Electrochemical sensor platform for MIP incorporated microfluidic paper-based analytical devices

Vreys F.[12], Oudebrouckx G.[12], Vandenryt T.[12], Ethirajan A.[12], Junkers T.[12], Thoelen R.[12]

frederik.vreys@uhasselt.be

[1]Institute for Materials Research(IMO), Hasselt University,
Wetenschapspark 1, 3590 Diepenbeek, Belgium
[2]IMEC vzw – Division IMOMEC,
Wetenschapspark 1, 3590 Diepenbeek, Belgium

Abstract: A biomimetic sensor platform capable of performing electrochemical measurements for the detection of molecules was developed by incorporating molecularly imprinted polymers (MIPs) into microfluidic paper-based analytical devices(µPADs). The usage of µPADs in combination with electrochemical measurements vastly improves several parameters compared to lab-sized electrochemical setups. Interdigitated electrodes were utilized, this way no top electrode is needed. The amplitude of the impedance was monitored and a complete impedance spectrum was measured continuously. The combination of low-cost, disposable paper-based microfluidics and electrochemical read-out, make an ideal point-of-care application.

Keywords: impedimetric, electrochemical, microfluidics, microfluidic paper-based analytical device(µPAD), molecularly imprinted polymer(MIP)

Introduction

Thoelen R. et al. showed that platforms capable of performing electrochemical measurements are suitable for the detection of molecules by applying molecularly imprinted polymers[1]. Impedimetric setups have since than been employed for different kinds of molecules in different kinds of fluids[2].

The use of paper-based microfluidics further miniaturizes the electrochemical read-out platform. Hereby some parameters (i.e. temperature[2]) are no longer controlled while others are vastly improved.

Firstly, paper-based microfluidics do not require actively driven pumps. Indeed, capillary forces of the paper fibres cause fluid to flow. In addition, paper-based microfluidics use less fluid which in turn leads to less stabilization time. This severely decreases the duration of a measurement. Paper-based microfluidics also enable sample pre-treatment because the pore size distribution filters out the unwanted larger molecules.

Materials & Methods

Whatman nr.1 was used as paper. Its design was cut-out with a CO_2-laser. It has an addition zone, a running zone which contains the non-imprinted polymers(NIP) and MIP, and a pumping zone which provides a sustained flow over time[3]. The paper is sealed on one side with Kapton tape. The edges of this tape are exploited to adhere the µPAD to the interdigitated electrodes. A schematic side view of the µPAD can be seen in Figure 1.

The amplitude of the impedance is observed for a complete spectrum. Since the NIP provides a negative control no non-spiked solution step is needed.

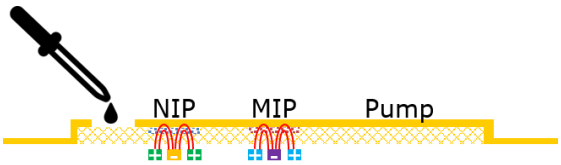

Figure 1: Schematic side view of the µPAD

Results and Discussion

$|Z_{MIP}|-|Z_{NIP}|$ is trending to the positive. It should be noted that only molecules that have past the MIP region will give rise to a higher differential signal. Therefore increasing the pump capacity could potentially boost the signal.

Conclusion

Although µPADs give rise to a lower signal it is yet the smallest biomimetic sensor platform based on imprinted polymers and electrochemical read-out. Therefore it is the most promising step towards a point-of-care device.

References

[1] Thoelen R. et al., Biosensors and Bioelectronics, 2008, Vol. 23, pp 913-918
[2] Peeters M. et al., Sensors and Actuators B, 2012, Vol. 171-172, pp 302-610
[3] Mendez S. et al., LANGMUIR, 2010, Vol. 26, pp 1380-1385

Acknowledgements

This work is funded by the BIOMAT project which is carried out under Interreg V-A grensregio Vlaanderen - Nederland and is supported by the European Union and The European Regional Development Fund and with financial support of province of Limburg - Belgium.