Projects at the EPFL Center of MicroNanoTechnology

MICROELECTRODE ARRAYS FOR ELECTRICAL MONIOTRING OF 3D ENGINEERED BRAIN TISSUES AT THE AIR LIQUID INTERFACE

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Project objective:

This project aims to develop a screening and test platform adapted to the electrophysiological monitoring of 3D neural tissues derived from reprogrammed human stem cells (iPSC) at the air-liquid interface. The tissue is interfaced using a porous microfabricated MicroElectrode Array (MEA) consisting of a porous polyimide membrane incorporating an array of 32 recording sites coated with black platinum material. The electrodes have a diameter of 30µm and are located on a 200µm grid. 10% area porosity is achieved by ø7.5µm etched through holes on a 20µm grid. The membrane obtained is mounted on a printed circuit board allowing connection to external electronics for signal amplification and acquisition. A fluidic part allows perfusion of brain tissue with nutrients as well as with compounds to be tested.

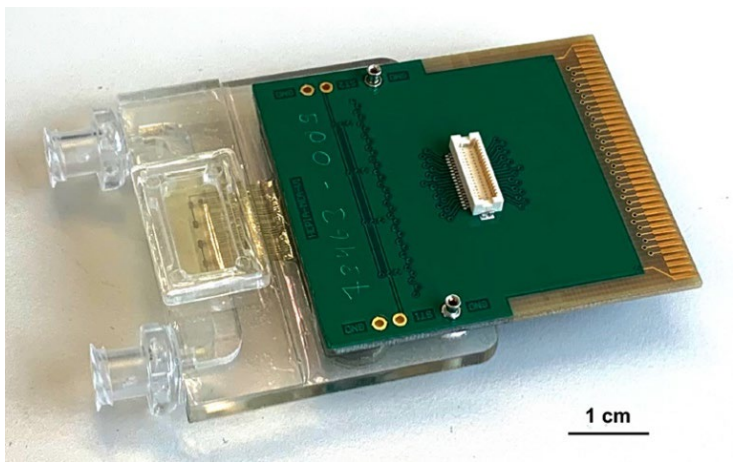

Figure 1: MEA32-4x8 biochip composed of a porous polyimide membrane comprising four recording areas with 8 recording sites each.

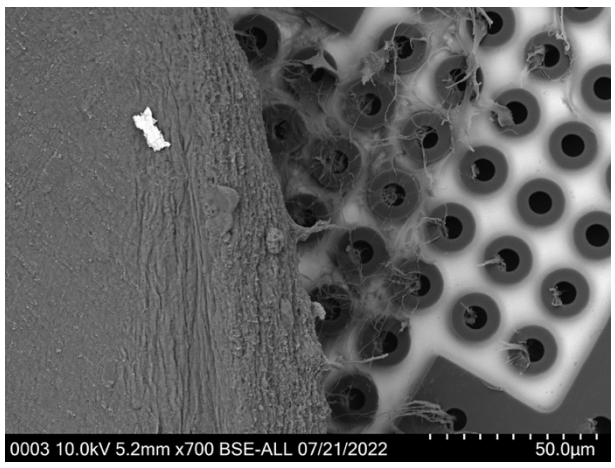

Figure 2: SEM picture showing 3D neural tissue placed on a polyimide membrane and neurites growing through the membrane porosity.

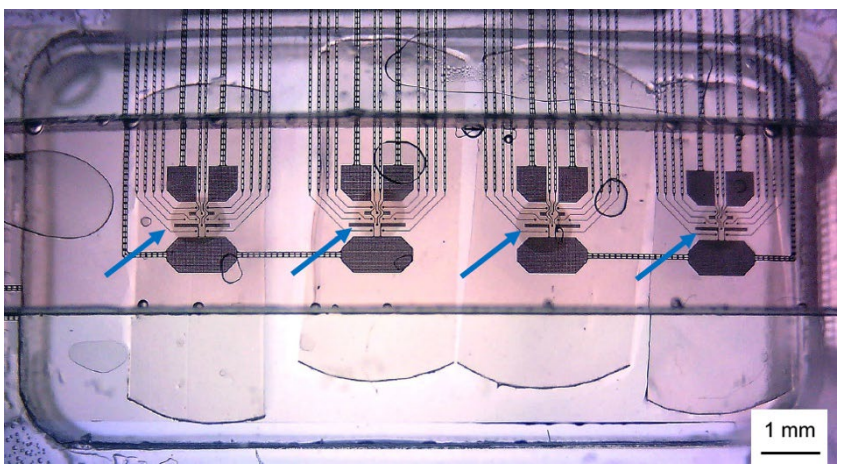

Figure 3: Magnified view of the MEA32-4x8 workspace. The polyimide membrane covers a fluidic channel allowing the cell culture medium to reach the neural tissues through its porosity. Four independent 3D neural tissues are placed above the MEA at air-liquid interface (arrows).

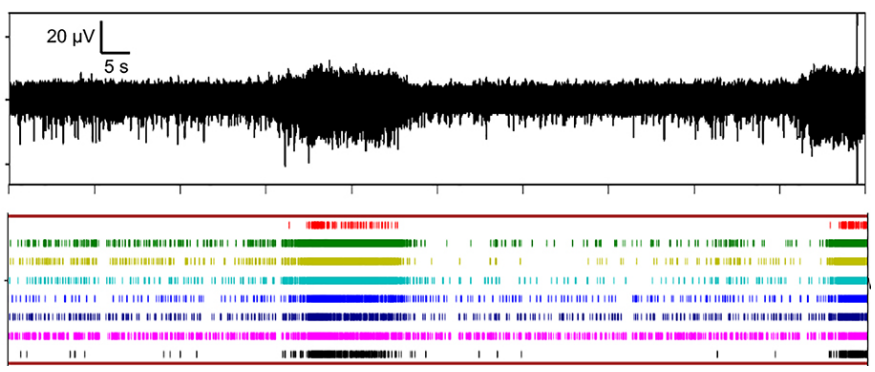

Figure 4: Typical electrical recording of 3D neural tissue illustrating spontaneous activity in the tissue. Top, electrical signal from a recording site. Bottom, raster-plot of event timestamps to visualize patterns of biological activity in a tissue (8 recording sites).

Techniques employed: Sputtering: SPIDER600; Dry etching: IBE and SPTS;
Photolithography: Polyimide PI-2611, AZ 10XT-20 and AZ ECI 3027

Publications:

[1] R. Wertenbroek, Y. Thoma, F.M. Mor, S. Grassi, M.O. Heuschkel, A. Roux, and L. Stoppini, *SpikeOnChip: A Custom Embedded Platform for Neuronal Activity Recording and Analysis*, IEEE Trans Biomed Circuits Syst., **15**:4, 743-755 (2021)

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