Brain Stimulation 16 (2023) 117–409

Contents lists available at ScienceDirect

Brain Stimulation

journal homepage: http://www.journals.elsevier.com/brain-stimulation

5th International Brain Stimulation Meeting — Abstracts

Acceptance type: Symposium oral
S1a.1

LARGE-SCALE NEUROMODULATION FOR TARGETED PLASTICITY IN PRIMATES

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Symposium title: Emerging technologies for brain stimulation
Symposium description: This symposium focuses on emerging technologies for brain stimulation, with an emphasis on recently developed preclinical technologies that improve the durability, stability, efficiency, and/or functionality of brain stimulation devices. Our symposium covers advances in neural engineering including novel materials and fabrication strategies for interfacing with the brain, advanced optical and ultrasonic tools for targeted neuromodulation and large-scale access for stimulation and readout of neural circuits across multiple brain regions. The collection of talks in our symposium covers a breadth of technologies with demonstrated utility in rodents and primates and clear promise in clinical translation. In particular these technologies have a strong focus on targeted and patterned neuromodulation enabling opportunities for neural circuit interventions at unprecedented scales. Furthermore, we discuss closed-loop neuromodulation in the context of these advanced technologies providing opportunities for state-dependent and personalized neuromodulation. These emerging technologies create testbeds for understanding brain circuits and function and pave paths towards developing more efficient stimulation-based therapies for a wide variety of neurological disorders.

Abstract
The brain shows marked plasticity across a variety of learning and memory tasks as well as during recovery after injury. Many have proposed to leverage this innate plasticity using brain stimulation to treat neural disorders. Implementing such treatments requires advanced engineering tools and a thorough understanding of how stimulation-induced plasticity drives changes in network dynamics and connectivity at a large scale and across multiple brain areas. We have developed a novel large-scale interface for non-human primates that achieves these goals and enables us to manipulate neural activity with high spatial and temporal resolution via virally transfected neurons containing light-sensitive ion channels, i.e. using optogenetics. In addition to its potential for greater spatial and cell-type specificity, this technique offers the significant advantage of artifact-free electrophysiological recording during stimulation. Our interface consists of state-of-the-art electrophysiology and optogenetics to simultaneously record and manipulate activity from about 5 cm2 of cortex in awake behaving macaques. Using this interface, for the first time, we have shown the feasibility of inducing targeted changes in cortical networks using optogenetics. Furthermore, we have incorporated the capability of producing ischemic lesions in the same interface enabling us to stimulate the cortex around the site of injury and monitor functional recovery via changes in blood flow, neurophysiology, and behavior. These technologies have a great potential to provide critical insight into the fundamentals of brain plasticity and the power of targeted cortical stimulation to drive rehabilitative reorganization following injury, and may have a profound impact on future therapeutic interventions for neurological disorders such as stroke.

Research Category and Technology and Methods
Basic Research: 13. Other Brain Stimulation Technology
Keywords: Optogenetics, Optogenetics, Non-human primates, stroke

http://dx.doi.org/10.1016/j.brs.2023.01.013

Abstract key: PL- Plenary talks; S- Regular symposia oral; FS- Fast-Track symposia oral; OS- On-demand symposia oral; P- Posters

S1a.2

NOVEL MATERIALS AND FABRICATION STRATEGIES FOR MULTIMODAL NEUROELECTRONICS

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Abstract
Neuroelectronic technologies are essential tools to treating neurological disorders, restoring and repairing lost functions, and modulating neural circuitry to control mood and behavior. Traditionally, metals and silicon have been the materials of choice for neurolectronics. However, these materials are intrinsically inadequate to address the mechanical, chemical, and electrical properties of neural tissues. Furthermore, they are complex to source and process, which makes the manufacturing of neuroelectronic devices time consuming and expensive. Thus, the development and successful clinical translation of safe, biocompatible, and long-term stable neuroelectronics require significant innovations in both materials and fabrication strategies. In this talk, I will discuss how nanoscale soft conductors can be engineered into high-resolution, minimally invasive neuroelectronic interfaces designed to seamlessly record and stimulate neural circuits at multiple scales. Specifically, I will introduce 2D transition metal carbides (a.k.a. MXenes), discuss their electrochemical properties at the interface with biological tissues, and show how they translate into significant impedance and noise reduction when MXene-based microelectrode arrays are used in vivo. Then, I will present novel scalable, rapid manufacturing processes designed to translate the exceptional material properties at the molecular scale into high-resolution, low impedance neuroelectronic interfaces that are also compatible with clinical neuroimaging modalities, such a magnetic resonance imaging (MRI) and computerized tomography (CT). Finally, I will present examples of applications in both implantable and wearable interfaces for neural recording and stimulation.

Research Category and Technology and Methods
Basic Research: 13. Other Brain Stimulation Technology
Keywords: Neuroelectronics, Neural interfaces

http://dx.doi.org/10.1016/j.brs.2023.01.014

Abstract key: PL- Plenary talks; S- Regular symposia oral; FS- Fast-Track symposia oral; OS- On-demand symposia oral; P- Posters

S1a.3

MRI-GUIDED FOCUSED ULTRASOUND NEUROMODULATION OF DEEP BRAIN REGIONS AND CIRCUITS WITH REAL TIME FEEDBACK

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