Programming Shape Shifting and Locomotion through Anisotropy

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Conventional robots are rigid. Although robust, they are often heavy, bulky, tethered and non-adaptive to environmental changes. Soft robots are light-weight, compliant, and adaptive, and can achieve multi-degrees of freedom. However, their softness makes it difficult to control the shape change and locomotion, or lift heavy weights. To precisely and locally control the shapes and agile locomotion with considerable strains, we create thin films and filaments from liquid crystal elastomers (LCEs) and their composites. Through designs of geometric surface patterns, e.g. microchannels, we program the orientational elasticity in LCEs to direct folding of the 2D sheets into 3D shapes, which can be triggered by heat, light, and electric field. We then fabricate tendon-like filaments as high strength, dual-adaptive actuators in soft robotic applications, as well as programmable gaits to achieve different modes of locomotion.

**A person smiling for the camera

Description automatically generated**Shu Yang is a Professor in the Departments of Materials Science & Engineering, and Chemical & Biomolecular Engineering at University of Pennsylvania (Penn). Her group is interested in synthesis, fabrication, and assembly of polymers, liquid crystals, and colloids; investigation of the dynamic tuning of their sizes, shape and assembled structures, and use geometry to create highly flexible, super-conformable, and shape changing materials. Yang received her B.S. degree from Fudan University in 1992, and Ph. D. degree from 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), Division of Polymeric Materials: Science and Engineering from American Chemical Society (ACS) (2018), Royal Chemical Society (2017), and National Academy of Inventors (2014).