CBE Seminar Series – Spring 2024

Dr. Youhong Nancy Guo
Postdoctoral Associate
Department of Chemical Engineering
Massachusetts Institute of Technology

Seminar: Wednesday, January 10, 2024
9:30 a.m. (Ricketts 203)

“Innovating Hydrogels at Multiscale for Water and Environmental Sustainability”

Abstract:

Advanced technologies on clean energy utilization and water resource management with low carbon emissions are crucial for the realization of a sustainable future. In this talk, I will present how to design hydrogel-based materials, from molecular-level building blocks to microscopic structures and surface properties, for efficient water purification and carbon capture that are powered by sunlight or electricity. First, the hydrophilic polymeric mesh of hydrogels interacts with water molecules in a unique way that energy consumption of targeted separation processes can be lowered. Next, through materials selection, molecular engineering, and structural design, many desired features including but not limited to pollutant sorption, anti-biofouling, moisture resistance, and mechanical robustness can be endowed. Along the way, I will discuss the potential of polymeric gels to bring deployable solutions to water scarcity and greenhouse gas emissions regardless of geographical or hydrologic conditions, or even for economically stressed and off-grid communities.

Biography:

Dr. Youhong Nancy Guo is currently a Postdoctoral Associate in the Department of Chemical Engineering at Massachusetts Institute of Technology. Dr. Guo received a B.Sc. degree and a M.S. degree in Chemical Engineering from the University of California San Diego. She earned a Ph.D. in Materials Science and Engineering at The University of Texas at Austin. Her research focuses on developing polymer materials for applications in energy and environmental sustainability, especially in solar desalination, atmospheric water harvesting, and carbon capture. Her work has been recognized by many awards and honors, such as ACS PMSE Future Faculty Scholar, Forbes 30 under 30 in Science, MIT Rising Stars in Chemical Engineering, and Materials Research Society Graduate Student Award.

Refreshments will be available at 9:00 a.m. in the Ricketts Coonley Lounge (RI 120).
The rich set of mechanoreceptors found in human skin offers a versatile engineering interface for transmitting information and eliciting perceptions, potentially serving a broad range of applications in patient care and other important industries. Targeted multisensory engagement of these afferent units, however, faces persistent challenges, especially for wearable, programmable systems that need to operate adaptively across the body. I present a miniaturized electromechanical structure that, when combined with skin as an elastic, energy storing element, supports bistable, self-sensing modes of deformation. Targeting specific classes of mechanoreceptors as the basis for distinct, programmed sensory responses, this haptic unit can deliver both dynamic and static stimuli, directed as either normal or shear forces. Systematic experimental and theoretical studies establish foundational principles and practical criteria for low-energy operation across natural anatomical variations in the mechanical properties of human skin. A wireless, skin-conformable haptic interface, integrating an array of these bistable transducers, serves as a high-density channel capable of rendering input from smartphone-based 3D scanning and inertial sensors. Demonstrations of this system include sensory substitution designed to improve the quality of life for patients in clinical trials of stroke and spinal cord injury.

Matthew T. Flavin is a postdoctoral researcher at Northwestern University, working with Prof. John A. Rogers. He received his M.S. and Ph.D. degrees in Electrical Engineering in 2021 from the Massachusetts Institute of Technology (MIT), and he received his B.S. in Electrical Engineering from the University of Illinois at Urbana-Champaign. He received the NIH Ruth L. Kirschstein Institutional National Research Service Award (T32) and the Draper Laboratory Fellowship. The vision for his independent research program is to develop powerful peripheral neural interfaces and mechatronic wearables that leverage advanced sensors and intelligent systems to address important and unresolved challenges in biomechanics and patient care.