Schedule for the 15th Mid-Atlantic Soft Matter workshop
University of Maryland, College Park
July 29, 2015

8:30 am
Registration and Breakfast

8:50 am
Opening Remarks

9:00 am
Zhihong Nie (University of Maryland):
Dancing With Nanoparticles: New Physics and Chemistry in Molecular-mimicking Nanoparticles

9:50 am
Sound-bite Session I

10:30 am
Coffee Break

10:45 am
Ronald Jones (National Institute of Standards and Technology):
Grazing Incidence Small Angle Neutron Scattering: The Next Big Thing for Soft Materials?

11:35 am
Sound-bite Session II

12:15 pm
Lunch

1:30 pm
Danielle Bassett (University of Pennsylvania):
Characterizing Force-Chain Network Architecture in Granular Materials

2:20 pm
Sound-bite Session III

3:00 pm
Break

3:15 pm
Kandice Tanner (National Institutes of Health):
Probing the physical properties of the microenvironment niche

4:05 pm
Sound-bite Session IV

4:35 pm
Break

4:50 pm
Peter Kofinas (University of Maryland):
In Situ Deposition of Polymer Fibers For Surgical Sealant Use

5:30 pm
End of Workshop

Zhihong Nie, University of Maryland

Dancing With Nanoparticles: New Physics and Chemistry in Molecular-mimicking Nanoparticles

The past decades have witnessed remarkable success in the synthesis of inorganic nanoparticles with interesting optical, electronic, or magnetic properties. Realizing the enormous potential of nanoparticles in such as energy, biomedical, and optoelectronic fields requires the organization of these particles into larger or hierarchically ordered structures with defined macroscopic properties. Inspired by molecular self-assembly into structures with astonishing complexities and functions in living organisms or synthetic systems, we and others are striving to achieve programmable self-assembly of nanoparticles as "molecule equivalents". The ability to do so holds great promises to manipulate matter at nanoscale scale and to exploit the emergent properties of nanoparticle ensembles. However, unmet challenges still remain at this frontier. In this talk, I will present our efforts to develop nanoparticles that can mimic conventional molecules to assemble into hierarchical structures with programmable architectures, and to understand the similarity and differences between these nanoparticles and molecules.

Ronald Jones, NIST

Grazing Incidence Small Angle Neutron Scattering: The Next Big Thing for Soft Materials?

Grazing Incidence Small Angle Neutron Scattering (GI-SANS) has been a topic of interest since the beginning of neutron scattering due to the need to characterize 3-D interfacial structure at the solid/solid and Solid/Liquid interface of soft materials and complex fluids. Successful implementation would significantly advance insight into problems in self assembling lipid bilayers, separation membranes, and the flow of complex fluids and polymer melts. Many issues related to the relatively small flux of neutron sources have limited the practicality of GI-SANS. However, recent progress in the field has begun to quantitatively determine and address the engineering challenges of using this technique in modern SANS instruments, and computational algorithms from X-ray analogs promise new solutions to the dynamic scattering problem. In this presentation, I will present results from our team at NIST that highlight potential routes forward to finally realize the potential of this scattering geometry.

Danielle Bassett, University of Pennsylvania

Characterizing Force-Chain Network Architecture in Granular Materials

Force chains form heterogeneous physical structures that can constrain the mechanical stability and acoustic transmission of granular media. However, despite their relevance for predicting bulk properties of materials, there is no agreement on a quantitative description of force chains. Consequently, it is difficult to compare the force-chain structures in different materials or experimental conditions and to quantify their impact on materials properties. To address this challenge, we treat granular materials as spatially-embedded networks in which the nodes (particles) are connected by weighted edges that represent contact forces. We use techniques from community detection, which is a type of clustering, to find groups of closely connected particles. By using a geographical null model that is constrained by the particles' contact network, we extract chain-like structures that are reminiscent of force chains. We use graph-based statistics to quantify the network architecture of these chain-liked structures, and we use persistent homology of the clique complexes of these structures to quantify their topology. These tools provide statistical descriptors that differentially measure spatial and topological properties, and their combination, in force-chain objects. We demonstrate the utility of these diagnostics for identifying and characterizing classes of force-chain network architectures in various materials. To illustrate our methods, we describe how force-chain architecture depends on pressure for both laboratory experiments and numerically-generated frictionless packings. By resolving individual force chains, we quantify statistical properties of force-chain shape, which are potentially crucial diagnostics of bulk properties (including material stability). These methods facilitate quantitative comparisons between different particulate systems, regardless of whether they are measured experimentally or numerically.

Kandice Tanner, NIH

Probing the physical properties of the microenvironment niche

Tissue microenvironment is composed of heterogeneous biological components and physical parameters, and nanometric topography in 3D is one of crucial factors that influence on cell phenotype, tissue morphogenesis and cancer progression. However, delineating the complex interplay between cells and their physical microenvironment is challenging using current techniques. What is needed is the ability to resolve and quantitate minute forces that cells sense in the local environment (on the order of microns) within thick tissue (in mm). 3D culture models approximate in vivo architecture and signaling cues, allowing for real time characterization of cell-ECM dynamics. We employ two approaches where we recreate diverse nanoscale topographies of protein distributions in 3D matrix for the purpose of mimicking tissue microenvironment. To achieve this, we chemically immobilize the proteins on the surface of magnetic nanoparticles then using an applied magnetic field – to program self-assembly. Using this simple technique, we achieved diverse 3D topography by varying fibril diameter, spacing and localized or interfaced architecture of proteins, and independent of other material parameters of the matrix, such as stiffness. Next, we used an optical tweezers calibrated in situ to perform active microrheology to measure material properties at length (μm) and frequency (1-10,000s Hz) scales unobtainable by bulk rheology. In situ trap calibration followed by active microrheology reduces the random noise that can occur in passive rheology, particularly at low frequencies. This allows for accurate measurements of many mechanical properties in 3D culture models to definitively account for microenvironmental impact on individual cells.

Peter Kofinas, University of Maryland

In Situ Deposition of Polymer Fibers For Surgical Sealant Use

Tissue reconstruction and closure of incisions/wounds is pertinent to almost all surgical interventions and traumatic injuries. Conventional suturing and tissue stapling have defined limitations, but remain ubiquitous to many procedures and few advances have been made in modern surgery with regards to improving the risks of these techniques. Effective tissue sealants have the potential to reduce risk, reduce cost of complications, enhance surgical competency, and improve patient comfort. These desired attributes have led to our investigation into using solution blow spinning for the direct deposition of biodegradable polymer blend fiber mats as surgical sealants. Our research is centered on the investigation of a polymer fiber mat deposition method called solution blow spinning. This fabrication technique allows for the rapid in situ generation of polymer fibers, offering the ability to conformally deposit polymeric materials directly on the surgical site of interest. Solution blow spinning was utilized to deposit a body temperature responsive, biodegradable polymer blend. Above a critical temperature, the two phase fibrous polymer mat transitioned into a one phase polymer film. This transition resulted in plasticization and promoted polymer-substrate interaction, leading to increased adhesion. Sealant efficacy was demonstrated in a cecal intestinal anastomosis mouse model, where the polymer blend was used to supplement sutures. Both burst pressure and survival rate were significantly improved over the suture-only control. Pilot animal studies demonstrate the potential of this technique for surgical applications.

Soundbite Talks: *MASM 15*

Session I

1. Stephanie Lam (NIST)
   Combining AUC and SANS for the Characterization of Adsorbed Surfactant and Hydration Layers around Colloidal Particles
2. Benjamin H Blehm (NIH)
   Measuring Microscale Heterogeneties in the Cellular Microenvironment using Optical Trapping Microrheology.
3. Anthony Kotula (NIST)
   Raman spectra analysis of alkanes in the rotator phase
4. Jonathan E. Seppala (National Institute of Standards and Technology)
   Soft Additive Manufacturing at NIST
5. Rachel Lee (University of Maryland)
   Quantifying collective cell migration during cancer progression
6. Pasha Tabatabai (Georgetown University)
   pH dependent structure of silk gels
7. Lia Papadopoulos (University of Pennsylvania)
   Geometric and Topological Measurements of Force Chains in Granular Materials
8. Matthew Sartucci (Georgetown University)
   Flow Behavior of Helical Flagella
9. Zoey S Davidson (University of Pennsylvania)
   Planar anchoring of achiral nematic liquid crystals in capillaries — with a twist!
10. Claire McIlroy (Georgetown University)
    Inkjet Printing Complex Fluids
11. Daniel Seeman (NIST)
    Microfluidic flow-SANS
12. Peter Olmsted (Georgetown University)
    Hydrodynamic theory of lipid bilayers - incorporation of thickness fluctuations.

Session II

1. Vishwas V Vasisht (Georgetown University)
   Shear rate dependence of local rearrangement of droplets in a dense emulsion.
2. Anthony Chieco (University of Pennsylvania)
   Characterizing Pixelized Patterns with a Hyperuniformity Disorder Length

3. Hongyu Guo (NIST/NCNR)
   Enhanced gelation of silica nanoparticles in water/ lutidine mixture.
4. Zhiyuan Wang (NCNR, Tsinghua University)
   Direct measurement of the Critical Casimir force between colloidal particles in the mixture of 2,6-lutidine and water by SANS
5. Anna Coughlan (Johns Hopkins University)
   Particle Hydrodynamics in a Rotating Field
6. Mehdi Bouzid (Georgetown University)
   On the relaxation and dynamics of colloidal gel
7. Vishnu Dharmaraj (NIST)
   Lysozyme Rheology at High Shear Rates
8. Howard Wang (University of Maryland)
   3D Mapping of Li Dendrites in Polymer Electrolytes
9. Gregory Hogan (Saint Joseph's University)
   Free Diffusion of Colloidal Particles in Multiple Dilute Polymer Solutions
10. Zachery Brown (Saint Joseph's University)
    Dynamical Heterogeneity in Colloidal Systems near the Reentrant Glass Transition
11. Daniel Seeman (UMass - Amherst)
    Attarctive Electrostatic Interactions Mediated by Hydrated Protein Surfaces
12. Andrew Blyskal (University of Maryland)
    Modified Coffee Rings for 1-D, Anisotropic Conductivity

Session III

1. Gregg Duncan (Johns Hopkins School of Medicine)
   Altered Sputum Microstructure as a Marker of Airway Obstruction in Cystic Fibrosis Patients
2. Koty McAllister (NIST/NCNR)
   Orientation of Wormlike Micelles Under Extensional Flow
3. Emanuela Del Gado (Georgetown University)
   Soft modes and non-affine rearrangements in the inherent structures of supercooled liquids
4. Vikram Rathee (Georgetown University)
   Shear Induced Phase Transition in Mixed Surfactant System.
5. Doug Henderson (University of Maryland)
   Small Angle Neutron Scattering of Cellulose/Ionic Liquid Solutions
6. Brian Josey (Carnegie Mellon/NIST)
   Association of Model Neurotransmitters to Lipid Bilayers

7. Matt Harrington (University of Maryland)
   3D imaging of particle-scale rotational motion in granular flows

8. Matthias Zorn (LMU Munich)
   Flow and Diffusion in Channel-Guided Cell Migration

9. Ruiliang Bai (University of Maryland / NIH)
   Detecting the laminar structure in cartilage using an NMR "MOUSE" depth profiler

10. Jiyun Kim (NIH)
    Engineering topography of cellular microenvironment in 3D using Magnetic field-induced nanoparticle self-assembly

11. Jack Staunton (NIH)
    Collagen type I ECM hydrogel architecture and mechanics

Session IV

1. Xin Zhang (University of Maryland)
   Block Copolymer Self-Assembly Guided Gold Nanoparticle Arrays for Sensor Applications

2. Rui Lu (University of Maryland)
   Quantification of Nanoparticle Arrays on Polymer Thin Films with X-Ray Reflectivity

3. Nancy Forde (Simon Fraser University)
   Investigating collagen and designing molecular motors in Vancouver, Canada

4. Isaac Torres-Diaz (Johns Hopkins University)
   Modeling anisotropic particles in electric fields

5. Mert Vural (University of Maryland)
   Polymer-nanoparticle composites for stretchable electronics

6. Robert Headrick (Rice University)
   Solution processing micrograms of carbon nanotubes into fibers

7. Matthew Petroff (Johns Hopkins University)
   kT measurements of multivalent protein-ligand interactions

8. Wonseok Hwang (Universify of Maryland)
   Microphase Separation in Low Molecular Weight Crystalline-Amorphous Block Copolymers

9. John Daristotle (University of Maryland)
   Synthesis of Degradable Polymers for Tissue Adhesion

10. Matthew Widstrom (University of Maryland)
    Polymer-Ionic Liquid Hybrid Electrolytes for Lithium Ion Batteries