AUTONOMOUS MOTILITY OF POLYMER FILMS COUPLED TO STIMULI GRADIENTS

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Adaptive soft materials exhibit a diverse set of behaviors including reconfiguration, actuation, and locomotion. These responses are typically optimized in isolation. Here, we explore the interrelation between these behaviors by developing a behavioral phase diagram for hygromorphic polymer films. We determine that the dynamic behaviors are a result of not only a response to, but also an interaction with a humidity gradient, which can be tuned via control of the environment and film characteristics, including size, permeability and coefficient of hygroscopic expansion to target a desired behavior such as multi-modal locomotion. Using the improved understanding of stimuli interactive materials gained from our study of monolithic polymer films, we demonstrate how robust composites can be designed to exhibit autonomous, environmentally-responsive behaviors, and how these concepts can be incorporated into origami structures to engineer the extent and sequence of motions.