Sensors and Materials, Vol. 16, No. 3 (2005) 139–153
MYU Tokyo

S & M 0593

Fabrication and Evaluation of a Flexible Sieve-Type Microelectrode Array for Monitoring the Regenerating State of Peripheral Nerves

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(Received April 10, 2004; accepted December 21, 2004)

Key words: flexible microelectrode array, peripheral nerves, polyimide, 'stress-free etch release,' *in vivo*, *in vitro*

This paper reports the design, fabrication and measurement of a flexible microelectrode array for monitoring the regenerating state of peripheral nerves. Polyimide was used so that the device would have biocompatibility, long-term stability and flexibility. Using a 'stress-free etch-release' scheme, it was possible to fabricate a microelectrode array with a smaller feature size because less geometrical deviation took place compared to that using a mechanical peeling-off method. The diameter of the via holes, which provide a path for regenerating nerve fibers, was 40 μm and 50 μm. *In vivo* tests were performed by implanting fabricated microelectrode arrays into the sciatic nerves of a rat and into the peroneal nerves of a rabbit using two different implantation methods. One is a direct inter-fascicular suture technique and the other is a method using a nerve conduit. In both cases, no side effects such as cytotoxicity, neuroma and antigen-antibody reaction were observed. *In vitro* measurement was carried out to confirm the feasibility of measuring nerve signals. The interfacial impedance between body fluids and microelectrodes was measured. The normalized interfacial impedance was 446 Ω/μm^2 at 1 kHz. Signal transfer characteristics were analyzed by applying square waves of various frequencies and magnitudes.

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