הנדסת ביוטכנולוגיה ומזון

הטכניון מכון טכנולוגי לישראל TECHNION Israel Institute of Technology

The Faculty of Biotechnology and Food Engineering
Seminar

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The James Franck Institute, the University of Chicago

Non-Genetic "Optogenetics": Silicon Based Bio-Interfaces for Optical Modulation at the Sub-Cellular, Cellular, and Tissue Level

Abstract

Bioelectronics for cellular interrogation requires a minimally invasive introduction of an electrical probe to the cell. Despite tremendous developments in the filed of electroceuticals in the past decades, the available technologies are still associated with major limitations. Micropipette electrodes, micro- and nanoelectrode arrays, and nano-field effect transistors allow intracellular access with extremely high spatial resolution. However, these technologies are substrate-bound, do not allow reconfigurable recording or stimulation, and lack deep tissue access, which limits their use to in vitro application. Optogenetics can offer numerous mechanistic insights into cellular processes, but its spatial resolution is limited, especially for 3D tissues. Moreover, it requires genetic modification, which limits its potential therapeutic applications. In this talk, I will present my recent studies of developing new approaches for bio-interfaces using silicon micro- and nanostructures for non-genetic optical modulation, spanning from sub cellular interrogation with extremely high spatial resolutions to whole organ optical modulation. For sub-cellular interrogation, we used tailored made photovoltaic silicon nanowires with p-i-n core-shell design. These nanowires were hybridized with living myofibroblasts and used as free sanding cell-silicon hybrids with leadless optical modulation capabilities. We used focused laser to perform intracellular electrical interrogation with high, sub-cellular spatial resolution. Thereafter, we used these hybrids to tackle a long-standing debate regarding electrical coupling between myofibroblasts and cardiomyocytes in vivo, by interrogating specific myofibroblasts within the 3D volume of the cardiac tissue. We also show this technology's utility for neuronal investigation by hybridizing myelinating oligodendrocytes and interfacing them with neurons, allowing the investigation of calcium transients' role in the myelination process with unprecedented spatial control. For whole organ interface we used flexible single crystalline silicon membranes, that were able to adhere and wrap around the heart and sciatic nerve. We used optical stimulation to perform heart pacing at different location on the heart, and sciatic nerve excitation. These results demonstrate potential biomedical applications for cardiac resynchronization therapy and sciatic nerve neuro-regenerative treatments.

Wednesday, 29/1/2020, 14:00 – 15:00, Room 300

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