In Search Of Simplicity – Complexity in Materials Through Self-Regulation

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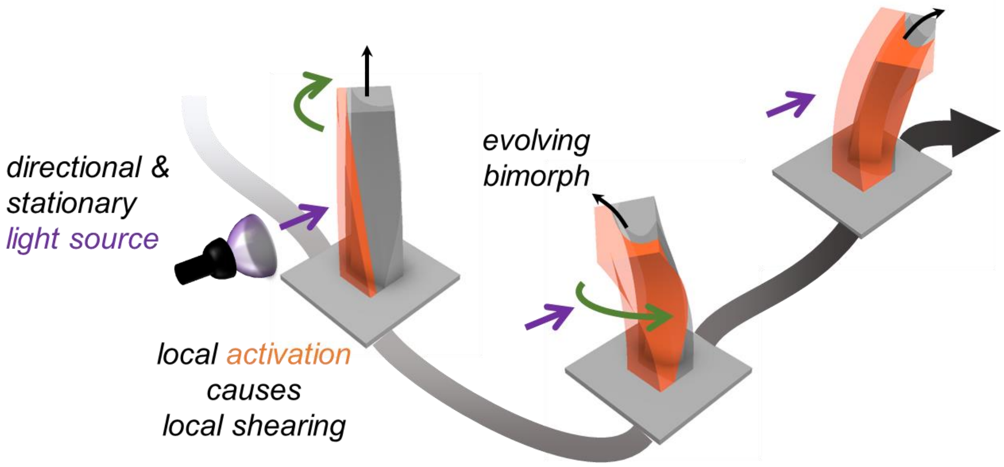

Chemo-mechanical feedback controls complex deformation

Nature's cilia and flagella beat and swirl in intricate patterns and allow organisms to move and navigate. The non-reciprocal beating of these microscale actuators requires intricate coordination, which in biology is usually achieved through self-regulation and feedback mechanisms. In synthetic microscale actuators, however, programming complex beating patterns and the ability to switch between multiple types of motions remains fundamentally challenging. So far, motional complexity has mostly been achieved by increasing complexity of the microactuators themselves, be it through use of multiple stimuli, multimaterial composites, or intricate microscale architectures, making microactuator fabrication and operation difficult and often impractical. Here, we present a completely opposite approach: we design chemo-mechanical feedback for simple, rapidly moldable, light-responsive polymeric microactuators to enable intricate beating patterns. This chemo-mechanical feedback is scalable to arrays of microactuators, where it facilitates complex motional patterns. Beyond being useful for applications in soft robotics and microfluidics, the behavior of the presented system raises interesting fundamental questions about how functional complexity may be engineered into synthetic actuators and robots.