Materials Science Seminars

Spring 2021

UCI Samueli School of Engineering | Department of Materials Science and Engineering

UC San Diego Jacobs School of Engineering

UCLA Samueli Materials Science & Engineering

Fri, 12 March 2021

Title: Programming Intelligence through Geometry, Topology, and Anisotropy

Presenter: Dr. Shu Yang
Professor of Materials Science and Engineering, University of Pennsylvania

Time:
10:00 AM – 11:00 AM (Pacific time)

Connection:
Zoom meeting ID: 842 506 6501
Password: 587901

Programmable shape-shifting materials can take different physical forms to achieve multifunctionality in a dynamic and controllable manner. Geometry is concerned with the configurations of points, lines, and circles, while topology is concerned with space, dimension, and transformation. By introducing holes and cuts in 2D sheets *macroscopically*, we demonstrate dramatic shape change and super-conformability via expanding or collapsing of the hole arrays without deforming individual lattice units. When choosing the cuts and geometry correctly, we show folding into the third dimension, known as kirigami. The kirigami structures can be rendered pluripotent, that is changing into different 3D structures from the same 2D sheet. We explore their potential applications in energy efficient building facade, super-stretchable and shape conformable energy storage devices and medical devices, as well as bioinspired robotics. We then take geometry in both *nano- and microscale*s by programming anisotropy in liquid crystal elastomers (LCEs) to direct folding of the 2D sheets into 3D shapes, which can be triggered by heat, light, and electric field. Taking this knowledge of guided inhomogeneous local deformations in LCEs, we tackle the inverse problem – pre-programming geometry on a flat sheet to take an arbitrary desired 3D shape, as well as reprogramming of LCE sheets.

Shu Yang is a Professor in the Departments of Materials Science & Engineering, and Chemical & Biomolecular Engineering at University of Pennsylvania. Her group is interested in synthesis, fabrication, and assembly of soft materials including polymers, liquid crystals, and colloids and their hybrids with precisely controlled size, shape, and geometry; investigation of the dynamic tuning of their sizes and structures, and use geometry to create highly flexible, stretchable, super-conformable, and foldable devices. Her lab explores potential applications of including self-cleaning coatings, dry adhesives, smart windows, sensors, actuators for robotics, and biomedical devices. Yang received her B.S. degree from Fudan University, China in 1992, and Ph. D. degree from Chemistry and Chemical Biology while researching in the Department of Materials Science and Engineering at Cornell University in 1999. She worked at Bell Laboratories, Lucent Technologies as a Member of Technical Staff before joining Penn in 2004. She received George H. Heilmeier Faculty Award for Excellence in Research from Penn Engineering (2015-2016). She is Fellow of Division of Soft Matter (DSOFT) from American Physical Society (APS), Fellow of Division of Polymeric Materials: Science and Engineering from American Chemical Society (ACS) (2018), Fellow of Royal Chemical Society (2017), Fellow of National Academy of Inventors (2014), and TR100 as one of the world's top 100 young innovators under age of 35 by MIT's Technology Review (2004).

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