NATURE-INSPIRED HYDROGELS THAT CHANGE SHAPE IN RESPONSE TO EXTERNAL STIMULI OR TO SPECIFIC BIOMOLECULES

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Materials found in nature frequently show an ability to change their shape or external morphology under different conditions. For example, the leaves of plants like the Venus fly trap transform from an open to a closed shape when an insect sits on it. Inspired by these natural systems, we have attempted to create hydrogels that undergo a change in their shape in response to external stimuli such as pH, temperature, light, or solvent quality. Towards this end, we have developed a method for creating hybrid hydrogels that comprise different gel types juxtaposed in predetermined zones or patterns. When such a hybrid gel is exposed to the stimulus of interest, only the portions of the hybrid that are responsive to the stimulus are affected. This introduces differential stresses in the material, which ultimately results in radical changes in shape. For example, we have made self-folding hydrogel sheets, where an initial flat sheet curls up into a folded tube under the action of the appropriate stimulus. An additional challenge in this area is to design gels that are responsive to specific solutes (e.g., proteins or enzymes, or small molecules such as glucose or fructose). In this regard, we have designed a hybrid gel containing specific regions of a degradable biopolymer. When exposed to a specific enzyme, the biopolymer portions get degraded causing the overall gel to change its shape. This transformation in the gel is highly specific and occurs with very low (millimolar) Sconcentrations of the biomolecule. Such shape-changing gels could have potential applications in biosensing, drug delivery and tissue engineering.