Cost Effective Sensing Platform for the Detection of Phosphate in Natural Waters

Insight
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Introduction

Nutrients such as Phosphate, Ammonia, Nitrite and Nitrate are central in many environmental processes within the marine environment, including several microbial, plant and animal metabolic processes. The Phosphate Analyser was developed as part of the COMMON SENSE FP7 project (614155). The analyser is based on a combination of microfluidic analytical systems, colorimetric reagent chemistry, low-cost LED-based optical detection, low cost pumps and wireless communications.

System Development

Development of the precompetitive Phosphate Analyser was made possible through the use of rapid prototyping techniques such as 3D printing, laser ablation techniques and Micro fabrication methods. These techniques allow components to be quickly and easily manufactured in house.

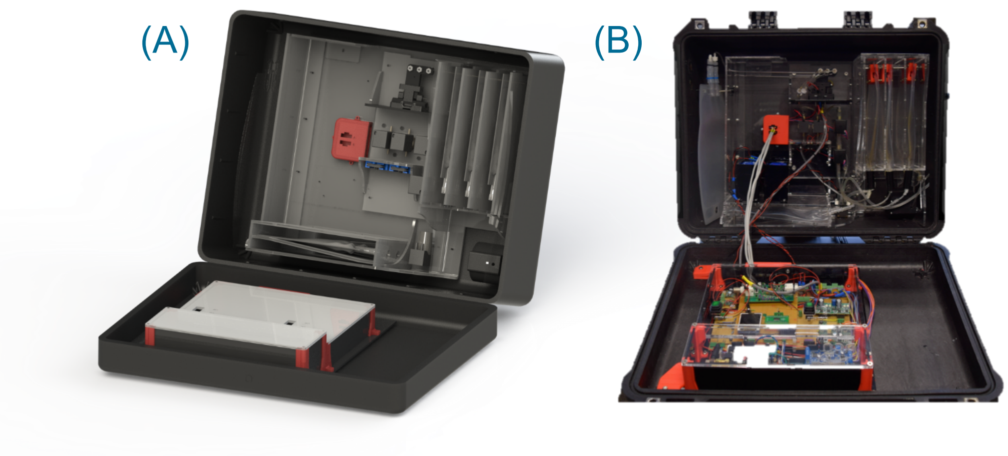

Figure 1: (A) Phosphate Analyser Rendered Image, (B) Developed Analyser.

Automation of the System is carried out using Arduino Microcontrollers; this is used to control the fluid handling of the system and is also integrated with GPRS for real time data transmittance of results. Low cost piezoelectric pumps and solenoid valves are used for fluidic control within the system.

A Microfluidic chip was integrated into the platform for sample mixing and optical detection. A novel- mixing pathway uses shear forces to mix sample and reagent introduced through individual inlets.

Optical detection takes place once mixing has occurred using a 2cm path length to increase the limit of detection. The use of a pulse width modulated LED, a Photodiode detector and an optical microfluidic chip have been used to detect Phosphate (PO_4^{3-}) with a limit of detection of 0.05μM.

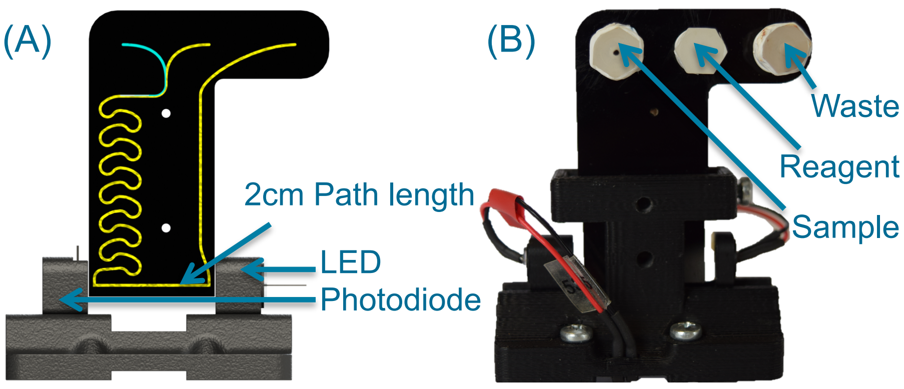

Figure 2: Rendered Image of Microfluidic Chip (A) Internal, (B) External.

Deployments

The Phosphate Analyser has been deployed in a number of areas of environmental interest such as the Italian Artic base in Ny-Aselund Svalbard and on board the RV Minerva Uno in the Mediterranean as part of CNR Italy's research cruise. These deployments aim to field test and ruggedize the prototype sensor. The most recent deployment took place at Milano San Rocco Waste Water Treatment plant Milan. The prototype eutrophication sensor was deployed at the outflow of the WWTP after the Clarifier and was deployed from the 4th to the 5th of May 2017.

Figure 3: (A) Phosphate analyser deployed at Milan WWTP, (B) Output Water after Clarifier and (C) Release of Sludge during sampling at clarifier.

During deployment the prototype sensor took representative sample for 2 ½ minutes every two hours. This sample was mixed with reagent within the Microfluidic chip where the concentration of Phosphate (PO_4^{3-}) was determined in reference to the internal standards.

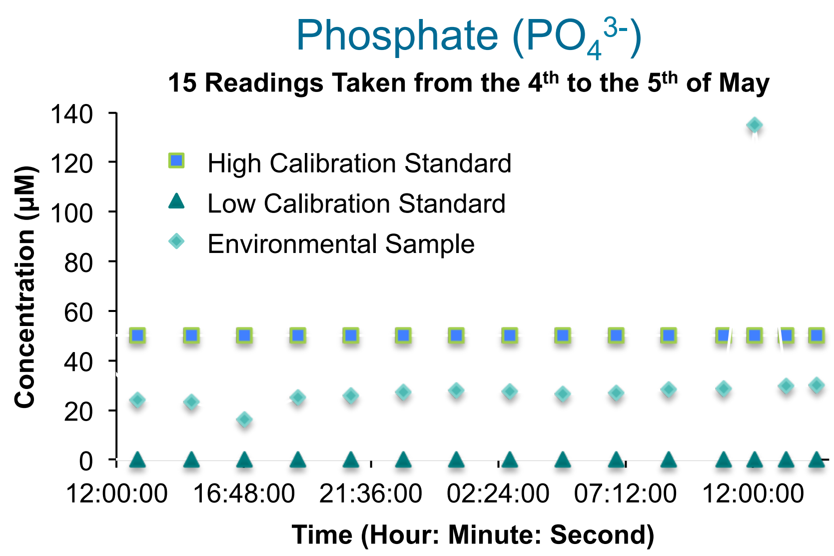

Figure 4: Phosphate detection at Milan WWTP during Deployment.

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