

## **Functional assembly of bioelectronics for tissue-wide electrophysiology with single-cell resolution and cell-type specificity**

Abstract: Tissue-wide electrophysiology with single-cell and single-spike spatiotemporal resolution, and cell-type specificity is critical for heart and brain studies. In this talk, I will first discuss the creation of cyborg organoids: the three-dimensional (3D) assembly of soft, stretchable mesh nanoelectronics across the entire organoid by the cell-cell attraction forces from 2D-to-3D tissue reconfiguration during organogenesis. We demonstrate that stretchable mesh nanoelectronics can migrate with and grow into the initial 2D cell layers to form the 3D organoid structure with minimal impact on tissue growth and differentiation. The intimate contact between the dispersed nanoelectronics and cells enables us to chronically and systematically observe the evolution, propagation and synchronization of the bursting dynamics in human cardiac organoids through their entire organogenesis. Second, I will discuss a general concept of genetically-targeted functional assembly in tissue--in this case through a convergence of protein engineering and polymer chemistry that genetically instructs specific living neurons to guide chemical synthesis of conductive polymers onto the plasma membrane. Conductive polymers were assembled in vivo at genetically- and subcellularly-targeted locations per design specifications, and were demonstrated to achieve intended functionality in the form of newly-created electrical conduction pathways. Imaging, electrophysiology, and behavioral analyses confirmed that in vivo conductive polymer assembly preserved neuronal viability, remodeled cellular membrane properties, and elicited cell-type-specific behaviors in freely-moving animals. In the end, I will discuss the prospects for future advances in bioelectronics to overcome challenges in neuroscience and cardiology.