Research at UMass Amherst Produces a New Approach for an Attach & Release System. By Kathlyn Swantko

An Innovation Inspired by the Gecko

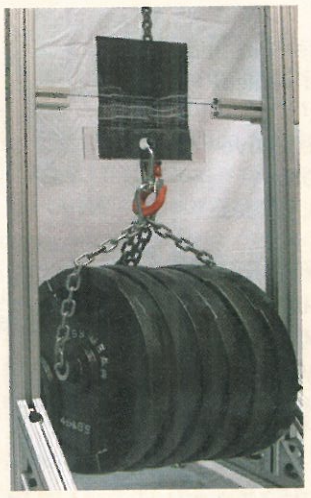
Ever see a gecko lizard climb up a smooth wall or crawl upside down across a plate of glass? Such impressive performance is due to the adhesion (van der Waals forces) developed between the climbing surface and the microscopic projections that cover the hair-like setae on the feet of the gecko. Inspired by the gecko, Geckskin, developed at UMass Amherst, is the newest innovation in "attach-and-release" systems. Geckskin can hold up to 700 pounds on an index card-sized piece of material, and has the potential for a wide range of applications.

Headed by Al Crosby, Professor of Polymer Science & Engineering, and Professor Duncan Irschick, Professor of Biology, UMass Amherst's Geckskin team is supported by graduate and undergrad students and researchers. The team has been working in the area of bio-inspired adhesion for more than 11 years. The Geckskin project was initiated in 2009, and the first publication of findings was released in February 2012.

Crosby notes, "As part of our focus, we decided not to directly mimic any of the exact features of the gecko, but rather focus on the math behind how gecko-like adhesion works. From our theory, we were able to make predictions regarding the optimized synthetic materials that would display gecko-like adhesion."

Crosby explains that in humans the tendons connect muscle to bone. However, in the gecko, the tendon is one of the stiffest tissues found in living organisms. This stiff, fibrous tendon tissue becomes increasingly thin as it integrates with the gecko's skin. It is hypothesized that the Geckskin structure takes on the same properties.

Unlike adhesive products that use viscoelastic properties for adherence and may leave a sticky residue, or other scientific materials that mimic the gecko foot by employing sophisticated and expensive nanotechnology, Geckskin is made from everyday fabric materials. This easy-release material is also highly robust and reusable.



Geckskin: Displaying its power, Geckskin holds 300 pounds with only a 16 square inch adhesive pad.

Since the adhesion capability utilized by the gecko is likely produced through van der Waals forces, the Geckskin teams' approach has focused on the basic lessons that enable geckos to be the largest animals that employ adhesion. However, to make large-size adhesions using van der Waals forces requires a great amount of contact, along with keeping the structures very stiff, two properties that usually contradict one another.

Rather than replicating the setae, the hairs on the toes on the gecko's footpad, the team utilized a soft compliant pad made from a simple elastomer (rubber-like material), which has many of the key properties found in a layer of setae. The Geckskin's high level of function is accomplished through "draping adhesion."

Geckskin has two components, an elastomer and a fabric, which create both a soft and stiff material. Using the analogy of a tablecloth to describe their hypothesis, Crosby explains, "Much like a tablecloth that can conform to a variety of shapes, yet when pulled taut the tablecloth fabric is very stiff. We use two simple components to make Geckskin—an elastomer and a fabric, which provides the soft and stiff materials. We integrate this soft pad into highly stiff fabrics, such as Kevlar and carbon fiber. Overall, this integration is similar to the integration between the skin and tendon found in geckos."

Crosby adds, "These textile elements replicate the setae, where a tendon on the toes integrates with the skin, which is directly connected to a soft and compliant pad. Our Geckskin thus employs both a synthetic 'tendon' and 'skin', which are interwoven together in much the same way as a gecko foot."

Going forward, Geckskin is anticipated to impact a broad range of applications including apparel, household hanging, and manufacturing assembly processes. Crosby says, "Our short term plans are to continue exploring a wide range of elastomer and fabric combinations to understand the fundamental mechanics of how these unique materials work, and to continue our extensive study of how geckos and insects develop their adhesive properties." ●

Professors Crosby and Irschick have also co-founded Felsuma LLC, which is commercializing Geckskin. For more information on UMass Amherst's Geckskin research and Felsuma LLC, contact Al Crosby, crosby@mail.pse.umass.edu, 413-577-1313.

Kathlyn Swantko, president of the FabricLink Network, created TheTechnicalCenter.com for Industry networking and marketing of specialty textiles, and FabricLink.com for consumer education involving everything fabric.