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Nanoelectronics Meets Neuroengineering:
Brain-inspired Systems and Neural Interfaces

Abstract: Brain-inspired architectures and reconfigurable-adaptive systems are emerging research fields aiming to go beyond capabilities of digital logic and eventually to reach brain-like computational efficiency. In this first part of my talk, I will present a novel electronic device for brain-inspired computing, mimicking functionalities of biological synapses in the brain. I will discuss several aspects of brain computation including energy efficiency, robustness and parallelism and then explain how synaptic devices are used in hippocampus-inspired synaptic grids to demonstrate learning and robustness in hardware. I also will discuss how synaptic devices can help to understand brain computation. In the second part of my talk, I will introduce a new flexible transparent neural probe made of graphene for simultaneous electrophysiology and neuroimaging. Understanding dynamics of neural circuits requires probing them with high spatial and temporal resolution, simultaneously. To date, none of the available neural recording technologies has the ability to see individual neurons and their connections and simultaneously record their activity at the temporal resolution of single spikes. I will explain how the transparent probes made of graphene enable simultaneous functional optical imaging and electrophysiology to combine spatial and temporal resolution advantages of both techniques. I will then demonstrate in vitro and in vivo recordings with transparent graphene electrodes and discuss electrochemical characteristics and noise performance of graphene neural electrodes.