Impedimetric detection of yeast using synthetic whole-cell receptors

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Abstract: *In previous research, synthetic whole-cell receptors were combined with the heat transfer method (HTM) for the detection of different kind of microorganisms. While this has been proven to be a low-cost and versatile biosensing technique, it is restricted by its limit of detection (LoD). In this project, we aim to overcome this problem by combining surface-imprinted polymers (SIPs) with electrical impedance spectroscopy (EIS). By linking both techniques, a current LoD of 10^3 CFU/mL could be achieved. Further optimizations are ongoing to lower this LoD even further.*

Keywords*:* Surface-imprinted polymers, biosensor, yeast, electrical impedance spectroscopy

Introduction

Microbiological contaminations can be detected by current state-of-the-art methods. However, these techniques are time consuming, costly and require trained staff [1]. Therefore, the development of a fast, sensitive and low-cost biosensing technique is necessary. In previous work, the authors of this abstract combined surface-imprinted polymers (SIPs) with an optimized thermal biosensor for the detection of *Escherichia coli* bacteria in buffer. By combining both techniques, a limit of detection (LoD) of 2.10×10^4 CFU/mL could be reached [2]. However, further decreasing this LoD is critical in order to be able to detect microorganisms within the strict limits of food- and water regulations. To overcome this problem, SIPs will be combined with electrical impedance spectroscopy (EIS).

Results and Discussion

As a proof of concept, baker's yeast cells (*Saccharomyces cerevisiae*) were used to create SIPs in a polyurethane (PU) layer. Due to the electrically isolating properties of PU, it was necessary to optimize the SIP protocol. This was done by testing different yeast concentrations and spin coating speeds on the polydimethylsiloxane (PDMS) stamp and by changing the spin coating of the polymer layer. As a result, a polymer layer of only 400 nm was created with a high density of yeast imprints. Characterization was performed using optical microscopy, water contact angle and atomic force microscopy.

In order to determine the LoD, measurements with *S. cerevisiae* SIPs were performed using increasing concentrations from 10^3 to 10^4 cells/mL. After each exposure step, the flow cell was rinsed with and PBS to ensure complete removal of the unbound yeast cells of the SIP layer (Fig. 1).

The results indicate that exposing the SIP to the lowest concentration resulted in a measurable jump in impedance. By implying the 3σ value into the fit, a theoretical LoD of 176 cells/mL could be obtained.

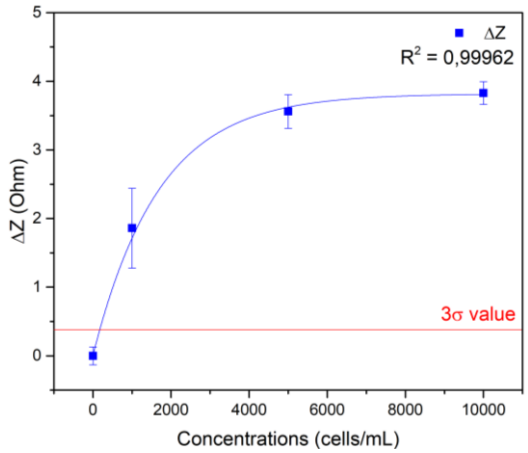

Figure 1: *Dose-response curve for the impedimetric detection S. cerevisiae in PBS buffer solution.*

Conclusion

By combining EIS with yeast SIPs it is possible to achieve a LoD of 10^3 cells/mL. However, it can be seen that the actual LoD can be found much lower. Therefore, lower concentrations will be measured and combining it with a new flow cell could also lower the 3σ value and consequently the LoD. A next phase can be also to use a planar, on-chip electrode configuration.

References

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