granular Layer Near the Jamming Transition"
3. Ed Van Keuren, Georgetown; "Sound Bite Title: Optical characterization of self assembly"
4. Hongyu Guo, Hopkins; "Structural Arrest in Nanocolloidal Suspensions Undergoing Gelation and Aging"
5. Kelly Schultz, Delaware; "Determining Material Properties of PEG-Heparin Hydrogels using Multiple Particle Tracking Microrheology"
6. Shang-You Tee, Penn; "The cell mechanosensor as a rheometer"
7. Manish Mittal, Delaware; "Interactions Between Polystyrene Particles in an Electric Field"
8. Shengfeng Cheng, Hopkins; "Molecular Simulations of Capillary Adhesion"
9. Peter Krsko, NIH; "Bacterial Extracellular Matrix as a Viscoelastic Hydrogel"
10. David Christian, Penn; "Spotted Polymersomes and Striped Worms - strong lateral segregation of diblock copolymers"
11. Ilya Levental, Penn; "Cholesterol, but not sphingomyelin, determines phase separation and Lo phase abundance in Giant Plasma Membrane Vesicles"
12. Paula Vasquez, Delaware; "Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions"
13. Zexin Zhang, Penn; "Experimental Study of Colloidal Jamming in Two Dimensions"
14. Jennifer Galanis, NIH; "Ordering of confined rods - with inspirations from liquid crystals."
15. Michihiro Nagao, Maryland & NIST; "Investigation of soft-matter dynamics by neutron scattering"
16. Jessamine Winer, Penn; "Fibrin strain stiffening as it relates to 3T3 cell/matrix interactions"
17. Eric Lin, NIST; "Soft Matter in the NIST Polymers Division"

Sound Bite Session III

1. Nathan Cappallo, Hopkins; "Nonlinear Microrheology of a Wormlike Micelle Solution Using Ferromagnetic Nanowire Probes"
2. Michele Mestrinaro, St. Joseph's; "Aging in attractive colloidal glasses"
3. Frances Spinelli, Delaware; ' 'Characterizing cell receptor-mediated erosion in heparin-based hydrogel networks"
4. Carl Modes, Penn; "Hard Discs on the Hyperbolic Plane"
5. Steve Hudson, NIST; "Patchy particle preparation and characterization"
6. Kefeng Ma, Georgetown; "Amphotropic and thermotropic ionic liquid crystals based on phosphonium salts"
7. Bryan Chen, Penn; "Plateau's laws for a nematic foam"
8. Suliana Manley, NIH; "Molecular imaging in living cells with photoactivatable markers"
9. Travis Larsen, Delaware; "Investigating the sequence-dependent gelation kinetics of beta-hairpin hydrogels using microrheology"
10. Qi Wen, Penn; "Mechanical Properties of PEG-fibrinogen"
11. Antonio Faraone, Maryland & NIST; "Investigation of soft-matter dynamics by neutron scattering"