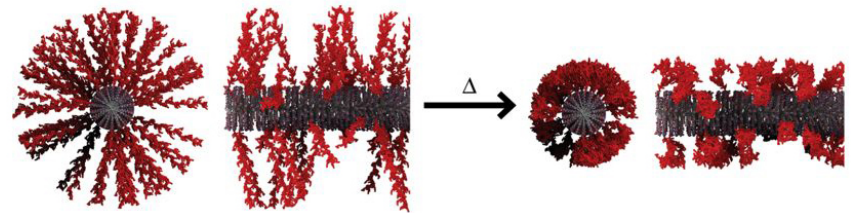


Covalent-supramolecular hybrid polymers as muscle-inspired anisotropic actuators

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Skeletal muscle provides inspiration on how to achieve reversible, macroscopic, anisotropic motion in soft materials. Here we report on the bottom-up design of macroscopic tubes that exhibit anisotropic actuation driven by a thermal stimulus. The tube is built from a hydrogel in which extremely long supramolecular nanofibers are aligned using weak shear forces, followed by radial growth of thermoresponsive polymers from their surfaces. The hierarchically ordered tube exhibits reversible anisotropic actuation with changes in temperature, with much greater contraction perpendicular to the direction of nanofiber alignment. The work reported suggests strategies to create soft active matter with molecularly encoded capacity to perform complex tasks.

We anticipate that hybrid materials based on the design principles outlined here will drive the development of superior soft actuators responsive to external stimuli and capable of performing complex mechanical tasks. The grand challenge moving forward is to explore the design of such active matter encoded molecularly to create complex forms of actuation.



Confinement of polymer chains. Schematic representation of confinement effect in grafted polymer chains below (extended) and above (collapsed) the transition temperature leading to pronounced volume changes in the material perpendicular to the supramolecular nanofiber.