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Formation of 3D microstructures through swelling of photo-crosslinked hydrogel films JUNGWOOK KIM, UMass Amherst, Department of Polymer Science and Engineering, MARCELO DIAS, CHRISTIAN SANTANGELO, UMass Amherst, Department of Physics, RYAN HAYWARD, UMass Amherst, Department of Polymer Science and Engineering — Thin sheets of hydrogels with spatially-varying propensities to swell or shrink provide a powerful means to controllably fold 2D elastic sheets into 3D structures. We have developed a material system based on photo-crosslinkable temperature-responsive polymers wherein films of several micrometers in thicknesses can be spatially patterned with locally varying equilibrium degrees of swelling. At ambient temperature where the gel is highly hydrated, the mutually constrained swelling of different regions leads to development of stresses within the microstructure and therefore out-of-plane deformation into well-defined 3D structures. By increasing temperature, the gel shrinks to a state with nearly uniform swelling, regenerating the original 2D shape. We theoretically model the buckling of the polymer film due to local swelling to explore the resulting three-dimensional shapes. This strategy for preparing patterned 2D soft elastic films that reversibly fold into 3D structures is anticipated to provide a tool for studying fundamental questions concerning the elasticity of thin sheets as well as stimuli-responsive smart micro-structures.

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