<u>Microelectrodes in Neuro-Transplants</u>

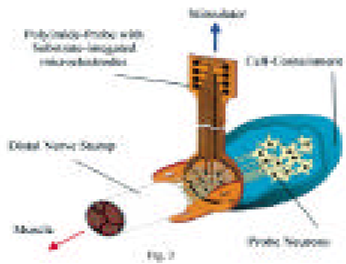
Biomedical Engineering Seminar

ELE 482

<u>Suchismita Datta</u>

The most important technical requirements of a Microprobe are it's adaptability to the distal nerve stump, suitability to combine microstructure with a container for cells and integrated microelectrodes as information transducers.

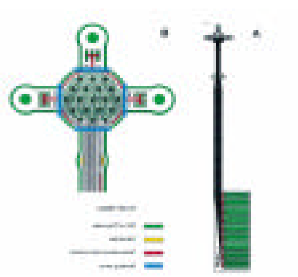
Micromachining technologies were applied to fabricate a polyimide based sieve-like microprobe with integrated ring electrodes and a distributed counter electrode. Electrode impedance was below 200 k-Ohms at 1 k-Hz frequency



When would we use such an electrode?

Where limbs of our body where communication between peripheral nerve has been disrupted due to a traumatic lesion to the nerve. Lesions of peripheral nerves interrupt bioelectrical signal transmission ultimately leading to paralysis.

The author proposes the Neuron Microprobe.



This probe can be used as a biohybrid neuro-prosthesis, to restore and control muscle function after peripheral nerve lesions. Axonal outgrowth from the guest neurons through holes of polyimide ring electrodes finally reinnervates muscles.

An experiment using the microprobe was performed on rats. Sieve implants must be adapted to the sciatic nerve of rats of diameter of about 1.5 mm; relative high portion of holes in comparison to the substrate are favorable for axonal sprouting through the sieve. Hole area is limited because they decrease the mechanical strength of the structure. Finally the dimensions that were decided on were a hole diameter of 40 micro meter with a hexagonal hole arrangement. Plastic-like synthetic substance called polyimide was used as the insulator and skeletal support system for the chip.

Polyimide is very useful in situations that require integrity and stability under a variety of situations. It is also non-toxic.

The two basic aspects of biocompatibility taken into account prior to design are the tolerance of the foreign system by the host body and the structural and functional integrity of the implant.

The implant must be stable in physiological environment, i.e., no degeneration must occur. All parts of an implant must not be toxic for cells, or they have to be encapsulated with a non-toxic material that serves as a diffusion barrier for toxic substances preventing their elution into the body. Conducting materials for interconnects and electrodes should have low tendency to generate corrosion products.

Implant should be biomechanically safe. Smooth geometry is used to prevent mechanically induced nerve trauma and irritation by sharp edges, and material should not be brittle and heavy weighted.

Recent studies showed excellent in vivo compatibility in rats. Excellent re-generation of myelinated nerve fibers through the sieve holes was reported. Three-dimensional shaping of polyimide based devices is an advantageous technology for neural micro devices.

References

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