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Grayscale gel lithography: From umlti-strips to responsive origami MYUNGHWAN BYUN, RYAN HAYWARD, Department of Polymer Science and Engineering, University of Massachusetts Amherst, CHRISTIAN SANTANGELO, Department of Physics, University of Massachusetts Amherst — Non-uniform swelling of hydrogel sheets with two-dimensional (2D) patterns of crosslink density has the potential to yield a rich array of three-dimensional (3D) structures, yet many of the design rules remain poorly understood. Here, we study the geometrically simple case of "multi-strips", consisting of alternating parallel strips of high and low crosslink density. These materials are patterned using sequential UV exposure of a photo-crosslinkable polymer film through two photomasks. We show that these materials deform by rolling around the axis perpendicular to the interface between the regions, with a characteristic dimension that depends on the strip width and sheet thickness. However, beyond a critical minimum strip width, the material remains flat, instead forming an anisotropically swelled state that provides fruitful information on the contrast in modulus between the two regions. We also consider the deformation of sheets patterned with multiple regions that define geometrically incompatible rolling axis. Finally, we discuss the formation of hinges based on symmetric tri-strips that can be used to defined fold patterns, yielding responsive gel origami structures.

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