Silicon Microsystems for use in Neuroscience and Neural Prostheses: Interfacing with the Central Nervous System

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This article will review the technologies, circuits, and system partitioning issues in these microsystems and prospects for their continued development.

After forty years of development, micromachined electrode arrays now allow the detailed monitoring of neural activity in targeted areas of the brain and the delivery of signals to neural structures using microstimulation. With substrate widths and thicknesses as small as 10-20µm and sites on 100-200µm centers in two and three dimensions, these arrays are facilitating new insights into the organization and function of the central nervous system and allow far more detailed mapping of neural structures than has been possible in the past.

Microfluidics is being added to these probes for in-vivo drug delivery with the integration of microchannels, shutters, flowmeters, valves, and chemical sensors. Shrinking these structures to still smaller dimensions and the use of biocompatible surface coatings are both being pursued to minimize the foreign-body response and extend implant durations from months to decades. The chronic utilization of these interfaces in neural prostheses will require embedded circuitry to select appropriate site locations, generate stimulus patterns, and amplify, buffer, and interpret the neural signals in-vivo, making closed-loop control decisions and communicating with the external world over a bidirectional wireless link.

Such systems are becoming increasingly sophisticated, supplying both event and full waveshape information from hermetically-sealed packages. They promise to extend the performance of cochlear and DBS implants and to make entirely new prostheses for blindness, deafness, paralysis, and epilepsy possible.

More information and registration to the event