Non-equilibrium stimuli-responsive soft materials

Lihua Jin

Department of Mechanical and Aerospace Engineering, University of California, Los Angeles

One recent impetus of developing stimuli-responsive soft materials (SRSMs) is to use them for sensors, actuators and soft robots. In these applications, mechanics and multi-physics fields are intrinsically coupled through non-equilibrium thermodynamic processes, including diffusion, reaction, viscoelastic relaxation, etc. The non-equilibrium processes of SRSMs not only determine their response speeds, but also govern how SRSMs spatiotemporally evolve their properties and structures. In this talk, using hydrogels, shape memory polymers, humidity-responsive polymers and liquid crystal elastomers as model SRSMs, I will present a few of our recent studies on programing the spatiotemporal properties, shapes, and locomotion of SRSMs through non-equilibrium processes. First, I will describe how mechanical stress can be used to induce and tune the phase separation processes of hydrogels. Second, I will show that the fracture properties and behavior of SRSMs are also highly intertwined with their non-equilibrium processes. Finally, by utilizing the displacement of SRSMs to alter their interaction with external stimuli, we are able to achieve complex and autonomous motion of SRSMs.