drive the robot forward, the researchers shortened one of the scaffold's pillars, causing the crossbeam to bend slightly and the muscle cells to exert differential force on the pillars.

This bio-bot is no cheetah: it moves at a relatively slow pace of around 1.5 body lengths per minute. However, Bashir hopes that the concept could ultimately be incorporated into a more complex machine with neural connections regulating the muscle cells. "Our next step is working to integrate neurons into the structure, so you could provide a signal to the neuron and the neuron would control the movement," he said.

"It's clear that there's an opportunity to take technological advances and combine them with what nature has developed to come up with ways of making things that are even better," said Ali Khademhosseini, a bioengineer at Harvard-MIT's Division of Health Sciences and Technology who was not involved in the research. "I think [this experiment] opens up a lot of new possibilities."

Laurel Hamers

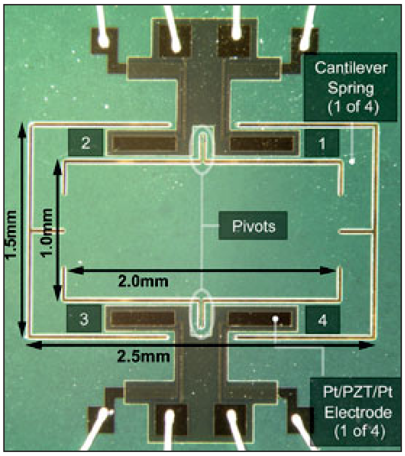
Bio Focus

Fly-inspired PZT sound detector

A team of researchers at The University of Texas at Austin (UT Austin) has developed a tiny prototype device that mimics the hearing mechanism of a parasitic fly, the yellow-colored *Ormia ochracea*. This development may be useful for a new generation of hypersensitive hearing aids. Described in the July 22 online edition of *Applied Physics Letters* (DOI: 10.1063/1.4887370), the 2-mm-wide device uses piezoelectric materials, which turn mechanical strain into electric signals. The use of these materials means that the device requires very little power.

The space between the ears of insects is typically so small that sound waves essentially hit both sides simultaneously. However, the *O. ochracea* has an unusual physiological mechanism in which the sound phase shifts slightly when the sound goes in one ear and when it goes in the other. The fly, whose ears are less than 2 mm apart, has an ear structure that resembles a tiny teeter-totter seesaw about 1.5 mm long. Teeter-totters, by their very nature, vibrate such that opposing ends have a 180° phase difference, so even very small phase differences in incident pressure waves force a mechanical motion that is 180° out of phase with the other end. This effectively amplifies the four-millionths of a second time delay the *O. ochracea* experiences in its hearing.

Neal Hall, an assistant professor in the Electrical and Computer Engineering Department at UT Austin, and his graduate student Michael Kuntzman built a miniature pressure-sensitive teeter-totter in silicon that has a flexible beam and integrated piezoelectric materials. By using multiple piezoelectric sensing ports, the researchers enable numerous vibration modes which then amplify the interaural time and level differences such as the fly experiences. The use of piezoelectric materials was their original innovation, and it allowed them to simultaneously measure the flexing and the rotation of the teeter-totter beam. Simultaneously measuring these two vibration modes allowed the researchers to replicate the fly's special ability to detect sound direction in a device essentially the same size as the fly's physiology.



A photograph of the biologically inspired microphone taken under a microscope, providing a top-side view. The tiny structure rotates and flaps about the pivots (labeled), producing an electric potential across the electrodes (labeled). Credit: N.Hall/UT Austin.

Bio Focus

Conducting polymers utilized to overcome electrode limits in ionic transport systems

The transport of particles through a fluid by an electric current, known as electrokinetics, is a process used in a number of well-known applications such as gel electrophoresis and drug delivery systems. These types of ionic conductors operate based on the interaction of a direct current (DC), applied between metal electrodes and charged ions suspended in a fluid. This process, however, can have a number of critical drawbacks such as the production of chemical side products or gases that may impede particle movement. Moreover, the charge limitations of typical metal electrodes present the largest handicap to current technology in this field.

As reported in the August 13 issue of *Advanced Materials* (DOI: 10.1002/adma.201401258; p. 5143), Magnus Berggren and his research team from Linköping University in Sweden have built a four-diode full-wave rectifier for the transport of ionic species using conducting polymer electrodes to overcome this considerable restriction. Conducting polymers can be used to improve electrode capacity by increasing effective electrode area; however, most conducting polymers cannot withstand prolonged DC, necessitating alternating current (AC) operation. The AC acts just as it would in an electrical circuit, producing a periodic reversal in the direction of particle flow that would produce no

https://doi.org/10.1557/mrs.2014.227 Published online by Cambridge University Press