Research team develops technology for creating flexible sensors on topographic surfaces

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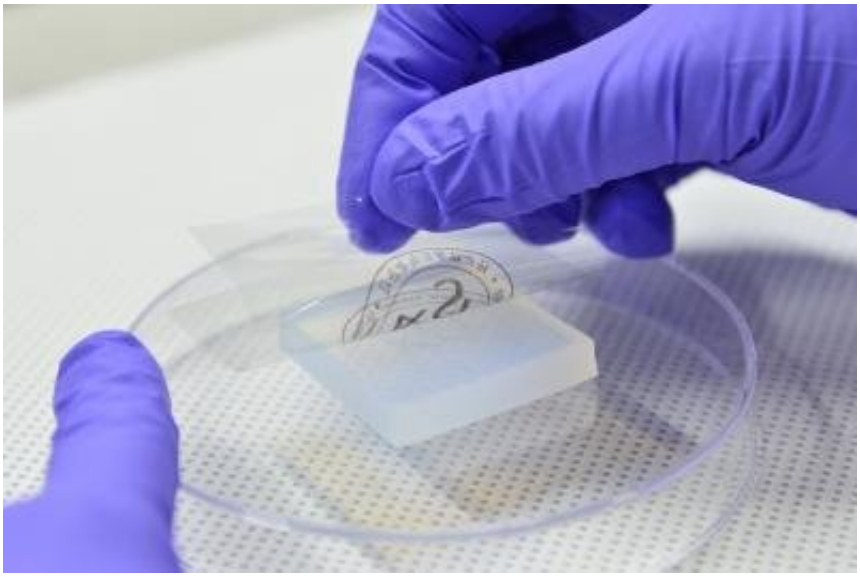
The real transfer-printing electrode that uses hydrogel and nano ink produced by Hyunjung Yi of the KIST's Post-Silicon Semiconductor Institute. Credit: Korea Institute of Science and Technology (KIST)

At the Korea Institute of Science and Technology, Dr. Hyunjung Yi of the Post-Silicon Semiconductor Institute and her research team have developed a transfer-printing technology that uses hydrogel and nano ink to create high-performance sensors on flexible substrates of diverse shapes and structures.

Withe the popularity of wearable devices including smartwatches and fitness bands that are attached directly to the skin, there is growing demand for technologies that allow for the production of high-performance sensors on surfaces of various shapes and types.

Transfer printing works in a way similar to that of a tattoo sticker—sticking the tattoo sticker on the skin and then removing the paper backing leaves an image on the skin. The newly developed process creates a structure on one surface and then transfers it to another in a similar way. The most notable advantage of this process is that it largely avoids the difficulties involved in creating devices directly on substrates that are thermally and/or chemically sensitive, which is why transfer printing is widely used for the manufacturing of flexible devices. On the other hand, the primary disadvantage of the current transfer printing processes is that they can usually only be used for substrates with flat surfaces.

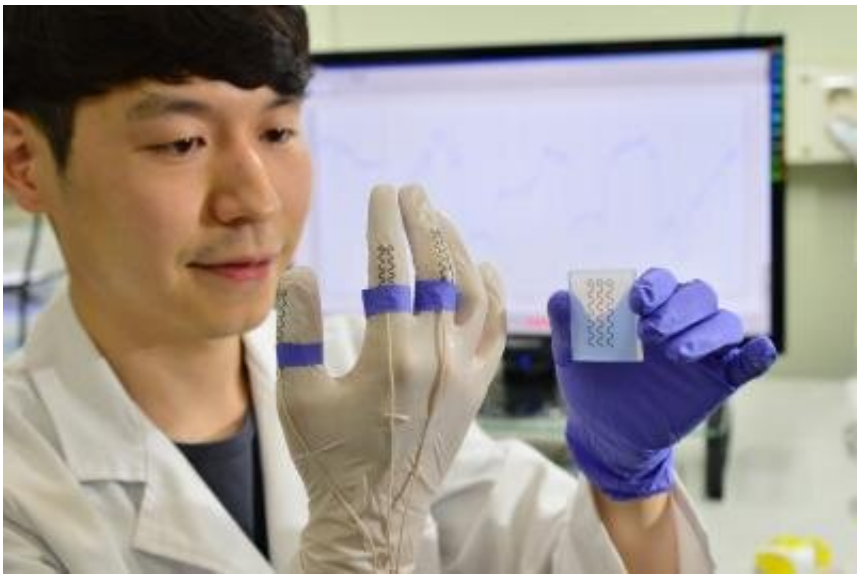


It is easily transferring electrodes on top of hydrogel (bottom) to PET film (top) with the transfer-printing technology that was developed by a researcher of KIST's Post-Silicon Semiconductor. Credit: Korea Institute of Science and

The KIST team overcame these limitations by developing a simple and easy transfer printing process that allows for the creation of high-performance, flexible sensors on topographic surfaces with diverse features and textures.

Using the porous and hydrophilic nature of hydrogels, the KIST team inkjet-printed an aqueous solution-based nano ink onto a hydrogel layer, which was solidified onto a topographic surface. The surfactant and water in the nano ink passed quickly through the hydrogel's porous structure, leaving only the hydrophobic nanomaterial remaining on the surface—the particles are greater in length than the diameter of the holes in the hydrogel.

The amount of nano ink used for this printing process was very small, allowing for the rapid formation of electrodes. Moreover, the electrical performance of the electrodes was outstanding due to the high levels of purity and uniformity of the resulting nanonetworks. Also, because of the hydrophobic nature of the nanomaterial, there was an extremely low degree of interaction between it and the hydrogel, allowing for the easy transfer of the electrodes to diverse topographic surfaces.



With the transfer-printing technology developed by researcher of KIST's Post-Silicon Semiconductor, they are conducting experiments to detect finger movements by implementing high-performance sensors on top of experimental gloves. Credit: Korea Institute of Science and Technology (KIST)

T technology for transferring nanonetworks via a method that solidifies a moldable elastomeric fluid onto a hydrogel surface enables the easy creation of flexible electrodes, even on substrates with rough surfaces. The team transferred nanoelectrodes directly onto a glove to create a modified sensor that can immediately detect finger movements. It also created a flexible, high-performance pressure sensor that can measure the pulse in the wrist.

Yi said, "The outcome of this study is a new and easy method for creating flexible, high-performance sensors on surfaces with diverse characteristics and structures. We expect that this study will be utilized in the many areas that require the application of high-performance materials onto flexible and/or non-traditional substrates, including digital healthcare, intelligent human-machine interfaces, medical engineering,

and next-generation electrical materials."

More information: Tae-Hyung Kang et al, Hydrogel-Templated Transfer-Printing of Conductive Nanonetworks for Wearable Sensors on Topographic Flexible Substrates, *Nano Letters* (2019). DOI: 10.1021/acs.nanolett.9b00764

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