Hydrogel micro-systems of controllable shapes and switchable functions

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Soft materials, such as polymer, colloidal suspension, gel, liquid crystal, or a number of biological materials, share a common feature in that their physical behaviors occur at an energy scale comparable to kT. Among these materials, hydrogels are characterized by their solid-like physical behaviors despite the majority of volume (or weight) being occupied by water. Owing to such qualities, i.e. being soft, physically structured, and high water content, hydrogels can undergo a large amount of swelling through a delicate balance between entropy and enthalpy, which are largely affected by a change in environmental conditions such as temperature, solvent quality, pH, electromagnetic fields, or chemical species, and therefore have uses in various applications including tissue engineering, bio-sensors, micro-actuators, and drug delivery vehicles. In this presentation, I will describe how we use such stimuli-responsive hydrogels along with micro-fabrication techniques to create dynamic, shape-controllable hydrogel-based micro-systems. With these, we created 1) hydrogel sheets that buckle into desired 3D morphologies through a locally differential swelling, and 2) dynamic surfaces that display or sequester surface biomolecular patterns.