Slimming down, beefing up deep brain implants

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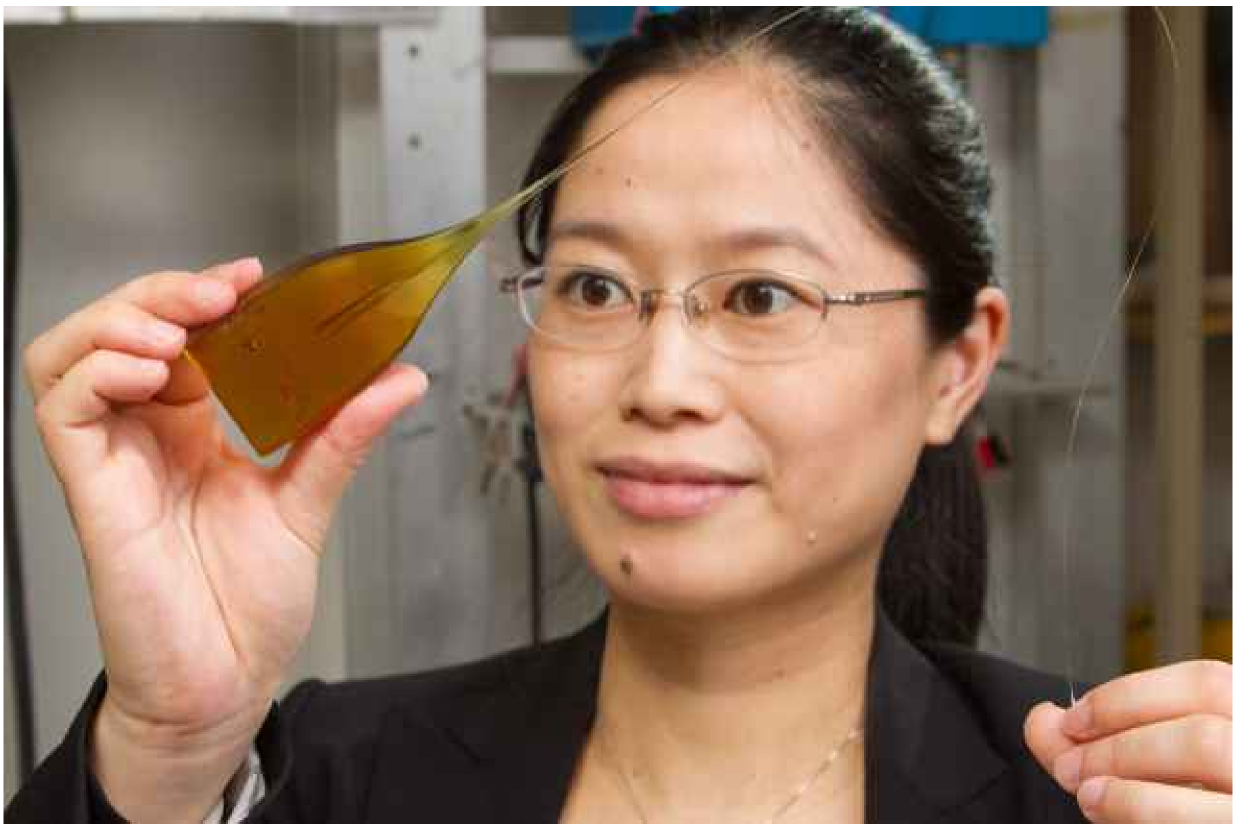

Virginia Tech researcher Xiaoting Jia holds up a miniature neural device that would not only record signals from the brain, but also stimulate neural activity. Credit: Virginia Tech

When it comes to sticking something into your brain, smaller is usually better.

Virginia Tech researcher Xiaoting Jia and her team found a new way to reduce the size and increase the conductivity of deep brain implants — potentially unlocking new treatment methods for neurological illnesses like Parkinson's disease. Jia is developing a miniature neural device that would not only record signals from the brain, but also stimulate neural activity.

As described in a study published in the American Chemical Society's *ACS Nano*, Jia, an assistant professor in the Bradley Department of Electrical and Computer Engineering, is collaborating with researchers from the Virginia Tech School of Neuroscience and the Massachusetts Institute of Technology to incorporate nanomaterial—specifically carbon nanofibers—into deep brain implants.

By using this material, Jia's team was able to increase the electrical conductivity of the neural implants while reducing their size.

Jia likens the reduction to "shrinking a pencil-sized device down to the width of a human hair."

In the study, titled "Polymer composite with carbon nanofibers aligned during thermal drawing as a microelectrode for chronic neural interfaces," Jia and her co-authors describe how they crafted tiny recording electrode sensors out of carbon nanofiber composites and integrated them into neural probes, which are about the size of a single neuron.

As the technology has evolved, microelectrode sensors have given researchers a direct channel for recording and affecting brain activity. Deep brain stimulation, for instance, has been used to treat many disabling neurological symptoms—including obsessive-compulsive disorders and Parkinson's disease.

But in their current form, microelectrode sensors that can be implanted in the brain are bulky and rigid, made from metal or silicon. The brain's soft, fragile tissue is easily damaged by these unyielding devices, which can be unsuitable for long-term implant.

Jia and her colleagues are working on the next generation of neural microelectrode sensors—which, to Jia, means robust, flexible, biocompatible, and very small.

To fabricate the tiny neural probes, Jia and her team started with a hand-sized version of the probe—called a macroscopic preform—that contained their new carbon-based electrodes as well as several other features.

After carefully heating the preform, the researchers stretched it from a tall tower (a fiber drawing tower), which pulls the preform into a long, thin strand. They were pleased to find that, during the thermal drawing, the carbon nanofibers lined up lengthwise within the strand.

"This drastically improved the electrical conductivity, but still maintained flexibility and biocompatibility," said Jia.

The probes themselves come from thin, cross-sectional slices of the strand, which contain nano-sized versions of the original features.

Technology developed in this vein could "make new inroads in the field of neuroscience," said Jia. "And, after more study and testing, clinical applications could potentially benefit human patients."

The devices are being tested in Professor Harald Sontheimer's laboratory in the Virginia Tech School of Neuroscience, where the group has been studying the stability and functionality of the implants in the hippocampi of mice brains.

More information: Yuanyuan Guo et al. Polymer Composite with Carbon Nanofibers Aligned during Thermal Drawing as a Microelectrode for Chronic Neural Interfaces, *ACS Nano* (2017). DOI: 10.1021/acsnano.6b07550

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