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"Highly integrated CMOS microsystems to interface with neurons at subcellular resolution"

To understand how functions and characteristics of neuronal networks arise from the concerted interactions of the involved neurons, it is necessary to have methods that allow for interacting with neuronal functional subunits and ensembles - somas, axons, dendrites, single neurons, and entire networks - at high spatiotemporal resolution and in real time. Extracellular electrical recordings by means of microtransducer arrays complement well-established patch clamp techniques and optical or optogenetic techniques.

The use of CMOS technology helps to overcome the connectivity problem of how to interface thousands of tightly-spaced electrodes, while, at the same time, it improves signal-to-noise characteristics, as signal conditioning is done on chip next to where the partially very small signals (< 10 μV) are generated. CMOS-based arrays also enable high-throughput monitoring of potentially all action potentials in a larger neuronal network (> 1000 neurons) over extended time to see developmental effects or effects of disturbances. Here, we demonstrate how CMOS high-density microelectrode arrays (HD-MEAs) featuring several thousands of transducers (> 3'000 transducers per mm^2) can be used to record from or stimulate potentially any individual neuron or subcellular compartment on the CMOS chip. Future applications may include research in neural diseases and pharmacology.