Schedule for the 20th MASM: The Mid-Atlantic Soft Matter Workshop

Georgetown University, Washington, DC

August 3, 2018

8:45 am
Opening Remarks

8:50 am
Christoph Schmidt (Duke University):
Statistical physics of active biological matter

9:30 am
Soundbite Session I

10:30 am
Coffee Break

10:50 am
Sujit Datta (Princeton University):
Stressing gels out: guts, tissues, and beyond

11:30 am
Soundbite Session II

12:20 pm
Lunch

1:30 pm
Soundbite Session III

2:20 pm
Coffee Break

2:40 pm
Douglas Jerolmack (University of Pennsylvania):
Glassy dynamics of landscape evolution

3:20 pm
Soundbite Session IV

4:10 pm
Coffee Break

4:25 pm
Brian Camley (Johns Hopkins University):
Soft matter in cell biology: cell polarity and collective chemotaxis

5:05 pm
Sylvia Centeno (Metropolitan Museum of Art):
Understanding the Structure and the Dynamics of Heavy Metal Soaps in Oil Paintings

5:45 pm
End of Meeting

Christoph Schmidt, Duke University
Statistical physics of active biological matter

Thermodynamic non-equilibrium is a defining feature of living systems on all levels of organization. Cells and tissues are built of active matter, dynamic materials with built-in force generators. Such materials self-organize in biological systems into well-ordered dynamic steady states, sustained by the dissipation of metabolic energy. The materials show striking collective phenomena on a mesoscopic scale.

We use advanced light microscopy as well as microscopic motion and force-sensing techniques to characterize the complex mechanical properties of and the motion and stress patterns in biological active matter, in particular the actin cortex, both in reconstituted model systems and in cells. I will also introduce methods to detect and quantitate thermodynamic non-equilibrium using fundamental concepts of statistical physics such as the fluctuation-dissipation theorem and the principle of detailed balance.

Sujit Datta, Princeton University
Stressing gels out: guts, tissues, and beyond

Diverse biological functions rely on how soft gels respond to environmental stresses. In this talk, I will describe two examples, in two very different settings, of how we study hydrogel deformations under osmotic stress and their consequences. Ultimately, this research stimulates new findings and questions at the interface of Engineering, Physics, Biology, and Materials Science.

Douglas Jerolmack, University of Pennsylvania
Glassy dynamics of landscape evolution

Soil on hillslopes slowly and imperceptibly creeps downhill, but suddenly liquefies to produce landslides. The onset of erosion in a river flood is similar. Although the forcing may vary — e.g., pore pressure for landslides and shear stress for rivers — our experiments and simulations show that the nature of this transition is a generic consequence of material disorder and granular friction. Creep changes rapidly but continuously to a dense-granular flow rheology at yield, in a manner consistent with a plastic depinning transition. Landscapes thus exhibit glassy dynamics. Because erosion plays out over geologic time, even exceedingly slow relaxation timescales become relevant. We show how consideration of this glassy behavior leads to a better understanding of the shape of mountains. Granular creep raises new questions, however — about the origins and persistence of particle motions in athermal systems, and how to reconcile this behavior with jamming.

Sylvia Centeno, Department of Scientific Research, The Metropolitan Museum of Art, New York, NY

Understanding the Structure and the Dynamics of Heavy Metal Soaps in Oil Paintings

Works of art are generally composed of heterogeneous materials consisting of inorganic and/or organic compounds structured in complex ways. In traditional oil paintings, the components are typically inorganic and/or organic pigments mixed with a drying oil binder, usually applied in multiple layers over a support, such as canvas, wood, or metal, with protective organic coatings on top. Deterioration processes often involve interactions at the interfaces of these components, with degradations in one triggering subsequent chemical reactions and physical changes in another.

One widespread degradation process in oil paintings is the so-called soap formation. Soaps are salts (carboxylates) formed by heavy metals contained in the pigments, such as lead and zinc, and long chain fatty acids that are present in the oil binding media. The process of soap formation may compromise the integrity of an artwork in different ways. Soap aggregates can be as large as 100-200 microns in diameter and may break through the paint surface. But soaps may also migrate to the surface of the painting and re-mineralize to form crusts of carbonates, hydroxychlorides, sulfates, and oxalates, presumably by reacting with carbon dioxide and other compounds in the environment. Soap formation has also been indicated as the cause of increased transparency of paint films.

Despite soap formation having been identified in hundreds of works of art dating from the 15th to the 20th century, the chemistry of the process is not yet fully understood. The formation of soaps does not take place in all artworks containing the potentially reactive materials. What factors trigger the process, what the mechanisms are, and how it can be arrested or prevented are not known.

To understand the mechanisms and factors that trigger soap formation and the dynamics of the reactive compounds in paints, NMR and XRD analyses, complemented by analysis with FTIR spectroscopy, were performed on a series of lead carboxylates and model paint samples. Experiments as a function of temperature and humidity provided insight into the factors that increase soap formation. The local dynamics of palmitic acid and lead palmitate, in a linseed oil matrix at different temperatures (T) were measured by 2H NMR spectroscopy. The results show the extent of mobility of palmitic acid and lead palmitate in the paint matrix, and how they depend on T. The kinetics of soap formation in model paint films subjected to different relative humidities was monitored by 13C NMR spectroscopy; the rate of soap formation increases with relative humidity. The elemental and molecular segregation due to the deterioration reactions in microsamples removed from a 15th century painting were studied by synchrotron X-ray fluorescence (XRF) microscopy and X-ray absorption near edge structure (XANES).

Understanding the nature of the chemical processes gives art conservators information on ways to slow, stop, and prevent the deterioration of unique artworks. For example, knowledge of the effect of relative humidity on the reaction allows conservators to assess the best possible environmental conditions to display and store the works, or whether aqueous solutions are safe to use in conservation treatments. Also, determining whether a paintings surface texture or paint transparency was intended by the artist or is the result of a degradation process is important when appreciating an object of cultural significance.

Soundbite Talks: *MASM 20*

Session I

1. Doug Henderson (University of Maryland)
   Small Angle Scattering of Ionic Liquid and Cellulose Films
2. Vikram Rathee (Georgetown University)
   Understanding shear thickening in oobleck
3. Minaspi Bantawa (Georgetown University)
   The role of network topology in soft gels
4. Xin Zhang (University of Maryland)
   Oligomeric Cellulose Crystallization in DMSO
5. Abhay Goyal (Georgetown University)
   Effective interactions from ion-ion correlations and water structuring
6. Feng Jiang (University of Maryland)
   Luminescent Supramolecular Diblock Copolymer Elastomers via Lanthanide Coordination
7. Girishma Grover (Georgetown University)
   Understanding gelation behavior of Low-Molecular-Mass Organic Gelators derived from naturally occurring Oleic acid.
8. Chenqian Pan (University of Maryland)
   The application of sodium carboxymethyl cellulose for the preservation and reinforcement of aging paper
9. Sara Orski (NIST)
   Characterization of Architecturally Perfect Polyolefins
10. Katherine Joyner (University of Maryland)
    Designing mucin-based hydrogels
11. Ryan P. Murphy (NIST)
    Capillary Flow SANS
12. Kimberly Dennis (University of Delaware)
    High-pressure linear viscoelasticity measurements of polymer solutions and gels
13. Teresa Duncan (NIST)
    Ultrasoft networks for the removal of particulates from rough surfaces
14. Adrian Defante (NIST)
    Interstitial Water Enhances Sliding Friction
15. Kara F. Googins (Georgetown University)
    Stress Relaxation of Type-I Collagen

Session II

1. Daniel Ou-Yang (Lehigh University)
   Quantifying packing and stress distribution in a drying latex
2. Peter Olmsted (Georgetown University)
   Polymer Scission in Extensional Flows
3. Alexandros Chremos (NIST)
   Bottlebrush polymer melts, thermodynamics and structure
4. Ali Seiphoori (University of Pennsylvania)
   Stability of colloidal aggregates in wetting/drying cycles: role of a multiscale solid bridging mechanism
5. Yimin Mao (NIST)
   Isotropic-Nematic Transition and Stack Alignment in Aqueous Cellulose Nanocrystal Suspension under 0.5 T Magnetic Field
6. Tamais Prileszky (University of Delaware)
   Reversible deposition of shaped emulsion droplets
7. Miklos Kertesz (Georgetown University)
   Fluxional aggregation modes between conjugated units
8. Ed Van Keuren (Georgetown University)
   Particle formation mechanism in the flash nanoprecipitation of polymers
9. Sébastien Kosgodagan Acharige (iUniversity of Pennsylvania)
   Sedimentation of kaolinite clay suspensions
10. Caleb Wigham (NIST)
    Crosslinking silica-based nanoporous networks under ambient conditions
11. Artemis Margaronis (University of Maryland)
    Non-Iridescent Photonic Films Fabricated by Capillary Action
12. Shadden Zaki (University of Maryland)
    Solution Blow Spinning of Polymer Blend Surgical Sealants
13. Malini Balachandran (University of Maryland)
    Biodegradation of Surgical Sealants
14. Claudia Dessi (Georgetown University)
    Active Microtubule Suspensions: Mechanical resistance response under shear flow

Session III

1. Joel Sarapas (NIST)
   Striving for Perfection: Defect-Free Polymer Networks for Improved Metrology
2. Sykes Cargile (Haverford College)
   N-mer Formations of Annular Sector Particles
3. Xiangwen Lai (Georgetown University)
   Shear thickening of silica rod suspension
4. Matthew Sartucci (Georgetown University)
   Soft Solid Structure in Suspensions of Cellulose Nanocrystals
5. Daniel Ou-Yang (Lehigh University)
   Active Brownian particles in a potential well
6. Louis Poon (Georgetown University)
   Ionic conductivity properties of polydimethylsiloxane ionic systems with amidinium pendant groups
7. Autumn Cook (University of Maryland)
   Rheology and dynamics of active microtubule suspensions I
8. David A. Gagnon (Georgetown University)
   Rheology and dynamics of active microtubule suspensions II
9. Ava Self (Penn State University)
   Traction Forces Generated by Conditionally Reprogrammed Cells
10. Roman Alvarado (University of Wisconsin)
    Characterization of Ventral Flagellar Beating in Giardia lamblia
11. Jeffrey Fagan (NIST)
    Molecules Inside Single-Wall Carbon Nanotubes
12. Andrea Giuntoli (NIST)
    Polymer architectures under confinement
13. Jack Douglas (NIST)
    The Interfacial Zone Around Nanoparticles in Polymer Nanocomposites and its Relation to the Average Scale of Collective Motion Within the Polymer Matrix
14. Anthony Chieco (University of Pennsylvania)
    Hyperuniformity Disorder Length Spectroscopy in Quasi-2D Foams

Session IV

1. Ted Brzinski (Haverford College)
   The role of Brownian motion in low-Re, high-Pe sedimentation
2. Scott Melis (Georgetown University)
   Optical and Electronic Properties of Charge Transfer Cocrystal Nanowires
3. Hanna Fejzic (Georgetown University)
   Organic Charge Transfer Crystal Preparation and Characterization
4. Cecile Noirot (ESPCI)
   Molecular Dynamics to model the structuring of hydrophobized silica beads
5. Joon Ho Roh (University of Maryland)
   Dynamics of RNA in crowded solutions
6. Hojin Kim (University of Delaware)
   Direct Observation of Polymer Surface Mobility via Particle Vibrational Modes
7. Ryan Nieuwendaal (NIST)
   Bulk heterojunction interfacial structure from REDOR NMR
8. Danielle Beaupre (Georgetown University)
   Thiol-Disulfide Interchange as Path to Redox-Reversible Gels: Design and Synthesis of Small Molecule and Polymer Gelators
9. Jesse Hanlan (University of Pennsylvania)
   Clog Prediction in Granular Hoppers using Machine Learning Methods
10. Justin Elenewski (NIST/UMD)
    A Spin-1 Representation for Dual-Funnel Energy Landscapes
11. Yuyin Xi (NIST/Univ of Delaware)
    structure engineering of self- and directed-assembled conjugated polymers
12. Anton Peshkov (University of Maryland)
    On the reversibility of granular rotations
13. Zachary Riedel (NIST)
    Capillary RheoSANS for High Shear Rate, Low Volume Studies