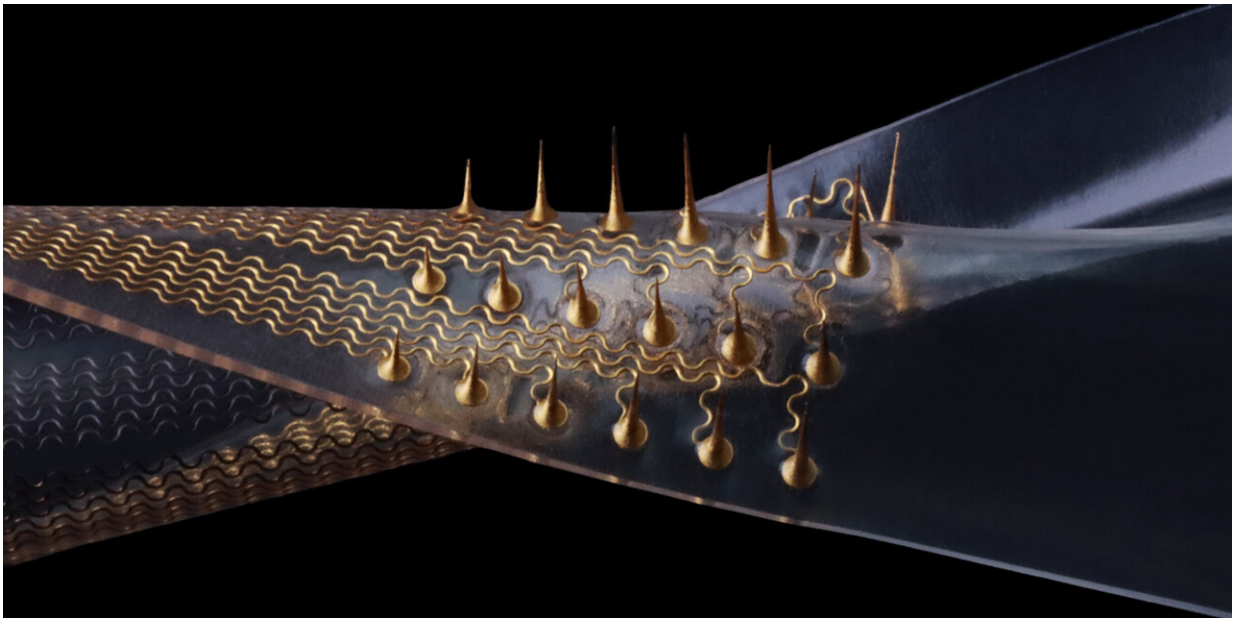


Sea slugs inspire highly stretchable biomedical sensor

May 2 2024, by Matilda Bathurst



Stretchable microneedle electrode arrays. Credit: Zhao Research Group

The revolution in personalized medicine is well underway—with wearable devices and DIY home testing, it's easier than ever to track everything from heart rate, to glucose levels, to microbiome diversity.

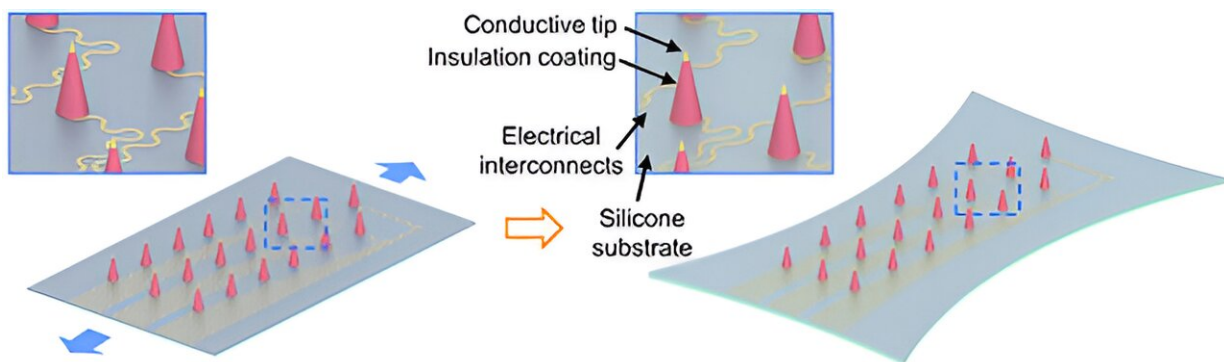
However, there's still an innovation gap before we achieve a seamless interface between the human body and invasive monitoring devices.

That's where USC researcher Hangbo Zhao comes in. Zhao is an expert in advanced manufacturing and flexible electronics. As assistant professor in the Department of Aerospace and Mechanical Engineering and the Alfred E. Mann Department of Biomedical Engineering at USC, Zhao has published a series of papers on stretchable sensors for biomedical purposes.

His most [recent paper](#), selected as the cover story for the journal *Science Advances*, presents new research that will directly enable the development of "soft" and more flexible microneedles—essential for ensuring the comfort and high accuracy of long-term health tracking.

The technology is enabled by stretchable three-dimensional penetrating microelectrode arrays, produced by a novel manufacturing process developed by Zhao and his research group.

Microneedle electrodes are widely used in sensing and stimulation of the brain, as well as diagnosis of biomarkers under the skin. However, almost all existing microneedle electrodes are rigid due to material and fabrication limitations. Zhao's expertise in advanced manufacturing gave him a new perspective when it came to envisioning a more flexible solution.



Schematic illustration of the stretchable microneedle electrode array. Credit: Zhao Research Group

The new "soft" microneedle electrodes are highly desirable in the case of muscle tissues and skin tissues that "deform" or change shape. Electrodes need to follow the deformations of the target tissues to ensure intimate contact and minimize [tissue damage](#); Zhao's research paves the way for advances in microneedles that can sense ever-deeper into tissues and gain more accurate results. Whether monitoring the workings of a weak bladder or tracking minute fluctuations in heartbeats, the necessity of high-fidelity sensing is ever more vital.

Central to the innovation is the development of a hybrid fabrication method discovered at Zhao's lab at USC. The low-cost and scalable method combines laser micromachining, microfabrication and transfer printing to make microneedle [electrode](#) arrays with the highest stretchability (60-90%) ever reported.

Crucially, the novel fabrication method enables convenient customization of key device parameters such as electrode geometry, recording sites, and mechanical and electrical properties. As with all Zhao's research, adaptability and accuracy is the organizing principle: his perspectives on soft electronics and robotics also inform the flexible fabrication method.

Another intriguing feature of the research is its deep-sea origins. The feasibility of the globally applicable [microneedle](#) electrodes was originally demonstrated by recording electrical activities inside the moving muscles of a sea slug.

The wider global biomedical applications of the results were

immediately clear to Zhao and his team of researchers. This platform technology can be used for the sensing and control of brain and nerve activities, electrochemical sensing of skin interstitial fluids, diagnosis of neuromuscular disorders and drug delivery into deep tissues.

For those who feel queasy at the thought of microneedles, the next phase of highly stretchable "soft" microneedles might just be the answer. In the quest for ever more accurate tracking to catch abnormalities and identify rapid treatment, Zhao's research is an important milestone for health care professionals, biotech companies, and anyone seeking to live a longer, healthier life.

More information: Qinai Zhao et al, Highly stretchable and customizable microneedle electrode arrays for intramuscular electromyography, *Science Advances* (2024). [DOI: 10.1126/sciadv.adn7202](https://doi.org/10.1126/sciadv.adn7202)

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