Autonomous self-regulating liquid-crystal elastomer photoactuators

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Natural systems act as an endless source of inspiration for scientific research. Recently, stimuli-responsive liquid-crystalline polymers have been used to mimic diverse motions of biological species. One of the grand challenges in biomimetic research is to mimic the autonomy of living systems, that is, self-action in response to certain environmental changes. Two prominent examples of self-acting systems in Nature are Venus Flytap and mammalian iris. The flytrap exhibits a fast snapping motion when meeting a specific target, being capable of distinguishing prey from random dust. Irises, in turn, as found in many animal species, can self-regulate their aperture size in response to varying incoming light intensities, in order to stabilize light transmission into retina.

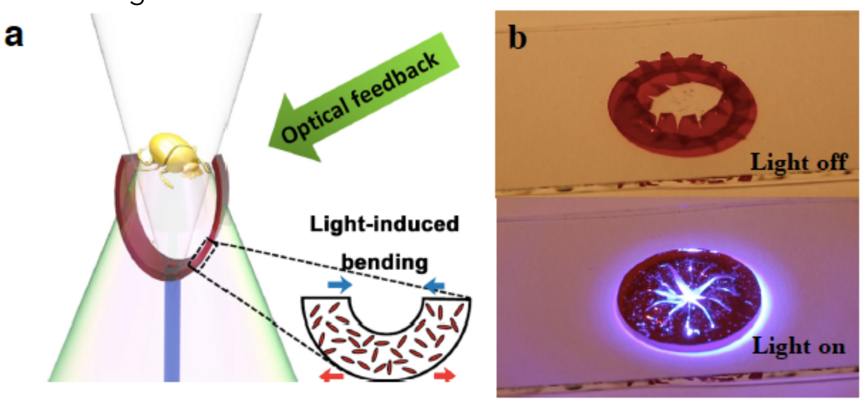

Figure 1: a) The optical "flytrap" closes when an object enters its field of view. Reflected light induces bending of the liquid-crystal elastomer, thus capturing the object. b) Soft liquid-crystal elastomer iris in the open state (top, no light) and closed state upon light illumination (bottom, illuminated with a 470 nm LED).

Here, we present our recent results on a flytrap-inspired autonomous gripping device [1] and a self-regulating iris [2]. The gripper comprises a liquid-crystal elastomer actuator fabricated onto the tip of an optical fiber. This optical 'flytrap' mimics the Venus Flytrap not only by autonomously gripping approaching objects, but also by distinguishing between different targets based on their optical feedback (reflectance) (Fig. 1a). The self-regulating iris is fabricated by utilizing photoalignment technique in combination with anisotropic thermal expansion of liquid crystal elastomers, devising a system that reduces symmetrically the aperture size in response to light intensity (Fig. 1b). The self-regulation demonstrated in these devices provides a new design tool for intelligent soft robotics and for tunable photonics.

References

[1] O. M. Wani, H. Zeng, and A. Priimagi, Nat. Commun. **8**, 15546 (2017).

[2] H. Zeng, O. M. Wani, P. Wasylczyk, R. Kaczmarekm, and A. Priimagi, Adv. Mater. **29**, 1701814 (2017).

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