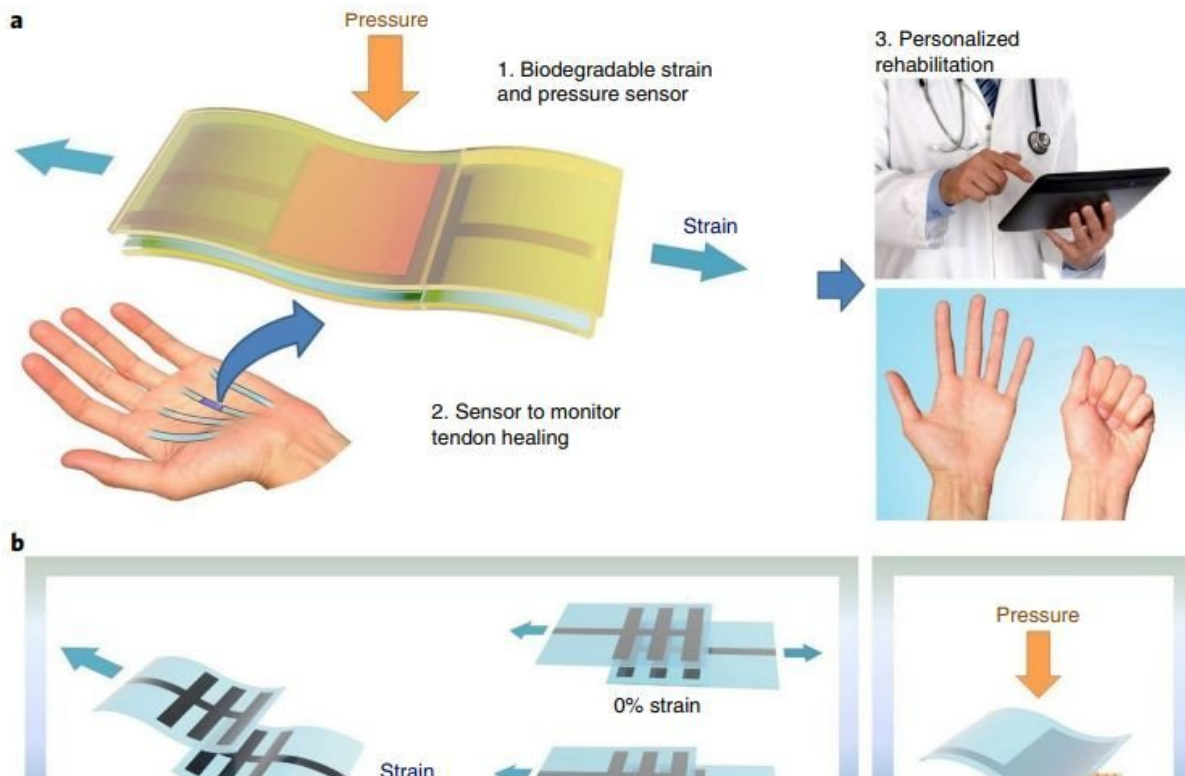


Implantable sensor decomposes when its usefulness ends

May 15 2018, by Bob Yirka



A fully biodegradable and stretchable strain and pressure sensor. a, The sensor can be attached to a tendon for real-time healing assessment, allowing the rehabilitation protocol after a tendon repair to be personalized for each patient. b, Concepts used for strain and pressure sensing. Strain sensing: On application of strain, the two thin-film comb electrodes slide relative to each other, resulting in variation of the capacitance. The range of 0–15% for strain sensing is chosen based on the fact that in vivo the strain exerted on tendons is lower than 10%. Pressure sensing: On application of pressure, variation of the distance between the top and bottom electrodes results in variation of the capacitance. The

dielectric layer, made of a thin, highly compressible, regularly microstructured rubber, enables the sensor to have high pressure sensitivity and a fast response time, improving the sensitivity by several orders of magnitude compared to previously published work based on an air gap approach. c, Materials and overall assembly of the fully biodegradable strain and pressure sensor. The biodegradable elastomer PGS (poly(glycerol sebacate)) is used as a dielectric layer for the capacitor constituting the pressure sensor. It is also used in the strain sensor architecture as a stretchable non-sticking layer, allowing the electrodes to slide relative to each other. The biodegradable elastomer POMaC (poly(octamethylene maleate (anhydride) citrate)) is used for the strain sensor and packaging¹⁸. POMaC is a soft stretchable biodegradable elastomeric biomaterial synthesized from citric acid, maleic anhydride and 1,8-octanediol, which is able to mimic the mechanical properties of a wide range of soft biological tissues. PLLA is the substrate layer for the magnesium electrodes. d, Picture of the assembled sensor. Credit: *Nature Electronics* (2018). DOI: 10.1038/s41928-018-0071-7

A team of researchers based at Stanford University has developed a new kind of implantable strain and pressure sensor that decomposes harmlessly when its usefulness ends. In their paper published in the journal *Nature*, the group describes developing and testing their sensor. Sung-Geun Choi and Seung-Kyun Kang with Korea Advanced Institute of Science and Technology offer a News & Views [piece](#) on the work done by the team at Stanford in the same journal issue.

As most people know, the standard procedure for recovery from orthopedic surgery is physical rehabilitation. But knowing how much stress or pressure repaired parts can withstand is still more art than science. For that reason, scientists have been looking for ways to implant [sensors](#) that will give a more accurate measure of what is going on inside the body during rehab. Ideally, such sensors would simply disappear once they are no longer needed—otherwise, a second surgery would be

necessary to remove them. But until now, such sensors have suffered from performance issues or were not wholly biocompatible. In this new effort, the team at Stanford reports that their new sensor overcomes both issues.

The sensor structure was made by stacking two sensors, one for measuring strain, the other for pressure—it was made from two types of biocompatible and biodegradable polymers and also features magnesium electrodes. The final product involved five layers of material including top and bottom packaging, covering the sensors. The team tested the sensor by implanting it in the back of a rat.

The team reports that the sensor was capable of measuring strains as small as 0.4 percent and pressures as small as 12 Pa. In addition, other than a small amount of initial inflammation, they observed no ill effects in the rat. They report also that they were able to set the amount of time before decomposition by mixing the ingredients when making the sensor structure. As a bonus, they noted that the sensor operated normally during the decomposition period, and only ceased when it was no longer useful. Furthermore, they report that [decomposition](#) of the sensor did not cause any problems for the rat.

More information: Clementine M. Boutry et al. A stretchable and biodegradable strain and pressure sensor for orthopaedic application, *Nature Electronics* (2018). [DOI: 10.1038/s41928-018-0071-7](https://doi.org/10.1038/s41928-018-0071-7)

Abstract

The ability to monitor, in real time, the mechanical forces on tendons after surgical repair could allow personalized rehabilitation programmes to be developed for recovering patients. However, the development of devices capable of such measurements has been hindered by the strict requirements of biocompatible materials and the need for sensors with satisfactory performance. Here we report an implantable pressure and

strain sensor made entirely of biodegradable materials. The sensor is designed to degrade after its useful lifetime, eliminating the need for a second surgery to remove the device. It can measure strain and pressure independently using two vertically isolated sensors capable of discriminating strain as small as 0.4% and the pressure exerted by a grain of salt (12 Pa), without them interfering with one another. The device has minimal hysteresis, a response time in the millisecond range, and an excellent cycling stability for strain and pressure sensing, respectively. We have incorporated a biodegradable elastomer optimized to improve the strain cycling performances by 54%. An in vivo study shows that the sensor exhibits excellent biocompatibility and function in a rat model, illustrating the potential applicability of the device to the real-time monitoring of tendon healing.

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