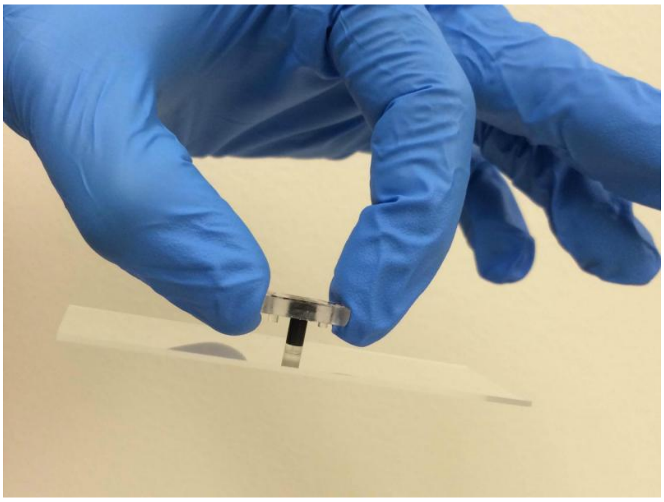
# Researchers develop a new type of gecko-like gripper

15 June 2015, by Evan Lerner



Researchers at the University of Pennsylvania are developing a new kind of gripper, motivated by the ability of animals like the gecko to grip and release surfaces, that is perfectly suited for the delicate work involved in semiconductor manufacturing.Like the gecko, the gripper has tunable adhesion, meaning that, despite having no moving parts, its effective stickiness can be tuned from strong to weak. Unlike the gecko and other artificial imitators that rely on structures with complex shapes, the Penn team's gripper uses a simpler, two-material structure that is easier to mass produce. At their current millimeter-scale size, the grippers can be used for moving smooth, fragile components, like silicon wafers or glass sheets. Scaled down, they could be used in arrays to grip to a range of rough and smooth surfaces, making them useful for climbing robots and other larger-scale applications. Credit: University of Pennsylvania

Picking things up and putting them down is a mainstay of any kind of manufacturing, but fingers, human or robotic, are not always best for the task at hand.

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The research was conducted by Kevin Turner, the Gabel Family Term Associate Professor in the School of Engineering and Applied Science's Department of Mechanical Engineering and Applied Mechanics, and Helen Minsky, a graduate student in his lab.

Their study was published in *Applied Physics Letters*.

"When it comes to tunable adhesion," Turner said, "everyone is familiar with the gecko, and everyone tries to copy it. The problem is that it's really hard to manufacture complex structures as well as nature. We've come up with a strategy that can achieve similar adhesion behavior but is much easier to make."

Geckos can stick to sheer surfaces due to complex structures on the pads of their feet. There, what look like ridges to the naked eye are actually a dense array of tiny fibers with flared tips, looking like a collection of long, thin mushrooms jutting out from their footpads at an angle.

These structures are sticky because of a phenomenon known as van der Waals adhesion, which is present any time two surfaces are in close contact; the closer the contact, the stronger is the attraction. Van der Waals forces generally aren't noticeable in everyday life, as even two seemingly smooth, flat surfaces are rough enough at the microscopic scale to make them ineffective. But with many angled, flared-tip fibers lying flush with this rough terrain, van der Waals forces are strong enough for the gecko to stick to a wall. Changing the angle of their feet is what makes the gecko's adhesion "tunable" and what allows them to detach from the wall to take each step.

"Other researchers have mimicked these structures to achieve tunable adhesion, but they are tough to make," Minsky said. "You can make a few of these structures, but, if you want to make larger arrays of them, it becomes much tougher. The angles and the flared tip means you can't just slip them out of a mold."

The Penn's team approach to realizing tunability and to address this manufacturing problem relies on a gripper with a fundamentally different structure. Rather than being angled or flared, they are simple cylindrical posts. The secret is in their composite construction: a hard plastic core surrounded by a softer silicone rubber shell.

"Anytime you have a corner, you have a place that has higher stress," Minsky said. "The reason the gecko's fibers stick so well is because the mushroom-shaped tip forces the high stressed region from edge to the center, where it's hard to start a crack."

"The composite post geometry," Turner said, "achieves the same effect as the mushroom shape. The soft rubber conforms to the roughness of the surface, and, by putting a stiff core in the middle, you concentrate the stress in the center when you're pulling straight up."

To detach the posts, the researchers apply a lateral force, which shifts the stress back to the edge and allows the crack to easily start from there.

The researchers' prototype grippers are a few millimeters in diameter and designed to grip smooth surfaces, such as glass. Their experiments and simulations suggest that this structure will remain effective once scaled down to microscopic sizes.

"Our view is that this composite post structure presented in this work is a fundamental building block to realize larger adhesive surfaces with tunable properties," Turner said.

**More information:** *Applied Physics Letters*, dx.doi.org/10.1063/1.4921423

Provided by University of Pennsylvania