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DESIGN AND ANALYSIS OF GECKO FOOT

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ABSTRACT

Researchers are developing the actual deal: palm sized, gecko based adhesives, which can lift a man up glass walls and that one day will even catch junk from space. Geckos wall climber and run across ceilings with the support of tiny layer of hairs on their feet. These hairs are known as setae, which can generate a multiple attitude of weak attractions between molecules on the two surfaces that sum up to a secure foothold. Furthermore, attaching and detaching the bonds that hold separate setae to a surface is easy. Therefore, it is different from the glue or tape, a gecko's sticky feet attach and detach effortlessly. The analysis of gecko foot is divided into to parts firstly we have found a detach angle with minimum stress on the foot the force is varied to get the maximum displacement of the foot. The foot is designed with different materials and the detach angle should be between 60 deg to 65 deg the stress produesed in the nano hair is very less as compared to other values below 60 and above 65 deg. The least stress is produced at 63 degree detach angle.

Keywords: Gecko Foot, Maximum Displacement, Detach Angle.

I. INTRODUCTION

In nature, various species apply advanced techniques for specialized tasks. For instance, gecko lizards use dry adhesion forces such as Van der Waals forces to climb walls. Dry adhesion is an interesting phenomenon for penetrating because it requires no energy to grip and there is no residue is leftover the surface. Gecko lizards have encouraged scientist and researchers to develop artificial gecko foot hairs, which can be used in, for example, robot application for purposes where humans cannot go.

II. MODEL DEFINITION

The Hair on a gecko foot is a very complex biological structure with hierarchical nano and micro sections. Gecko feet have billions of nanoscale hairs that are in contact with surfaces while it climbs. These nanohairsare attached to tip of a gecko's toes made up of microscale hairs.

Critical design parameters for nanohairs to attain the best sticking are detach angle, distance between nanohairs, hair length, and the cross section area of one hair. By varying these parameters, the hairs can stick onto very rough surfaces, but on the other hand they must be stiff enough to avoid sticking to each other's. Proper material choices help achieving the design goals while providing the essential adhesion force. Typically the Young's modulus for materials used in synthetic nanohair vary in between 0.1GPa and 15 GPa.

This design contains the pyramid of artificial gecko foot hair, which has nano and micro cantilever beams describe by seta and spatula parts of one spatular stalk connected to a gecko foot.
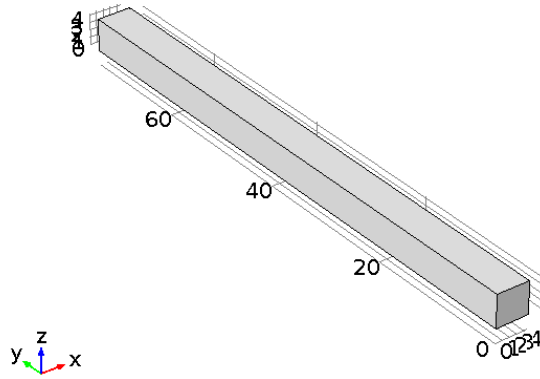
Figure 1: Micro Hair

The analyzed micro hair structure has this following measurements width of 4.53 µm, height of 4.33 µm and length of 75 µm.

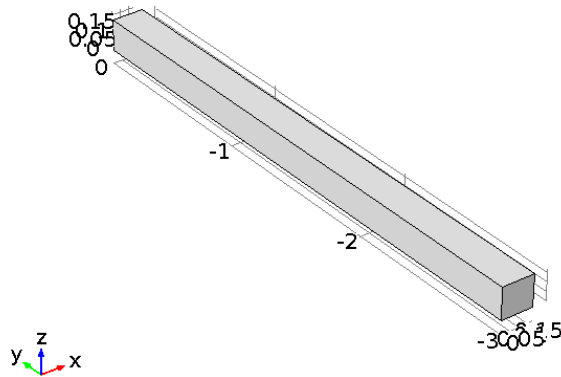*Figure 2: Nano Hair*

The tip of the micro hair is attached to 169 nanohairs are attached and have with of 0.18 µm, height of 0.17 µm, and length 3 µm, respectively.
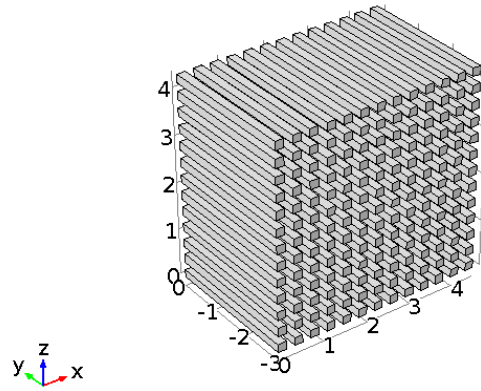
Figure 3: Nano Hair Array.

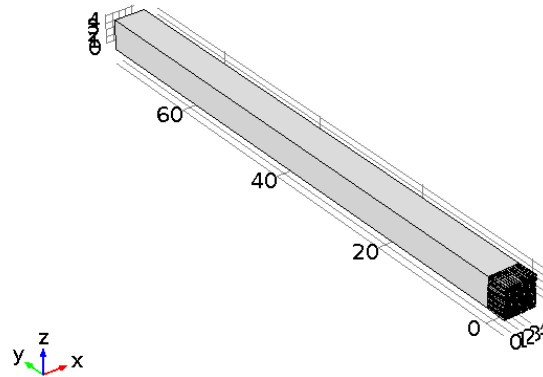The nanohairs are placed in a 13*13 array each nana hair is placed at 0.36 um distance.

Figure 4: Gecko Foot

The micro hair fixed at the one end, while the contact and friction forces applied as loads at the end of every nanohair.
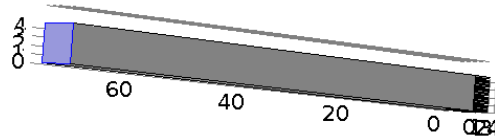
III.   APPLYING PHYSICS

Figure 5: Fixed End

The end of micro hair is fixed and load of Force/area is applied on the nano hair.
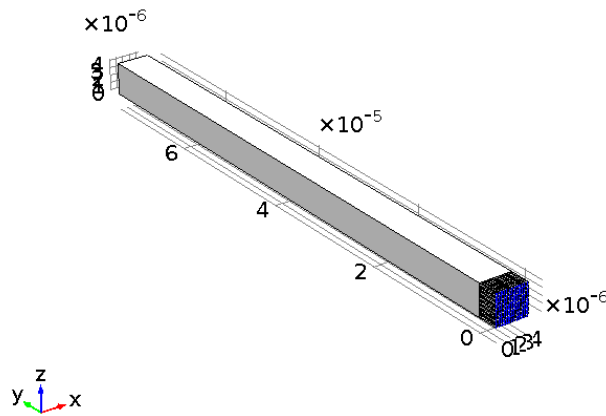
Figure 6: Load Boundaries

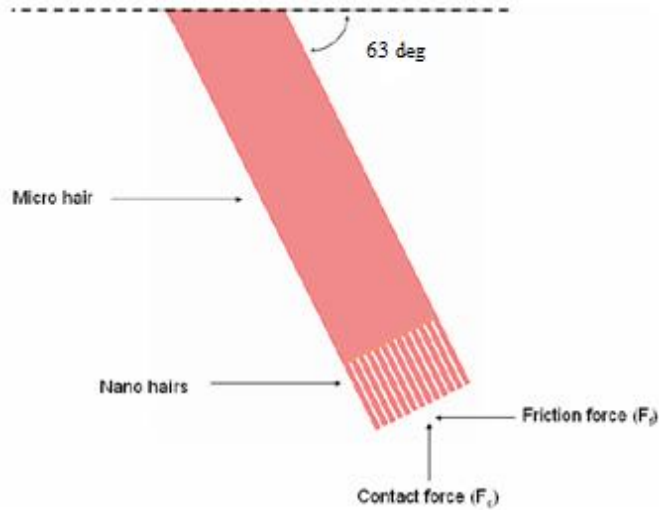The free-body diagram of one micro/nanohair illustrates the applied forces.

Figure7: Forces and Detach Angle

Applied forces are varied from 0.2 to 0.6µNand 0.2µN for the friction force with contact angle to target surface varied from 45^0 to 80°.
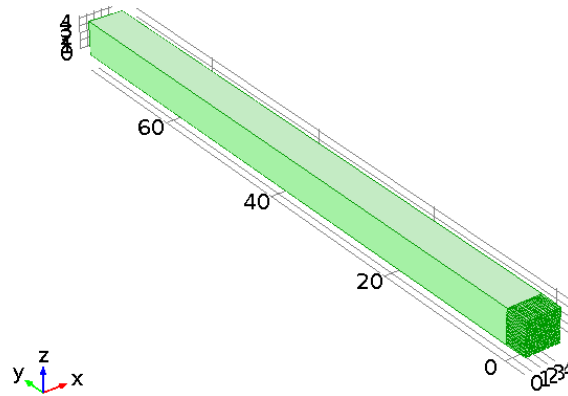

Figure 8: Appling Material

The structure is made of PTFE with material property having Young's modulus of 0.4GPa and Poisson's ratio of 0.4.
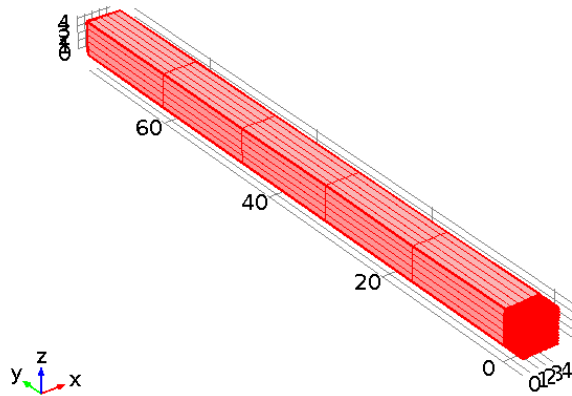
Figure 9: Meshing

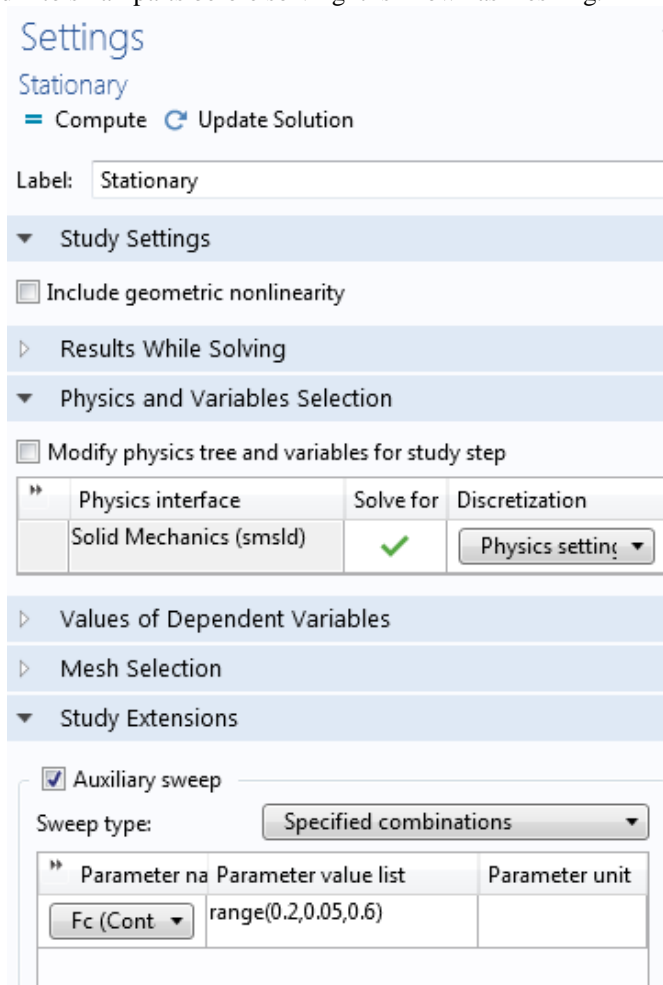The design is the divided into small parts before solving it is known as meshing.

Figure 10: Study Parameters

Applied contact force is varied from 0.2 to 0.6 μN as shown above and the detach angle is varied form 45^0 to 80^0.

IV.   RESULTS

The analysis of gecko foot is divided into to parts firstly we have found an detac
h angle with minimum stress on the foot the force is varied to get the maximum displacement of the foot.
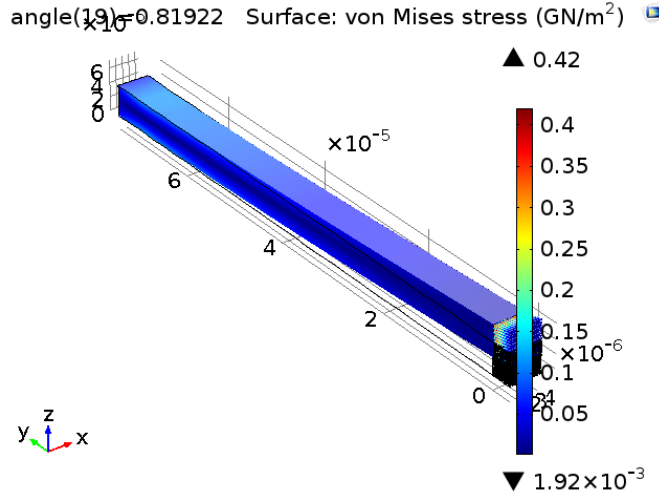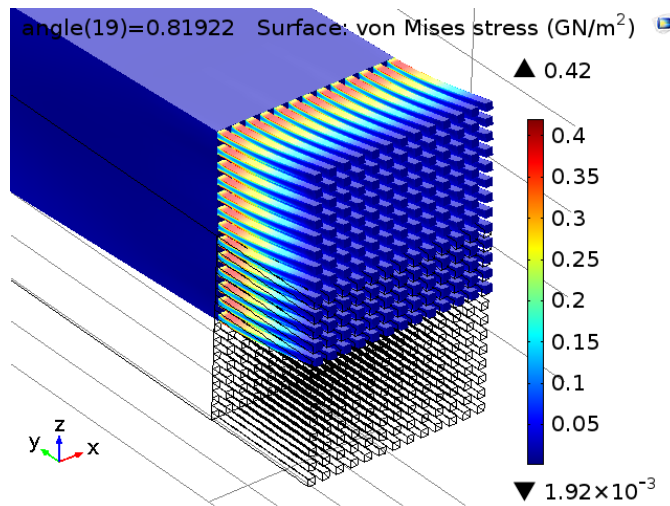

Figure 11: Stress at 50 degree

Figure 12:Stress in Nano hair

From figure 11 and 12 we can analiysis the the stress is only produced at the contact of nano and micro hair only no stress is shown in micro hair and starting of nano hair.
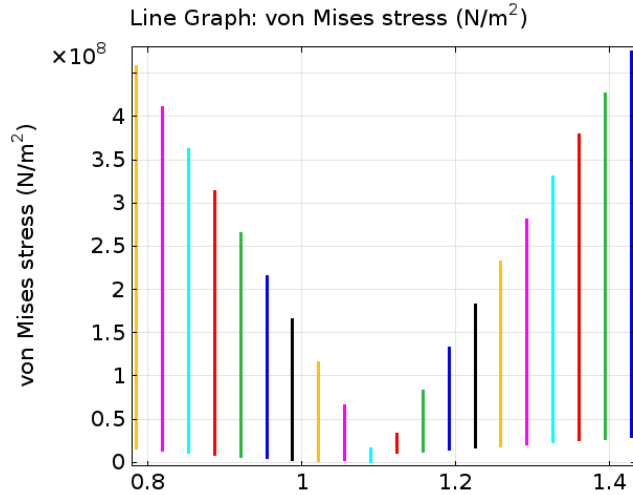
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Figure 13: Stress Vs Angle

By figure 13 it is clear that if the detach angle should be between 60 deg to 65 deg the stress produesed in the nano hair is very less as compared to other values below 60 and above 65 deg. The least stress is produced at 63 degree detach angle.

Now we have analyzed the effect of contact force in the hair when varied from 0.2 to 0.6 uN at 63 deg detach angle.
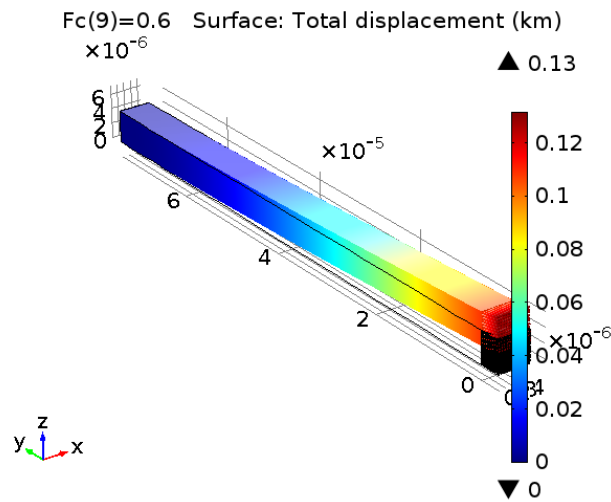

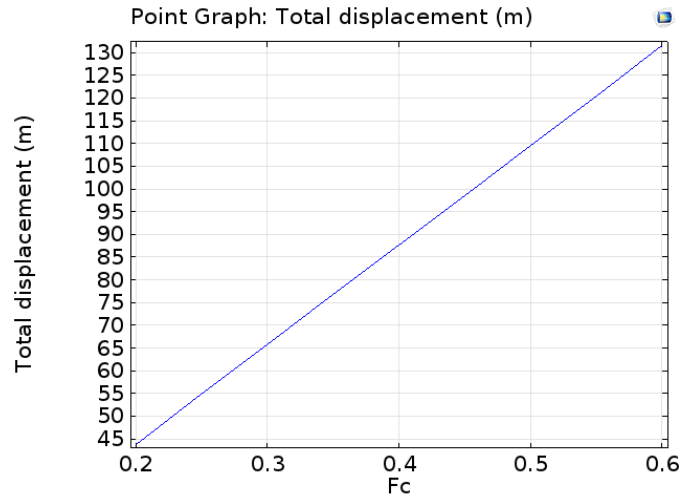*Figure 14: Total Displacement at 0.6 uN Force*

Figure 15: Displacement Vs Force

From figure 14 and 15 we found that as we increase the contact force the movement will increase. it is clear that if the detach angle should be between 60 deg to 65 deg the stress produesed in the nano hair is very less as compared to other values below 60 and above 65 deg. The least stress is produced at 63 degree detach angle.

V.   CONCLUSION

The analysis of gecko foot is divided into to parts firstly we have found a detach angle with minimum stress on the foot the force is varied to get the maximum displacement of the foot. the stress is only produced at the contact of nano and micro hair only no stress is shown in micro hair and starting of nano hair.