Biomimetic Polymeric Receptors Integrated with Portable Sensors for Detection of Clinically Relevant Biomarkers

Summary

The overall objective of the PhD study is to develop a portable sensor armed with Molecularly Imprinted Polymers (MIPs) as biomimetic polymeric receptors and targeted for detection of clinically relevant compounds. The project addresses the limitations of current biosensors and point-of-care testing devices related to the use of biological receptors as recognition elements. The developed sensor is expected to provide a low-cost analytical tool capable of fast and reliable detection of clinically relevant biomarkers in complex matrices such biological fluids.

Research field:	Chemical, materials and energy technology
Supervisors:	Dr. Vitali Sõritski Dr. Jekaterina Reut
Availability:	This position is available.
Offered by:	School of Engineering Department of Materials and Environmental Technology
Application deadline:	Applications are accepted between October 02, 2023 00:00 and October 23, 2023 23:59 (Europe/Zurich)

Description

Nowadays, there is a growing need in healthcare for analytical methods that are fast, reliable, and capable of achieving high selectivity with low limits of detection. These methods should also be low-cost, portable, and capable of delivering rapid and dependable results. Most of the current biosensing systems, including Point-of-Care Testing (PoCT) devices, rely on labile biological recognition elements, which offer high selectivity but have limitations such as a short shelf life, increased cost, and longer analysis time. Molecularly Imprinted Polymers (MIPs) have emerged as robust biomimetic receptors that can overcome these limitations. Through the process of molecular imprinting, MIPs are designed to bind target molecules by creating specific molecular cavities within a polymeric network. These cavities accurately mimic the size, shape, and chemical functionalities of the target molecules, resulting in a highly specific and efficient binding capability. MIPs offer a unique combination of selectivity and affinity comparable to biological receptors, while also providing additional benefits. These benefits include enhanced chemical and thermal stability, cost-effectiveness, reproducibility, and an animal-free fabrication process. Integrating MIPs with portable sensor platforms, such as screen-printed electrodes (SPE), which are compatible with large-scale fabrication, enables reproducible and rapid analysis of biological samples in a multiplexed manner. This integration provides a significant advantage in the development of innovative sensing systems for various applications in healthcare.

The goal of this PhD project is to a molecularly imprinted polymer (MIP) endowed with the selectivity to a disease-related protein biomarker or a panel of biomarkers, e.g. biomarkers of neurological diseases, and its integration into a sensor chip or a sensor array to develop a cost-effective sensor platform for medical diagnostics. Appropriate data processing methods enabling efficient interpretation of the data generated by MIP sensor will also be established.

Responsibilities and (foreseen) tasks

- to actively participate in the experimental work:

- the rational selection of functional monomers using computational modeling and spectroscopic analysis;
- finding of an optimal polymerization method and an efficient procedure for target molecule removal to produce MIP;
- adapting the synthesis methods to generate MIP on a sensor array;
- rational improvement of MIPs to approach biological receptors in terms of affinity and selectivity towards the chosen target analytes;
- study of the analytical performance of the prepared MIP based sensors.

- to collaborate with internal and external groups;

- to communicate results at meetings, conferences, and write reports and publications.
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Applicants should fulfil the following requirements:

- We are looking for top motivated candidates having some practical experience in polymer synthesis, biochemistry (protein characterization and analysis), electrochemistry, nanofabrication. Furthermore, we expect good laboratory skills and the ability to work independently, the ability to write up results of your own research and prepare for presentations. The top candidates for the post may be interviewed and asked to present their scientific work and experience.

Mandatory requirements:

- MSc in the field of chemistry, analytical chemistry, biochemistry, or materials science.
- ENGLISH: Excellent (Level B2 or higher)
- strong and demonstrable writing and analytical skills

The following experience is beneficial:

- Programming in Matlab, Python
- Working knowledge of data analysis and graphing software OriginLab Origin
- Knowledge of electrochemistry

The candidate should submit a research plan for the topic, including the overall research and data collection strategy. The candidate can expand on the listed research questions and tasks and propose theoretical lenses to be used.

About the Laboratory of Biofunctional Materials

The Laboratory of Biofunctional Materials of the Department of Materials and Environmental Technology develops smart sensing functional materials to propose solutions with considerable potential impact on essential areas of human life such as environmental protection and medical diagnostics. Employing the molecular imprinting technology, the group designs and synthesizes polymeric materials so called Molecularly Imprinted Polymer (MIP), which, thanks to their synthetic nature, possess excellent chemical and thermal stability and are associated with reproducible, cost-effective fabrication. MIPs can be easily integrated with a variety of sensor platforms and allow, thus, label-free detection of a target analyte with high sensitivity and selectivity. The laboratory has succeeded in developing the MIP-based sensors capable of determining various antibiotics (sulfamethizole, amoxicillin, erythromycin) in aqueous media as well as clinically relevant compounds such as immunoglobulin G, neurotrophic factors (BDNF, CDNF) and viral proteins (SARS-Cov-2 nucleocapsid and spike proteins).

Additional information

For further information, please contact Dr. Vitali Syritski vitali.syritski@taltech.ee and Dr Jekaterina Reut jekaterina.reut@taltech.ee, web: https://taltech.ee/en/laboratory-biofunctional-materials.

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