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Nano-bio interface array on a CMOS chip

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Creating an electrophysiological tool capable of both intracellular and parallel recording of membrane potentials of electrogenic cells such as neurons and cardiac muscle cells has been an outstanding challenge in neurobiology and cardiology. Traditionally, these fields have relied upon the patch clamp technique for sensitive intracellular measurements, which led to fundamental understandings of membrane potentials and ion channel properties. However, patch clamp glass electrodes are not well suited for scaling, and thus cannot perform parallel measurements of a large number of cells at the network level. By contrast, network level parallel measurements of membrane potentials have been achieved with micro electrode arrays, but these are limited to extracellular recording, thus the micro electrode arrays trade reduced signal-to-noise for increased spatial coverage at the network level. A tool combining both parallel and intracellular features for high-precision membrane potential recording across a large electrophysiological network in a simultaneous fashion could open up new and exciting possibilities in bioengineering, neuro- and cardio-technology. Professor Hongkun Park's research group (Harvard Chemistry and Physics) and my research group have collaborated for the past few years, seeking to develop a tool that addresses this long-standing intracellular vs. parallel dichotomy. Specifically, we have been developing top-down fabricated nano electrode arrays on custom-designed silicon complementary metal-oxide semiconductor (CMOS) integrated circuits (ICs). In this presentation, I will discuss our prototype devices, their designs and implementations, their electrical, electrochemical, and electrophysiological measurement results, and future outlooks.

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