Bridging neurons and electronics with carbon nanotubes

New implantable biomedical devices that can act as artificial nerve cells, control severe pain, or allow otherwise paralyzed muscles to be moved might one day be possible thanks to developments in materials science.

Writing today in *Advanced Materials*, Nicholas Kotov of the University of Michigan and colleagues describe how they have used hollow, submicroscopic strands of carbon, carbon nanotubes, to connect an integrated circuit to nerve cells. The new technology offers the possibility of building an interface between biology and electronics.

Kotov and colleagues at Oklahoma State University and the University of Texas Medical Branch have explored the properties of single-walled nanotubes (SWNTs) with a view to developing these materials as biologically compatible components of medical devices, sensors, and prosthetics. SWNTs are formed from carbon atoms by various techniques including deposition and resemble a rolled up sheet of chicken wire, but on a tiny scale. They are usually just a few nanometers across and up to several micrometers in length.

The researchers built up layers of their SWNTs to produce a film that is electrically conducting even at a thickness of just a few nanometers. They next grew neuron precursor cells on this film. These precursor cells successfully differentiated into highly branched neurons.

A voltage could then be applied, lateral to the SWNT film layer, and a so-called whole cell patch clamp used to measure any electrical effect on the nerve cells. When a lateral voltage is applied, a relatively large current is carried along the surface but only a very small current, in the region of billionths of an amp, is passed across the film to the nerve cells. The net effect is a kind of reverse amplification of the applied voltage that stimulates the nerve cells without damaging them.

Kotov and his colleagues report that such devices might find use in pain management, for instance, where nerve cells involved in the pain response might be controlled by reducing the activity of those cells. An analogous device might be used conversely to stimulate failed motor neurons, nerve cells that control muscle contraction. The researchers also suggest that stimulation could be applied to heart muscle cells to stimulate the heart.

They caution that a great deal of work is yet to be carried out before such devices become available to the medical profession.

Citation: Nicholas A. Kotov et al., Stimulation of Neural Cells by Lateral Currents in Conductive Layer-by-Layer Films of Single-Walled Carbon Nanotubes, *Advanced Materials* 2006, 18, No. 22, doi: 10.1002/adma.200600878

Source: Advanced Materials