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Novel electrochemical sensor for lab-on-a-chip and biomedical technology

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Introduction:

Culturing of organotypic brain tissues is a routine procedure in neural research. The visual inspection of the medium is the only way of determining the state of the tissue. At the end of culturing, post-processing techniques such as HPLC can be used to measure the concentration of the secreted metabolites in the waste products. Continuous measurements would enable improved monitoring as compared to the end-point assay. Here, we developed a sensor system capable of real time measurements of the analytes directly secreted from the tissue. The presented system can be readily integrated in the standard procedures allowing for better assessment of the progress of the culturing.

The sensor system was initially developed for monitoring of cells and tissue cultures but has lately been considered for, and tested in, a wide range of applications. Some of these include pathogen detection and integration in microfluidic devices for sample preparation.

Fabrication

The membrane electrodes can be fabricated in several different ways, depending on material choices and available equipment. Currently sputtering have been used for creating electrodes on membrane inserts as the one seen in Figure 1. The increased temperatures encountered during sputtering process has ben seen to have some effect on the membrane morphology but not in a destructive manner. For fabrication of electrodes on flat membranes E-beam evaporation has been used with great success. The process works at room temperature and thus does not change the morphology of the membrane material. An example of a membrane fabricated with E-beam evaporation can be seen in Figure 2.

In order to test the stability of the electrodes during storage CVs in 10 mM ferri ferrocyanide were performed every second week on three different electrodes. Three of the measurements on one of the electrodes can be seen in Figure 5. The graphs were obtained in the following order: red, green and blue. As can be seen the signal did not change considerably.

As the membrane electrodes were initially developed for measuring on cell cultures and tissue it was decided to do dopamine sensing as a preliminary test. The result of the first measurement can be seen in Figure 6. The graph shows an amperometric measurement on one electrode. The measurement was made as a preliminary proof of concept and no optimization has been made.

Characterisation

Long term stability

In order to test the stability of the electrodes during longer measurements CVs with 100 cycles was performed in 10mM ferri ferrocyanide. The CVs were performed using scan rates of 500 mV/s, 400 mV/s, 300 mV/s, 200 mV/s and 100 mV/s. The result of one of these measurements can be seen in Figure 6 were the peak potential has been plotted as a function of the cycle number.

Flow through the membrane

In order to determine if the deposition of the electrodes affects the flow through the membranes tests were performed. First the membranes were studied using SEM. One of the resulting pictures can be seen in Figure 7. Based on these observations the pore size was unchanged after metal deposition.

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