Researchers develop novel liquid metal circuits for flexible, self-healing wearables

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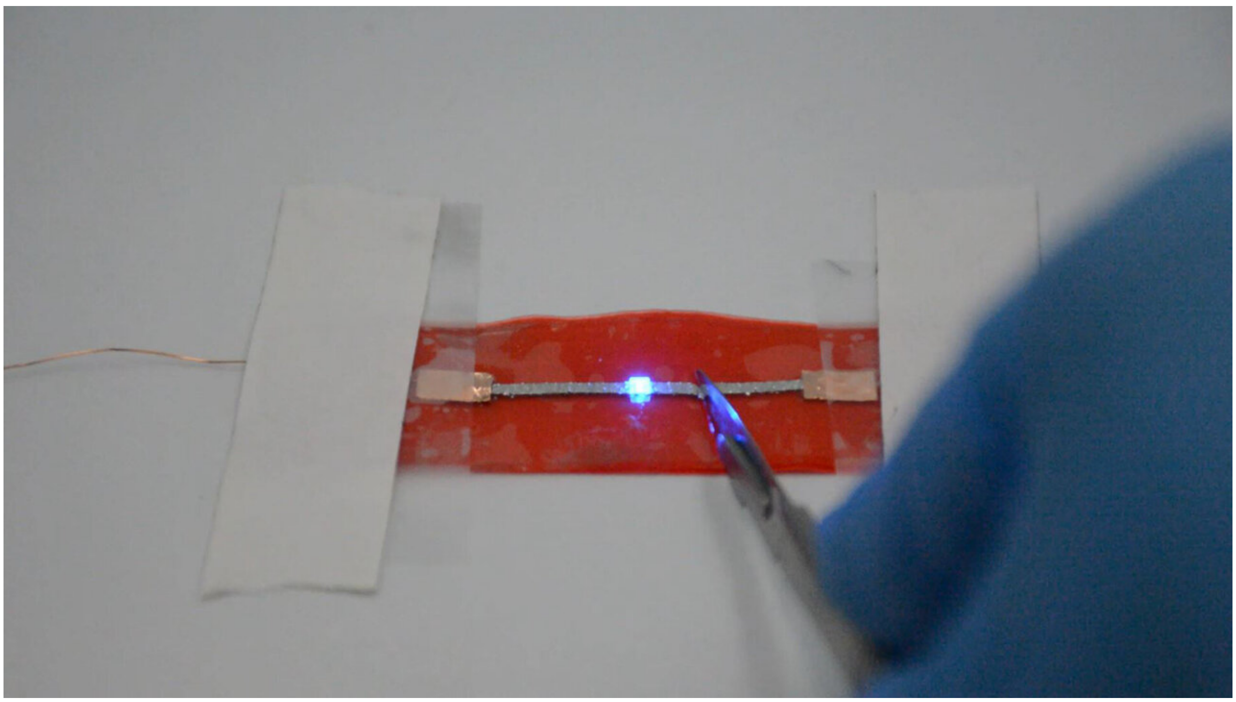


The new conductive and stretchable 'super-material' developed by NUS researchers can heal cracks or cuts almost instantaneously to maintain its electrical conductivity. Credit: National University of Singapore

Imagine a stretchable and durable sensor patch for monitoring the rehabilitation of patients with elbow or knee injuries, or an unbreakable and reliable wearable device that measures a runner's cardiac activities during training to prevent life-threatening injuries. Innovations in wearable technology are often limited by the electronic circuits—which are usually made of conductive metals that are either stiff or prone to damage—that power these smart devices.

Researchers from the National University of Singapore (NUS) have recently invented a new super flexible, self-healing and highly conductive material suitable for stretchable electronic circuitry. This breakthrough could significantly improve the performance of wearable technologies, soft robotics, smart devices and more.

The newly engineered material, called the Bilayer Liquid-Solid Conductor (BiLiSC), can stretch up to a remarkable 22 times its original length without sustaining a significant drop in its electrical conductivity. This electromechanical property, which has not been achieved before, enhances the comfort and effectiveness of the human-device interface, and opens a wide array of opportunities for its use in health care wearables and other applications.

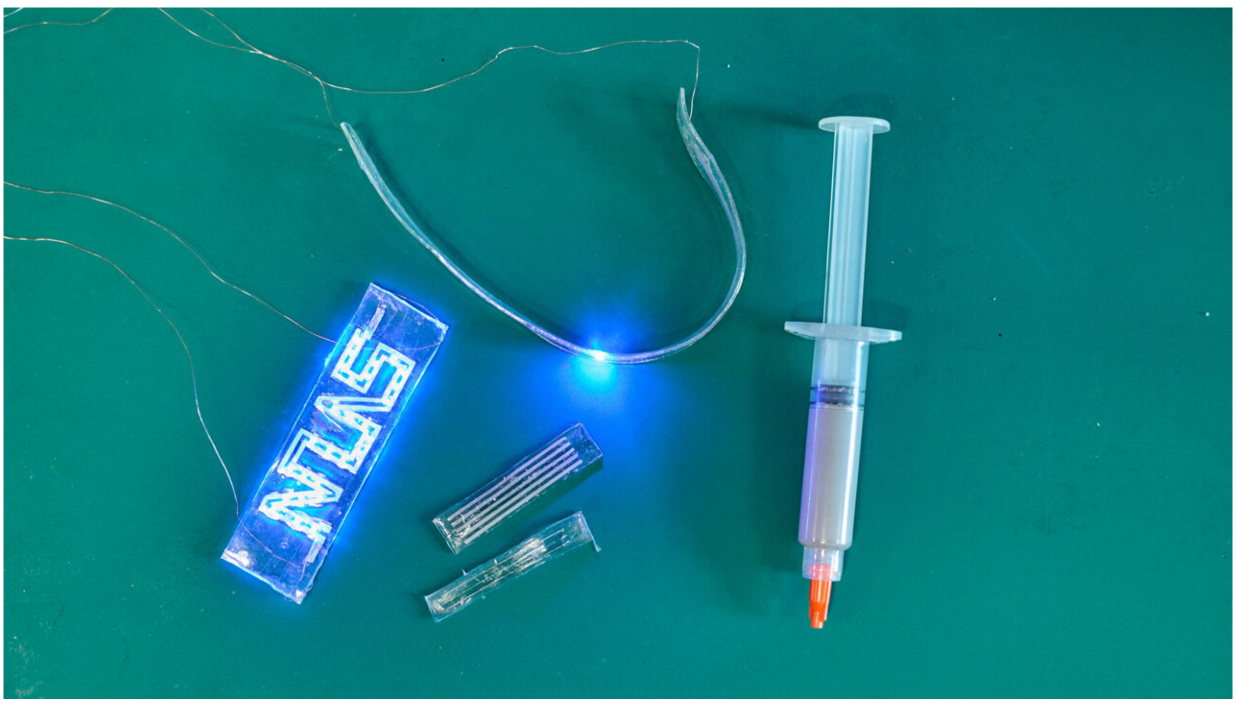
Professor Lim Chwee Teck, Director of the NUS Institute for Health Innovation & Technology and leader of the research team, said, "We developed this technology in response to the need for circuitry with robust performance, functionality and yet 'unbreakable' for next-generation wearable, robotic and smart devices.

"The liquid metal circuitry using BiLiSC allows these devices to withstand large deformation and even self-heal to ensure electronic and functional integrity." Prof Lim and his team are also from the Department of Biomedical Engineering under the NUS College of Design and Engineering.

Flexible, self-healing and conductive 'super material'

BiLiSC is an exciting technology that is ideal for use in wearable devices, which would need to account for the shape, and varied movements, of the body.

It consists of two layers. The first layer is a self-assembled pure liquid metal, which can provide high conductivity even under high strain, reducing the energy loss during power transmission and signal loss during signal transmission.



Liquid metal circuitry using a newly engineered material called Bilayer Liquid-Solid Conductor (BiLiSC) allows devices such as wearables to withstand large deformation and even self-heal to ensure electronic and functional integrity. Credit: National University of Singapore

The second layer is a composite material containing liquid metal microparticles and it is able to repair itself after breakage. When a crack or tear occurs, the liquid metal flowing out from the microparticle can flow into the gap, allowing the material to heal itself almost instantaneously to retain its high conductivity.

To ensure that the innovation is commercially viable, the NUS team found a way to fabricate BiLiSC in a highly scalable and cost-efficient manner.

This technological breakthrough was reported in *Advanced Materials* in November 2022.

High performance and multifunctional

The NUS team demonstrated that BiLiSC can be made into various electrical components of wearable electronics, such as pressure sensors, interconnections, wearable heaters, and wearable antennas for wireless communication.

In laboratory experiments, a robotic arm using interconnections was quicker in detecting and responding to minute changes in pressure. In addition, the bending and twisting motion of the robotic arm did not impede the transmission of signals from the sensor to the signal processing unit, compared to another interconnection made with a non-BiLiSC material.

Following the successful demonstration of BiLiSC, the NUS team is now working on material innovation and process fabrication. They are looking to engineer an improved version of BiLiS that could be printed directly without needing a template. This would reduce cost and improve the precision in fabricating the BiLiSC.

More information: Shuwen Chen et al, Ultrahigh Strain-Insensitive Integrated Hybrid Electronics Using Highly Stretchable Bilayer Liquid

Metal Based Conductor, *Advanced Materials* (2022). DOI: 10.1002/adma.202208569

Provided by National University of Singapore

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