Biomimetic Polymeric Receptors Integrated with a Sensor Array for Environmental Monitoring

Summary

The overall objective of the PhD study is to develop next-generation sensor arrays by implementing Molecularly Imprinted Polymers (MIPs) as robust, low-cost biomimetic receptors for multiplex and/or simultaneous detection of targets that are of significant interest to environmental monitoring. The study addresses overcoming the limitations of current biosensors and point-of-care testing devices, particularly regarding their restricted capability to analyze complex samples and the use of biological receptors as recognition elements. The resulting sensor arrays are expected to provide an affordable and easy-to-use analytical tool capable of accurately analyzing complex environments, such as environmental water, in a multiplexed manner.

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 January 01, 2024 00:00 and January 22, 2024 23:59 (Europe/Zurich)

Description

The research

Nowadays, the detection of environmental pollutants, such as pharmaceuticals and toxins, is a critical concern in various fields, including environmental monitoring and homeland security. Environmental pollutants often coexist at varying concentrations, making the simultaneous detection of multiple analytes, rather than a single analyte, more rational. There is an increasing demand for portable, low-cost analytical devices with enhanced stability capable of delivering rapid and accurate results for complex environments in multiplexed manner. Multiplexed sensing devices have proven highly relevant in this context, particularly concerning the screening of highly toxic and strictly regulated food mycotoxins and water pollutants.

The use of Molecularly Imprinted Polymers (MIPs) as robust biomimetic receptors in sensing devices is an attractive approach to overcome limitations associated with biological recognition elements. 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. The synergy of MIP strategies for creating robust biomimetic receptors and sensor arrays can further expand the significance and applicability of these technologies, ultimately leading to more efficient and accurate monitoring of environmental hazards.

The objective of this PhD project is to develop affordable synthesis approaches that enable the generation of MIPs with selectivity towards high-priority analytes in environmental monitoring e.g. antibiotics, cyanotoxins etc. These approaches should be compatible with the automated and efficient integration of MIPs into a sensor array (preferably, an electrochemical sensor array), facilitating reproducible and rapid analysis of complex samples in a multiplexed manner. The project also aims to establish appropriate data processing methods enabling efficient interpretation of the data generated by MIP sensor array.

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, e.g. electrochemical sensor array;
- rational improvement of MIPs in terms of affinity and selectivity towards the chosen target analytes;

- study of the analytical performance of the prepared MIP sensor array.
- to collaborate with internal and external research groups;
- to communicate results at meetings, conferences, and write reports and publications.

Applicants should fulfil the following requirements:

- MSc in the field of chemistry, analytical chemistry, materials science, or in a related field
- a clear interest in the topic of the position
- excellent command of English (Level B2 or higher)
- strong and demonstrable writing and analytical skills

We are looking for top motivated candidates having practical experience in polymer synthesis, electrochemistry, chemo- or biosensors preparation and study. 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 will be interviewed and asked to present their scientific work and experience.

The following experience is beneficial:

- Programming in Matlab, Python
- Working knowledge of data analysis and graphing software Origin (OriginLab Corporation)
- Knowledge of electrochemistry
- Knowledge in the machine learning

The candidate should submit a research plan for the topic, including the overall research. 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)

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