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Soft active materials—when mechanics meets chemistry

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Soft materials, such as elastomers and gels, can mimic a salient feature of life: deformation in response to diverse stimuli. For example, an electric field can cause an elastomer to stretch several times its length. As another example, a change in pH can cause a gel to swell many times its volume. The deformation is large and reversible. These soft active materials are being developed for soft robots, adaptive optics, self-regulated fluidics, and programmable haptic surfaces. This talk describes recent work in my group on the mechanics of soft active materials. We formulate theories to answer commonly asked questions. How do mechanics, chemistry, and electrostatics work together to generate large deformation? What is the maximal energy that can be converted by a material? We also develop experimental methods to characterize nonlinear time-dependent mechanical behavior. Also described in this talk are hydrogels of exceptional toughness and stretchability.