Automatization and Validation of a Next Generation Smart Multi-Well Plate Lid for Organ-on-Chip Applications

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Introduction

Advanced in-vitro models such as Organ-on-Chip models have revolutionized biomedical research and drug discovery. However, as these models become increasingly complex and sophisticated, manual lab tasks do as well. Therefore, it is desirable to reduce workload and secure controlled outcomes (standardization) and meaningful results by automatizing repetitive tasks such as glucose concentration monitoring in cell culture medium. In the framework of this thesis several novel components were integrated and automatized into one smart lid platform compatible with a 96 multiwell plate. On the one hand, a novel microfluidic device was integrated and characterized with pneumatically driven peristaltic pumps realized by a flexible membrane integrated in hard plastic, an improvement over prior solutions made of PDMS [1]. On the other hand, a disposable screen printed 2nd generation electrochemical glucose biosensor sheet was used with 8 parallel sensor patches.

Materials and Methods

To automate the peristaltic pumps a microcontroler was used where 6 valves and 2 pumps could be actuated. To enable use in a sterile environment, including moving in and out of the incubator/laminar flow hood, a housing was designed in SolidWorks and 3D printed out of PLA (see Fig. 1). The microfluidic device and the sensor sheet were characterized qualitatively (food dye test) and quantitatively (fluorescence absorption test and spiked buffer test).

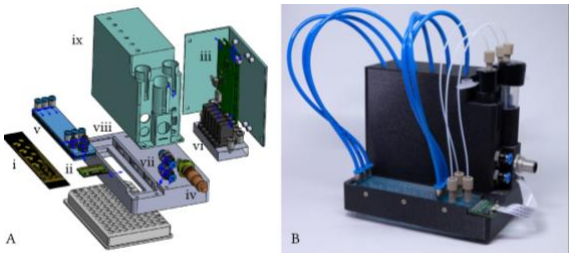

Fig. 1 A) i) Sensor sheet ii) Sensor adapter iii) Sensor reader iv) Electronic connection to microcontroller v) Microfluidic device vi) Manifold and valves vii) Pneumatic connection to pumps viii) Lid ix) Housing B) Final prototype

Results

Qualitative characterization of the microfluidic device revealed the proper functioning of the peristaltic pumps but uneven operation of the 8 parallel sensor patches and differences between the conveyer paths for the different reservoirs (see Fig. 2).

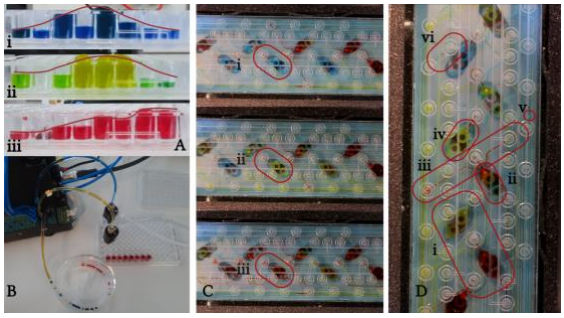

Fig. 2 Qualitative Characterization

Quantitative characterization of the sensor sheet in a centrifuge tube showed results similar to previous measurements, conducted with an earlier badge of sensor sheets (see Fig. 3).

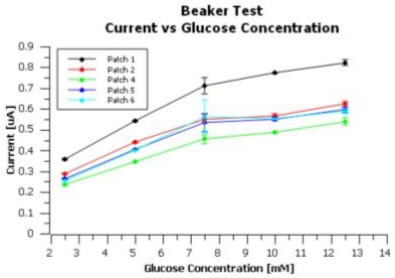

Fig. 3 Quantitative Characterization

Discussion

These results show the feasibility of such a device for automating the biomonitoring of Organ-on-Chip applications. Further work is needed to optimize the system regarding pressure monitoring, channel design, and wettability.

References

[1] Unger et al. ‚Monolithic Microfabricated Valves and Pumps by Multilayer Soft Lithography. *Science* 288, 113-116 (2000).

Acknowledgements

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