SolidState TECHNOLOGY

Harvard scientists use nanowires to connect neurons

August 25, 2006 - As part of ongoing work to improve electrophysiological measurements of brain activity -- not to mention demonstrate the potential of hybrid bioelectronics -- researchers at Harvard U. have developed artificial synapses between nanoelectronic devices and individual mammalian neurons, and linked a solid-state device (a nanowire transistor) to neuronal projections that interconnect and carry information in the brain.

Previous work from the group, headed up by Harvard chemist Charles Lieber and colleagues, showed how nanowires can precisely detect molecular markers that indicate the presence of cancer and single viruses in the body. In their current research, they gently touched ultrafine silicon nanowire transistors to a neuronal projection to form a hybrid synapse, able to detect, stimulate, and inhibit propagation of nerve signals along the axons and dendrites of live mammalian neurons. Contact with the neuron is no more than 20μm in length, allowing measurement and manipulation of electrical conductance at as many as 50 locations along a single axon.

The nanowire filaments are "a good match for intercepting nerve signals" due to size similarities to the axons and dendrites projecting from nerve cells (tens of nanometers in width). The devices also are thousands of times smaller and far more effective than current electronic methods to measure brain activity -- e.g., micropipette electrodes invasively poked into cells, or microfabricated electrode arrays that are too bulky to detect activity at the axon/dendrite level, the scientists claim.

Current work involves measurement of signals only within single mammalian neurons, but the researchers are exploring how to monitor signaling among larger networks of nerve cells. The devices could also eventually be configured to measure or detect neurotransmitters, the chemicals that leap between synapses to carry electrical impulses from one neuron to another, according to Lieber.

Calling the work "revolutionary," Lieber cited possible end-uses for the work: new ways to study and manipulate signal propagation in neuronal networks, sophisticated interfaces for external neural prosthetics, real-time cellular assays for drug discovery. "And it opens the possibility for hybrid circuits that couple the strengths of digital nanoelectronic and biological computing components," he said.

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