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Electrically induced twist in smectic liquid-crystalline elastomers[1]
JONATHAN SELINGER, ROBIN SELINGER, Liquid Crystal Institute, Kent State Univ, CHRISTOPHER SPILLMANN, JAWAD NACIRI, B. R. RATNA, Ctr for Bio/Molecular Science and Engineering, Naval Research Lab — Liquid-crystalline elastomers are cross-linked polymer networks covalently bonded to liquid-crystalline units, so that any change in the orientational order influences the shape of the polymer network. As a new approach to developing electrically controllable actuators, we prepare elastomers of chiral smectic-A liquid crystals, which have an electroclinic effect, i.e. a molecular tilt induced by an applied electric field. For thin films in a bookshelf orientation, one would expect the electroclinic effect to cause an in-plane shear of the elastomer, leading to a distortion from a rectangle to a parallelogram. Surprisingly, our experiments find instead that an electric field causes a twisting of the film out of the plane, leading to a helically curved shape. The twist is rapid and reversible, with a helical sense that depends on the sign of the applied field. To explain this electrically induced twist, we develop a continuum elastic theory based on the assumption that the film has an asymmetry between front and back, which can be attributed to the preparation conditions. We further present finite-element simulations of the twist, which show the dynamic shape change.

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