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Modeling Liquid Crystal Elastomers: from Auto-origami to Light-driven Autonomous Soft Robotics

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ABSTRACT

Liquid crystal elastomers combine the orientational order of liquid crystals with the elasticity of polymers. They flex under stimuli such as heat or light, acting as artificial muscles and morphing into complex shapes. Molecular orientation of the liquid crystal defines the local strain axis, and can be patterned to induce a programmed shape transformation, via 3D printing or by forming between patterned surfaces. We model these shape transformations using finite element elastodynamics, looking at materials that self-fold, a process known as auto-origami. We also investigate a polymer film that oscillates spontaneously via directional waves, driven entirely by UV light [1]. Our simulations demonstrate the mechanism that produces wave motion, with a feedback loop driven by self-shadowing. Potential applications include autonomous light-driven locomotion and self-cleaning surfaces.

Work supported by NSF-DMR 1409658 and NSF-CMMI 1436565. [1] AH Gelebart, DJ Mulder, M Varga, A Konya, G Vantomme, EW Meijer, RLB Selinger and DJ. Broer, Nature 546, 632 (2017).

BIO:

Professor Robin Selinger holds bachelor's, master's and Ph.D. degrees in physics from Harvard University. After postdoctoral work at UCLA, Univ. of Maryland and NIST, she joined the Physics faculty at the Catholic University of America in 1995, and later moved to Kent State University's Liquid Crystal Institute as Professor of Chemical Physics in 2005. Her work in soft condensed matter theory has been funded by the NSF, US Navy, and ACS-PRF, and she is also strongly committed to STEM outreach. She was elected a Fellow of the American Physical Society in 2016.