Gecko Inspired Dry Adhesive Tape

Khalil Bethea[1], Isaac Omodia[2,3], Kausik S. Das[2,*]
[1]Morgan State University, Baltimore, MD
[2]University of Maryland Eastern Shore, Princess Anne, MD 21853
[3]Harvard University, Cambridge, MA

Abstract: Normal adhesive tape people use in day-to-day life can only be used a few times before adhesion wears off and can also leave behind unwanted residue. Velcro tape is a technology that serves the same purpose as adhesive tape, but it requires a mating surface. This new form of tape can bypass these drawbacks and requirements by imitating the physical attributes of a gecko's foot. Geckos can stick to surfaces using a physical concept called Vander Waals Forces because on their feet are very tiny hair like structures. These "hairs" stick to surfaces because of very small attractive forces at the atomic level. This behavior can be imitated by creating thin pieces of plastic with microscopic hairlike structures similar to the foot of a gecko.

Introduction Filter paper is a type of paper typically used in chemistry to separate solid substances from gas or liquid. The key feature of filter paper is that they have many microscopic pores that vary in size depending on its type. This attribute of filter paper presents a very promising method of creating the microscopic hairlike structures similar to a gecko's foot by using nanomolding techinques.

Hypothesis: When liquid silicon rubber is poured over filter paper, the rubber material will have small hair-like structures when allowed it solidifies and then peeled from the filter paper. The newly created "Gecko Tape" will be able to stick to surfaces by mimicking the behavior of gecko's feet.

Goals:

1) Design a material that can meet the standard of adhesive tape and Velcro tape without the need for a mating surface, requiring chemicals, or leaving behind residue when removed.
2) Compare the strength of Gecko Tape depending on it's thickness and the pore size of the filter paper used.

Methods and Materials

Materials Used:

- Isopore 0.2µm PC membrane filter paper
- Isopore 5.0µm PC membrane filter paper
- Startso World 30A platinum RTV-2 silicone rubber
- Wheel and Axle for pulley
- Petri Dish
- String
- Staples
- Weight hanger with slotted masses
- Force Sensor

Method

I. Tape a piece of filter paper to the bottom of a petri dish or any suitable and clean base using double-sided tape. Make sure that the tape is the same size or larger than the filter paper.

II. Mix the two parts of the silicone rubber in a disposable container. Equal parts of side A and side B by volume.

III. Carefully stir the mixture for about 5 minutes using a clean utensil.

IV. Pour the silicone mixture over the filter very slowly. Do not cover the entire petri dish, only make a thin layer over the filter paper.

V. Wait for the plastic to cure in the petri dish overnight.

VI. While testing, always handle the tape delicately using rubber gloves. Remove the tape from the petri dish and place onto a clean surface.

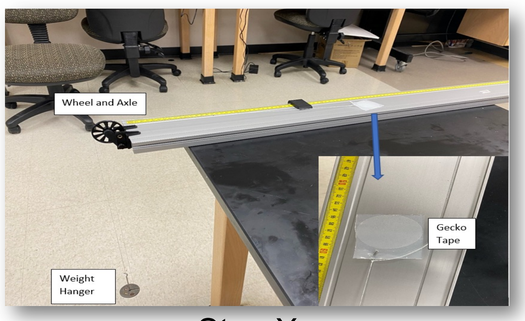
VII. Cut off excess plastic from 3 sides of tape leaving 1 side of excess which will be needed for testing.

VIII. Connect a staple to the end of the tape with excess plastic and tie a string around the staple.

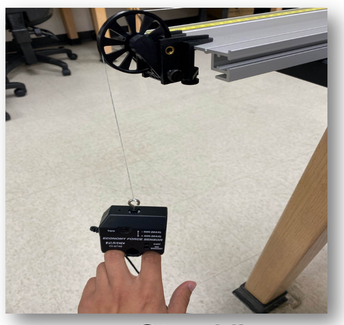
IX. Connect the other end of the string to a hooked weight hanger or force sensor.

X. Press the tape down on a horizontal surface while suspending the weight hanger vertically over the pulley. Test the tape by adding weights to the hanger until the tape fails.

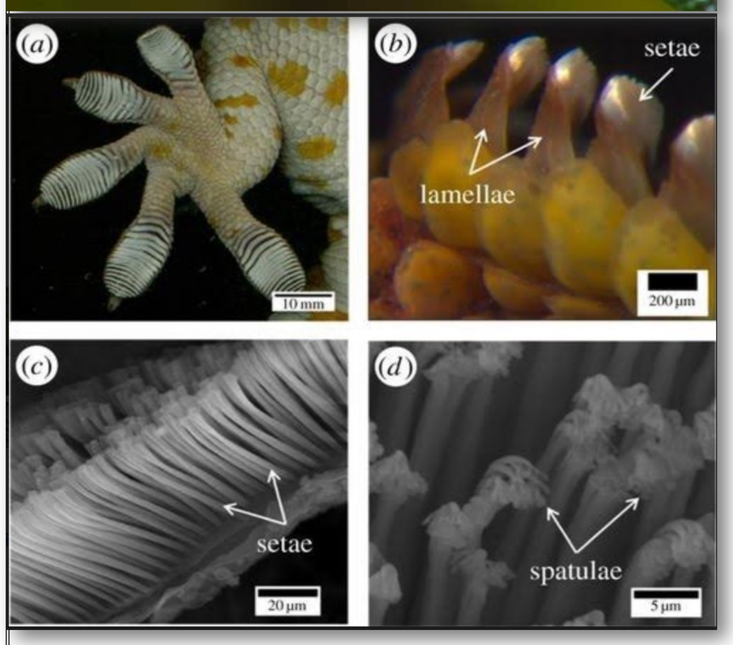
XI. If using a force sensor instead of weights, slowly pull the force sensor until tape fails.



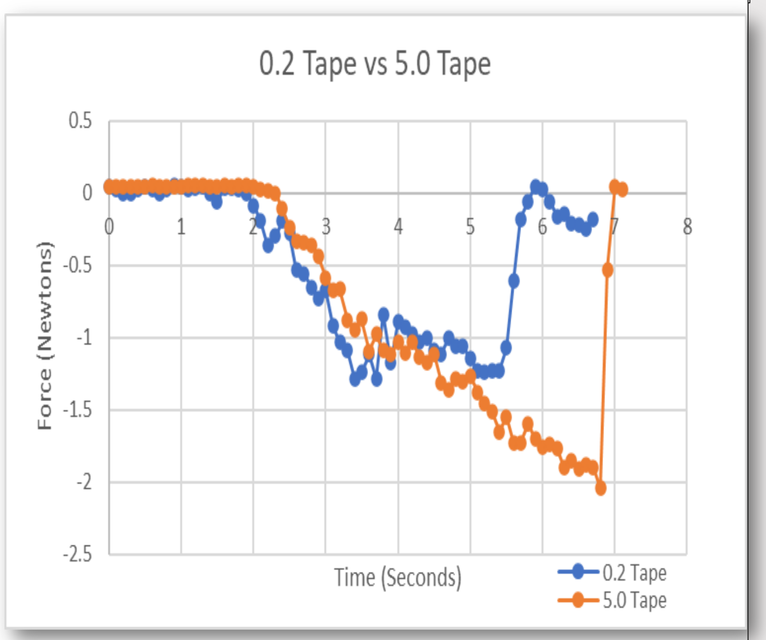
Step X


Step XI

Results and Discussion:



The above pictures depicts close-up images of a gecko's foot.



The above figure compares the overall strength and endurance of the Gecko Tape created from filters of different sized pores. The blue data represents tape created from a filter with 0.2µm pores and the orange data represents tape created from a filter with 5.0 µm.

Tape Characteristics	Mass of Tape (grams)	Critical Mass (grams)	Mass at Failure (grams)	Stickiness Score
Thin Tape 0.2µm	4.03	295	305	73.2
Thick Tape 0.2µm	10.55	25	35	2.37
Thin Tape 5.0µm	2.99	315	325	105.35
Thick Tape 5.0µm	10.373	85	95	8.19

The above figure displays the data recorded from testing different samples of Gecko Tape. The stickiness score is calculated by dividing critical mass by the mass of the tape, how much weight the tape can withstand with respect to its own weight before it fails.

Conclusions:

- The Gecko Tape is capable sticking to surfaces and resist very high levels of force being applied to it and can be a practical replacement for normal adhesion methods.
- The Gecko tape created from the filter tape with larger pores had better sticking strength and was able to stick for longer. The tape also increases in strength as it's thickness decreases

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