Application of Graphene micro-transistor arrays to investigate the impact of 'brain tsunamis' to paroxysmal neurological disorders.

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Spreading depolarisations (SDs) are the largest disruption to neuronal homeostasis possible, resulting in a breakdown of ionic concentrations across neuronal membranes. They produce neuronal depolarisation block, suppression of brain activity, and bulk release of neurotransmitters and neuroinflammatory molecules. SDs are known to occur in several neurological diseases including stroke, traumatic brain injury, migraine with aura and epilepsy. As SD presence is associated with worsening outcomes in these diseases, and they propagate slowly across the brain, neurologists who study SDs call them "brain tsunamis".

However, given their importance for monitoring, and for the prognosis of neurological disorders and injuries, SDs have remained poorly studied, particularly in clinical settings. This is due to the associated technical difficulties recording such slow potentials which require DC-coupled amplifiers and highly stable electrodes. Solution-gated field effect graphene micro-transistors (gSGFETs) take profit from the field effect property of the two dimensional material graphene[1] to implement a local transduction of neural signals[2]. The high electrochemical stability of graphene permits a stable gain across a wide-range of frequencies, enabling DC-coupled recordings with the same fidelity as liquid-filled glass micropipettes with Ag/AgCl wires[3]; the current gold standard for DC-coupled recordings while overcoming their spatial sampling limitations and allowing high-density mapping[3].

We have applied gSGFETs to electrographically detect SDs *in vivo* either in anesthetised rats[3] or in awake head-fixed mice[4],[5], in a variety of disease-relevant preclinical models. Due to their optical transparency, gSGFET arrays are compatible with a range of commonly used imaging modalities and optogenetics[4] making them particularly attractive tools for preclinical neuroscience research. We will present recent data collected using gSGFET arrays which demonstrate their ability to map with high-fidelity SDs, and importantly provide insight into the mechanisms by which SDs worsen stroke outcome by modulating regional blood flow changes.

References

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