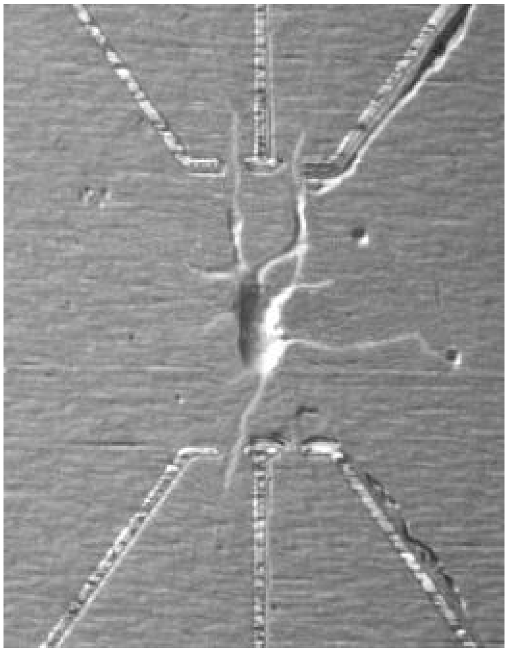
Neuron forms links with silicon nanowires

17:27 24 August 2006
NewScientist.com news service
Mason Inman

Silicon nanowires have been connected to individual neurons, creating “artificial synapses” similar to the links brain cells naturally form between each other.



Nanowires form good links with neurons (Image: Charles Lieber)

The development could prove a major step towards creating advanced neural prosthetics – devices that allow people to control a computer or robotic limb with their thoughts.

Neurons have been grown on silicon chips for some time. But artificial electrodes are much larger than neurons, which prevents researchers from monitoring or triggering individual neuron activity. Nanowires, however, are much smaller.

So Charles Lieber and colleagues at Harvard University in Cambridge, Massachusetts, US, built a chip with 20-nanometre-wide silicon wires running across its surface. On top of the chip they grew rat neurons, which include axons, relatively long projections that transmit signals to other cells, and dendrites, shorter extensions that receive signals. The axons and dendrites formed connections with the nanowires – more than 50 connections per neuron. These connections were about the size of a natural synapse.

Live implants

The researchers were able to watch signals as they passed down an individual axon, and to stop or enhance the signals by stimulating the axon with an electrical pulse. They are now building larger arrays of nanowires, on which they hope to grow a network of neurons.

This will “dramatically contribute towards clarifying the mechanisms of how neurons process information,” says bioengineer Jose Carmena of the University of California, Berkeley, US, who was not involved in the study.

The team must still make the leap from developing cell cultures to producing devices that can be implanted into live animals, says Carmena. So far, Lieber’s group has been able to keep the cells alive and firing on the nanowires for around 10 days.

The work could one day help people with paralysis. Electrodes have already been implanted into the brains of some paralysed people, which has allowed them to control devices such as a computer cursor and robot arm (see *Overcoming paralysis is a case of mind over matter*).

Biological computers

However, these devices measure signals from groups of neurons, and can only sample a fraction of the brain’s activity. “They’re amazing advances, but it’s still pretty crude,” says Lieber. “The electrodes are just poking in there, at the scale of the whole cell. If you could actually start to communicate with neurons in the way the brain itself does, you’re going to be able to do much more.”

This would enable researchers to convert a wider range of thought processes into electrical signals, helping paralysed people make more movements and giving neuroscientists more information on how the brain works, he says.

Lieber is also interested in connecting neurons to electronic devices, to create hybrid systems that could lead to new types of biological computers. He and his colleagues connected a neuron to their silicon nanowires to create a simple circuit that acted as a logic gate, the basic building block of computers.

“These systems would take advantage of the strengths of biological systems and their ability to grow interconnections, and the power of nano-electronic devices, which are much faster,” says Lieber.

Journal reference: *Science* (vol 313, p 1100)

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