Schedule for the 13th Mid-Atlantic Soft Matter workshop, August 4, 2014
Johns Hopins University, Departments of Physics and Astronomy and ChemBE

8:30 am
Registration and Breakfast

8:50 am
Opening Remarks

9:00 am
Manoj Chaudhury (Lehigh):
Pattern Formation in Soft Elastic Films and its Role in Adhesion

9:40 am
Sound-bite Session I

10:20 am
Coffee Break

10:40 am
Randy Kamien (UPenn):
Pure and Applied and Pure Smectics

11:20 am
Sound-bite Session II

12:10 pm
Lunch

1:20 pm
Shelley Anna (CMU):
Generation of monodisperse non-spherical capsules controlled by particle loading at the interface

2:00 pm
Sound-bite Session III

2:40 pm
Break

3:00 pm
Anna Balazs (Pitt):
Predicting the dynamic behavior of chemo-responsive gels

3:40 pm
Sound-bite Session IV

4:20 pm
Break

4:40 pm
Joelle Frechette (JHU):
Lubrication and wet adhesion in the presence of draining channels

5:20 pm
End of Workshop

Shelley Anna, Carnegie Mellon University

Generation of monodisperse non-spherical capsules controlled by particle loading at the interface

The complex interfaces of particle-stabilized drops and bubbles dramatically impact their formation, shape, and dynamics. Here we show that bubbles and droplets immersed in a particle suspension and translating along the axis of a microfluidic channel form highly stable non-spherical capsules. The capsule shape is directly related to the residence time of the bubble within the channel. By modeling particle transport we show that particle coverage on the bubble surface is also a function of residence time. Comparing non-spherical capsule surface areas suggests that the bubble interface does not relax when the particle surface concentration approaches a maximum packing concentration. Furthermore, independent measurements of dilatational interfacial rheology show that these densely packed interfaces are highly elastic, promoting their stability. Thus, we show that microfluidic methods permit direct, independent control of droplet size, shape, and interfacial mechanical properties, all of which are critical parameters relevant to the stability and rheology of a particle-stabilized emulsion or foam.

Anna Balazs, University of Pittsburgh

Predicting the dynamic behavior of chemo-responsive gels

A remarkable feature of certain biological organisms is their ability to alter their shape and functionality in response to environmental cues. Polymer gels undergoing the Belousov-Zhabotinsky (BZ) reaction are unique self-oscillating materials that can be used to design a variety of soft materials with biomimetic functionality. We focus on chemically-mediated communication between multiple pieces of BZ gels. We show that the system exhibits autochemotaxis, which results in a spontaneous self-aggregation of the pieces. We also find that the aggregated structure can undergo spontaneous, autonomous rotation. Moreover, the gels coordinated motion can be controlled by light, allowing us to achieve selective self-aggregation and control over the shape and motion of the aggregates. We then focus on novel polymer gels that combine two distinct functionalities. First, these gels contain spirobenzopyran (SP) chromophores grafted onto the polymer matrix; the SP moieties are hydrophilic in the dark in an acidic aqueous solution, but become hydrophobic under illumination with blue light. Hence, incorporation of these chromophores into the gel allows us to remotely control the gel's swelling or shrinking. Second, these gels also contain a Ru catalyst that is grafted onto the polymer chains. When placed into a solution containing all the reagents needed for the Belousov-Zhabotinsky (BZ) reaction, these SP-BZ gels undergo self-oscillations. We show that these systems undergo large scale shape changes, with an initially flat sheet morphing into a variety of complicated 3D forms. Moreover, these SP-BZ gels undergo self-propelled motion, with the mode of motion being controlled by external light. Our results point to a novel class of active self-oscillating materials and to a robust method for controllably re-configuring their 3D shapes and their self-propelled motion.

Manoj Chaudhury, Lehigh University

Pattern Formation in Soft Elastic Films and its Role in Adhesion

This story is about elastic instability, and its role in adhesive crack propagation in soft confined films. A hydrostatically stressed soft elastic film relieves the imposed constraint by undergoing a morphological instability, the wavelength of which is dictated by the minimization of the surface and the elastic strain energies of the film. The wavelength is entirely dependent on the film thickness provided that the role of the surface tension of the film is negligible in comparison to that of elasticity. When the role of surface tension is significant, the instability exhibits a longer wave feature. With such a film continually subjected to a stress, the morphologicial patterns evolve into cracks, which, in turn provide the length scale needed to relate the fracture stress to the adhesion energy and the elastic modulus. While for a stiffer film, the thickness provides the relevant length scale for fracture leading to the well-known Kendall-Griffith like criterion, the fracture stress is modified non-trivially by an elasto-capillary number for a very compliant film. If time permits, we will present a related story about some simple artificial patterns that can be used to control the adhesion of thin elastomeric films. We will provide examples of how cracks can be arrested in such patterned films, thereby enhancing the adhesive strengths of low energy films in contact with various substrates.

Joelle Frechette, Johns Hopkins University

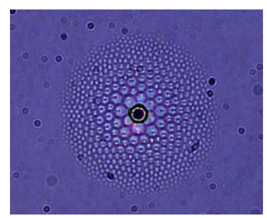
Lubrication and wet adhesion in the presence of draining channels

Tree frogs are able to adhere remarkably well in flooded environments. This wet adhesion is likely due to their compliant and structured toe pads which facilitate removal of fluid and promotes closer contact with interacting surfaces. We examine the effects of surface structure and elasticity on the adhesion between a smooth and a structured surface submerged in viscous Newtonian fluids. The structured surfaces are designed to mimic the tree frog toe pads and consist either of a rigid polymer or a soft elastomer. We contrast rigid surfaces where the posts are made from SU-8 (E 1GPa) and soft or compliant surfaces using different PDMS (E ¡ 1MPa). We characterize and model the out-of-contact elastohydrodynamic deformation and hydrodynamic forces of the smooth and structured surface for different approach velocities and fluid viscosities. The work of separation and adhesion is obtained via peeling measurements and highlights three different regimes of adhesion based on loading conditions. If there is sufficient fluid between the two surfaces we find that surface structures have no role in adhesion. For intermediate surface separations we observe that surface structures lead to a decrease in the pull out force, likely due to drainage through the structured surface. Finally in certain surface separations, the presence of surface structures lead to higher adhesion, likely due to increased elastic deformation and surface compliance. A theoretical analysis based on hydrodynamic and elasticity is presented to explain the onset of these regimes and their behavior which is consistent with our measurements.

Randall D. Kamien, University of Pennsylvania

Pure and Applied and Pure Smectics

I will discuss the homotopic classification of topological defects in liquid crystals with special attention to systems with broken translational symmetry. In the simplest case of smectics, we can see that this classification breaks down and needs repair or reformulation. I will discuss the latter and show how it leads to a surprising, underlying symmetry in smectic ground states. In related work epitaxially assembled toric focal conic domain (TFCD) arrays of smectic-A liquid crystals onto pillar arrays. The 3D nature of the pillar array is crucial to confine and direct the formation of TFCDs on the top of each pillar and between neighboring pillars, leading to highly ordered square and hexagonal array TFCDs persisting deeply into the bulk. Finally, exploiting our two experiences with these materials, we study the flower-like pattern shown on the below and develop new rules for tying together equally-spaced layers in thin films.



1. G.P. Alexander, B.G. Chen, E.A. Matsumoto, and R.D. Kamien, Phys. Rev. Lett. 104 (2010) 257802.

2. A. Honglawan, D.A. Beller, M. Cavallaro, Jr., R.D. Kamien, K.J. Stebe, and S. Yang, Proc. Natl. Acad. Sci. 110 (2013) 34.

3. D.A. Beller, M.A. Gharbi, A. Honglawan, K.J. Stebe, S. Yang, and R.D. Kamien, Phys. Rev. X 3 (2013) 041026.

Soundbite Talks: *MASM 13*

Session I

1. Sheng Song (Georgetown University)
   Unique Adsorption Configurations and Self-assembly of Fibrinogen on Chemically Uniform and Alternating Surfaces including Block Copolymer Nanodomains
2. Wei-Shao Wei (University of Pennsylvania)
   Ordered colloidal particle monolayers at liquid crystal interfaces
3. Amanda McDermott (NIST)
   Probing the interlamellar amorphous phase in semicrystalline polymers using vapor flow and neutron scattering
4. Kui Chen (Johns Hopkins University)
   Colloidal Transport and Periodic Stick-Slip Motion in Cholesteric Finger Textures
5. John J. Williamson (Georgetown)
   Free energy for coupled bilayer leaflets
6. Tara Edwards (Johns Hopkins University)
   Exploring Excluded Volume: Reconfigurable Depletion Mediated Colloidal Assembly on Multi-Scale Topographical Patterns
7. Sebastian Hurtado Parra (Saint Joseph's University)
   Vibrational properties of colloidal suspensions with short-range interparticle attraction
8. Zachery Brown (Saint Joseph's University)
   Investigating the Colloidal Glass Transition in Suspensions with Hard Sphere and Attractive Interparticle Potential
9. Luz J. Martinez-Miranda (University of Maryland)
   Local Structure due to the Presence of Nanoparticles in Liquid Crystal Nanocomposites

Session II

1. Aditi Chakrabarti (Lehigh University)
   Interaction of Rigid Cylinders on a Thin Elastic Film Supported on Liquid
2. Pasha Tabatabai (Georgetown University)
   Silk Gels: Structure from Rheology
3. YUGUANG YANG (Johns Hopkins University)
   Measuring NoisyColloidal Dynamics using a Hidden Markov Model Analysis
4. Victoria Muir (University of Delaware)
   Phase Separation of High Molecular Weight Polystyrene-Polyisoprene Blend Thin Films
5. Jillian Emerson (University of Delaware)
   Phase separation in poly(3-hexylthiophene)/polystyrene thin films

6. John Royer (NIST)
   Shape Matters: Dynamics of cubic colloids
7. Zhihong Nie (University of Maryland at College Park)
   Design and self-assembly of colloidal molecules: anisotropic functionalization is not necessary
8. Cameron Shelton (University of Delaware)
   Tracking Substrate Surface Energy Effects on Block Copolymer Thin Films
9. Charles Dhong (Johns Hopkins University)
   Peeling Structured Surfaces in a Viscous Newtonian Fluid to Understand Tree Frog Adhesion

Session III

1. Jeffrey Gilman (NIST)
   Imaging the Interphase in Nanocellulose Composites using FRET
2. Pasha Tabatabai (Georgetown University)
   Colloidal Depletion Gel Stiffening and Yield
3. Anna Coughlan (Johns Hopkins University)
   Measuring and Modeling Dipolar Interactions in a Rotating Magnetic Field
4. Michelle Calabrese (University of Delaware)
   Transient responses of branched wormlike micelles under nonlinear shear flows
5. Annekathrin Mutze (ETH Zurich)
   Time-resolved rheo-SANS: Evidence for simultaneous appearance of gradient and vorticity shear bands
6. Yumo (Johns Hopkins University)
   Role of surface structure on elastohydrodynamic forces between compliant surfaces
7. Tristan Sharp (Johns Hopkins University)
   Stresses in crystalline solid contacts
8. Bradley Rupp (Johns Hopkins University)
   Colloidal rod equilibria in AC fields
9. JUN DONG PARK (SEOUL NATIONAL UNIVERSITY)
   Structural evolution of colloidal gels under shear flow
10. Klebert Feitosa (James Madison University)
    Bubble dynamics in a bubble raft driven by oscillatory compression

Session IV

1. Xiaoqing Hua (Johns Hopkins University)
   Measurements and models of reversible adsorption of nanoparticles at o/w interface
2. Luz J Martinez-Miranda (University of Maryland, College Park)
   Local Structure due to the Presence of Nanoparticles in Liquid Crystal Nanocomposites
3. Charles Thomas (University of Pennsyvlannia)
   Clogging Transition in Granular Hopper Flow
4. Olivia Cypull (James Madison University)
   Droplet Dynamics of a Coarsening Emulsion System
5. Bonnie Newman (NIST)
   Extensional Flow-SANS of Wormlike Micelles
6. Marguerite Braun (Georgetown University)
   Biopolymers as Model Materials
7. Emanuela Del Gado (Georgetown University)
   Stress localization, stiffening and yielding in a model colloidal gel
8. Daniel B. Allan (Johns Hopkins University)
   Interfacial Microrheology of Layer Formation by Wild and Disordered Proteins
9. Peter Olmsted (Georgetown University)
   Flip-Flop in Stratum Corneum (skin) Lipid Bilayer Membranes
10. Robert Bradbury (Indiana University)
    Charge effects on surfactant membrane stability