BIONICS – HOUSEFLY LIKE INSPIRATION

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Abstract

Bionics is a relatively young science, which was founded by the late 50's and 60's of the 19th Century. This branch of science is the study of natural organisms, materials and structures. These findings are trying to convert to technology. Life on earth has existed for more than 4 billion years. Throughout the organisms on the planet had to adapt to hostile conditions prevailing here. These adaptations brought most of the natural structures and materials to perfection. In this article it was studied a primitive animal, at first sight, that bother many people. The aim of the study is the housefly. How could this little annoying insects inspired us? Housefly is a very good flier, which can very well plough through the vertical smooth glass surface and has a very short reaction time on the stimulus. By scanning electron microscope, we entered into the secret of how to plough through the smooth vertical walls. We were inspired by the structure located at the end of feet of housefly. After a detailed study it was made a model of the feet of housefly in a macro scale. This model was subsequently tested for the functionality in a macro scale.

Key words:

Housefly, rapid prototyping, Scanning Electron Microscopy, Diptera

1. INTRODUCTION

A housefly belong to the order of dipterans (diptera) and it is the best known representative of this order. For animals of this order is typical a single pair of wings. Instead of the second pair of wings the animals of this order have a knobbed structure (halterae), which is used to maintain stability in flight. [1, 2]

Fig. 1 *Photo of the Housefly [3]*

A housefly is most common found near to human dwellings. This is due to the fact that after people a lot of garbage which is an easy bread and butter for housefly is left. The housefly does not need to produce additional energy needed to provide (hunting) some food. An adult can grow to up to the size of 9 mm. [1, 2]

A housefly is able to fly up to 20km without stopping. To compare, Boeing 747 has a range of flight 12 400 km, with the length of the aircraft being 70.6 m. In case of maintaining the ratio of the range of flight to size, boeing should therefore fly a distance of approximately 156 000 km. [3]

2. EXPERIMENTAL PART

2.1 The scanning electron microscope

The scanning electron microscope is a powerful tool that allows to examine materials and structures at multiple magnification (up to 100 000x) and the depth of field is much greater than in the case of light optical microscopes. Scanning electron microscope was used in this article for a detailed view on the fly leg.

2.2 Rapid Prototyping

Using Carl Zeiss AXIOVISIO software was made a measurement of sizes of suction cups. By this measurement was designed a model of first prototype of housefly leg (see figure. 4). In this concept, it was necessary to adjust the size of the model resolution of used production method. For easy preparation and precision of the data was used a Rapid Prototyping. The resolution of used 3D Printer is 200µm. Therefore, the resulting model is in a thousand times higher magnification compare to the original. This model was created with great approximation, it means that the structure was designed as simple as possible.

3. RESULTS AND DISCUSSION

Macro view of a housefly leg taken by SEM is shown in figure 2.

Fig. 2: *Macro view of the Housfly leg, magnification 169x*

From figure 2 is obvious why house fly so easily overcomes rough vertical walls. It is because the legs of the housefly are equipped with a pair of hooks which can catch of the inequality on walls. At higher magnification (see figure 3) we found out that the "foot" of the housefly has special treatment. On the foot are grown hundreds of hairs. These hairs are enlarged at the ends to the shape of bells and thus forming a suction cups.

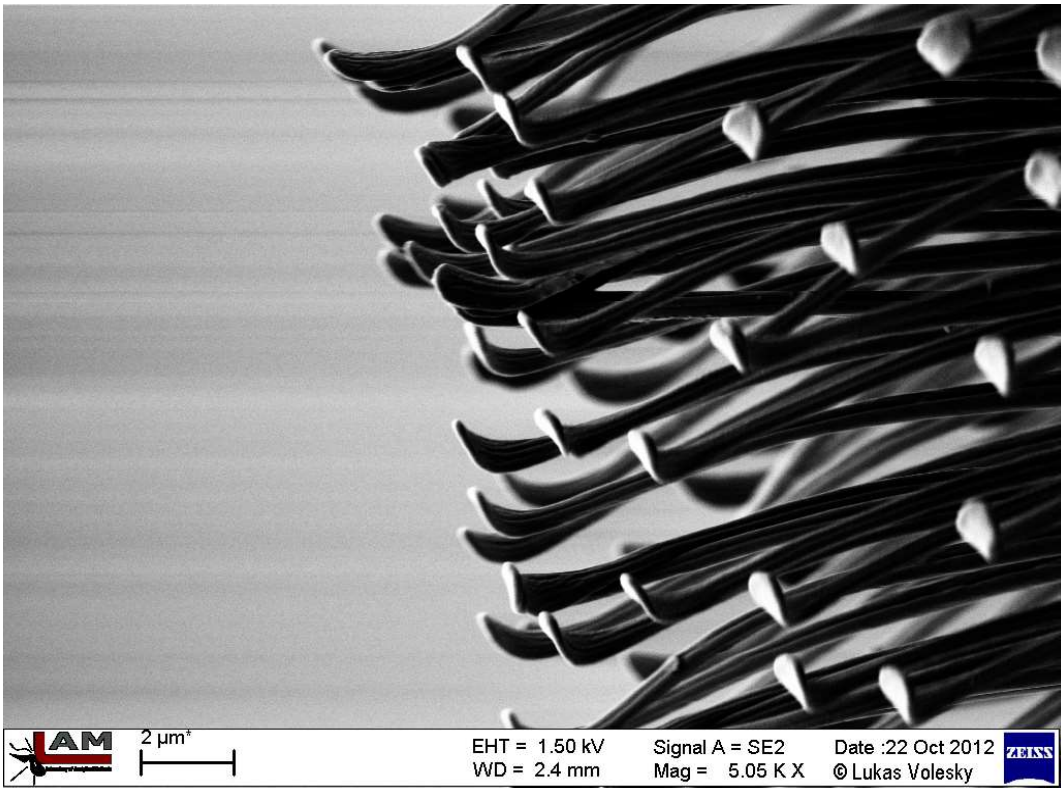

Fig. 3: *Detail view of the Housfly foot, magnification 5.05kx*

*Hou*sefly excludes the viscous liquid that gets stuck between the suction cup and a smooth surface. Once the pressure is being exerted after cracking down on the surface is all the air extruded from the suction cup and inside of the suction cup is hermetically sealed by viscous liquid. In order for the housefly to be able to continue the motion, a simple and quick detaching of suction cups from the surface is necessary. This problem is resolved by misalignment of stem of the suction cups. During the detaching a part of the suction cup is lifted up and the air is being sucked under the suction cup. Due to this simple mechanism the housefly can move on the smooth vertical glass walls.

Fig. 4: *Photo of the first model*

After production of the first prototype it was revealed several defects. The biggest defect of this prototype was a very common damage of "bell" of the suction cup even with very gentle and careful manipulation. This defect was a result of a poorly chosen material and the diameter of the stem. In addition, the model was not very similar to the original. As stated above, the housefly uses misalignment of stem of the suction cups for better detaching of foot from the surface. Both these defects are eliminated in the second model (figure 5). This model has already misalignmented stem of the suction cups and improved mechanical properties of the stem by using a different material and a larger diameter of the stem. The shape of the suction cup was changed so it can better simulate the real shape of suction cup of the housefly.

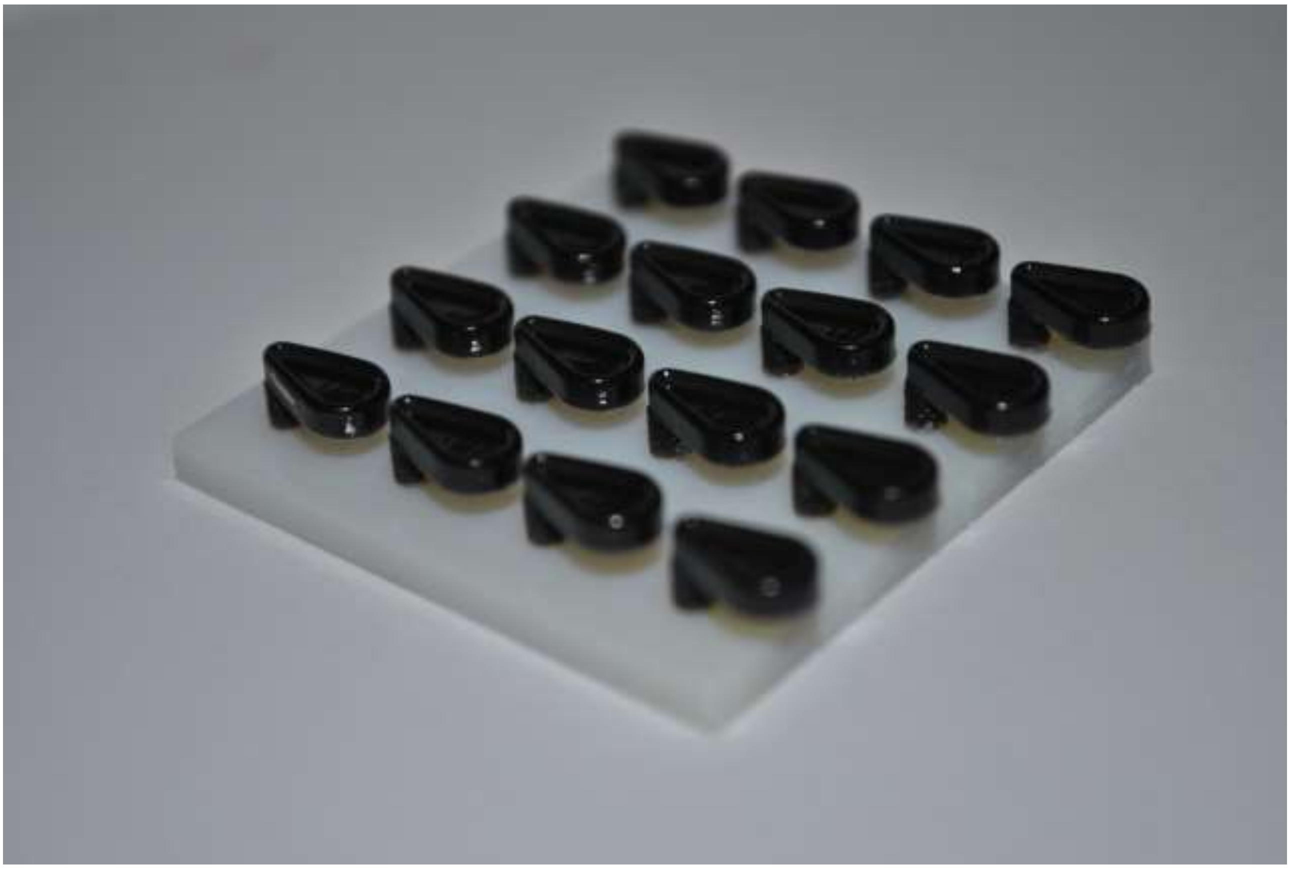

Fig. 5: *Photo of the second model*

4. CONCLUSION

In the future, it is necessary to make test for adhesion of produced model. Considering the size of the housefly leg and the produced model it is necessary to adjusted conditions during testing (such as the viscosity of the used liquid for better airtightness between the smooth surface and and the foot of the housefly).

Natural structures; materials and organisms have evolved and perfected for over 4 billion years. As you can see from the example of housefly, even so "primitive" animal may inspire us to improve the existing structures. Natural structures; materials and organisms are found everywhere around us and nothing can stop us to explore; test and imitate them. Maybe one day it will be find a solving of so far insolvable problems in much more primitive organisms than the above-mentioned housefly.

ACKNOWLEDGMENT

This article is supported by SGS project dealing with Modern trends in material engineering, Faculty of mechanical enginnering, Technical university of Liberec.

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