THE UNIVERSITY OF RHODE ISLAND

94th New England Complex Fluids Workshop

University of Rhode Island, Kingston, RI
March 17, 2023

Schedule

8:00 am – 9:00 am	Registration and Breakfast (Toray Commons)
9:00 am – 9:15 am	Introductory Remarks - URI President Marc Parlange
9:15 am – 10:00 am	Invited Talk: Evan Wujcik, University of Maine
10:00 am – 10:45 am	Morning Sound Bites
10:45 am – 11:15 am	Coffee Break (Toray Commons)
11:15 am – 12:00 pm	Invited Talk: Corey O'Hern, Yale University
12:00 pm – 1:30 pm	Lunch (Toray Commons)
1:30 pm – 2:15 pm	Invited Talk: Leslie Shor, University of Connecticut
2:15 pm – 3:00 pm	Afternoon Sound Bites
3:00 pm – 3:30 pm	Coffee Break (Toray Commons)
3:30 pm – 4:15 pm	Invited talk: Ian Wong, Brown University
4:15 pm	Closing remarks

THINK BIG WE DO℠

Structural, vibrational, mechanical properties of jammed packings of deformable particles

Corey O'Hern (corey.ohern@yale.edu)
Mechanical Engineering & Materials Science, Applied Physics, and Physics, Yale University

We investigate the structural, vibrational, and mechanical properties of jammed packings of deformable particles with shape degrees of freedom in three dimensions (3D). Each 3D deformable particle is modeled as a surface-triangulated polyhedron, with spherical vertices whose positions are determined by a shape-energy function with terms that constrain the particle surface area, volume, and curvature, and prevent interparticle overlap. We show that jammed packings of deformable particles without bending energy possess low-frequency, quartic vibrational modes, whose number decreases with increasing asphericity and matches the number of missing contacts relative to the isostatic value. In contrast, jammed packings of deformable particles with non-zero bending energy are isostatic in 3D, with no quartic modes. These studies underscore the importance of incorporating particle deformability and shape change when modeling the properties of jammed soft materials.

Emulated soil micromodels: understanding microbial system function and development of sustainable agriculture biotechnology

Leslie Shor (leslie.shor@uconn.edu)
Chemical & Biomolecular Engineering, Univeristy of Connecticut

The function of any biological system depends on local environmental conditions. For bacterial systems, micro-scale structures including the chemical properties and physical topography of surfaces, micro-scale chemical gradients, and patterns of biological distribution impact diversity, abundance, and activity of microbial communities. However, conventional bacterial culturing methods do not faithfully emulate key micro-scale features of real microbial habitats; as a result, most microbial assay systems do not accurately capture the realistic range of microbial function of the real system being studied. The Shor lab designs, builds, and operates emulated microbial habitats in order to better understand microbial system function. Recent applications include biofilm assays that measure biofilm attachment, growth, or respiration as a function of material or operating conditions and soil-emulating micromodels to accelerate the development of agriculture biotechnology for more sustainable food production. Emulated soil micromodels (ESMs) systematically replicate physical, chemical, and biological features while at the same time enabling direct observation of biological responses down to the micrometer scale and in real time. ESMs enable systematic hypothesis-driven research of rhizosphere processes and make the development of agriculture biotechnology less time-consuming, expensive, and difficult. Our work has shown that the microbe-extracellular matrix system in porous media can double evaporative resistance and dramatically improve system resiliency, but this functionality is only realized in realistic pore-scale geometries. With the loom of climate change and its increasing demands on our water and food systems, there will be rapidly-increasing demand for more productive and cost-effective sustainable agriculture technology, and increasing demand for food production to serve double-duty as a technology for reliable carbon sequestration. Microfluidics may thus play a central role in efforts to promote a sustainable future.

Mechanics and topology of collective cell migration

Ian Wong (ian_wong@brown.edu)
Engineering and Medical Science, Brown University

Epithelial cells transition between collective and individual migration during development and disease, analogous to interacting building blocks (dis)assembling as an active material. In this seminar, I will present recent results on my group to investigate so-called epithelial-mesenchymal transitions in the context of soft matter physics, mechanobiology, and machine learning. First, we investigate how mammary epithelial cells transition from a fluid-like "unjammed" phase to a solid-like "jammed" phase. We show that these collective behaviors exhibit striking analogies with a gelation-like mechanism during the diffusion limited aggregation of non-living colloidal particles. Second, we analyze the disorganization and dissemination of multicellular clusters cultured in 3D matrix, which exhibit both collective and individual invasion phenotypes with spatially non-uniform traction signatures. Third, we describe the use of topological barcodes for automated classification of tissue architecture based on spatial connectivity (i.e. persistent homology). These emergent phenomena in living and non-living systems exhibit striking similarities, which may enable new fundamental insights into the morphogenesis of tissues and tumors.

Investigation of polymer systems and their composites for advanced functional materials

Evan Wujcik (evan.wujcik@maine.edu)
Chemical and Biomedical Engineering, University of Maine

The Materials Engineering and Nanosensor [MEAN] Laboratory focuses on fundamental synthesis-structure-property-function relationships of advanced materials and composites for biomedical and water quality applications, as these are of great importance to society and directly impact our daily lives. With recent developments in polymer science & engineering, advances are being made in polymer systems and their composites for applications in environmental engineering, healthcare, and defense—among many others. Prof. Wujcik will discuss current and future research thrusts in the MEAN Lab related to conducting polymers and wearable polymeric strain sensors. The MEAN Laboratory has current or completed projects supported by the National Science Foundation [NSF], US Department of Defense [DoD], US Department of Energy [DoE], US Environmental Protection Agency [EPA], US Department of the Interior [DOI], as well as state/local funds. MEAN Laboratory graduate and undergraduate researchers have also won 15 national, regional, and university-wide awards for research/presentation excellence and scholarship. . . and Prof. Wujcik is immensely proud of them!

94^{th} New England Complex Fluids: Soundbite Titles

Session I: Particles, Polymers, and Colloids

1. **Daniel Keane** and Ryan Poling-Skutvik (University of Rhode Island, dkeane@uri.edu)
   Probing the structure of polymer-linked emulsions through multiparticle tracking
2. **Arya Ajeev** and Colton Duprey (University of Maine, arya.ajeev@maine.edu)
   Effects of small molecule acids on a PAAMPSA/PANI system
3. **Colton Duprey**, Evan K. Wujcik, and Yang Lu (University of Maine, colton.duprey@maine.edu)
   The rheology of the PAAMPS/PANI/PA system as a nanocomposite material with AGNWs
4. **Elnaz Nikoumanesh** and Ryan Poling-Skutvik (University of Rhode Island, elnaznm@uri.edu)
   The effect of thixotropy on the yield transition in cellulose nanocrystal gels
5. **Lidia Mrad**, James Dalby, Yucen Han, and Apala Majumdar (Mount Holyoke College, lmrad@mtholyoke.edu)
   Nematic liquid crystals in microfluidic channels
6. **Robert Hunt**, Roberto Camassa, Richard M. McLaughlin, and Daniel Harris (Brown University, robert_hunt@brown.edu)
   Diffusion-limited settling of particles in stratification
7. **Jack Barotta**, Giuseppe Pucci, Alireza Hooshanginejad, and Daniel Harris (Brown University, jack-william_barotta@brown.edu)
   Synchronization of interfacial capillary spinners
8. **Soroush Kargar** and Joanna Dahl (University of Massachusetts - Boston, soroush.kargar001@umb.edu)
   Micro particle image velocimetry analysis in shear flow
9. **John Antolik** and Daniel Harris (Brown University, john_antolik@brown.edu)
   Single-camera 3D particle tracking for shear-induced migration

Session II: Biotechnology and Nanotechnology

1. **Luke Alventosa** (Brown University luke_alventosa@brown.edu)
   Capillary scale impacts: waves and energy dissipation
2. **Liyuan Gong**, Omar Martinez Pedro Mesquita, Yang Xu, and Yang Lin (University of Rhode Island, liyuan_gong@uri.edu)
   A microfluidic approach for label-free identification of small-sized microplastics in seawater
3. **Sara Ghanbarpour Mamaghani** and Joanna Dahl (University of Massachusetts - Boston, ghanbarpourmamagh001@umb.edu)
   Precise measurement of hydrogel viscoelastic properties using a microfluidic extensional flow device
4. **Payel Biswas** and Irene Andreu (University of Rhode Island, payel.biswas@uri.edu)
   Magnetic nanoparticles for biofilm diruption: a potential solution for marine fouling
5. **Matthew Card** and Daniel Roxbury (University of Rhode Island, matthew_card@uri.edu)
   Towards single-molecule detection using single-walled carbon nanotubes
6. **Joanna Dahl** and Hyungsoon Im (University of Massachusetts - Boston, joanna.dahl@umb.edu)
   Biomedical and biomolecular characterization of large extracellular vesicles to predict treatment responses for triple-negative breast cancer
7. **Devleena Chowdhury** and Daniel Roxbury (University of Rhode Island, devleena.chowdhury@uri.edu)
   Optimized fluorescent single-walled carbon nanotubes based fibers for multiplex sensing and drug delivery
8. **Sydney Packard** and Elizabeth Stewart (Worcester Polytechnic Institute, srpackard@wpi.edu)
   Biophysical properties of cellular clusters released from biofilms after biofilm matrix disruption;
9. **Theadora Vessella**, Esteban Rozen, Jason Shohet, Qi Wen, and Susan Zhou (Worcester Polytechnic Institute, tvessella@wpi.edu)
   Dynamic interplay between collagen and ddr2 on neuroblastoma cell mechanics
10. **Aceer Nadeem** and Daniel Roxbury (University of Rhode Island, aceer_nadeem@uri.edu)
    Misfolded protein identification using nanotube fingerprinting; a pathway towards neuro-degenerative disease detection