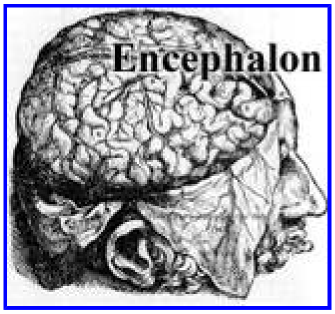


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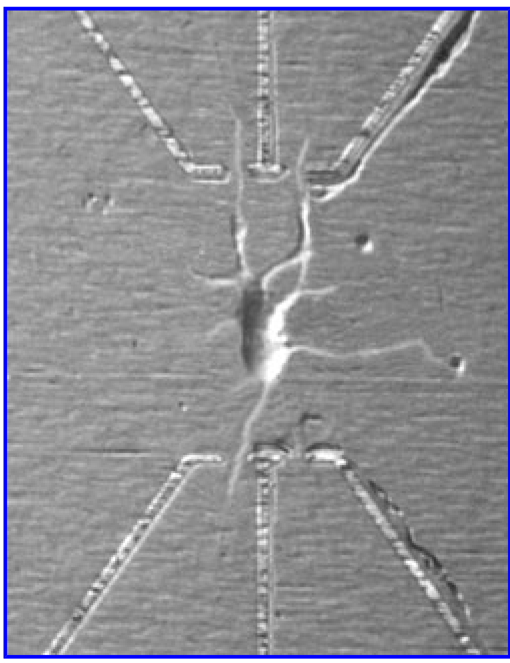
## An integrated neuron-nanowire device

Posted by The neurophilosopher on August 25th, 2006



Researchers have developed a hybrid device consisting of an array of silicon nanowires integrated with live neurons from the neocortex of rats. The device displays bi-directional communication between the biological and electronic components, and can be used to control the electrical activity of the cells.

Charles Lieber, a professor of chemistry at Harvard University, and his colleagues, use a bottom-up approach for the en masse fabrication of integrated assemblies consisting of up to 50 nanowires. The synthesis of assemblies containing so many nanowires is itself is a major breakthrough; what Lieber and his team then did with the assemblies is remarkable - in effect, they have created artificial synapses.

The nanowires are synthesized in a vacuum from silane gas, using a technique called gold nanocluster chemical vapour deposition. They are aligned onto silicon chips, which are then sterilized and incubated, before having cortical or hippocampal cells from embryonic rats transferred onto them from culture dishes.

Photolithography, the technique used to etch patterns onto conventional silicon chips, is also used by Lieber's group to create patterns on their nanowire assemblies. 30-50 micrometre squares house the cell bodies of the neurons which are transferred onto the chip, and 2-3 micrometre-wide channels etched onto the chip surface guide the outgrowth of axons and dendrites. The chips are coated with a protein which promotes neurite outgrowth.

The nanowires incorporated into the chip have a diameter of 20 nanometres, similar to that of neuronal processes, and act as field-effect transistors, which use electric fields to control the shape and conductivity of a channel in a semiconducting material. The nanowires can therefore electrically stimulate the neurons growing on the surface of the chip. Because of their small diameter, they can simultaneously detect electrical signals from 50 different points along an axon, measure the frequency and amplitude of those signals, and sense how the neurons respond to them.

The assemblies can also be used for precise focal application of chemicals. Thus, tetrodotoxin, a potent sodium channel blocker obtained from puffer fish, was applied to selected cells on the chip, preventing them from generating action potentials.The ability to use the nanowire assemblies to detect a large number of signals will help neuroscientists to study how single nerve cells integrate inputs from other cells, and, because they can also act as sensitive chemical sensors, the chips may be used to probe the mechanisms of neurotransmission. Lieber and his group are developing nanowires which can detect the release of neurotransmitters, and possibly even release transmitters in a controlled manner as well.

One obvious application of the nanowire assemblies is in the development of neural prostheses that are far more sophisticated than those which are currently available. The ultra-sensitivity of the nanowires may allow for the development of advanced biomedical assays and single-particle chemical sensors.

Because the nanowires are at least four times faster than conventional silicon transistors, there are many other potential applications for them, particularly in digital electronics and computing, where they may be used to manufacture high performance transistors, or to design new computer architecture and systems.

(Image courtesy of Professor Charles Lieber, Harvard University.)

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This entry was posted on Friday, August 25th, 2006 at 12:28 pm and is filed under Nanotechnology, Neuroscience. You can follow any responses to this entry through the RSS 2.0 feed. You can leave a response, or trackback from your own site.

### 2 Responses to "An integrated neuron-nanowire device"

1. *Anna Shin* Says:
   September 1st, 2006 at 9:43 pm

   Dear Neurophilosopher,

   You mentioned the image in your article is distantly related as far as devices but it's certainly not direct. Please feel free to use the images from the Science paper which are posted in our Image Gallery. http://cmliris.harvard.edu/gallery/index.php

   We only ask that you include image credit "Charles Lieber, Harvard University".

   Thank you,
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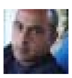
   Assistant to Professor Lieber

2.  *The neurophilosopher* Says:
   September 2nd, 2006 at 9:23 am

   Ms. Shin,

   I have changed the image, and credited the new image to Prof. Lieber at the bottom of the entry. I hope this is satisfactory.

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