Flexible Smart Intracortical Neural Probes

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Keywords Neural probe, Microelectrodes, Silicon, Polymers, Bioresorbable, Stiffening

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Context The long-term recording capability of silicon-based (Si-based) intracortical neural probe arrays {Fig.1} is a challenge in neuroscientific research. This limitation is caused by a loss of neural signals and probe encapsulation related to the size and mechanical properties of the probe and the foreign body response. While flexible polymer probes can lower the mechanical mismatch to the cortical tissue and reduce adverse tissue reactions, only CMOS-based silicon devices provide access to high-density microelectrode arrays [1]. This research aims at implementing a Si/polymer-composite neural probe with improved mechanical properties and CMOS microelectronics for intracortical neural recording.

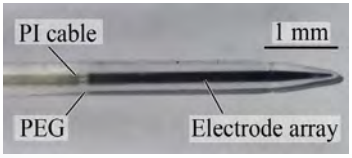

Fig. 1. Micrograph of neural probe rigidified with a 225 µm-thick PEG layer.

Objectives & Methods In this study efficient fabrication and assembly techniques for miniaturized Si-based electrode arrays and polymer interconnects are developed. Wafer-level fabrication of Parylene-C-based interconnects directly on the electrode array will allow to avoid chip-level flip-chip bonding of the two components [2]. Bioresorbable coatings and miniaturization of the rigid electrode array will provide appropriate mechanical stability during implantation as well as high flexibility in-situ.

Results Flexible neural probes with a pronounced reduction in footprint have been fabricated and coated with polyethylene glycol (PEG) by a novel centrifuge-based molding process (Fig. 1). Rigidified probes were inserted into an electrically conducting agar-based brain model and PEG dissolution was observed using time-dependent impedance spectroscopy. Roughly 1 min after implantation, stable electrode impedances of 520 kΩ on average have been recorded, indicating the usability of the probe (Fig. 2). [3]

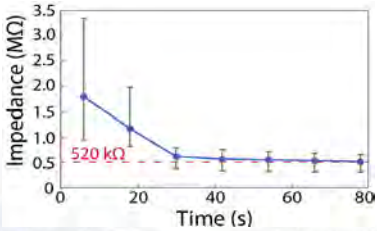

Fig. 2.Results of the time-dependent impedance spectroscopy of platinum microelectrodes.

References

[1] K. Seidl et al., Proc. IEEE MEMS 2009, pp. 232-235.
[2] S. Kisban et al., Proc. IFMBE 2009, pp. 107-110.
[3] F. Barz et al., Proc. IEEE MEMS 2015, pp. 636-639.