NTU Singapore scientists produce innovative ultrathin and stretchable electronics with wide range of applications in health and wellness

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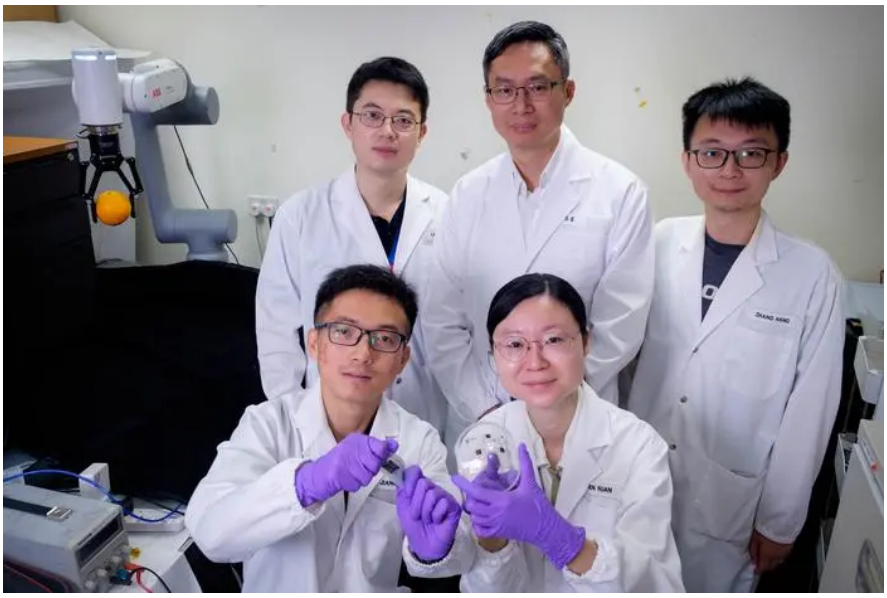

Credit: NTU Singapore

Waving your hand at a robot and controlling it to pick up an item may sound like a Jedi using the Force in a Star Wars movie, but this has become a reality at **Nanyang Technological University, Singapore (NTU Singapore).**

NTU Singapore has set up a **high-tech pilot laboratory** capable of rapid prototyping ultrathin and stretchable electronics that detect bioelectric signals from skin, muscles and organs, and transmit these signals to control robots or other electronic devices.

When these smart sensors are attached to limbs or the head, they empower individuals with limb disabilities or mobility impairments by providing an accessible method to control robotic prostheses, machinery, and motorised wheelchairs using alternative muscle movements and bio-signals.

According to the United Nations, about 15 per cent of the world's population is living with some form of disability[1].

NTU researchers developed these innovative soft electronics devices by combining in-house designed soft materials and processes with commercially available hardware components.

This hybrid combination allows the NTU team to integrate many types of sensors on the market, such as wireless connectivity, accelerometer, temperature sensing, and monitoring vitals like heart rate, blood pressure, oxygen levels, and more.

The resulting sensors, encased in a gel-like skin, are soft, flexible and stretchable, similar to silicon bandages used in healthcare. These sensors adhere to the skin, enable joint movement, and come in various sizes and thicknesses, ranging from centimetres to sub-microns – thinner than the width of a human hair (0.01 millimetres).

Spearheading these numerous innovations, **NTU Professor Chen Xiaodong** has been a trailblazer in soft electronics over the last decade and has his name in over 50 patents. His scientific breakthroughs have earned him multiple prestigious accolades including Singapore's prestigious **President's Science Award 2021**, and most recently, the Kabiller Young Investigator Award 2023 presented by Northwestern University in US.

Over the years, Prof Chen's research projects and innovations have been supported by the **National Research Foundation, Singapore (NRF)**, **Agency for Science, Technology and Research (A*STAR)**, and NTU, resulting in many promising technologies with impactful practical applications.

For instance, his most recent breakthrough is **a new biocompatible material that can readily shrink and wrap around soft tissues** like the heart when moisture[2] is applied.

The developed materials achieved conformity and flexibility that enables real-time heart monitoring and reduces the risk of implant rejections. The technology can also help pave the way for newer types of better pacemakers and bio-monitors in future.

In agriculture, **soft sensors attached to plants can monitor their health** [3]and **control their actions**[4], presenting new possibilities for crop disease management. Similarly, low-cost smart sensors can also be used on food packaging as an indication of freshness and enhance food safety[5].

As the **President's Chair Professor in Materials Science and Engineering** and the **Director** of the **Innovative Centre for Flexible Devices (iFLEX)**, Prof Chen has a vision to push the frontiers of soft electronics.

"We aim to address some of humanity's most pressing challenges, from climate change to healthcare advancements. My goal is to establish a new centre of excellence for soft electronics, building a team of industry experts and commercial partners to swiftly bring these technologies to market," Prof Chen explained.

To kickstart the scaling-up process, Prof Chen has established the pilot laboratory which aims to co-develop and produce soft electronic devices with industry partners, including Small and Medium Enterprises (SMEs).

Through joint projects, Prof Chen hopes to establish industry standards that will facilitate the mass production of soft electronics in the future and develop the necessary expertise for this emerging industry.

Supporting this vision is the **NTU Innovation and Entrepreneurship** initiative, launched in March last year. As a pillar of the NTU 2025 five-year strategic plan, the initiative aims to accelerate the transition from research to commercialisation for faculty and students, providing mentorship and industry insights.

NTU Vice President (Innovation and Entrepreneurship) Professor Louis Phee explained: "In today's fast-paced global market, accelerating disruptive innovations is not just an advantage, it's a necessity for maintaining global leadership. NTU's breakthroughs in soft electronics exemplify Singapore's role as a frontrunner in advanced technology. Prof Chen Xiaodong's innovations, borne at the world's top university for materials science[6], are a testament to Singapore's commitment to be a leader in the fields of science and technology."

Multiple inventions to make soft electronics a reality

Conventionally, semiconductor manufacturing produces electronics that relies on silicon as the primary substrate or platform. However, silicon is hard and rigid.

Soft electronics, instead, use a soft platform – such as hydrogels or biocompatible plastics that are stretchable and flexible, of which NTU material scientists have invented numerous formulations.

To enable electronic circuits to accommodate movement without breaking under repeated stress, these circuits are printed on soft substrates using intricate patterns at the micro and nanoscale, about 10 times thinner than the width of human hair. One such pattern developed by Prof Chen's team is **a wavy ribbon form for soft electronics**, which will allow it to stretch without breaking.

Another one of his innovations is "BIND" – a soft, stretchy, **"Lego-like" universal connector[7]** that joins flexible electronics by simply pressing them together. It can withstand stretching up to seven times its length and is 60 times tougher than conventional connectors.

When used together, these patent-pending technologies allow the combination of conventional hardware chips to be mounted and linked to resistors and capacitors through printed circuits.

Singapore's economy heavily relies on manufacturing, which constituted 22 per cent of its GDP in 2021. Advanced electronics manufacturing and innovation, including the burgeoning sector of soft electronics, have been identified as key pillars for the nation's economic development.

Moving forward, Prof Chen is dedicated to establishing Singapore as a leading-edge research and manufacturing hub for soft electronics and is seeking support from **Singapore's Research, Innovation and Enterprise (RIE) plan** – a cornerstone for the country's transformation into a knowledge-based, innovation-driven economy and society.

[1] United Nations Department of Economic and Social Affairs Disability. (25 Jan 2024.). Factsheet on persons with disabilities. United Nations. https://www.un.org/development/desa/disabilities/resources/factsheet-on-persons-with-disabilities.html

[2] Yi, J., Zou, G., Huang, J. et al. Water-responsive supercontractile polymer films for bioelectronic interfaces. Nature 624, 295–302 (2023). https://doi.org/10.1038/s41586-023-06732-y

[3] Li, W., Matsuhisa, N., Liu, Z. et al. An on-demand plant-based actuator created using conformable electrodes. Nat Electron 4, 134–142 (2021). https://doi.org/10.1038/s41928-020-00530-4

[4] Zhang, K., Li, W., Li, H., Luo, Y., Li, Z., Wang, X., & Chen, X. (2023). A Leaf-Patchable Reflectance Meter for In Situ Continuous Monitoring of Chlorophyll Content. Advanced Science. https://doi.org/10.1002/advs.202305552

[5] L. Guo, T. Wang, Z. Wu, J. Wang, M. Wang, Z. Cui, S. Ji, J. Cai, C. Xu, X. Chen, Portable Food-Freshness Prediction Platform Based on Colorimetric Barcode Combinatorics and Deep Convolutional Neural Networks. Adv. Mater. 2020, 32, 2004805. https://doi.org/10.1002/adma.202004805

[6] U.S. News & World Report. (2022/2023). Materials science. Retrieved from https://www.usnews.com/education/best-global-universities/materials-science

[7] Jiang, Y., Ji, S., Sun, J. et al. A universal interface for plug-and-play assembly of stretchable devices. Nature 614, 456–462 (2023). https://doi.org/10.1038/s41586-022-05579-z

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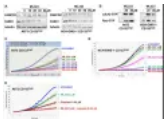

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