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NEURON GUIDANCE ON BIO-ELECTRONIC CHIPS

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INTRODUCTION: Two-dimensional electrode arrays fabricated using microelectronic circuit processing are an ideal tool for studying the electrical activities of neuronal networks [1]. Prior to measurements, neurons are placed onto the electrodes and cultured until a neuronal network is formed. Once the network is established, electrophysiological tests can be performed where specific neurons get electrically stimulated and extracellular potentials are subsequently recorded using the array of electrodes.

As a pre-requisite, neuronal cell growth on different surface layers of the microelectronic electrode array (silicon nitride and platinum) has to be characterized. Also, the influence of adhesion proteins such as laminin-1 and poly-L-lysine is important to analyze.

In this study, Dorsal Root Ganglia (DRGs) from chicken embryos have been used. It turned out that the neurite extension is essentially the same on silicon nitride and on platinum. However, differences occur using the two adhesion proteins.

METHODS: Figure 1 shows a schematic of the chip layout, which was used for electrical characterization. Platinum was used as measurement- (20 x 20 μm^2) and as reference electrodes, while silicon nitride (1000 nm) was deposited as insulation layer to cover the conducting lines between electrodes and bondpads [2].

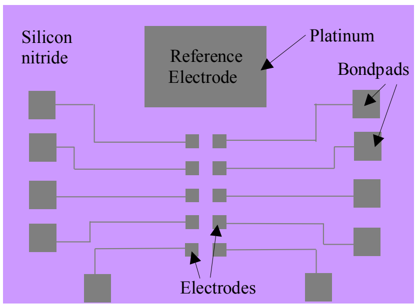

Fig. 1: Layout of the chip.

Biocompatibility of the chip surfaces was analyzed using either laminin-1 (20 µg/ml) or poly-L-lysine (PLL) (0.05%). The surface has been pre-treated with 30% H_2O_2 followed by sterilization under UV-light. DRGs were harvested from 10-day-old chicken embryos and cultured for up to 7 days in EAGLE's MEM 10% FCS, 5% chick serum and 100 ng/ml NGF.

RESULTS: Figure 2 shows a DRG placed at the border between a platinum reference electrode and the nitride passivation. The surface was coated with laminin-1 and after 4 days in culture, neurite growth was very similar on platinum and nitride surfaces.

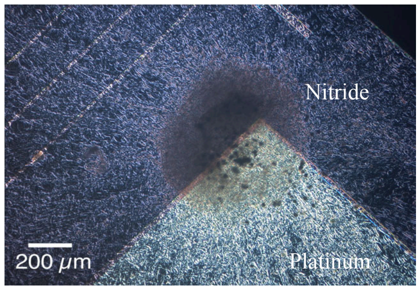

Fig. 2: DRGs on laminin-1 coated microchip surface (4 days culture).

Different proteins, however, seem to affect the neurite growth substantially (Fig. 3). Here, silicon nitride was coated with laminin-1 (left panel) and PLL (right panel). The DRG placed on laminin-1 spread well on the surface, while the DRG on PLL remained smaller in diameter and very densely packed. Neurite outgrowth was different as well, since neurites extended longer and more frequent on laminin-1, whereas they remain few and short on PLL. These results correspond well with results observed for DRGs cultured on laminin-1 and PLL absorbed to tissue culture polystyrene (not shown).

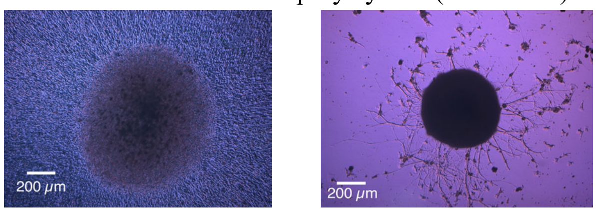

Fig. 3: DRG placed on silicon nitride, absorbed with laminin-1 (left) and PLL (right).

DISCUSSION & CONCLUSIONS: Laminin-1 provides a good adhesive substrate, however forms, because of its large molecular mass (800kDa), a thick protein layer. Therefore, electrical measurements could be impaired as the signals from the neurons are minute. Future aims are to find an adhesion layer as good as laminin-1, but having low molecular mass.

REFERENCES: [1] M. Jenkner, B. Müller, P. Fromherz (2001) *Biol. Cybernetics* **84**:239-249. [2] F. Greve, J. Lichtenberg, A. Hierlemann, H. Baltes (2003), SmallTalk 2003.