April 21, 2020

Start in May/June 2020

MASTER thesis in Nanosciences

Nano-Engineered Neural Interfaces (NENI)

Background

The human brain contains 86 billion cells, which communicate via signaling molecules and electrical pulses with amplitudes comparable to the ones in currently used computers. So far, the man-made electrodes are orders of magnitude stiffer than the brain. This mismatch and the pulsatile micro-motion of the brain tissues induce the formation of scar tissue around the electrodes and prevent the exchange of information over reasonably long periods of time.

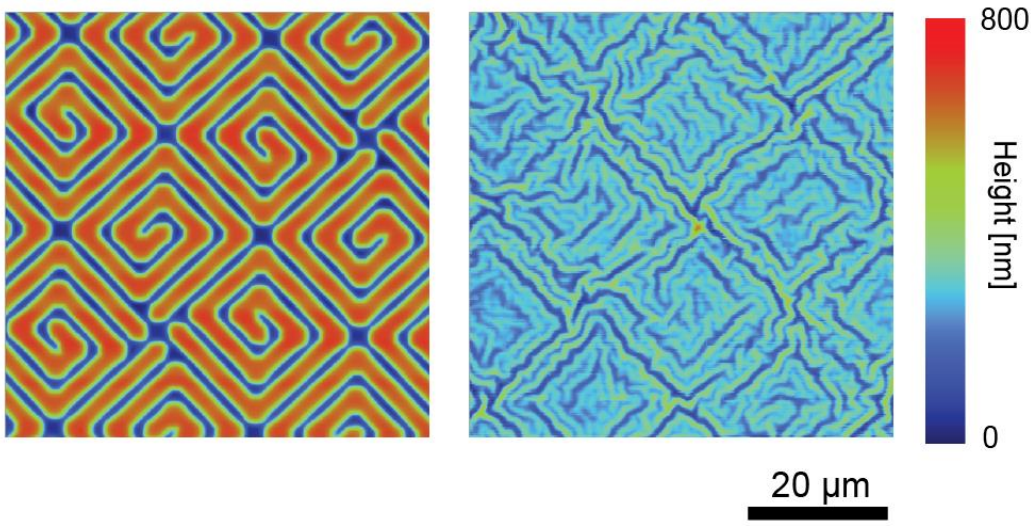

Fig. *Biomimetic electrodes on NIL-patterned medical-grade PEEK films for interfacing the brain and as highly flexible spinal cord arrays.*

We have developed a method to fabricate soft and flexible conducting thin films, four orders of magnitude softer than the state-of-the-art Pt/Ir electrodes (1-3). This combination of micro- and nanostructures is a hybrid of gold and silicone. By the control of the nanostructure's amplitude and their orientation we have obtained anisotropic properties, as present in human tissues, see Figure above. Equally important, these nanostructures immensely increase the available interface area to the cells so that the activity of the neural interface could become drastically enhanced.

Project description

Nature of thesis:

Experimental 90% (Physics/Engineering 60%, Bio 30%)
Documentation 10%

Activities: Fabrication of NENI Prototypes, AFM, Nanoindentations, Molecular Beam Deposition, four-point probing of sheet resistance, contact angle measurements, electrical stimulation of neuronal cells, a.o.

Literature:

(1) B. Osmani, H. Schift, K. Vogelsang, R. Guzman, M. Kristiansen, R. Crockett, A. Chacko, S. Bucher, T. Töpper, B. Müller, "Hierarchically structured polydimethylsiloxane films for ultra-soft neural interface", *Micro and Nano Engineering* **7**, 10005 (2020).

(2) B. Osmani, T. Töpper, B. Müller, "Conducting and stretchable nanometer-thin gold/thiol-functionalized polydimethylsiloxane films," *Journal of Nanophotonics* **12**(3), 033006 (2018).

(3) B. Osmani, H. Deyhle, T. Töpper, T. Pfohl, B. Müller, "Gold layers on elastomers near the critical stress regime," *Advanced Materials Technologies* **2**, 1700105 (2017).

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