METRO | SCIENCE

THE COLUMBUS DISPATCH | TUESDAY, AUGUST 7, 2007 | BREAKING NEWS: DISPATCH.COM

MARK STAHL | FOR THE DISPATCH

University of Akron researchers say they have figured out the gecko's sticky secrets.

Going gecko

More and more researchers are searching for ways to mimic the lizard's sticky footprints

By Kevin Mayhood
THE COLUMBUS DISPATCH

Geckos have a grip that glue and tape makers have coveted for more than a century.

The lizards scurry up walls, across ceilings and can even sleep hanging upside down. Their traction is so strong that they can hold more than 100 times their weight.

But the gecko's feet aren't sticky to the touch and leave no remnants of adhesive behind.

That's why the gecko's sticky secret has become the Holy Grail of adhesion research.

And while scientists believe they've figured out how the feet work, replicating the gecko's properties will be some time coming.

Still, a number of recent discoveries are bringing them closer.

Ali Dhinojwala has created a super-strong adhesive tape.

One in particular, which uses nanotechnology, appears to do the gecko one better.

"Our tape sticks four times better than the gecko's foot," said Ali Dhinojwala, a polymer scientist at the University of Akron.

A gecko can climb overhead because its feet swiftly turn on and off a force called van der Waals attraction, an electromagnetic force that occurs when the positive and negative ends of molecules come into close proximity.

The gecko's foot is covered with microscopic hairs called setae, which are made of keratin — similar to the material that makes up human fingernails and hair. Each seta is about one-tenth the diameter of a human hair and divides into hundreds of split ends called spatulae.

When the gecko slides its foot along a surface and curls its toes, the electron clouds in the spatulae and the wall are temporarily distorted and polarized, creating an attraction.

The Gecko curls and uncurls its toes to tighten or loosen the grip. The lizard can repeat this process more than 15 times a second.

Dhinojwala worked with Pulickel M. Ajayan — a professor of material sciences and engineering at Rensselaer Polytechnic Institute in Troy, N.Y. — and three graduate students on the tape.

They said it grips a variety of surfaces, even rough Teflon, which remains nonstick to reptiles.

"The tape sticks in a vacuum, which means it would work in space," Dhinojwala said.

The group estimates that a dime-size piece of tape can hold more than 10 pounds without losing strength over

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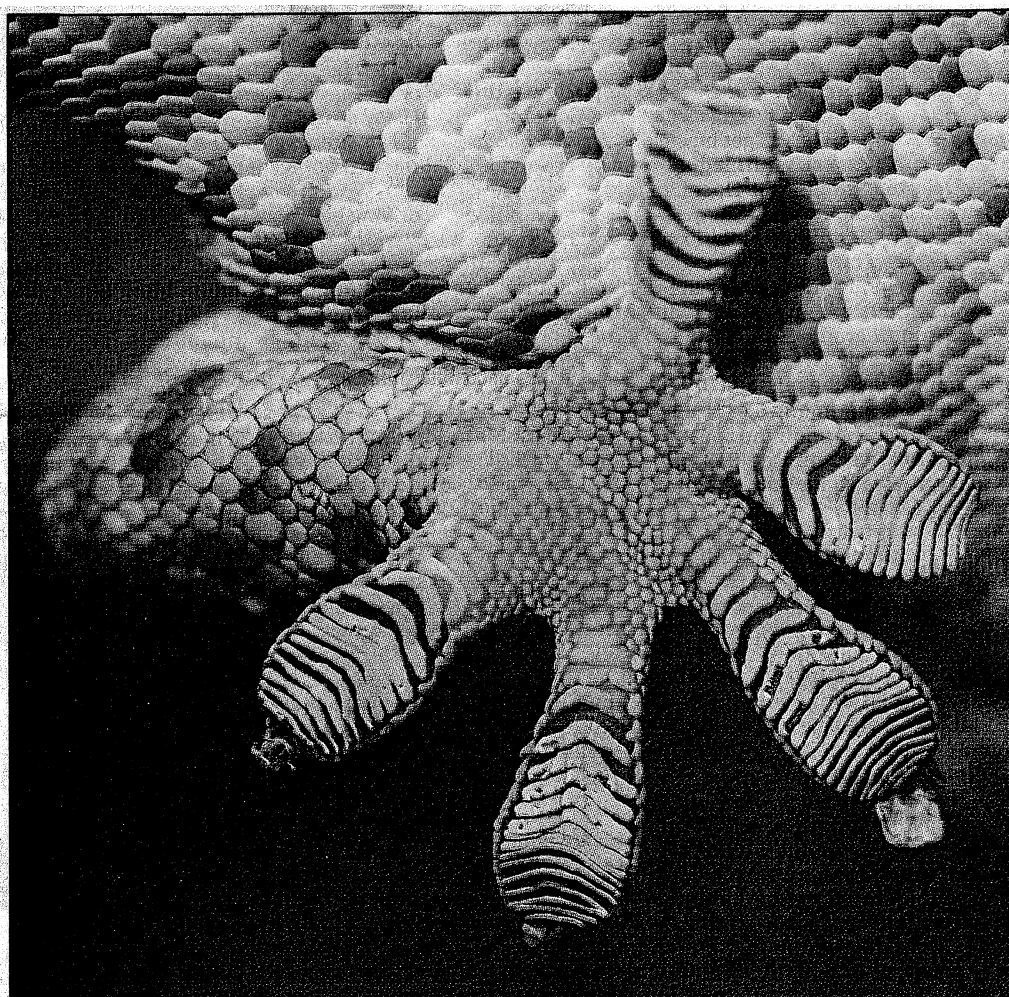

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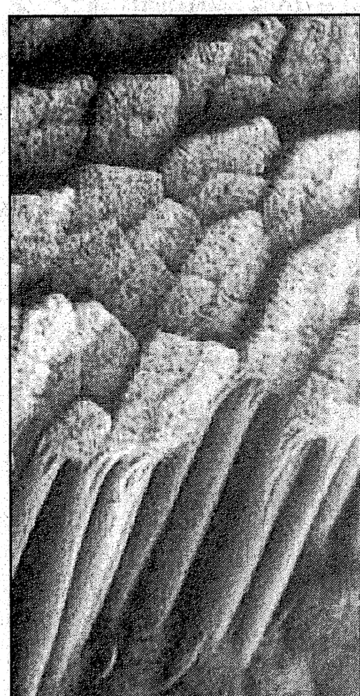
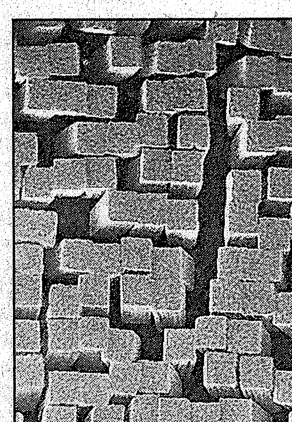
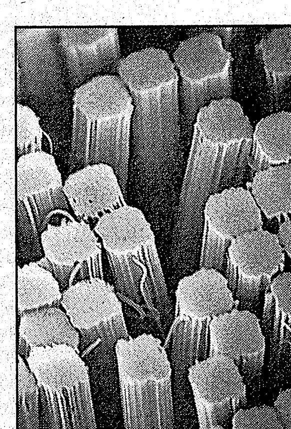
Geckos' feet don't leave behind any surface residue. Researchers are trying to mimic the clean-stick properties for use in adhesive tape, athletic shoes and tires — even for wall-climbing robots.

Climbing walls

For years, scientists have tried to replicate the gecko's uncanny ability to stick to nearly any vertical surface. The image on the left is a close-up of the hairlike setae on the bottom of a gecko's feet. Each seta divides into hundreds of split ends called spatulae. When the spatulae touch a surface, they create an electromagnetic attraction or stickiness. The images below are bundles of carbon nanotube hairs that imitate the lizard's remarkable adhesive qualities.







UNIVERSITY OF AKRON PHOTOS

"The tape sticks in a vacuum, which means it would work in space."

ALI DHINOJWALA | researcher

GECKO

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time.

First, carbon nanotubes about the same size as spatulae are grown in a pattern on silicon at about 1,400 degrees Fahrenheit.

Then tubes are transferred to a piece of Scotch tape and tested on a sheet of mica. The researchers grew the nanotubes in groups of varying size to reflect the different setae and spatulae.

The work impressed Ron Fearing, an electrical engineering professor at the University of California, Berkeley.

"It's a pretty nice improvement, a factor of four over what people have been able to do before," said Fearing, whose work helped uncover how gecko feet work.

He also has worked on projects to mimic them.

Metin Sitti, an associate professor of mechanical engineering at Carnegie Mellon University in Pittsburgh, has worked on carbon nanotube designs based on the gecko foot.

He said he foresees using the technology in tires and athletic shoes, "where you need good friction but you don't want to be stuck."

Dhinojwala said his tape could be developed for use in microelectronics, by wall-climbing robots or to help astronauts better grip tools in space.

A team at Northwestern University in Evanston, Ill., is taking a different approach.

The researchers coated microscopic silicon pillars — based on gecko design — with a synthetic protein based on glues produced by mussels to stick to underwater rocks.

They call the creation "geckel."

In tests, the geckel stuck and unstuck 1,000 times and "ours sticks underwater," said Phillip B. Messersmith, professor of biomedical engineering at Northwestern.

(Real geckos and Dhinojwala's tape don't stick that well when submerged.)

There have been 16 scientific papers published on gecko-inspired adhesives this year. In 2000, there were two.

Fearing said the research continues to create better and better gecko materials. One day, he said, man will use the technology to climb buildings.

"He might be wearing a pair of gloves the size of catcher's mitts and may not do it quickly, but if he's willing to rely on van der Waals forces he can't even see ... "

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