Engineers create ultra-sensitive artificial skin

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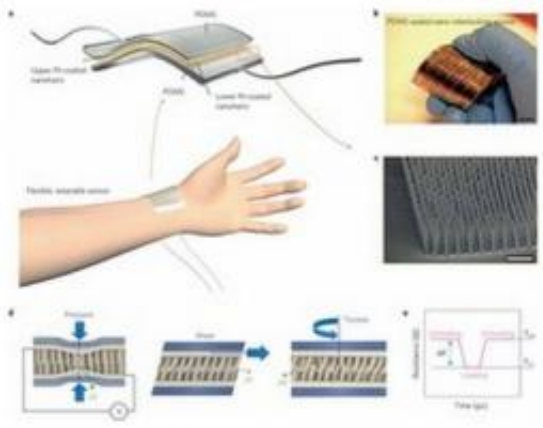

Multiplex, flexible strain-gauge sensor based on the reversible interlocking of Pt-coated polymer nanofibres. Image: *Nature Materials* (2012) doi:10.1038/nmat3380

(Phys.org) -- Engineers from South Korea and the United States working together have developed a new type of artificial skin that is less complex, cheaper to make and more sensitive than other electronic sensors designed to mimic human skin. In their paper published in *Nature Materials*, the team says the idea for their strain gauging material came from the way tiny hairs on some beetles' bodies interlock with equally tiny hairs on their wings, allowing them to sense very small external stimuli.

To replicate the beetle sensing abilities, the team attached a multitude of polymer fibers, each just 1 micrometer long and 100 nanometers around,

to a solid base, forming what looked like a tiny bed of nails. They then created another just like it and placed in on top of the first, causing the "hairs" of each to intermingle, sort of like pushing two hairbrushes together. Since each fiber was coated with a very thin layer of metal, the team was able to measure electrical current sent though them. The amount of current varied at each hair junction depending on how much of the hair touched another, and that varied depending on external stimulation. With this arrangement, the team was able to measure torque (twisting motion), direct overhead pressure and sheer, which is what happens when the material is subjected to sideways movement, such as a gentle caress.

In testing their artificial skin, the team found that they were able to trace the path of a tiny bug as it made its way across its surface, to detect the motion of a water droplet and even the subtle beating of a human heart when it was placed against the skin.

The researchers say that their method replaces the complex circuits that others have used to allow robots to "feel" their environment with something that is much simpler to create and use. Their design is also somewhat proven in that the sensor reception electronics is not unlike that used in some screen displays that rely on tactile input via user's fingers.

In addition to allowing robots to gain a better understanding of their environment, it's possible the new technology might one day be used to help human beings who have lost feeling in their skin or better, as way to restore sensation to those with artificial limbs.

More information: A flexible and highly sensitive strain-gauge sensor using reversible interlocking of nanofibres, *Nature Materials* (2012) doi:10.1038/nmat3380

Abstract

Flexible skin-attachable strain-gauge sensors are an essential component in the development of artificial systems that can mimic the complex characteristics of the human skin. In general, such sensors contain a number of circuits or complex layered matrix arrays. Here, we present a simple architecture for a flexible and highly sensitive strain sensor that enables the detection of pressure, shear and torsion. The device is based on two interlocked arrays of high-aspect-ratio Pt-coated polymeric nanofibres that are supported on thin polydimethylsiloxane layers. When different sensing stimuli are applied, the degree of interconnection and the electrical resistance of the sensor changes in a reversible, directional manner with specific, discernible strain-gauge factors. The sensor response is highly repeatable and reproducible up to 10,000 cycles with excellent on/off switching behaviour. We show that the sensor can be used to monitor signals ranging from human heartbeats to the impact of a bouncing water droplet on a superhydrophobic surface.