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The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

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Zoom: https://technion.zoom.us/j/2884793963?omn=94602738796

Highly stretchable, moisture-permeable, on-skin electrodes from liquid metal and fiber mat

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MSc Seminar

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Stretchable epidermal electronics with stable electrical performance have been widely applied in numerous fields, including advanced medical therapy, wearable electronics, soft robotics, and human-machine interaction. However, conventional stretchable devices, which typically integrate a pliant substrate and a conductor, often encounter inferior electrical performance under sustained or intense stretching due to poor stretchability, limited permeability, and the notable disparity in Young's modulus between the substrate and the conductor. This mechanical discord intensifies problems such as reduced durability and inconsistent conductivity.

Here, we addressed these limitations by devising a liquid metal (LM)-based flexible electrode via an innovative direct coating method. Firstly, to strengthen the mechanical properties of the electrode, an electrospun styrene-block-butadiene-block-styrene (SBS) fiber film was used to be the substrate. Compared to the traditional SBS solution dissolved by Tetrahydrofuran and N, N-Dimethylformamide, the SBS solution we utilized was dissolved by 1, 2 dichloroethane, which exhibited stronger viscosity. Due to the increased viscosity of SBS solution, the electrospun SBS film showed higher stretchability.

Then we utilized ultrasonic technology to decrease the high surface tension of LM. After ultrasonic treatment, the LM was dispersed into nanoparticles which can be directly coated on the substrate. Finaly to enhance the permeability, we conducted a pre-stretch activation process. After pre-stretch process, the planar LM was transformed into a mesh-like porous structure hanging among the SBS microfibers.

The resulting electrode demonstrated remarkable electrical conductivity (3730 S cm^{-1}), superior permeability (40.2 g m^{-2} h^{-1}), and extraordinary stretchability (>2000% strain), coupled with exceptional mechanical durability. The LM fiber mat structure allows for the creation of permeable, on-skin electronics capable of long-term electrophysiological monitoring, rendering it ideal for continuous health monitoring applications.