Flytrap-Inspired Lenses May Lead to New Materials for Adhesives, Optics, Coatings

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Imagine paint that adheres to a surface but releases on command, or road signs that change their reflectivity with changing weather conditions. These are two potential uses of a novel, responsive material designed by researchers in the University of Massachusetts Amherst polymer science and engineering department. The research was published online this week in the journal *Advanced Materials*.

Inspired by the way a Venus flytrap captures its pray, Alfred Crosby and his doctoral candidate Douglas Holmes created a polymer surface covered with small holes capped by thin lenses of the same material. The lenses can snap between convex and concave when triggered.

Venus flytrap leaflets work in a similar way. Through a combination of geometry and materials selection, the flytrap leaflets snap from concave to convex when an object triggers their hairs. The key to the flytrap's ability to capture prey, and a key feature in Crosby and Holmes' material, is the speed and sensitivity that accompany a "snap" transition.

For the Venus flytrap, the transition occurs in roughly 100 milliseconds, and the "snapping surfaces" can snap at least as fast as 30 milliseconds. Even more important is the fact that this speed can be easily adapted for faster or slower transitions depending on the final use.

This "snap" transition changes the surface of the material from a series of mounds to a series of depressions, a strategy that has great potential for creating release-on-command coatings, "smart" adhesives, adaptable optical devices or surfaces with responsive reflective properties.

“This material’s design could allow for the removal of superglues, wallpaper and paints without toxic solvents, which would be an advantage for the environment,” says Crosby.

The connection to controlling adhesion with the responsive “snapping” surfaces is fueled by another project in Crosby’s research group that is focused on understanding and mimicking the gecko, a small lizard with pattern-covered toes that provide enhanced adhesion and release properties. The “snapping surfaces,” which are really Venus flytrap-gecko hybrids, can be turned into smart adhesives by covering the lenses with hairs that adhere in the convex position and release when the lenses are concave.

“This novel surface has many advantages over existing shape-memory polymers,” says Crosby. “The snap-through transition is caused by an elastic instability, therefore it requires very small amounts of energy to initiate large changes in geometry. The transition can also be limited to one lens or the entire sheet.”

Currently Crosby and Holmes have demonstrated mechanical pressure, swelling and surface chemistry as triggers for the “snap” transition. “Using different materials may lead to surfaces that transition in response to heat, light and voltage, and changing the size scale permits use in electronics and nanodevices,” says Crosby. “There is no physical reason why we can’t go down to the nanometer scale. That is what we are currently researching.”

Source: University of Massachusetts Amherst