A CMOS Based Nano-Electrode Array for High-Throughput Electrophysiology

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It has been an outstanding challenge in the field of electrophysiology to build a tool capable of both high-fidelity intracellular recording and simultaneous interrogation. Current prevalent intracellular recording techniques, based on glass pipettes, have suffered from the lack of multiplexing because of bulky mechanical setup and elaborated patching process. Recent advanced in solid nanoscale electrodes have opened up new lines of attack for intracellular recording, however, demonstrations to date are limited to less than 10 cells at the same time. In this work, combining the intracellular capability of nano-electrodes with the scalability of CMOS circuits, we have built the CMOS based nano-electrodes array (CNEA) as a platform for high throughput electrophysiology.

A customized circuit is designed in a 32 x 32 array with a dedicated amplifier and stimulator at each pixel. Metal-coated vertical nanowire electrodes are then fabricated on top of the circuit via top-down post fabrication techniques, and packaged for cell culture.

Single cell experiments with human embryonic kidney (HEK) cell, rat cortex neurons and neonatal rat ventricular cardiomyocyte have proven the electrodes' intracellular capability and the circuits' functions. With the assistance of optogenetically modified HEK cells and self pacing cardiomyocytes, parallel intracellular recording from 364 cells have been demonstrated.