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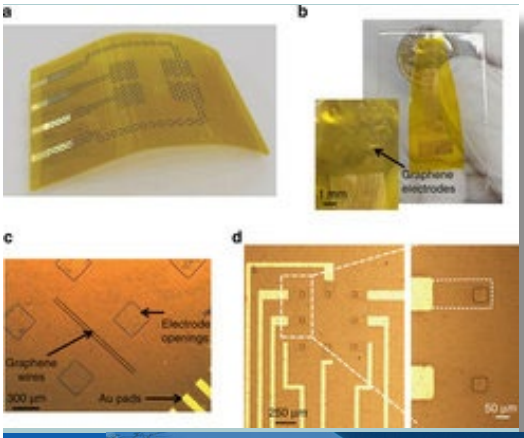

Transparent graphene electrodes to image and monitor biological tissues

Brief Description

Transparent electrode arrays for visualization, simultaneous imaging, and electrophysiology

Docket # 14-7016

INTELLECTUAL PROPERTY

PCT patent application PCT/US2015/024229 filed April 2015 pending

DESIRED PARTNERSHIPS

Implanted biosensors; neural prosthesis; neural electrodes.

REFERENCE MEDIA

Kuzum, et al. Nature Communications, October, 2014. 5:5259. doi: 10.1038/ncomms6259.
http://www.ncbi.nlm.nih.gov/pubmed/?term=kuzum+litt

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Problem

Calcium imaging is a versatile tool capable of resolving single neurons and their connectivity with single-cell spatial resolution in the brain. Unfortunately, its coarse temporal resolution limits its ability to detect neural activity with a single spike resolution. Electrophysiological recordings provide high temporal, but limited spatial resolution, due to the dense 3D architecture and geometrical inaccessibility of the brain. An approach that integrates the advantages of both techniques could provide new insights into functions of neural circuits.

Solution

The Litt Lab has developed a transparent and flexible electrode array that contains graphene electrodes. This electrode array enables simultaneous optical imaging of biological tissue, with high signal-to-noise ratio recordings of electrophysiological activity. Specifically, graphene electrodes provide low electrical noise, which can lead to sensor technologies with increased sensitivities that may enable detection of individual molecules. Graphene also provides flexibility and protection against corrosion, and is optically transparent at wavelengths useful for optical imaging.

Transparent graphene electrodes can simultaneously record neural activity during calcium imaging with confocal or multi-phone microscopy without any laser-induced artifacts in the recordings. Combination of both techniques has shown temporal and spatial characteristics of high frequency bursting activity and synaptic potentials in hippocampal slices with high precision.

Advantages

- Electrodes and wires are all optically transparent.
- The graphene electrode has a maximum dimension ranging from 50-500µm.
- Provides a method for simultaneous optical imaging and electrical sensing

State of Development

• Developed microfabrication techniques to build completely transparent graphene microelectrodes on flexible substrates.
• Conducted experiments to show that electrical characterizations and in vivo neural recordings using graphene electrodes could achieve a significant improvement in signal-to-noise ratio and substantial reduction in electrical interference noise compared to gold electrodes. Additionally, the inventors found that transparent graphene electrodes could simultaneously record neural activity during calcium imaging with a confocal microscope