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Designing a bio-inspired self-propelling hydrogel micro-swimmer[1]

SVETOSLAV NIKOLOV, PETER YEH, ALEXANDER ALEXEEV, Georgia Institute of Technology — Artificial micro-swimmers have found numerous applications in microfluidics, drug delivery systems, and nanotechnology. In our current research we use dissipative particle dynamics to design and optimize a self-propelling hydrogel micro-swimmer with an X-shaped flat geometry and bi-layered hydrogel structure. The two polymeric layers that bind to each other have identical material properties but distinctive chemical responses to external stimuli. In the presence of outside stimuli one of the layers swells where the other remains passive resulting in hydrogel bending. Our simulations demonstrate that under periodic applications of an external stimulus this actuation routine is capable of creating time-irreversible motion in a low Reynolds number environment. Initially, when the external stimulus is introduced a forward stroke is initiated, as the swimmer first expands and then bends. When the outside stimulus is removed the forward stroke is terminated and a backward stroke begins, as the swimmer contracts and then straightens. Propulsion results due to the difference in momentum exchange between the forward and backward strokes. We use our simulations to probe how alterations in the material properties of the bi-layered hydrogel can affect swimming performance.

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