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an automated microfluidic electrochemical analysis platform

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Real-time multiparameter monitoring of cellular dynamics - an automated microfluidic electrochemical analysis platform

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Since the conceptual emergence of microfluidics, many devices have demonstrated capabilities in diverse application areas. During the recent years the most flourishing application area has been cell manipulation and analysis. Although most devices are based on the concept of a small microfluidic chip operated by bulky external instrumentation, a new trend is modularity that encompasses all the necessary automated operations in a small footprint device [1]. In an analogous way as cell biological application are predominantly based on optical/fluorescence based detection, microfluidic devices for cell biology are implementations of optical detection. However, many relevant parameters are detectable using electrochemical techniques. Moreover, electrochemical detection can strongly contribute to automation and portability in device design.

Here, we present a new microfluidic concept that encompasses modularity in both microfluidic and electrochemical meaning. A compact motherboard, which a further development of our previous work for cellular redox assays [2], houses all fluidic operations, temperature control, and gas control needed for automated cellular assays without an incubator (Fig. 1a). Through an optimized integration process microelectrode chips can be easily combined with different microfluidic chip designs. Moreover, the electrochemical experiments can be performed using a previously developed miniaturized 24-channel potentiostat [3], which is custom-made to fit on top of the modular microfluidic motherboard. The system is designed for on-line electrode modification followed by diverse cell-based investigations, and its capabilities have been demonstrated in, e.g., repeated dopamine exocytosis monitoring from cell populations (Fig. 1b), impedance based monitoring of toxic effect of chemotherapeutic substances (Fig. 1c), wound healing, and mediated amperometric monitoring of cellular redox environment.

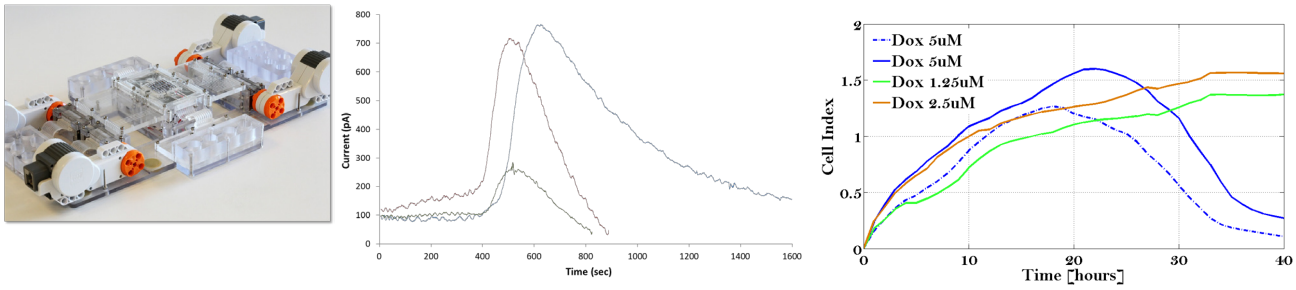

Figure 1. a) Modular microfluidic platform for electrochemical cell-based investigations, such as b) repeated monitoring of dopamine exocytosis from the same cell population, and c) impedance based monitoring of toxic effects of cancer drugs.

References:

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[2] Heiskanen et al. Anal. Bioanal. Chem. 405 (2013) 3847.
[3] Vergani M. et al. IEEE Trans. Biomed. Circuits Syst.6 (2012) 498.