Polymer Seminar

April 11, 2025

11:15 am Science 1 - Room 1002

Host: Yao Lin

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Autonomously Moving Soft Matter Systems

Abstract: Soft materials, such as polymer gels, have long been realized as a potential platform for actuation; however, several challenges have limited their integration into translatable technologies. In particular, soft matter actuators are slow, unable to generate significant power, and typically require external intervention to initiate multiple, sequential actuation events. Here, we describe our efforts to meet these challenges. We first introduce materials science principles and lessons that we have learned as part of a multi-university team, which takes inspiration from examples in nature including mantis shrimp and trap-jaw ants. These organisms use Latch-Mediated Spring Actuation (LaMSA) to achieve high power, impulsive movements by integrating actuators, elastic elements, and stability-mediating latches. We demonstrate how transient metastable deformations associated with swelling and deswelling of a polymer gel can be exploited to generate mechanical bi-stability, giving rise to multiple, self-repeating, snap-through movements. Second, we describe the use of structural asymmetry to mediate swelling/deswelling processes in order to control the kinematics of mesoscale polymer ribbons. We use this control to form bundled structures that resemble powerful biological actuators, e.g. muscles, and their formation processes open pathways for creating a future generation of materials that have textile-like properties without requiring energy intensive spinning and weaving processes. Collectively, the strategies and results discussed here provide new insight into how polymer properties can combine with purposeful structural design to achieve complex tasks, which can be used in the development of microscale robots and new adaptable composite materials.

Website: https://www.umass.edu/polymer-science/crosby-research-group

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