Nanostructured Electrochemical Sensor for Seawater Nutrients Detection

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Project Location:
Salve Regina University

Project Description:
An alternative approach to SERS is electrochemical detection. Nanostructured sensor surfaces will be specifically designed and coupled to microfluidic sample delivery system for electrochemical detection of PO_4^{3-}, NO_3^- and NO_2^- in seawater samples. This project aims to advance the EPSCoR C-AIM research themes: "What new innovations in sensors are needed to improve the collection of data on the physical, bio-geo-chemical, and ecological processes as well as anthropogenic stressors (e.g., pollution) that are impacting Narragansett Bay?" and will be undertaken in collaboration with Dr. Yi Zheng (University of Rhode Island, Department of Mechanical and Systems Engineering). A number of strategies have been used for Phosphate determination including calorimetry, electrochemistry, and fluorescence emission spectroscopy. On the other hand, most nitrate detection methods indirectly measure nitrate by first converting it to nitrite. This conversion is mostly commonly facilitated by copperized cadmium columns. The use of toxic cadmium columns can be avoided by using UV radiation to convert nitrate to nitrite, but this technique is not suitable for on-site measurements. The most ubiquitous spectroscopic technique is the Griess Assay, a reaction that produces a colored azo chromophore whose concentration can be used to infer nitrate concentration. Nitrite detection methods include fluorescence spectroscopy, absorption spectroscopy, and Raman spectroscopy. These techniques rely on the conversion of the ion to an optical signal. Although highly accurate, spectroscopic techniques require expensive and time consuming of-site analysis and are therefore not suitable for use in resource limited areas. Moreover, optical methods unlike electrochemical detection techniques present a major challenge when used in turbid water samples. Microfluidic devises (Lab –on-chip) coupled to electrochemical detection are an ideal means for rapid on-site measurements as they allow for miniaturization and automation of laboratory based protocols, leading to the development of simple, low cost, portable, compact devices. The use of microliter volumes results in a reduction in reagent consumption, waste production and analysis time compared to standard lab protocols. The nanostructured electrochemical sensors will be fabricated on our in-house screen printed electrode (SPE). In contrast to most lab based electrochemical procedures, the mass production of SPE sensors could provide a more economically viable and technologically realizable platform for commercial exploitation.

Students will be exposed to various research techniques including electrochemical sensor development, microfluidic fabrication (Salve and URI), screen printing, synthesis of nanoparticles, spectroscopic characterization and surface characterization (URI). Students will also learn how to analyze and present their research work enhancing their written and communication skills. An integral part of students training also involve doing literature searches, analyzing and presenting the journal articles retrieved from various data bases such as scifinder scholar, acs.pubs.org, www.sciencedirect.com etc.

This project involves ***primarily lab or computer work***

Required/preferred skills for student applicant:
Students should have completed at least a year of college chemistry (General Chemistry I & II with labs)

Student transportation needed for project?
Yes