Potentiometry is one of the basic analytical methods in almost every chemical, physical and/or biological laboratories all around the world. This widely used method is based on the measurements of the potential of an electrochemical cell under static conditions. It can be applied for detection of various ions, but at the beginning it was used only to few analytes. Its applications increased with development of ion-selective electrodes (ISEs) based on using a selective membranes which allow for separation of the target ion from sample matrix. Continued development of ISEs and used membranes extends potentiometry to a diverse array of analytes.

Nevertheless, the abovementioned membranes are parts of electrodes – cylinders with a length of several centimetres, a diameter of slightly more than 1 cm. For potentiometric detection two electrodes are needed – one for detection of a target analyte and another one as a reference. Sometimes a combined electrode can be used – one cylinder contains two electrodes – indicator and reference ones. In conventional potentiometric analysis the electrodes have to be immersed into the solution by dipping to a depth of a few cm. This requires higher volume of sample to be used per analysis.

Nowadays, cheap, mobile, disposable, and easy-to-use analytical devices consuming low sample volume are sought after. Microfluidic paper-based analytical devices (μPADs) meet these requirements. What is more, filter paper ensures the matrix for reactions occurrence as well as for detection. Despite the fact that in common utility there are several available paper-based tests (e.g. pregnancy tests, diabetes tests, HIV, malaria, COVID-19) the novel and more complex portable systems are still being developed. μPADs for potentiometric determination have been mentioned in literature, but their applications for real samples analysis are limited in case of heavy metals analysis due to their low concentrations in environmental as well as biological samples. This problem the proposed project will deal with.

The aim of the project is to develop the new concept of ion-selective electrodes fabrication in the paper matrix. The idea is to cover electrodes with the polymer membranes providing selectivity and lowering the detection limit. Polymer inclusion membranes (PIMs) offer selective capturing of the target ions with blocking from further movement the interfering ones. These membranes will be merged with the filter paper on which the electrodes will be printed first using the screen-printing methodology. The μPAD-PIM-ISE systems will ensure selective, fast and precise potentiometric detection in a small sample volume of low level of heavy metal (e.g. lead, copper ions). Moreover, the use of PIMs provides also the lowering of detection limit by entrapping target ions in membrane what will allow to achieve the preconcentration before detection. The detectors used in the project will also decrease in size and detection will be firstly done with a conventional potentiostat, then with pH-meter/multimeter and at the end – portable potentiostat connected to smartphone.

To sum up, the concept of novel standalone μPAD-PIM-ISEs which might be used to conduct measurements in the field, will be developed. The prototype of the device will be characterized by low size, weight, and stabile storage. This new approach to potentiometric analysis in micro-scale will be firstly mentioned in scientific literature. Final result of the project would enrich the analytical chemistry knowledge and open the door to new possibilities in fabrication of potentiometric paper-based devices with much lower detection limits dedicated to heavy metal ions determination.