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Development and application of new optogenetic tools in Neuroscience

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CMOS Electronics for Implantable Neural Interfaces

Investigating the human brain and understanding its neuronal communication is one of the prominent tasks of modern neuroscience. The ongoing technological improvement of microsystem technologies thereby offers an increased measurement precision that allows for the transition from non-invasive procedures (e.g. EEG), over intracranial approaches (e.g. ECoG), towards the electrophysiological characterization of single neurons in-vivo. The small size of neurons between 4 and 100 µm requests not only for the miniaturization of tools, but the fast response of a single neuron in contrast to the averaged answer of a large brain area requires improvements in signal processing. Modern tools thus have to process local field potentials (LFPs) as well as action potentials (APs), and should be able to separate these two frequency bands of interest.

This talk will address recent advances in implantable neural recording interfaces. It will present some of the most prominent tools and will discuss their respective achievements, e.g. in terms of area, channel count, or overall functionality. We will furthermore see how modern CMOS technologies are used to maintain an optimal signal quality and cope with micro motions of the implant or plastic reorganization of the brain, i.e. discussing the concept of electronic depth control (EDC). EDC combines the high spatial resolution of neuron-sized electrodes with the processing power of CMOS electronics. Challenges of such CMOS probes with active assistance arise from the fact that each recording site has to be equipped with a gain stage consuming very little area. This talk will therefore finally present CMOS circuit techniques for area-efficient implementations of analog signal-processing features and name possible future trends for CMOS-assisted neural interfaces.

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