

MULTISITE MICROELECTRODE PROBES

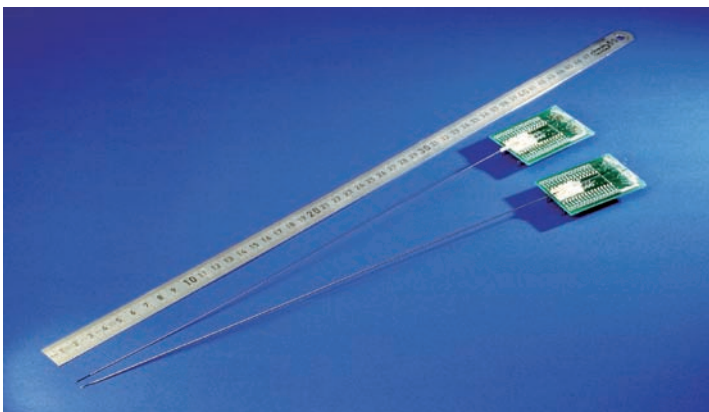
> for deep brain interventions



Motivation

Neurodegenerative disorders of the movement apparatus such as Parkinson's disease or Dystonia are today in an increasing number of cases symptomatically treated by implantation of a so-called neurostimulator with one or two electrodes that are placed inside the basal ganglia in the deep brain. Maximum therapeutic effectiveness and minimum side effects require however extreme precise positioning of the stimulation electrodes.

Preferably, the identification of the target area – usually the subthalamic nucleus (STN) – is performed by insertion of a microelectrode probe on a pre-planned trajectory. Recording and evaluation of the neural activity step-wise every mm in penetration direction allows to localize the boundaries of the target region and hence to verify the stereotaxic and image guided target coordinates. However, using available single microelectrodes for neuro-navigation, makes the localization of the target area a complex and time consuming procedure, that considerably enhances the surgical risk as well as stress and discomfort of the patient.



*Fig. 1: 32-channel microelectrode probes
length: 340 mm, diameter approx. 600 μ m*

Product Description

The novel multi-site microelectrode probes developed at IMM (fig. 1, 2) exhibit an array of up to 31 microelectrodes allowing locally resolved, simultaneous recording of the neural signals in the target area and thus help to increase speed, efficiency and precision in deep brain interventions. With an overall length of up to 340 mm at a diameter of only 600 μm the probes can easily be adapted to standard stereotaxic frames (fig. 5).

Different embodiments with linear or helical recording site arrangements have been realized. All probes are equipped with a central electrode which can be employed for neural signal recording as well as for deep brain stimulation (DBS) procedures. The probe tips are slightly rounded in order to minimize tissue traumatization and the risk of damaging blood vessels.

All materials in direct contact to tissues during a surgical intervention comply with medical product regulations and permit easy sterilization of the probes e.g. through autoclavation. Due to their geometrical and mechanical parameters and their high number of recording sites the multisite microelectrode probes made by IMM are presently unique.



Fig. 2: Detailed view of the linear and helical probe tips

Ongoing Activities

The electrode probes currently undergo pre-clinical testing on different animal models (fig. 3, 4). They can be custom-manufactured in various lengths and diameters according to the number of electrodes and are suited for use in stereotaxic deep brain interventions as well as in brain research on animal models.

Recently, IMM started together with partners from research and industry a new activity aiming for a more efficient therapy of Parkinson's disease using a new closed-loop system to provide a demand sensitive stimulus for suppression of the symptoms. For this purpose IMM develops flexible, chronically implantable microprobes which are equipped with a dense microelectrode array comprising sites for neural signal recording as well as for stimulation. A first prototype for concept evaluation on a rat model is shown in fig. 6.

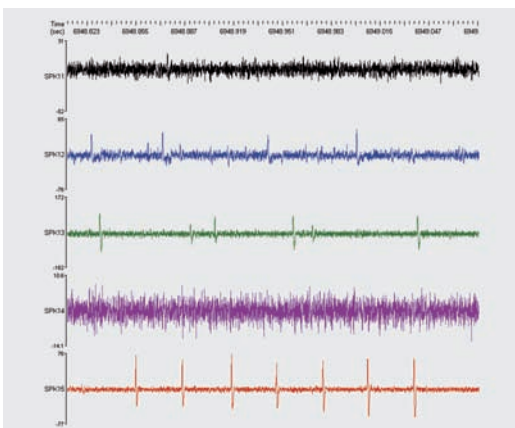


Fig. 3: Synchronous five channel recordings of multi-unit activity from a ferret's cortex (Source: Clinic for Neurology, University Hospital Hamburg-Eppendorf, Germany)

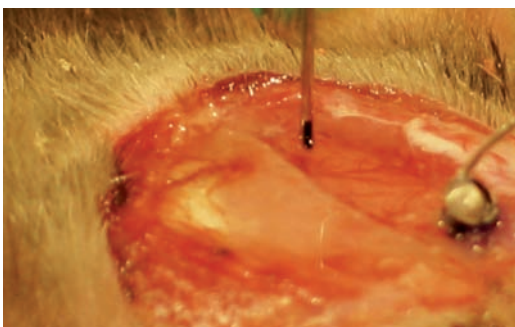


Fig. 4: IMM-microprobe during insertion into an anesthetized ferret's cortex (Source: Clinic for Neurology, University Hospital Hamburg-Eppendorf, Germany)

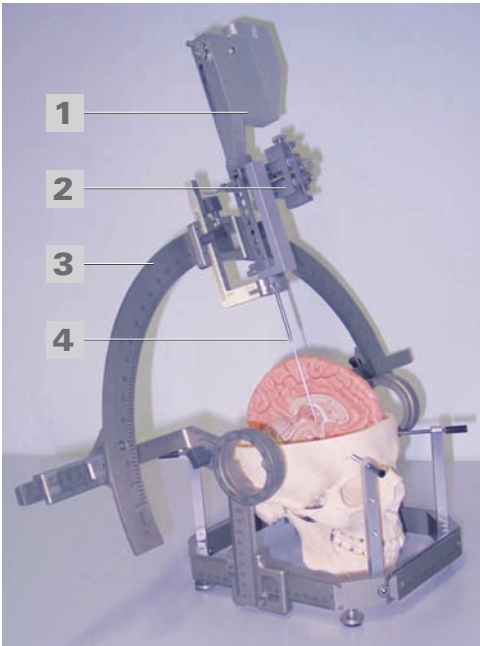
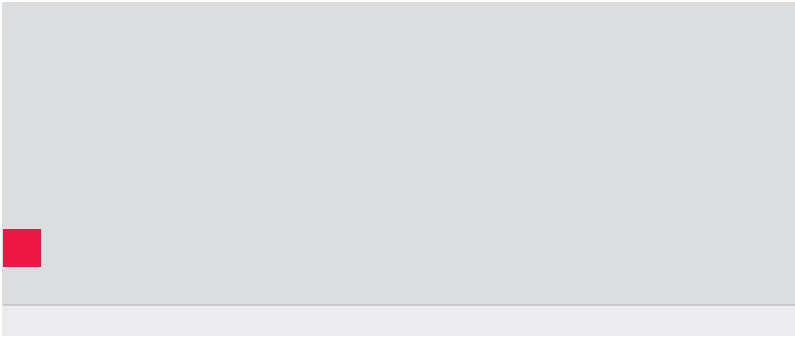


Fig. 5: Microdrive (1) with loaded 32-channel microelectrode mounted on a CRW® (Cosman, Roberts and Wells) stereotaxic frame (®by Tyco healthcare, Radionics, USA) (2). The microdrive (Thomas Recording GmbH) is equipped with a 32-channel low noise preamplifier, a rubber tube drive and a xyz-manipulator (3) with telescopic guide tube (4) for exact DBS electrode placement.

	Helical Probe	Linear Probe V.1	Linear Probe V.2
Total length	Up to 340 mm	Up to 340 mm	Up to 340 mm
Diameter	550 μm	650 μm	300 – 600 μm
Electrodes	32	32	8 – 24
Array length	0 – 10 mm	3 – 8 mm	3 – 6 mm
Logitudinal pitch	0 – 300 μm	100 – 250 μm	130 – 250 μm
Electrode diameter	30 μm	35 μm	45 μm

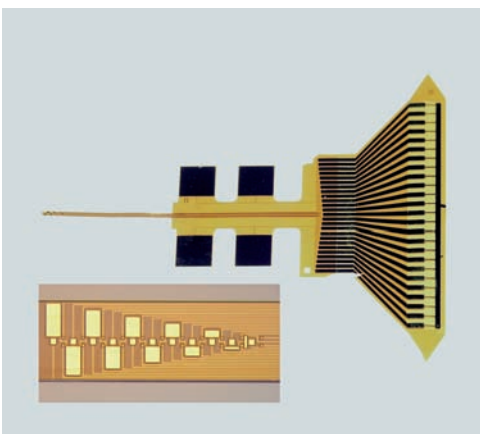


Fig. 6: First prototype of an implantable, flexible microelectrode array with sites for recording and stimulation

References

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