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Shape morphing and motion of responsive hydrogel composites

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Composites of stimuli-responsive hydrogels paired with stiff structural elements or functional inorganic materials offer myriad opportunities to control the shape, properties, and motion of materials. In one example, our group has studied the geometry and mechanics of swelling-induced buckling of polymer trilayer films consisting of patterning rigid layers sandwiching a swellable hydrogel layer. Of particular recent interest has been the formation of helical structures from seedpod-type architectures with perpendicular orientation of stripes on opposite faces. We have studied the concatenation of two or more helical segments, yielding simple geometric design rules for the fabrication of 3D constructs. In a second example, we have considered the light-driven reshaping and motion of hydrogels containing plasmonic nanoparticles as photothermal heating elements. In contrast to systems pre-programmed to take on a single, or perhaps a few, different 3D shapes, this approach enables continuous shape reconfiguration, and correspondingly, directed motion of composite hydrogel sheets.