[Emerging Device Technology](#) > **Development of Neuroelectronic Interfaces**

Collaboration with University of Cambridge, departments of Materials Science, Chemistry and Brain Repair Centre.

The objective of this work is to use microfabrication to construct neuroelectronic interfaces for the peripheral nervous system and other neural systems.

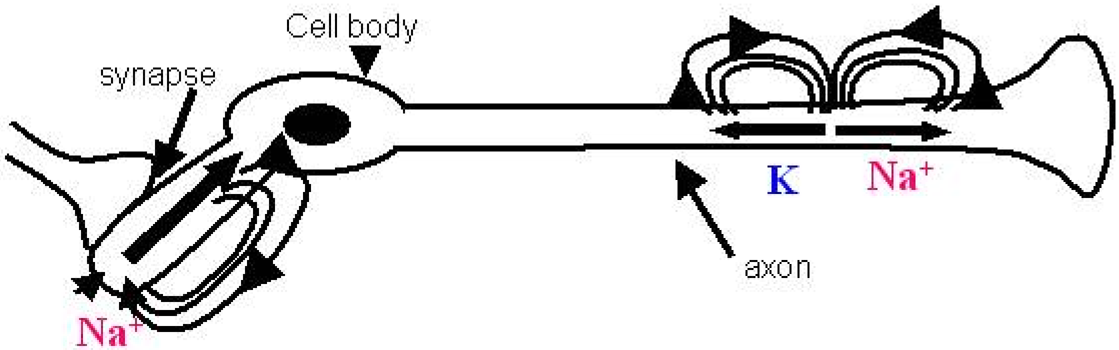

Figure 1. Schematic of neurone, showing ion currents inside the cell and return currents outside.

A nerve fibre can be divided into three parts. It has an input stage which detects electrical and chemical signals from other nerves, a cell body where the nucleus containing the genetic information for the cell resides and an output stage, which is a long thin tubular fibre called the axon, down which voltage pulses called action potentials are transmitted. When a nerve is damaged because it is severed or crushed, the parts of the fibres on the other side of the damage from the fibres die, but the part on the same side can form a new growing tip and will try and grow through the damaged region. For the spinal cord this doesn't really work at all but for peripheral nerves it can, which is why patients who have nerves stitched back together following limb amputation regain some movement. However there are no signals guiding the regenerated fibres back to the original connection points, so a motor fibre for the thumb may end up attached to the back of the hand. Alternatively an amputated limb may be so damaged that it cannot be reattached.

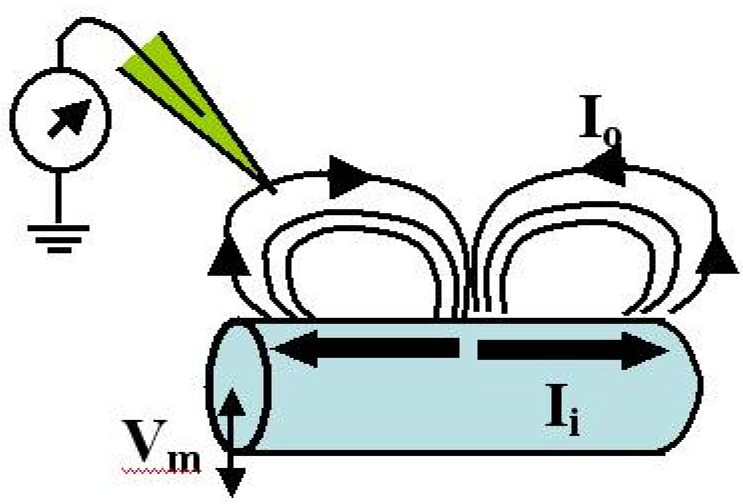

Figure 2 Whilst the voltage difference Vm across the membrane can be as large as 100mV an electrode at some distance from the axon will detect a smaller voltage signal.

We are working on the technologies required to build a long term implant containing electrodes to detect the electrical activity of regenerated axons. These signals could be used to drive an artificial limb. The problems involved relate to the electrical coupling between the nerve fibre and the electrodes. As a voltage pulse travels down the nerve fibre, the electric current associated with it spreads into the fluid outside and the electrode has to detect the associated voltage in that region. If the electrode is too far away, that voltage is small and difficult to detect, in addition when you put a metal electrode in fluid, it develops a large electrical impedance at the surface, due to the different chemical properties of the metal and the fluid. You can solve some of these problems by carefully shaping the surface of the implant and by depositing a roughening material on the electrode surface to increase it area and reduce its impedance. However, whatever you do has to be biocompatible in the first place because the body mustn't reject it or be poisoned by it. If the implant is designed to be used for the long term, they also mustn't degrade. For that reason we are working with polyimide as a substrate material with gold as an electrode material.

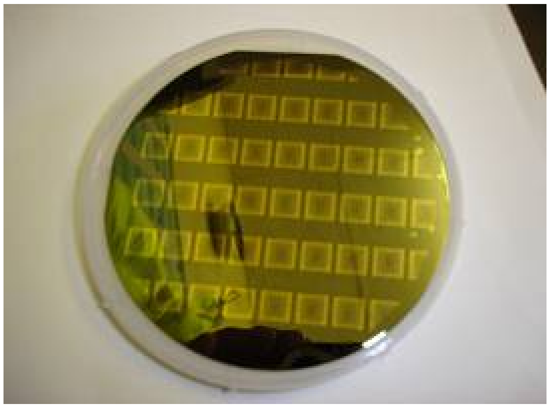

Figure 3. A 4 inch silicon wafer is used as a support for the polyimide substrate for and array of gold test structures.