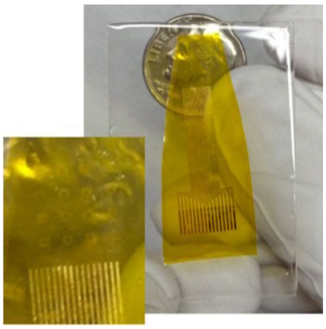
Transparent Microelectrode Gives New View of Neural Circuits



Researchers at the Perelman School of Medicine and School of Engineering at the University of Pennsylvania and The Children's Hospital of Philadelphia have used graphene to fabricate a new type of microelectrode. This could possibly solve a major problem for investigators who are interested in understanding the intricate circuitry of the brain. The work has been published in *Nature Communications*.

Epilepsy and other neurological disorders require real-time observation of how neural circuits operate. They also require a close evaluation of the circuits' location, firing patterns and other factors. This can be achieved through the use of high-resolution optical imaging and electrophysiological recording. However, the traditional metallic microelectrodes are opaque and may inhibit a complete view, as well as creating shadows that can obscure critical details. Moreover, researchers are currently able to obtain high-resolution optical images *or* electrophysiological data, but not both at the same time.

This problem has now been solved. Brian Litt, PhD of the Center for NeuroEngineering and Therapeutics (CNT) has developed a completely transparent graphene microelectrode. This microelectrode allows for simultaneous optical imaging and electrophysiological recordings of neural circuits.

According to Dugy Kuzum, PhD and the co-first author of the study, "There are technologies that can give very high spatial resolution such as calcium imaging; there are technologies that can give high temporal resolution, such as electrophysiology; but there's no single technology that can provide both."

There are several advantages of graphene. First, it can act as an anti-corrosive for metal surfaces. This helps eliminate all corrosive electrochemical reactions in tissues. Second, it is a low-noise material which can play an important role in neural recording since clinicians try to get a high signal-to-noise ratio.

Previous efforts to construct transparent electrodes using indium tin oxide have proven to be expensive and brittle. Since graphene is so flexible, it is possible to make thin electrodes that have the capability to hug the neural tissue.

During this study, calcium imaging of hippocampal slices were performed in a rat model. Both confocal and two photon microscopy were performed and electrophysiological recordings were also conducted. The researchers were able to observe temporal details of seizures and seizure-like activity with very high resolution.

The researchers believe that these techniques could also be adapted to study other larger areas of the brain with more expansive arrays. Kuzum points out that the graphene microelectrodes can be used in any application that needs to record electronic signals. This includes cardiac pacemakers and peripheral nervous system stimulators. In addition, they can also be used to increase the longevity of neural implants and also allow for safe, artefact-free MRI reading.

Kuzum and her colleagues hope to gain greater insight into the physiology of the brain as this technology is further developed. "It can provide information on neural circuits, which wasn't available before, because we didn't have the technology to probe them," she says.

Source: Science Daily

Image Credit: Duygu Kuzum and Euijae Shim

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