Schedule for the 17th MASM: The Mid-Atlantic Soft Matter Workshop

The University of Delaware, Newark, DE

February 3, 2017

8:40 am

Opening Remarks

8:50 am

April Kloxin (University of Delaware):

Controlling structure within hydrogel-based synthetic extracellular matrices

9:25 am

Ramón Castañeda-Priego (University of Guanajuato):

Formation of clusters, dynamical arrest and effective interactions in many-body systems

10:00 am

Sound-bite Session I

10:40 am

Coffee Break

11:00 am

Rob Riggleman (University of Pennsylvania):

Thermodynamic and kinetic routes for the design of polymer nanocomposites

11:35 am

Sound-bite Session II

12:10 pm

Lunch

1:30 pm

Sound-bite Session III

2:15 pm

Quick Break

2:20 pm

Chris Roberts (University of Delaware):

What is the role of electrostatic interactions for controlling the ssembly of proteins and peptides in solution from low to high volume fractions?

2:55 pm

Sound-bite Session IV

3:40 pm

Break

3:55 pm

Rodney Priestley (Princeton University):

Crystallization of Polymer Thin Films by Quasi-Vapor Deposition

3:30 pm

Sound-bite Session V

4:15 pm

Break

4:25 pm

Grethe Jensen (NIST/University of Delaware):

Structural Kinetics in Soft Matter Studied with Small-Angle Scattering

April Kloxin, University of Delaware

Controlling structure within hydrogel-based synthetic extracellular matrices

Hydrogel-based biomaterials increasingly are used as extracellular matrix (ECM) mimics for cell culture and regenerative medicine applications. Synthetic hydrogels have been designed to afford precise control of mechanical and biochemical properties for directing cell function and fate. However, these materials often are homogeneous on the nanoscale unlike the hierarchically structured native ECM. To address this, we have synthesized self-assembling peptides decorated with reactive groups for incorporation within hydrogels formed by light-mediated thiolene click chemistry. Specifically, collagen mimetic peptides (CMPs) based on variants of Proline-Hydroxyproline-Glycine repeats $[(\mathrm{POG})_n]$ have been functionalized with alkenes. These multifunctional CMPs assembly to form fibrils ($\sim 10 - 250$ nm wide, TEM and AFM) and physical gels (G$\sim$100 Pa, rheometry). Pendant groups on these multifunctional CMPs have been reacted with various thiols (e.g., thiol-functionalized peptides, PEG) by photoinitiated, radically-mediated thiolne reaction. This approach is promising for controlling the nanostructure within well-defined hydrogels for various biological applications.

Ramón Castañeda-Priego, University of Guanajuato

Formation of clusters, dynamical arrest and effective interactions in many-body systems

One major goal in condensed matter is identifying the physical mechanisms that lead to the formation of the main building blocks that are partially responsible for the birth of new equilibrium phases and arrested states of matter, for example, fluids of clusters, gels, glasses, among others. Contrary to the well-established thermodynamic criteria that allow us to determine the conditions where the equilibrium states of a many-body system can occur, there is no a general, consistent and unified definition to clearly identify those non-equilibrium states accessible to the system under consideration. Additionally, little is known about the effective interactions among macromolecules dispersed in a host medium close to a non-equilibrium thermodynamic state. Then, in this talk, we will briefly discuss both the formation of clusters and the structure of colloidal gels in colloidal dispersions with competing interactions; a few results are explicitly compared with recent confocal microscopy experiments in colloid-polymer mixtures with intermediate colloidal volume fraction. Through Monte Carlo computer simulations of states identified in experiments, we also show that dynamical arrest in adhesive hard-sphere dispersions is the result of rigidity percolation. Finally, based on the integral equations theory for simple liquids, we account for the effective forces among colloids under situations where the colloidal system is close to a thermodynamic instability or near to the boundary of gelation.

Rob Riggleman, The University of Pennsylvania

Thermodynamic and kinetic routes for the design of polymer nanocomposites

Polymer nanocomposites have the potential for a wide array of applications, ranging from light-weighting structural materials, to conductive polymer films, to metamaterials with exotic optical properties such as cloaking. In applications involving polymer nanocomposites, controlling the dispersion and assembly of the nanoparticles is one of the most critical aspects of their design, and the final distribution of nanoparticles is a complex interplay of both processing conditions and the entropic and energetic interactions between the matrix polymers, nanoparticles, and any surface functionalization on the particles. In this talk I will briefly describe our work that extends polymer field theory to polymer nanocomposites both in and out of equilibrium, and I will discuss its application in two example systems. First, we find that solvent annealing processes can play a large role in the final distribution of the nanoparticles in block copolymers, and by varying the solvent removal rate relative to the particle diffusion time we can tune the final distribution of nanoparticles in the film. Second, I will show recent results where we use evolutionary design strategies to tune the chemistry of polymer-grafted nanoparticles so that they self-assemble into targeted structures. We find that the stability of the resulting structure against fluctuations in both the surface chemistry and the nanoparticle concentration depends on the targeted structure, and that many-body effects become critical in evaluating the stability of the structure.

Rodney Priestley, Princeton University

Crystallization of Polymer Thin Films by Quasi-Vapor Deposition

We demonstrate a polymeric thin film fabrication process in which molecular-scale crystallization proceeds with additive film growth, by employing an innovative vapor-assisted deposition process termed Matrix Assisted Pulsed Laser Evaporation (MAPLE). In comparison to solution-casting commonly adopted for the deposition of polymer thin films, this physical vapor deposition (PVD) methodology can prolong the time scale of film formation and allow for the manipulation of temperature during deposition. For the deposition of molecular and atomic systems, such a PVD manner has been demonstrated to facilitate molecular ordering and delicately manipulate crystalline morphology during film growth. Here, using MAPLE, we deposited thin films of a model polymer, polyethylene oxide (PEO), atop a temperature-controlled substrate with an average growth rate of less than 10 nm/hr. The mechanism of deposition is sequential addition of nanoscale liquid droplets. We discovered that the deposition process leads to the formation of two-dimensional (2D) PEO crystals, composed of monolamellar crystals laterally grown from larger nucleus droplets. The 2D crystalline coverage and crystal thickness of the films can be manipulated with two processing parameters, deposition time and temperature. We also demonstrate that irreversible chain adsorption during deposition can dramatically suppress thin film crystallization. Finally, we demonstrate the ability to tune melting point and extent of crystallinity by changing deposition conditions.

Grethe Jensen, NIST/University of Delaware

Structural Kinetics in Soft Matter Studied with Small-Angle Scattering

Soft materials are easily deformed on the molecular scale by even slight changes of conditions such as pressure, temperature, solvent, salt, etc., which is important for their macroscopic properties. For optimal understanding and control of the materials, one must not only know the nanoscale structure under the different conditions, but also the kinetic pathways for the structural transitions. Small-Angle X-ray and Neutron Scattering (SAXS and SANS) are valuable tools for addressing this type of questions, as they can cover many relevant length scales and time scales. Studies are presented where structural transitions of micelles and proteins in dilute solution are induced by fast mixing, using either a stopped-flow apparatus or microfluidic chips, and then followed on the millisecond time scale with synchrotron SAXS. The examples cover formation of micelles [1], transition of micelle shape [2-3], as well as protein unfolding [4].
A structural response can also be induced by mechanical stress. Here, the perspectives for a hydrogel of telechelic polymer micelles are discussed. Through use of isotope labeling, SANS was applied to probe the molecular exchange dynamics at equilibrium, which were then related to the mechanical properties of the hydrogel [5]. Next step will be to understand the relaxation mechanism after applying a strain to the material, using rheo-SANS.

[1] Jensen et al., J. Am. Chem. Soc., 135, 7214-7222 (2013) [2] Jensen et al., Ang. Chem. Int. Ed., 53, 11524-11528 (2014) [3] Jensen et al., J. Phys. Chem. Lett., 7, 2039-2043 (2016) [4] Jensen et al., In preparation [5] Zinn et al., ACS Macro Lett., 5, 1353-1356 (2016)

Chris Roberts, University of Delaware

What is the role of electrostatic interactions for controlling the ssembly of proteins and peptides in solution from low to high volume fractions?

Proteins and peptides are inherently anisotropic molecular structures that have the potential to create weak(metastable) or strong (stable) assemblies in solution. This talk focuses on a range of behaviors that are realizable with proteins, peptides, and peptide-polymer conjugates, and it highlight the balance of electrostatic and non-electrostatic repulsions and attractions that span a range of assembly behaviors. The most recent results also highlight that the net behavior of protein solutions also depends on whether one considers dilute versus concentrated conditions, and suggests that protein solution viscosity is sensitive to only a subset of the ensemble of molecular configurations that are probed by established experimental methods. Examples include monoclonal antibodies, globular proteins, and peptide-polymer conjugates.

Soundbite Talks: *MASM 17*

Session I

1. Chad Greco (University of Delaware)
   Photo-Responsive Block Copolymer Nanocarriers for siRNA Delivery
2. Julie Hipp (University of Delaware)
   Percolation Behavior of Carbon Black Suspensions in Polar Aprotic Solvents
3. Ru Chen (University of Delaware)
   Towards wearable electronics and sensors: self-assembly of block copolymers in ionic liquid
4. Gang Duan (University of Pennsylvania)
   Salt Organized Nanoscale Interfacial Complexation in Emulsion
5. Ryan P. Murphy (University of Delaware)
   Rigidity percolation of anisotropic colloids with thermoreversible short-range attractions
6. Sarah Hann (University of Pennsylvania)
   Polyelectrolyte complexation at all-aqueous interfaces: transport-dependent structure formation
7. Kimberly Dennis (University of Delaware)
   High-pressure linear viscoelasticity measurements of polymer solutions and gels
8. HOJIN KIM (University of Delaware)
   Building Phononic Crystals via the Directed Self-Assembly of Anisotropic Particles
9. Kaelan Reed (University of Delaware)
   Directed Self-Assembly in Toggled Electric Fields
10. Kaleigh Reno (University of Delaware)
    Lignin derived alternatives to bisphenol A in diamine hardened epoxy resins
11. Marco Galvani (Johns Hopkins University)
    Effect of Flow-Induced Molecular Alignment on Welding of Polymer Interfaces
12. Claudia Dessi (Georgetown University)
    Dynamic mechanical properties of microtubule based biopolymer gels during active-to-passive transition

Session II

1. Vikram Rathee (Georgetown University)
   Localized Stress Fluctuations Drive Shear Thickening in Dense Suspensions

2. Abhay Goyal (Georgetown University)
   Understanding the mechanical properties of cement in terms of its early-stage gelation

3. Markus Bleuel (NIST/NCNR)
   USANS (Ultra Small Angle Neutron Scattering) and MISANS (Modulated Intensity Small Angle Neutron Scattering)

4. Kara F. Googins (Georgetown)
   Stress Relaxation in Cross-linked Collagen

5. Cameron Shelton (University of Delaware)
   In Situ Characterization of Block Polymer Thin Films

6. Joseph Monti (Johns Hopkins University)
   Contact and Static Friction of Rough Surfaces

7. Yimin Luo (University of Pennsylvania)
   Near-field interaction of colloid near wavy walls

8. Louis Poon (Georgetown University)
   Investigation of polysiloxane copolymers with amidine pendant groups

9. Kevin Whitcomb (University of Delaware)
   Rheo-SANS Measurements of a Discontinuous Shear Thickening Fluid

10. Jeff Fagan (NIST)
    AUC of a Molecular Nanoparticle Population

11. Anna Coughlan (Johns Hopkins University)
    Coarse grained models of non-equilibrium, steady-state colloidal assembly in rotating magnetic fields

12. Tamoghna Das (National Institute of Standards and Technology & University of Maryland)
    A route to dynamical heterogeneity through local geometry of two-dimensional particulate system.

Session III

1. Shu Wang (University of Delaware)
   Effect of methoxy substitutes on the properties of lignin-inspired poly(dimethoxy phenyl methacrylate)

2. Yuguang Yang (Johns Hopkins University)*Optimal control of self-propelled swarming colloidal machines for cargo capture and transport*

3. Alexandros Chremos (NIST)
   Structure of polyelectrolyte solutions with concentration and molecular architecture variation

4. Jack Douglas (NIST)
   Influence of Varying Temperature, Cohesive Interaction Strength and Pressure on Alpha-Relaxation in a Simulated Glass-forming Polymer Melt

5. Jannat Nayem (University of Delaware)
   Effects of Surfactant Degradation on Solution Physiochemical Properties Relevant for Therapeutic Protein Formulations

6. Seyeon Park (University of Delaware)
   Directed self-assembly of paramagnetic ellipsoids

7. Abhi Shetty (Anton Paar)
   heo-polarized light imaging of polymers and soft materials

8. santosh kamble (Georgetown University)
   Synthesis of low-molecular organic gelators from a long-chained, naturally occurring fatty acid.

9. Teresa Duncan (Georgetown University)
   Formation of stable organogels from partially hydrolyzed poly(vinyl acetate) and benzene-1,4-diboronic acid

10. Isaac Torres-Diaz (Johns Hopkins University)
    Super-Sphere & Super-Ellipsoid Particle-Wall DLVO Potentials

11. K. Michael Salerno (US Naval Research Lab)
    Using Coarse-Grained Models for Nanoscience Applications

12. Michael J Bertocchi (Georgetown)
    Photophysics of Pyrenyl-Functionalized Poly(isobutylene-alt-maleic anhydride) and Poly(isobutylene-alt-maleic N-alkylimide). Influence of Solvent, Degree of Substitution, and Temperature

Session IV

1. Neha Manohar (University of Pennsylvania)
   Solvent-driven infiltration of polymer into nanoparticle packings

2. Jyo Lyn Hor (University of Pennsylvania)
   Nanoporous Polymer-infiltrated Nanoparticle Films via Undersaturated Capillary Rise Infiltration (UCaRI)

3. Pasha Tabatabai (Georgetown University)
   Percolation in not the end of gelation

4. Zachery Brown (Saint Joseph's University)
   Investigating correlated rearrangements of disordered colloidal suspensions

5. Rui Zhang (Saint Joseph's University)
   Force-induced diffusion in colloid suspensions

6. Mahlet Woldeyes (University of Delaware)
   Examining effect of protein interactions on protein solution viscosities

7. Tamas Prileszky (University of Delaware)
   Endoskeletal droplets as anisotropic interfaces

8. Jeffrey Richards (NIST)
   Electrical Characterization of Conducting Colloidal Suspensions

9. Mehdi Bouzid (Georgetown University)
   Investigating the strain softening and harding in soft amorphous solids

10. Fabio Mercado (Georgetown University)
    Zero valent iron nanoparticles in polysiloxane matrixes for remediation of chlorinated pollutants in water supplies.

11. Susana Teixeira (University of Delaware/NIST)
    Biological Small Angle Neutron Scattering studies under Pressure

12. zhenhuan zhang (University of Delaware)
    Investigation of Surface Adsorption Behaviors of Non-ionic Surfactant Polysorbate 20 by Neutron Reflectometry

13. Claire McIlroy (Georgetown University)
    Polymer Disentanglement during 3D Printing

Session V

1. Hongyu Guo (University of Delaware)
   A universal method of size selective purification of nanoparticles

2. Caitlin Wood (University of Delaware)
   Protein Interactions at Interfaces

3. Nairiti Sinha (University of Delaware)
   Self assembly of computationally designed peptide nano-cages

4. Thomas O'Connor (Johns Hopkins University)
   Modeling the Nonlinear Rheology and Chain Dynamics of Flowing Polymer Melts

5. Joyjit Chattoraj (Georgetown University)
   Endothelial cell dynamics during gap formation

6. Joel Clemmer (Johns Hopkins University)
   Anisotropic exponents in the depinning of the random field Ising model

7. BRISA L. ARENAS-GOMEZ (University of Guanajuato - Mexico)
   Microstructure, rheology and dynamics in Non-Newtonian fluids

8. Jose Ramon Villanueva-Valencia (University of Guanajuato)
   Hydrodynamic correlations in a quasi-two-dimensional colloidal mixture

9. Peter Olmsted (Georgetown University)
   What's the correct constitutive model to describe shear banding and wall slip in entangled polymeric fluids?

10. Xiangwen Lai (Georgetown University)
    Shear-Induced aggregation in Silica Rod Suspension

11. Steve Hudson (NIST)
    High shear rheometry in rectangular channels

12. zhenhuan zhang (University of Delaware)
    Investigation of Surface Adsorption Behaviors of Non-ionic Surfactant Polysorbate 20 by Neutron Reflectometry

13. Jeffrey Horner (University of Delaware)
    Investigation of the non-Newtonian Behavior of Human Blood Through Bulk Rheology