Micromechanical Actuators for Insect Flight Mechanics

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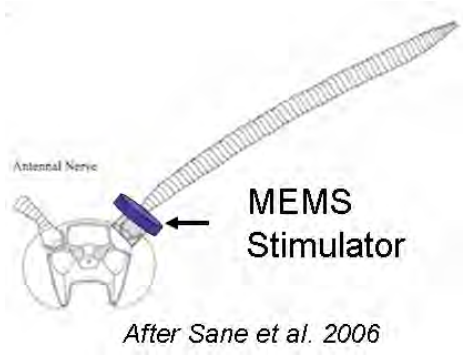
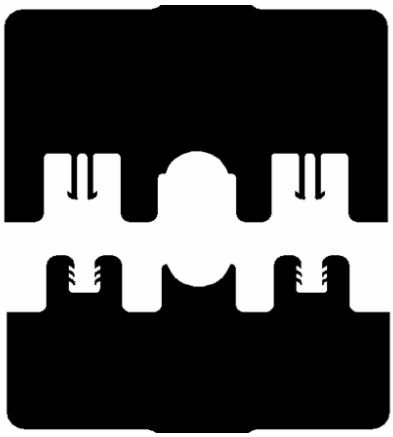
This project aims to develop MEMS actuators to aid in the study of insect flight mechanics. Specifically, we are developing actuators that can stimulate the antennae of the crepuscular hawk moth *Manduca Sexta*. The possible mechanosensory function of antennae as airflow sensors has been suggested [1], and recent discoveries of our collaborators reveal that mechanosensory input from the antennae of flying moths serves a similar role to that of the hind wings of two-winged insects, detecting Coriolis forces and thereby mediating flight stability during maneuvers [2]. Early evidence suggests that mechanical stimulus of the antennae may enable flight control. In addition, the crepuscular hawk moth *Manduca Sexta* has a wide wingspan (~110 mm) and is capable of carrying at least one quarter of its own weight. Thus, studying the flight of *M. Sexta* by attachment of microsystems seems plausible. The goal of our project is to design and fabricate micromechanical actuators, which will be mounted onto the moth antennae (Figure 1). Our collaborators will study the flight control mechanism by mechanical stimulation.

Our first step is to fabricate "dummy" silicon rings for our biologist collaborators for implant experiments. The diameters along the antenna vary from tip to base, being thickest in the middle. As a result, in order to prevent the ring's being thrown off, the mounting of the silicon ring onto the base cannot be as simple as pushing it from the tip with a large inner hole. On the other hand, the sizes of the antennae vary from moth to moth. Two-piece construction was designed and fabricated to be like a "zip strip" to meet the mounting requirements (Figure 2). Future work will focus on refining the design and fabrication of the mounting kit and integrating actuators into it. To generate adequate displacement, strain amplification will be needed, such as reported by Conway, et al. [3].



▲ Figure 1: Schematic view of mechanical actuators for hybrid insects MEMS.



▲ Figure 2: "Zip-strip-" like mounting kit for *M. Sexta* moth antennae.

REFERENCES

[1] M. Gewecke, "Antennae: Another wind-sensitive receptor in locusts," *Nature*, vol. 225, no. 5239, pp. 1263-1264, Mar. 1970.

[2] S.P. Sane, A. Dieudonné, M.A. Willis, and T.L. Daniel, "Antennal mechanosensors mediate flight control in moths," *Science*, vol. 315, pp. 863-866, Feb. 2007.

[3] N.J. Conway and S.-G. Kim, "Large-strain, piezoelectric, in-plane micro-actuator," in *Proc.17th IEEE International Conference on Micro Electro Mechanical Systems*, Maastricht, the Netherlands, Jan. 2004, pp. 454 - 457.