Hierarchical Control Over Polymer Assembly for Functional, Responsive Polymer Architectures

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12:30 PM
Bowen Hall, Room 222

MAE Seminar Series

Emily C. Davidson
Princeton University

Nature creates materials with remarkable properties by controlling hierarchical assembly from the molecular through the macroscopic length scales. This talk describes how we combine molecular design with directed assembly via extrusion-based 3D printing to programmably define the structure and function of polymer-based materials across length scales. First, I will describe how we leverage bioinspired sequence-defined polypeptoids to systematically investigate the impact of helical secondary structures on block copolymer self-assembly. We find that the molecular helix is stiffer but more compact than the analogous coil, and that the stiffness of the molecular helix dominates space-filling effects in controlling self-assembly. Next, I will introduce the design of liquid crystal elastomers (LCEs) that contain light-activated dynamic bonds. Using extrusion-based 3D printing, the molecular alignment of bulk LCEs can be programmed to encode desired shape transformations when thermally cycled above and below their nematic-to-isotropic phase transition temperatures. These functional elastomers can be reprogrammed on demand via exposure to UV light due to the coupling of the functional and dynamic components of the elastomer network. Finally, I will highlight a path towards integrated polymer architectures with stimuli-responsive structure and function via multimaterial 3D printing.

Emily Davidson joined Princeton University as an Assistant Professor of Chemical and Biological Engineering in January 2021. She carried out her graduate research at UC Berkeley (Ph.D. 2016) and UC Santa Barbara with Professor Rachel Segalman, where she synthesized and studied (1) conjugated block copolymers to probe the interplay between crystallization and self-assembly and (2) sequence-defined block copolymers to gain insights into the role of secondary chain shape in block copolymer self-assembly. In 2017, Emily joined Professor Jennifer Lewis's group at Harvard University as a Postdoctoral Research Fellow, where her research focused on the development and 3D assembly of liquid crystal elastomers with light-activated dynamic bonds. Emily received her bachelor's degree in Chemical Engineering from the Massachusetts Institute of Technology in 2010. From 2010-2012, Emily taught high school chemistry and physics through the Teach for America program.

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