 DOI: 10.3217/978-3-99161-050-2-080

Investigation on the material-tissue-interface of flexible epicortical electrode arrays in a ferret animal model

I.G. Vasilaş[1], J. Schulte[1], P. Čvančara[1], F. Pieper[2], A.K. Engel[2], T. Stieglitz[1]*

[1]*Laboratory for Biomed. Microtechnol., IMTEK & BrainLinks-BrainTools Center, University of Freiburg, Freiburg, Germany;* [2]*Dept. of Neurophysiology and Pathophysiology & Hamburg Center of Neuroscience, University Medical Center Hamburg-Eppendorf, Hamburg, Germany*

*IMBIT//Neuroprobes, Georges-Koehler-Allee 201, 79110 Freiburg, Germany. E-mail: thomas.stieglitz@imtek.uni-freiburg.de

Introduction: Engineering and material sciences have driven developments of miniaturized neural probes as tools to decipher function of the brain in neuroscientific investigations. Translation of implantable brain-computer-interfaces into clinical applications, however, is quite slow [1]. Development of active implantable devices has to comply with medical device regulations to meet safety standards. Amongst the most important topics should always be the investigation of the stability of implants for a predetermined time and their effect on the brain tissue. This work is about such a study.

Material, Methods and Results: µECoG arrays have been developed of polyimide with thin-film metal (platinum, iridium oxide) as electrode and interconnect material for chronic neuroscientific investigations in ferrets (Mustela putorius) [2] obtaining LFP and spike-like activity. Studies have been conducted up to one year with high quality of the recordings over the whole time. After termination of the experiments, methods for probe and brain dissection were developed (Fig.1). Initially, µECoGs and brain tissue were jointly investigated before being separated for detailed characterization. Even though probe thickness of 10 µm should not lead to any mechanical interaction with the brain [3], cortical depression was still observed. Electrodes showed signs of stress cracking, embrittlement and progressive adhesion loss [4].

Conclusion: Flexible µECoG allow stable recordings over months. Despite excellent functionality, deterioration of thin-films and tissue alterations around the array indicate limits in longevity and knowledge of the comprehensive processes in foreign body reactions for translation of implantable brain-computer-interfaces for life-long human applications.

Acknowledgments: Part of this work has been conducted within BrainLinks-BrainTools, which is funded by the Federal Ministry of Economics, Science and Arts of Baden Württemberg within the sustainability program for projects of the excellence initiative.

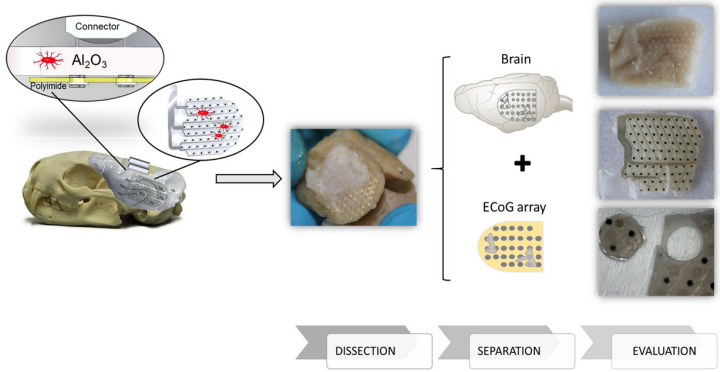

Figure 1: Investigation of ECoG arrays after chronic implantation in ferrets. Fixed brains with probes were dissected, separated and evaluated with respect to morphological changes of the brain and material alterations and adhesion loss of the ECoG array.

References:

[1] Schalk G., Brunner P, Allison BA, Soekadar SR,Guan C, Denison T, Rickert J, Miller KJ. Translation of Neurotechnologies. *Nat Rev Bioeng* 2, 637–652, 2024

[2] Stitt I, Hollensteiner KJ, Galindo-Leon E, Pieper F, Fiedler E, Stieglitz T, et al. Dynamic reconfiguration of cortical functional connectivity across brain states. Sci Rep.;7: 8797, 2017.

[3] Vomero M, Porto Cruz MF, Zucchini E, Ciarpella F, Delfino E, Carli S, Boehler C, Asplund M, Ricci D, Fadiga L, Stieglitz T. Conformable polyimide-based µECoGs: Bringing the electrodes closer to the signal source. *Biomaterials*. 255: 120178, 2020.

[4] Schulte J, Hofert MM, Vasilaş IG, Stieglitz T. Biological Impact on the Stability and Reliability of Acute and Chronic Platinum based Thin Film Neural Interfaces in Vivo. in *Proceedings of the 44th Annual International Conference of the IEEE/EMBS,* 4139-4142, 2022.

Published by Verlag der Technischen Universität Graz