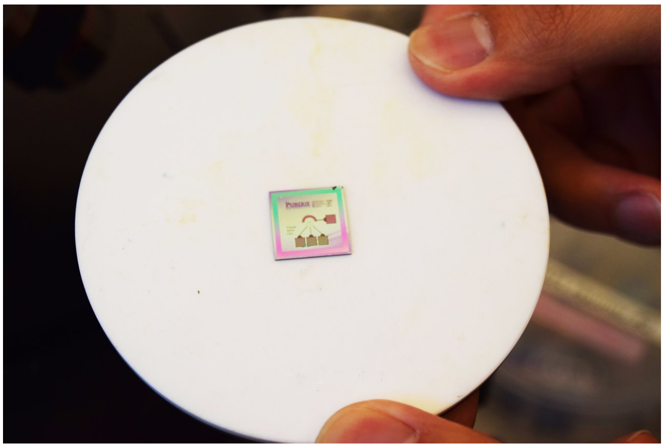
Electrode shape improves neurostimulation for small targets

24 April 2018, by Kayla Wiles



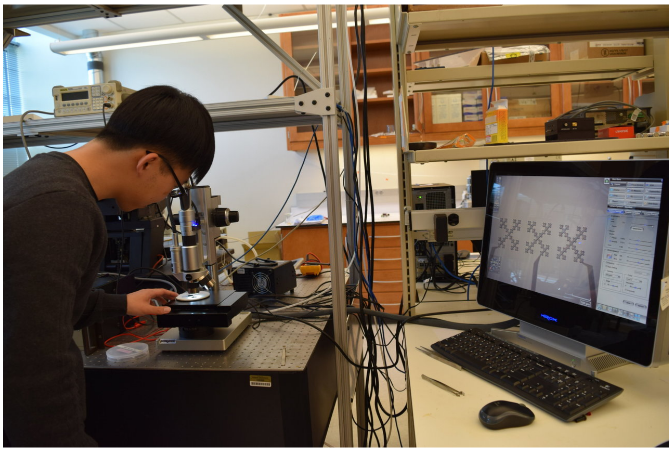
This small chip holds a 2-D electrode with a shape that can better stimulate small targets in the body over time. Credit: Purdue University image/Kayla Wiles

A cross-like shape helps the electrodes of implantable neurostimulation devices to deliver more charge to specific areas of the nervous system, possibly prolonging device life span, says research published in March in *Scientific Reports*.

The shape, called "fractal," would be particularly useful for stimulating smaller areas, such as deep brain structures or the retina, since it maximizes perimeter within a smaller surface area - providing the higher resolution needed for restoring bodily functions and potentially enabling neurostimulation devices to last longer in the body without a recharge.

"There are challenges with shrinking the size of these electrodes," said Hyowon "Hugh" Lee, assistant professor of biomedical engineering. "If you shrink them too small, then you can't inject enough energy to be able to activate the underlying substrate."

Industry currently produces circular or rectangular electrodes for neurostimulation devices. "There's really no reason to maintain these shapes other than the fact that it makes it easier for the conventional manufacturing techniques to facilitate," Lee said. "But microfabrication allows batch processing or even more scalable roll-to-roll fabrication, in which we have the design freedom to create any type of electrode design with high resolution to improve their functionality."



The fractal electrode shape, as seen from under a microscope, outperforms conventional circular or rectangular electrode shapes. Credit: Purdue University image/Kayla Wiles

Lee's lab experimented with other shapes that could better inject charge with electrode size limitations. The fractal shape outperformed conventional shapes and the "serpentine," or snake-like shape, even though it has a similar perimeter to surface area ratio as fractal. This could be because the repeating patterns of the fractal design better facilitate the continuous diffusion of charge transfer species, or reactants, to the platinum electrode surface.

"When you have a lot more diffusion of species to the surface, it allows for faster Faradaic charge transfer from the electrode surface," Lee said. The charge then reaches a threshold on neurons to trigger an action potential, or electrochemical signal, to stimulate a target.

Because fractal designs also feature lower impedance than conventional electrodes, they could allow more charge to be injected onto an electrode surface over time and extend the life span of neurostimulation devices. "If you have less load, meaning it takes less energy to get the same effect, then the fixed battery life of implantable stimulation devices is going to be improved," Lee said.

The next step is to test the robustness and longevity of fractal designed-electrodes in comparison to conventional shapes. Lee's lab is also looking into using the fractal design for improving sensitivity in devices such as biosensors. "The goal would be better control of stimulation over targeted areas and more pinpointed therapy," Lee said.

More information: Hyunsu Park et al, Electrochemical Evaluations of Fractal Microelectrodes for Energy Efficient Neurostimulation, *Scientific Reports* (2018). DOI: 10.1038/s41598-018-22545-w

Provided by Purdue University
APA citation: Electrode shape improves neurostimulation for small targets (2018, April 24) retrieved 14 November 2019 from https://phys.org/news/2018-04-electrode-neurostimulation-small.html