Modeling photo-induced reconfiguration and directed motion of active gels

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Remarkable features of certain biological species involve their ability to alter their shape and functionality in response to environmental cues. Polymer gels undergoing the Belousov-Zhabotinsky (BZ) reaction are unique self-oscillating materials that can be used to design a variety of soft materials with biomimetic functionality. Herein, we focus on chemically-mediated communication between multiple pieces of BZ gels. We show that these pieces can both emit and sense a chemical signal and thus, drive neighboring pieces to spontaneously self-aggregate, so that the system exhibits autochemotaxis [1]. We also find that the aggregated gel pieces can rotate as a unit. For example, four millimeter-sized gels can associate into a structure that resembles a pinwheel and then undergo spontaneous, autonomous rotation. Moreover, the gels' coordinated motion can be controlled by light, allowing us to achieve selective self-aggregation and control over the shape of the gel aggregates.

Finally, we focus on a different photo-responsive polymer gel that contains spirobenzopyran (SP) chromophores. We developed a computational model for these gels and demonstrated that they can be patterned remotely and reversibly by illuminating the samples through photomasks and thus, "molded" into a variety of shapes. Furthermore, we show that by repeatedly rastering the light source over the sample, the system can be driven to exhibit another biomimetic behavior: sustained, directed motion. The results point to a robust method for controllably reconfiguring the morphology of soft materials and driving the self-organization of multiple reconfigurable pieces into complex architectures.

1. P. Dayal, O.Kuksenok and A. Balazs, *PNAS*, **110**, 431 (2013).