Materials Science and Engineering Department

Spring Seminar Series

Polymer Actuators from Hierarchically Ordered Hydrogels

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11AM-12PM | Hill Seminar Room (LeBow 240)

Advances in functional soft material actuators that contract, expand, or rotate when triggered with an external stimulus are necessary to realize the future of new robotic assemblies with superior biologically relevant functions. Current research efforts are focused on synthesizing new soft materials to mimic natural systems from a performance perspective, but overlook the impact of chemical composition and structure, which are core features for the exceptional actuation properties of human muscles. Recently, a new class of fiber actuators has been reported that contract or rotate when triggered by heat or hydration. The fibers, termed "strain crystallized actuators" (SCAs), are produced by combining solution-phase block copolymer self-assembly and strain-programmed crystallization. The strained fibers consist of highly aligned nanoscale structures with alternating crystalline and amorphous domains, resembling the ordered and striated pattern of mammalian skeletal muscles. Polymer fiber densification and chemo-mechanical energy conversion during water evaporation-driven crystallization and crystalline domain orientation lead to changes in the fiber stiffness while generating internal stress in the fiber. The usable work generated by the fibers is a combination of elastically stored energy (i.e., a spring) and energy stored through a phase change (i.e., transitioning between crystalline and amorphous solid states). The versatility and recyclability of the polymer fibers, combined with the facile fabrication method, opens new avenues for creating soft actuators.

Prof. Rob Hickey is currently an Associate Professor in the Department of Materials Science and Engineering at The Pennsylvania State University. He received his B.S. and Ph.D. in Chemistry at Widener University (2007) and the University of Pennsylvania (2013), respectively. Before starting his independent career at Penn State in 2016, he was a postdoctoral researcher at the University of Minnesota (2013 – 2016). The Hickey group investigates non-equilibrium chemical and self-assembly methods to create hierarchically ordered polymeric materials. Rob received the John H. Dillon Medal from APS (2025), the Humboldt Fellowship for Experienced Researchers (2023), the NSF CAREER Award (2020), the Air Force Office of Scientific Research Young Investigator Prize (2019), and he was recognized as an ACS PMSE Young Investigator in 2019..

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