Highly uniform and low hysteresis pressure sensor to increase practical applicability

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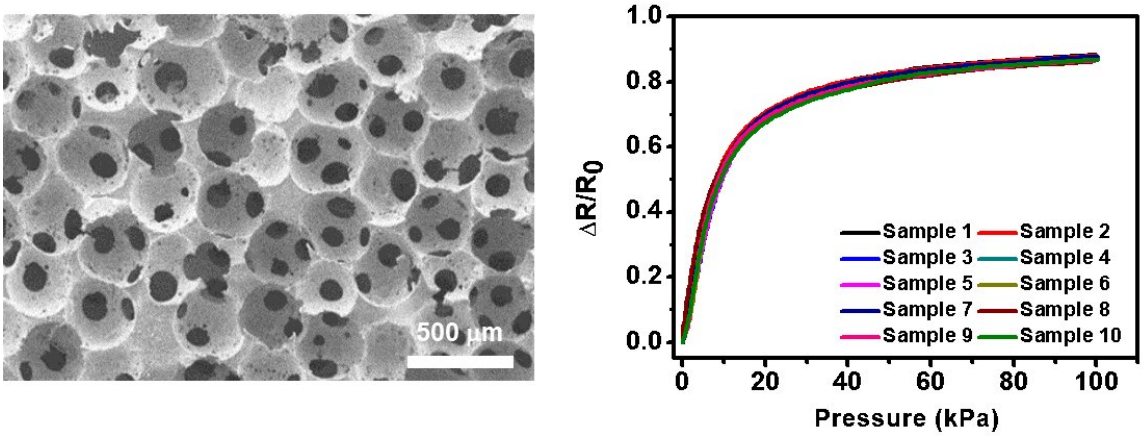

Figure 1. Image of a porous elastomer template with uniform pore size and shape (left), Graph showing high uniformity in the sensors' performance (right). Credit: The Korea Advanced Institute of Science and Technology (KAIST)

Researchers have designed a flexible pressure sensor that is expected to have a much wider applicability. A KAIST research team fabricated a piezoresistive pressure sensor of high uniformity with low hysteresis by chemically grafting a conductive polymer onto a porous elastomer template.

The team discovered that the uniformity of pore size and shape is directly related to the uniformity of the sensor. The team noted that by

increasing pore size and shape variability, the variability of the sensor characteristics also increases.

Researchers led by Professor Steve Park from the Department of Materials Science and Engineering confirmed that compared to other sensors composed of randomly sized and shaped pores, which had a coefficient of variation in relative resistance change of 69.65 percent, their newly developed sensor exhibited much higher uniformity with a coefficient of variation of 2.43 percent. This study was reported in *Small* as the cover article on August 16.

Flexible pressure sensors have been actively researched and widely applied in electronic equipment such as touch screens, robots, wearable healthcare devices, electronic skin, and human-machine interfaces. In particular, piezoresistive pressure sensors based on elastomer-conductive material composites hold significant potential due to their many advantages including a simple and low-cost fabrication process.

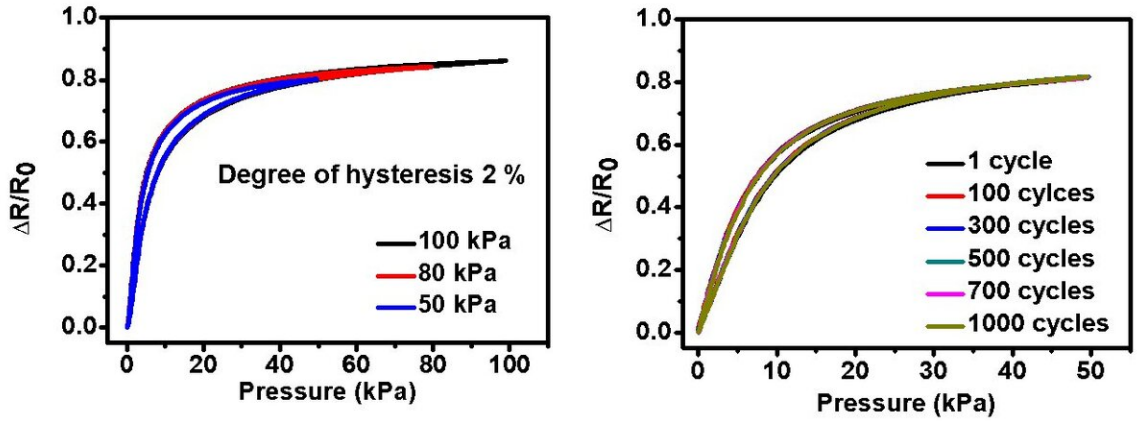

Figure 2. Hysteresis loops of the sensor at different pressure levels (left), and after a different number of cycles (right). Credit: The Korea Advanced Institute of Science and Technology (KAIST)

Various research results have been reported for ways to improve the performance of piezoresistive pressure sensors, most of which have been focused on increasing the sensitivity. Despite its significance, maximizing the sensitivity of composite-based piezoresistive pressure sensors is not necessary for many applications. On the other hand, sensor-to-sensor uniformity and hysteresis are two properties that are of critical importance to realize any application.

The importance of sensor-to-sensor uniformity is obvious. If the sensors manufactured under the same conditions have different properties, measurement reliability is compromised, and therefore the sensor cannot be used in a practical setting.

In addition, low hysteresis is also essential for improved measurement reliability. Hysteresis is a phenomenon in which the electrical readings differ depending on how fast or slow the sensor is being pressed, whether pressure is being released or applied, and how long and to what degree the sensor has been pressed. When a sensor has high hysteresis, the electrical readings will differ even under the same pressure, making the measurements unreliable.

Researchers said they observed a negligible hysteresis degree which was only 2 percent. This was attributed to the strong chemical bonding between the conductive polymer and the elastomer template, which prevents their relative sliding and displacement, and the porosity of the elastomer that enhances elastic behavior.

"This technology brings forth insight into how to address the two critical issues in pressure sensors: uniformity and hysteresis. We expect our technology to play an important role in increasing practical applications and the commercialization of pressure sensors in the near future," said

Professor Park.

More information: Jinwon Oh et al. Highly Uniform and Low Hysteresis Piezoresistive Pressure Sensors Based on Chemical Grafting of Polypyrrole on Elastomer Template with Uniform Pore Size, *Small* (2019). DOI: 10.1002/smll.201901744

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