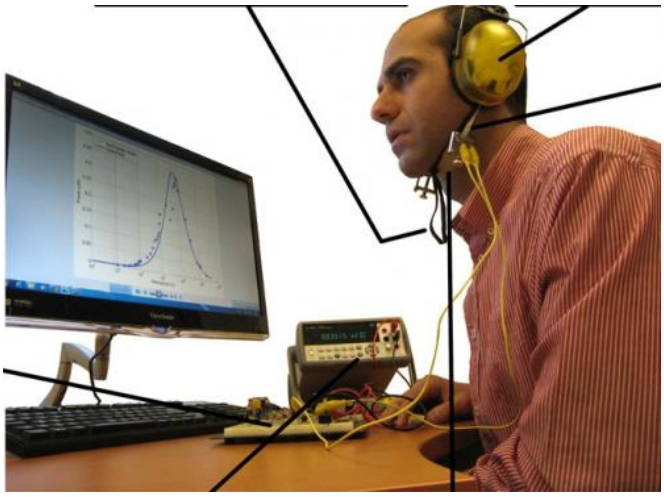
# 'Smart material' chin strap harvests energy from chewing

16 September 2014



Experimental set up of an energy harvesting chin strap. Credit: *Smart Materials and Structures*

A chin strap that can harvest energy from jaw movements has been created by a group of researchers in Canada.

It is hoped that the device can generate electricity from eating, chewing and talking, and power a number of small-scale implantable or wearable electronic devices, such as hearing aids, cochlear implants, electronic hearing protectors and communication devices.

The first results of the device's performance have been published today, 17 September, in *Smart Materials and Structures*.

Jaw movements have proved to be one of the most promising candidates for generating electricity from human body movements, with researchers estimating that an average of around 7 mW of power could be generated from chewing during meals alone.

To harvest this energy, the study's researchers, from Sonomax-ETS Industrial Research Chair in In-ear Technologies (CRITIAS) at École de technologie supérieure (ÉTS) in Montreal, Canada, created a chin strap made from piezoelectric fiber composites (PFC).

PFC is a type of piezoelectric smart material that consists of integrated electrodes and an adhesive polymer matrix. The material is able to produce an electric charge when it stretches and is subjected to mechanical stress.

In their study, the researchers created an energy harvesting chin strap made from a single layer of PFC and attached it to a pair of ear muffs using a pair of elastic side straps. To ensure maximum performance, the chin strap was fitted snugly to the user, so when the user's jaw moved it caused the strap to stretch.

To test the performance of the device, the subject was asked to chew gum for 60 seconds whilst wearing the head-mounted device; at the same time the researchers recorded a number of different parameters.

The maximum amount of power that could be harvested from the jaw movements was around 18 µW, but taking into account the optimum set-up for the head-mounted device, the power output was around 10 µW.

Co-author of the study Aidin Delnavaz said: "Given that the average power available from chewing is around 7 mW, we still have a long way to go before we perfect the performance of the device.

"The power level we achieved is hardly sufficient for powering electrical devices at the moment; however, we can multiply the power output by adding more PFC layers to the chin strap. For example, 20 PFC layers, with a total thickness of 6 mm, would be able to power a 200 µW intelligent

hearing protector."

One additional motivation for pursuing this area of research is the desire to curb the current dependency on batteries, which are not only expensive to replace but also extremely damaging to the environment if they are not disposed of properly.

"The only expensive part of the energy harvesting device is the single PFC layer, which costs around $20. Considering the price and short lifetime of batteries, we estimate that a self-powered hearing protector based on the proposed chin strap energy harvesting device will start to pay back the investment after three years of use," continued Delnavaz.

"Additionally, the device could substantially decrease the environmental impact of batteries and bring more comfort to users.

"We will now look at ways to increase the number of piezoelectric elements in the chin strap to supply the power that small electronic devices demand, and also develop an appropriate power management circuit so that a tiny, rechargeable battery can be integrated into the device."

**More information:** 'Flexible piezoelectric energy harvesting from jaw movements' Delnavaz A and Voix J 2014 *Smart Mater. Struct.* 23 105020: iopscience.iop.org/0964-1726/23/10/105020

Provided by Institute of Physics