'Transformative electronics systems' to broaden wearable applications

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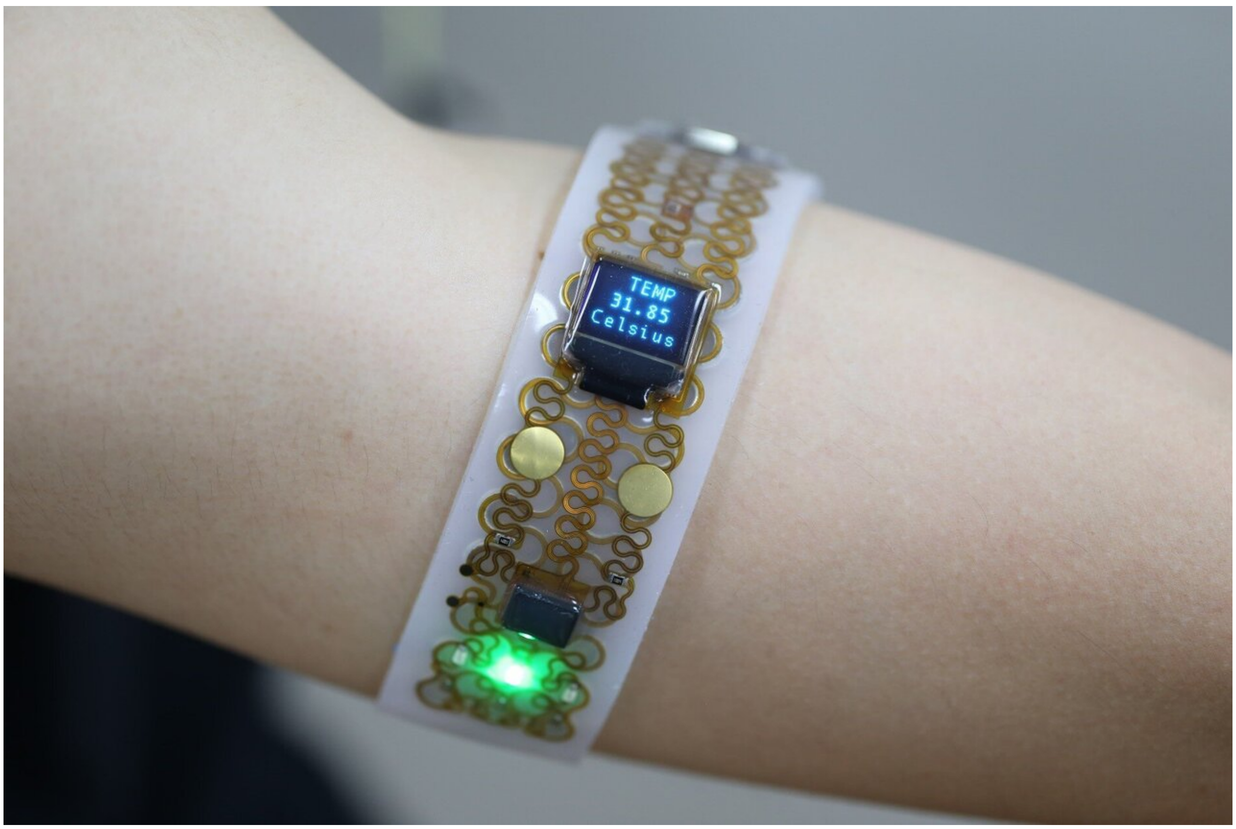


Transformative electronics in soft mode, which becomes wearable for outdoor applications. Credit: KAIST

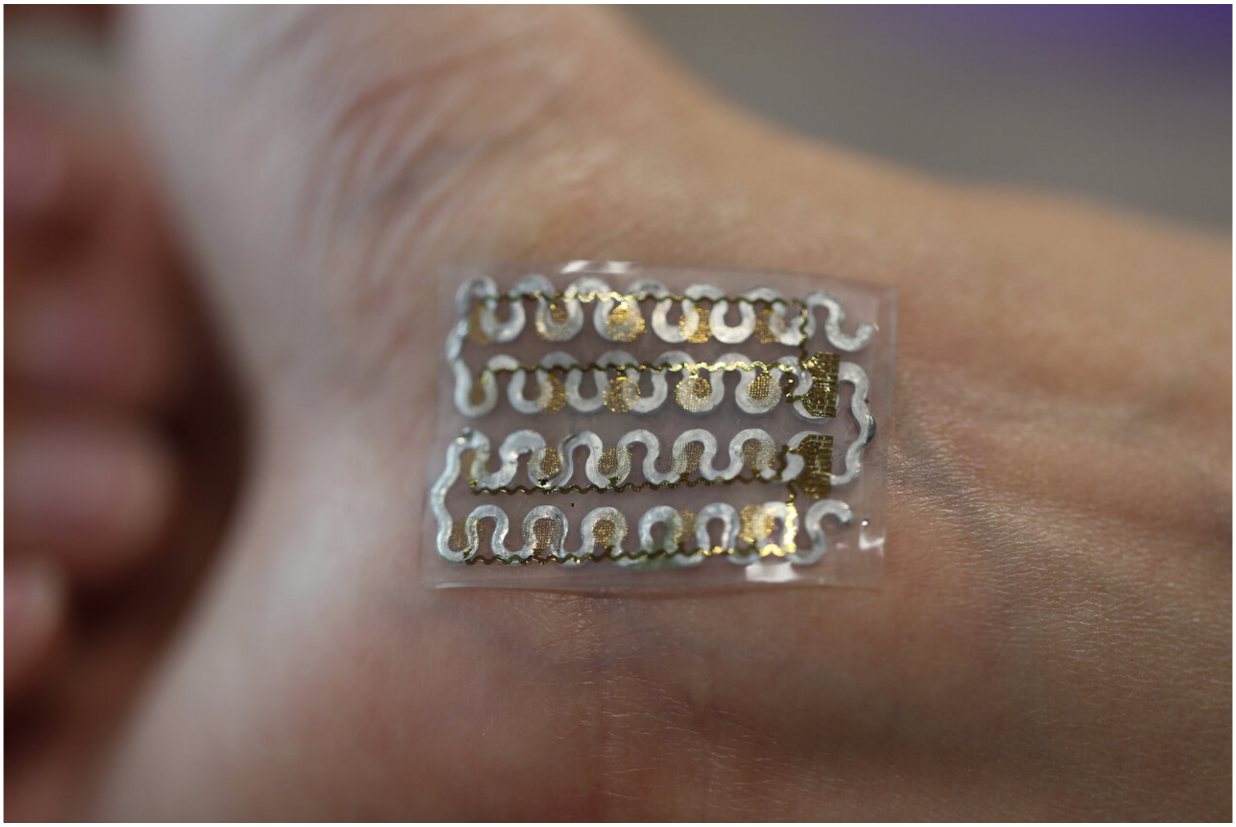
Imagine a handheld electronic gadget that can soften and deform when attached to our skin. This will be the future of electronics we all dreamed of. A research team at KAIST says their new platform called 'Transformative Electronics Systems' will open a new class of electronics, allowing reconfigurable electronic interfaces to be optimized for a variety of applications.

A team working under Professor Jae-Woong Jeong from the School of Electrical Engineering at KAIST has invented a multifunctional electronic platform that can mechanically transform its shape, flexibility, and stretchability. This platform, which was reported in *Science Advances*, allows users to seamlessly and precisely tune its stiffness and shape.

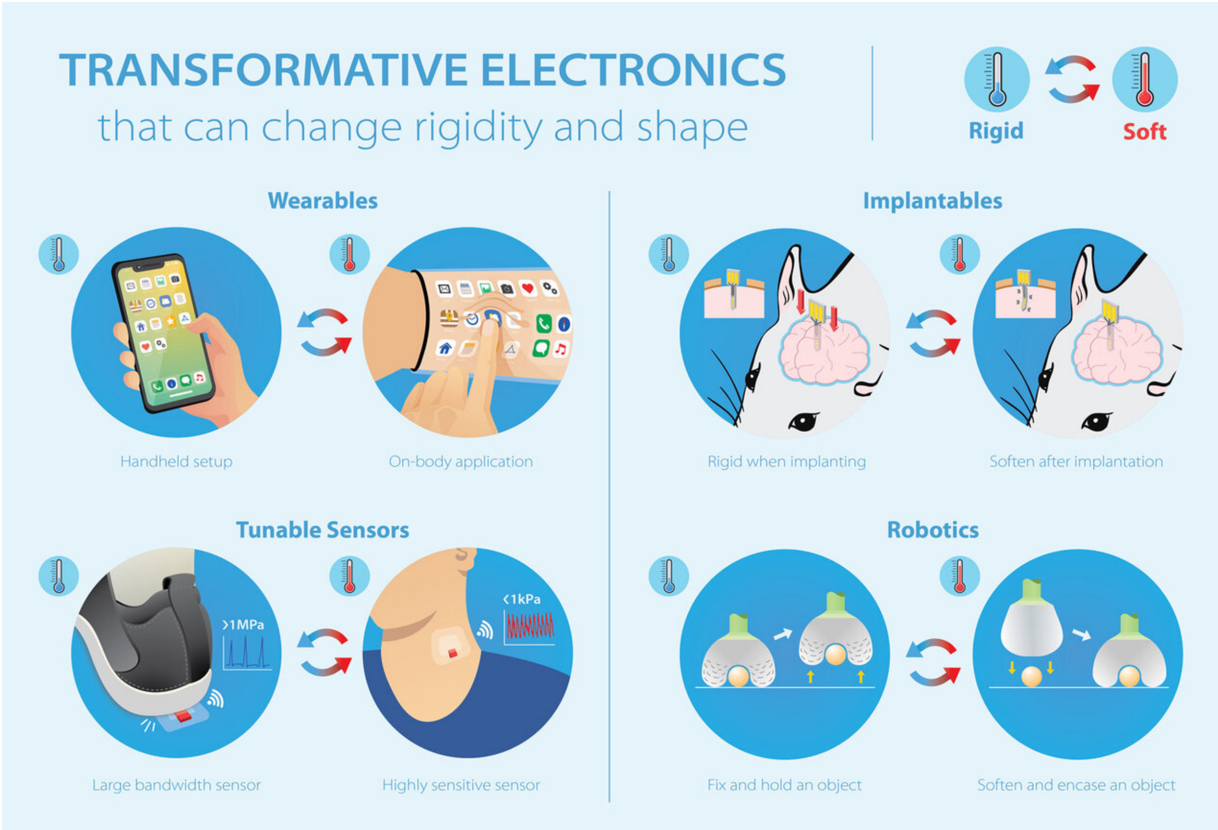
"This new class of electronics will not only offer robust, convenient interfaces for use in both tabletop and handheld setups, but also allow seamless integration with the skin when applied onto our bodies," said Professor Jeong.

The transformative electronics consist of a special gallium metal structure, hermetically encapsulated and sealed within a soft silicone material, combined with electronics that are designed to be flexible and stretchable. The mechanical transformation of the electronic systems is specifically triggered by temperature change events controlled by the user.

"Gallium is an interesting key material. It is biocompatible, has high rigidity in solid form, and melts at a temperature comparable to the skin's temperature," said lead author Sang-Hyuk Byun, a researcher at KAIST.



Transformative electronics adaptable to skin deformation. Credit: Jeong Research Group, KAIST



Infographic that shows the concept of transformative electronics. Credit: Jeong Research Group, KAIST

Once the transformative electronic platform comes in contact with a human body, the gallium metal encapsulated inside the silicone changes to a liquid state and softens the whole electronic structure, making it stretchable, flexible, and wearable. The gallium metal then solidifies again once the structure is peeled off the skin, making the electronic circuits stiff and stable. When flexible electronic circuits were integrated into these transformative platforms, it gave them the ability to become either flexible and stretchable or rigid.

"This technology could not have been achieved without interdisciplinary efforts," said co-lead author Joo Yong Sim, who is a researcher with ETRI. "We worked together with electrical, mechanical, and biomedical engineers, as well as material scientists and neuroscientists to make this breakthrough."

This universal electronics platform allowed researchers to demonstrate applications that were highly adaptable and customizable, such as multi-purpose personal electronics with variable stiffness and stretchability, a pressure sensor with tuneable bandwidth and sensitivity, and a neural probe that softens upon implantation into brain tissue.

Applicable for both traditional and emerging electronics technologies, this breakthrough can potentially reshape the consumer electronics industry, especially in the biomedical and robotic domains. The researchers believe that with further development, this novel electronics technology can significantly impact the way we use electronics in our daily life.

More information: DOI: 10.1126/sciadv.aay0418 S.-H. Byun el al., "Mechanically transformative electronics, sensors, and implantable devices," *Science Advances* (2019). advances.sciencemag.org/content/5/11/eaay0418

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