Algae-Surface Enhanced Raman Spectroscopy (A-SERS) based Detection of Nitrates and Phosphates in Water

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Project Location:
University of Rhode Island-Kingston

Project Description:
Excessive levels of nitrates and phosphates in water, coming from agricultural or wastewater runoff and by flooding, create large algae blooms. Dissolved oxygen levels then drop precipitously, affecting all aquatic life. Additionally, many of these algae, such as red tides, are toxic to humans. Accurate detection of nitrates and phosphates in fresh or ocean water remains a challenge. We propose a novel natural bio-accumulation technique that exploits the ability of algae to draw in nitrates and phosphates as nutrients to detect these ions in water.

Surface Enhanced Raman Spectroscopy (SERS) active nanoparticles fabricated in our laboratory have been used to detect nitrate ions in salt water. Ulva spp algae (sea lettuce) will be immersed in a suspension of these particles. This weed is native to salt water and is known for high and rapid nutrient uptake. The particles will enter into the leaves as they draw in surrounding liquid as a part of their normal metabolic cycle. When these doped Ulva spp leaves are exposed to water 'contaminated' with sodium nitrate, they will draw the nutrient solution into their individual cells, exposing them to the SERS-active particles in those locations. The sea lettuce cells concentrate nutrients and act as natural filters, thus removing any macroscopic 'debris' that can confound the analysis. They also have natural anti-biofouling properties. These algae leaves will then be examined in a Raman microscope using near-IR laser excitation (785nm; NIR penetrates through biological material), and, using data from a calibrated system, the concentration of the nitrates can be determined quantitatively. Since each ion has a distinct Raman signature, this approach will be highly specific, allowing quantitative detection of phosphates as well.

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

Required/preferred skills for student applicant:
At or beyond sophomore level in engineering, chemistry, or other science disciplines. High degree of motivation.

Student transportation needed for project?
None