USC Viterbi
School of Engineering
Ming Hsieh Department of Electrical and Computer Engineering

Seminar

Translational Neuroelectronics

Dion Khodagholy
Columbia University

Date: Friday, April 7, 2023
Time: 9:30am
Location: EEB 132

Abstract: Our understanding of the brain's physiology and pathology is fueled by sophisticated bioelectronics that enable visualization and manipulation of neural circuits at multiple spatial and temporal resolutions. All components of these bioelectronic devices must be engineered with biocompatibility and clinical translation in mind. Organic electronics offer a unique approach to this 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. We then use these devices in systems neuroscience experiments in animal models and humans to analyze neural network functions and facilitate new discoveries that could improve patient care.
These devices established new experimental paradigms that allowed discovery of novel brain oscillations and elucidated patterns of neural network maturation in the developing brain. Furthermore, these devices were used for intra-operative recording from patients undergoing epilepsy and deep brain stimulation surgeries, highlighting their translational potential. We have also leveraged them to form responsive electrical interventions that target biomarkers for memory consolidation and affect the progression of epilepsy.
To expand beyond neural interfaces to complete devices, we are developing fully-implantable, conformable implantable integrated circuits based on high-speed internal ion-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 has permitted innovation of new organic electronic devices that could be leveraged establish a sustainable track of impactful bioelectronic inventions and address clinical applications such as brain-machine interfaces and therapeutic closed-loop devices.

Bio sketch: 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 of the Ecole des Mines (France). He completed a postdoctoral fellowship as a Simon's Society fellow in systems neuroscience at New York University, Langone Medical Center. He is a recipient of the NSF CAREER award, junior fellow of Simons society, and SEAS Translational Award.
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, and thereby enhancing our understanding of neural networks and brain function.