Karlsruher Institut für Technologie

Institut für Funktionelle Grenzflächen
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Master Thesis

Impedimetric sensing of early-stage acute kidney injury biomarkers using molecularly imprinted polymers

Background

The recent global epidemic has highlighted the emerging need for accessible, rapid, and accurate biosensing platforms. While biological receptors, such as antibodies, offer sensitive and selective detection of target analytes, they are costly, resource intensive, and susceptible to environmental conditions. Therefore, considerable efforts have been made to develop artificially designed alternative receptors, such as molecularly imprinted polymers (MIPs). MIPs can be formed by synthesizing a polymeric matrix in the presence of template (analyte) molecules. The MIPs preparation mechanism involves several steps: first, a pre-polymerization complex is formed between the template and functional monomer molecules. Then polymerization takes place in the presence of a cross-linker, resulting in the formation of a polymer matrix. Finally, template molecules are extracted, leaving 3-D cavities complementary to the extracted template molecule. Electropolymerization is a well-established technique that enables the controllable formation of MIPs on electrode surfaces. The recognition sites ensure specific (re)-binding of target analytes during detection. Electrochemical impedance spectroscopy (EIS) offers label-free, fast and sensitive detection. The impedance signal alters with physical and biochemical processes occurring at the electrode interface which is particularly appealing in biosensing applications.

This thesis aims to investigate the impedimetric sensing of early-stage acute kidney injury (AKI) biomarkers (NGAL and Cystatin C) using MIPs. Therefore, MIPs will be synthesized by means of electropolymerization and the detection will be characterized by EIS analysis following both a faradaic and non-faradaic approach. An adequate already established equivalent circuit (EC) will be used to fit the generated data. Towards this aim, the suitability of the fabricated MIP will be tested for analyte detection to prove their utility for biosensing.

Objectives and work packages:

Work packages depend on the current state of the project and usually include:

- Literature study to gain insights about MIPs, EIS and early-stage AKI
- Detection studies
- Selectivity studies
- Specificity studies

In addition to the theoretical and experimental work, various software programs (i.e., Gamry Toolkit, OriginLab) should be trained. The results will be presented in a final report and as a presentation. Only the written thesis material counts for the assessment and grading of the thesis.

Start date: *now*

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