IOWA STATE UNIVERSITY
Department of Mechanical Engineering

Translational Neuroelectronics

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Department of Electrical
Columbia University
Faculty host: Reza Montazami

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Abstract

Our understanding of the brain's pathophysiology relies on discoveries in neuroscience and neurology fueled by sophisticated bioelectronics enabling visualization and manipulation of neural circuits at multiple spatial and temporal resolutions. In parallel, to facilitate clinical translation of advanced materials, devices, and technologies, all components of bioelectronic devices have to be considered. Organic electronics offer a unique approach to device design, due to their mixed ionic/electronic conduction, mechanical flexibility, enhanced biocompatibility, and capability for drug delivery. We design, develop, and characterize conformable, stretchable organic electronic devices based on conducting polymer-based electrodes, particulate electronic composites, high-performance transistors, conformable integrated circuits, and ion-based data communication. These devices established new experimental paradigms that allowed monitoring of the emergence of neural circuits during development in rodents and elucidated patterns of neural network maturation in the developing brain. Furthermore, the biocompatibility of the devices also allowed intra-operative recording from patients undergoing epilepsy and deep brain stimulation surgeries, highlighting the translational capacity of this class of neural interface devices. In parallel, we are developing the fully-implantable, conformable implantable integrated circuits based on high-speed internal ionic gated organic electrochemical transistors that can perform the entire chain of signal acquisition, processing, and transmission without the need of hard Si-based devices. This multidisciplinary approach will enable the development of new devices based on organic electronics, with broad applicability to the understanding of physiologic and pathologic network activity, control of brain-machine interfaces, and therapeutic closed-loop devices.

Dr. Dion Khodagholy is an associate professor in the Department of Electrical Engineering, School of Engineering and Applied Science at Columbia University. He received his Master's degree from the University of Birmingham (UK) in Electronics and Telecommunication Engineering. This was followed by a second Master's degree in Microelectronics at the Ecole des Mines. He attained his Ph.D. degree in Microelectronics at the Department of Bioelectronics (BEL) of the Ecole des Mines (France). He completed a postdoctoral fellowship in systems neuroscience at New York University, Langone Medical Center. His research aims to use unique properties of materials for the purpose of designing and developing novel electronic devices that allow efficient interaction with biological substrates, specifically neural networks and the brain. This process involves design, characterization, and fabrication of high-performance biocompatible electronics to acquire and analyze neural data. The ultimate goal is to translate such advances in electronics, materials and neuroscience into more effective diagnostics and treatments for neuropsychiatric diseases.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.

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