Seminar
Department of Materials Engineering

Thursday, January 15th, 2026, 11:00-12:00
Seminar Room (015) of Building 51 (Marcus Campus)

Active Capillary Microfluidics

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Abstract:

Directional liquid transport in confined spaces is a fundamental physical problem that appears across many natural and technological systems. It underlies vascular transport in animals, capillary networks in plants, and a wide range of applications in medicine and science. Pump-free structures designed to induce spontaneous directional liquid motion are commonly referred to as liquid diodes, owing to their functional analogy with electrical diodes. Existing liquid diodes, however, are static and limited to enforcing unidirectional flow.

We introduce dynamically switchable liquid transport, enabling three distinct flow states: unidirectional, bidirectional, and blocked. To achieve this, we develop pioneering sub-millimeter, stimuli-responsive liquid diodes that serve as modular building blocks for constructing centimeter-scale, reconfigurable complex networks. By bridging microscale flow control with large-scale transport, our approach allows dynamic modification of network topology and real-time regulation of transport distance, rate, and direction. We employ and extend tools from statistical mechanics, particularly percolation theory, to elucidate the relationship between network architecture and emergent liquid propagation. This work enables applications in systems where precise transport control is critical, including water harvesting, diagnostics and sensing, heat transport, chemical reactors and separations, and artificial organs.

Prof. Bat-El Pinchasik received her B.Sc. in Materials Engineering and Physics from the Technion in 2010, where her Master's research was conducted at the Max Planck Institute of Colloids and Interfaces, Department of Interfaces, in Potsdam, Germany (2012). She then pursued her Ph.D. at the Max Planck Institute of Colloids and Interfaces, in the Departments of Interfaces and Biomaterials. In 2015, she became a postdoctoral fellow at the Max Planck Institute for Polymer Research, Department of Physics at Interfaces, in Mainz, Germany. Since 2018, she has been the head of the Biomimetic Mechanical Systems and Interfaces Lab at the School of Mechanical Engineering, Tel Aviv University, Israel. Her research interests include biomimetics, interfacial and wetting phenomena, insect biomechanics, and bio-inspired materials and robotics. Email: pinchasik@tauex.tau.ac.il