Microstructure for continuous and localised intrinsic curvature creation

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Abstract

Nematic elastomers and glasses hugely and reversibly contract/elongate parallel/perpendicular to their directors under heating or illumination. With uniform directors and as slender sheets, they can pull with huge load-to-weight ratios, but cannot push because of Euler instabilities.

For complex tasks at small scales, the material must be the machine itself[1]. We show how to design continuous, non-uniform director fields enable flat sheets to develop intrinsic curvature[2,3], that is mostly continuously distributed, and thereby adopt complex shapes. Likewise, piecewise-continuous fields give Gaussian curvature localised at points[4], much as origami folding of paper does. But in this case the "origami" is instead non-isometric[5].

Blocking emerging non-developable surfaces causes stretch away from the new metric and the response can be strong pulling, and strong pushing[6] without Euler failures. New micromechanical possibilities arise.

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