98th New England Complex Fluids Workshop

Friday, March 22, 2024
9:00 a.m. – 4:00 p.m.
at Tufts University

Location: All events will take place at the Joyce Cummings Center (JCC) in Rooms 170-180 on the Medford campus of Tufts University located at 177 College Avenue, Medford, MA 02155.

Registration: Register at https://complexfluids.org

Tentative Agenda:

8:45 a.m. – 9:00 a.m.	**Registration and Check-in** (JCC lobby)
9:00 a.m. – 9:45 a.m.	**Amy Peterson (UMass Lowell)** *Highly filled additively manufactured polymer composites with interface-mediated mechanics*
9:45 a.m. – 10:15 a.m.	**Coffee Break**
10:15 a.m. – 11:15 a.m.	**Sound Bites I**
11:15 a.m. – 12:00 p.m.	**Graham Leverick (Tufts University)** *Manipulating liquid electrolytes through non-covalent interactions for energy applications*
12:00 p.m. – 1:00 p.m.	**Lunch**
1:00 p.m. – 1:45 p.m.	**Abigail Plummer (Boston University)** *Shape morphing with swelling hydrogels and expanding foams*
1:45 p.m. – 2:15 p.m.	**Coffee Break**
2:15 p.m. – 3:15 p.m.	**Sound Bites II**
3:15 p.m. – 4:00 p.m.	**Benjamin McDonald (Brown University)** *Macromolecular design for the bioinspired construction of soft matter*

Sound Bites I (10:15 a.m. – 11:15 a.m.)

1. **Xingcai Zhang** (Stanford University)
   Machine-learning microfluidics-mediated materials & medicine (m4)
2. **Christopher Pawul** (Brown University)
   Effects of mucin on swarming of sm3
3. **Thomas Powers** (Brown University)
   Flow states of two dimensional active gels driven by external shear
4. **Mossab Alsaedi** (Tufts University)
   Zwitterionic polymer-supported ionic liquid gel electrolytes
5. **Karl Wieck** (Tufts University)
   Zwitterionic polymer-supported electrolytes for energy storage applications
6. **Ekta Jagtiani** (University of Pennsylvania)
   Smart hydrogels (ph responsive) calcium alginate and hydrophilic polymer-based systems for tunable swelling and de-swelling properties
7. **Jason Chung** (Northeastern University)
   The oscillatory flow of soft jammed systems through constrictions
8. **Maliheh Teimouri** (Tufts University)
   Understanding normal stress instability in viscoelastic flows
9. **Chang Liu** (University of Connecticut)
   Reduced-order modeling and analysis of fluid flows: from wall-bounded shear flows to convection
10. **Gabriel Yerger** (Brown University)
    Pore stability in colloidal membranes
11. **Bricker Like** (Tufts University)
    A quantitative thermodynamic metric for identifying deep eutectic solvents
12. **Daniel Keane** (University of Rhode Island)
    Midblock rigidity controls bridging fraction in polymer-linked emulsions
13. **Elnaz Nikoumanesh** (URI)
    Unveiling the role of physicochemical bonds on yield stress and thixotropy
14. **Aslihan Gokaltun** (Center for Engineering in Medicine and Surgery, MGH, Harvard Medical School)
    Supramolecular hybrid hydrogels as rapidly on-demand dissoluble, self-healing, and biocompatible burn dressings
15. **Pragya Arora** (Brandeis University)
    Unveiling dynamics of programmable dna nanostructures in engineered lipid membranes
16. **Silverio Johnson** (Brown University)
    A simple model for tumbling bacteria based on viscous rotation of a prolate ellipsoid
17. **Savannah Harpster** (Boston University)
    Rapid characterization methods for targeted microbubble formulations

Sound Bites II (2:15 p.m. – 3:15 p.m.)

1. **Delace Jia** (MIT)
   Flow-induced structures in liquid crystals
2. **Changshuo Fu** (University of Massachusetts Boston)
   Investigation on the properties of 2d liquid crystal foams
3. **Vajra Badha** (University of Massachusetts Boston)
   Smectic films as potential biosensors for living microorganisms
4. **Meghann Dunn** (University of Massachusetts, Boston)
   Investigating the influence of varying confinement geometries on 2d liquid crystal foam

5. **John Rolleri** (University of Massachusetts Boston)
   Interfacial interaction between two liquid crystal phases
6. **Rupam Saha** (Brandeis University)
   Programmable dihedral angle in dna origami: an economical approach for complex nanostructure assembly
7. **Michael Stehnach** (Brandeis University)
   Developing a robust protocol to generate double emulsion droplets for directed evolution
8. **Soroush Kargar** (University of Massachusetts Boston)
   Dynamics of multi component lipid bilayer vesicles in extensional flow
9. **Jose E Flores** (Tufts University, UAM Iztapalapa)
   Free energy coupling parameter of np in lc host via molecular dynamics simulations
10. **Louison Thorens** (Tufts University)
    Understanding the role of polymer streamline crossing in viscoelastic instabilities
11. **Chaitanya Joshi** (Tufts University)
    Cylindrical colloidal membranes: splay relaxation at the edge
12. **Anca Andrei** (Tufts University)
    Efficient algorithms for shape optimization of liquid crystal tactoids
13. **Rongguang Xu** (Harvard Medical School and University of Texas Medical Branch)
    Investigating the impact of force loading rate on vwf-platelet binding: insights from molecular dynamics and monte carlo simulations
14. **Sara Ghanbarpour Mamaghani** (University of Massachusetts Boston)
    Investigating the shape metrics of cell spheroids deforming in extensional flow
15. **Ryan O'Hara** (Tufts University, Massachusetts General Hospital)
    Antifouling and functionalizable poly(dimethyl siloxane) (pdms) surfaces using a functional surface segregating zwitterionic copolymer additive
16. **Max Liljenstolpe** (Tufts University)
    Microbial motility in dead-end pores

Invited Talks

Amy Peterson (UMass Lowell)

Title: *Highly filled additively manufactured polymer composites with interface-mediated mechanics*

Abstract: Digital light processing (DLP) is a popular method of vat photopolymerization additive manufacturing of thermosetting polymers with high resolution that is well-suited to fabrication of highly filled composites. Interfacial interactions are particularly important in highly filled composite systems given the large surface area of interface per unit volume. In this work, high volume fraction (50 vol.%) glass microsphere-reinforced composites were fabricated via DLP. The effect of surface chemistry and interfacial interactions on the mechanical properties of additively manufactured composites were investigated using two model systems: one where glass microsphere surface chemistry was modified using silane coupling agents, and one where interfacial interactions were mediated with the addition of monomers to the resin system that have previously been shown to improve adhesion through non-covalent interactions. Interfacial interactions between the urethane acrylate-based resin system and glass microspheres were found to dictate the overall performance of the composites. The efficacy of these two approaches are compared with respect to their ability to alter mechanical and thermomechanical properties of the composite. Combining different surface functionalization was also explored and leads to mechanical properties that deviate from rules of mixtures, including strains to failure that exceed other composite formulations. These emergent properties may be used for new, high-performance composites and also advance our understand of crack propagation in highly filled composites.

Graham Leverick (Tufts University)
Title: *Manipulating liquid electrolytes through non-covalent interactions for energy applications*
Abstract: Electrolytes will play a central role in the development of next-generation batteries with increased energy density and cycle life, and reduced cost. While molecular designs can enable liquid electrolytes with favorable properties like increased (electro)chemical stability, such properties can also be manipulated through the non-covalent interactions among species within the electrolyte. In this talk, several examples are discussed where controlling these intermolecular interactions enabled altering the discharge/charge pathway, as well as altering other key properties of the electrolyte such as its stability and ionic conductivity. Moreover, other electrolyte-centered design strategies are discussed including incorporating redox active species in the electrolyte, which can reduce the reaction overpotential and enhance cycle life Finally, future opportunities to exploit these intermolecular interactions to gain unprecedented molecular control over the electrolyte and enable next-generation batteries are discussed.

Abigail Plummer (Boston University)
Title: *Shape morphing with swelling hydrogels and expanding foams*
Abstract: Materials that increase in size offer intriguing possibilities for shape morphing applications. Here, we explore two such systems—swelling polyacrylamide hydrogels and expanding polyurethane foams. The hydrogels swell by absorbing water into crosslinked polymer networks. They can therefore be modeled by coupling solvent migration with the deformations of a hyperelastic solid. In contrast, the foams initially behave as liquids with viscosity and volume increasing in time, responding as an elastic solid only when close to solidification. We investigate how these expanding materials can be sculpted by complex environments with obstacles and trenches and discuss the relevance of our findings for industrial and manufacturing applications.

Benjamin McDonald (Brown University)
Title: *Macromolecular design for the bioinspired construction of soft matter*
Abstract: Nature's soft materials such silk, tendon, byssus, and membraneless organelles span a diverse range of biological roles, but are unified in their formation, dynamic liquid-liquid phase separation dictated by the structure of macromolecules. Inspired by this multiscale intersection of molecular structure, the McDonald Laboratory examines how the composition and topology of synthetic polymers cooperatively impact the chemoresponsive properties of macromolecular systems. The intention is to translate the hierarchies of protein structure, primary, second, and tertiary, to design elements for programming the assembly, structure, and properties of soft materials. In this seminar, we will discuss characterization of an amphiphilic cation-π sidechain motif that engenders a variety of salt induced phase transitions in linear polymers, as well as progress towards ultradense graft polymers as rod-like nanoparticles for fibrillar soft matter.