NEXT GENERATION AUTONOMOUS CHEMICAL SENSORS FOR ENVIRONMENTAL MONITORING

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Microfluidic technology has great potential to fulfil the increasing demand for environmental monitoring. Through the minimisation of reagents, standard solutions and power consumption, compact autonomous instruments have been developed to perform in situ monitoring of remote locations over long deployable lifetimes.

The objective of this research is to produce autonomous chemical sensing platforms with a price performance index that creates a significant impact on the existing market. The main focus is on developing a detection platform for ammonium, nitrate and nitrite for water and wastewater using colorimetric techniques. The goal is to integrate polymer actuators valves into the microfluidic chip, to drive down the overall cost.

• Minimisation /Multi-Analyser

•Latest phosphate platform (fig 1) currently €200 (component cost).
•Drive this to €20 by the introduction of **biomimetic materials**
•New platform technology that can be applied to many environmental targets (fig 4).

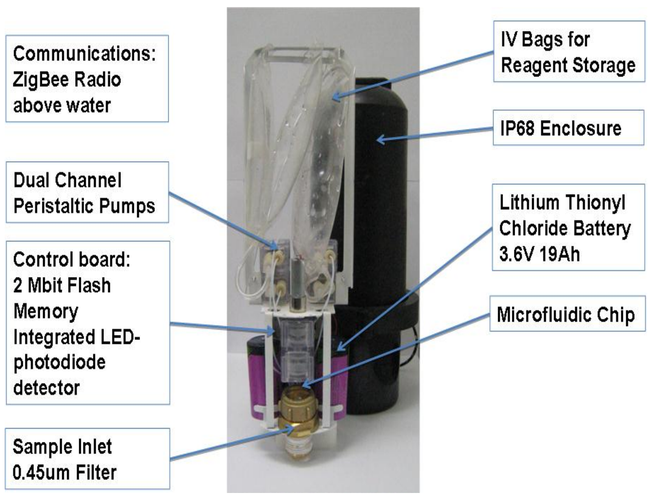

Fig 1: GEN2 Nutrient Analyser Design.

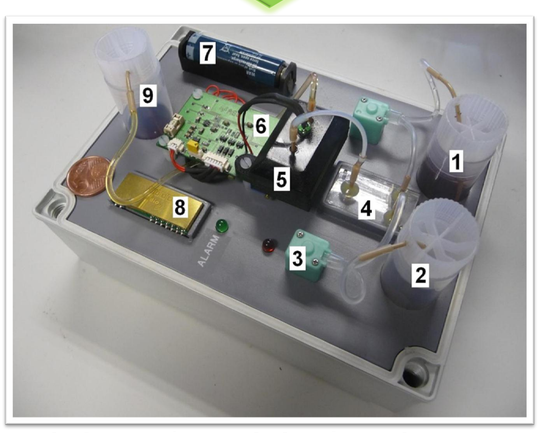

Fig 2: Benchtop nitrite detection system. (1) Reagent storage (2) Sample storage (3) Micro-pump (4) Mixing chip (5) Detector (6) Control board (7) Battery (8) Easy-Radio (9) Waste storage.

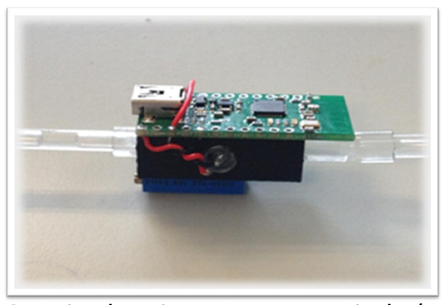

Fig 3: Paired Emitter-Detector Diode (PEDD).

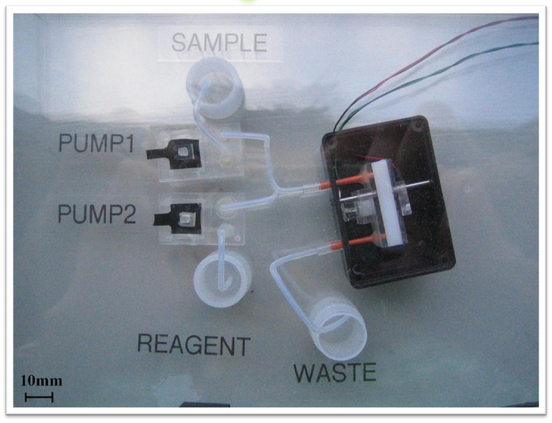

Fig 4: Prototype for next generation micro analyser platform. Micropumps based on electro-responsive polymer actuators are used to deliver sample and reagent to the LED and photodiode based optical detector.

• Phosphate Sensor Deployment

The phosphate analyser (fig 1) is a fully integrated system incorporating fluid handling, microfluidic technology, colorimetric chemical detection, and real time wireless communications in a compact and rugged portable device.

The system was placed in situ at Broadmeadow Water Estuary, Co. Dublin for the period 22Feb2012 - 2March2012 (fig 5).

Fig 5: Image of sensor in situ.

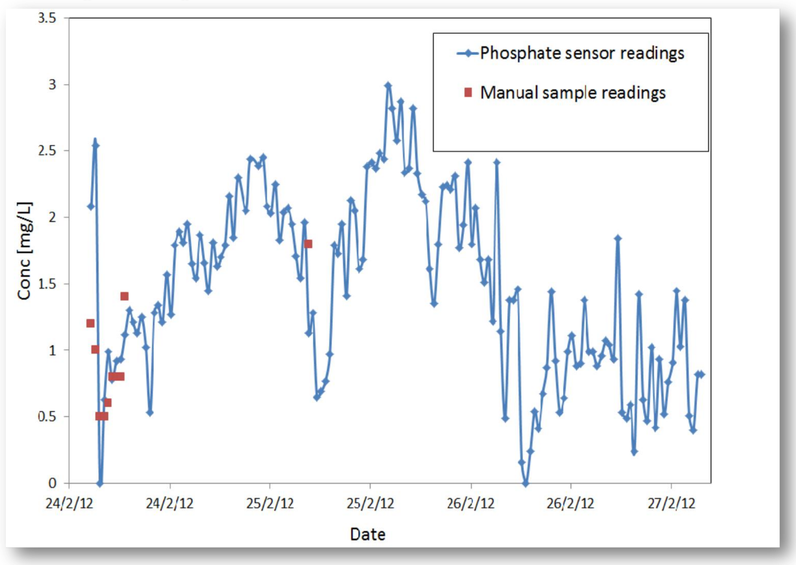

Fig 6: Data from the phosphate analyser and manual calibration samples (red) during the Broadmeadow trial.

A second trial is on-going at the Integrated Constructed Wetland System in Glaslough, Co. Monaghan.

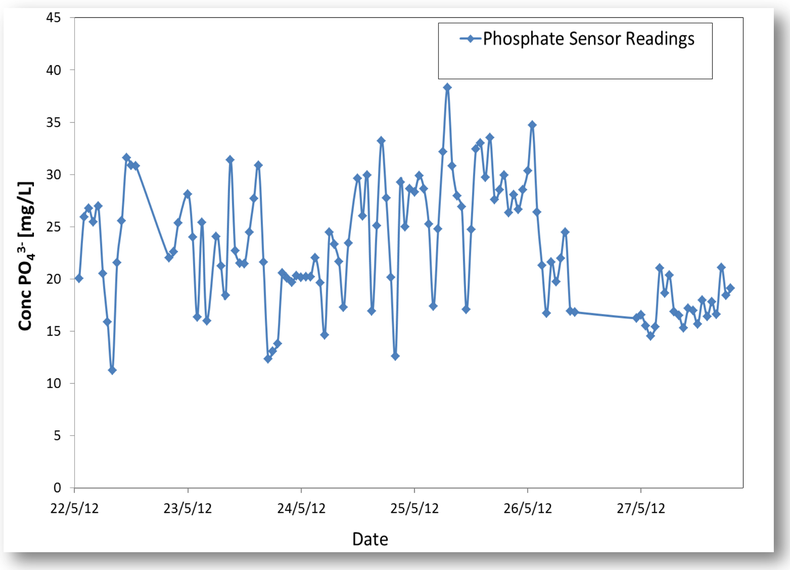

Fig 7: Data from the phosphate analyser during the Glaslough trial.

• Nitrite (NO_2^-) Analyser Based on Griess Reagent

Testing of the nitrite reagent chemistry set with the platform (fig 2). Absorbance is proportional to nitrite concentration at 540nm (fig 8 & 9).

Fig 8: Cuvettes showing the change in colour intensity of nitrite samples with Griess reagent.

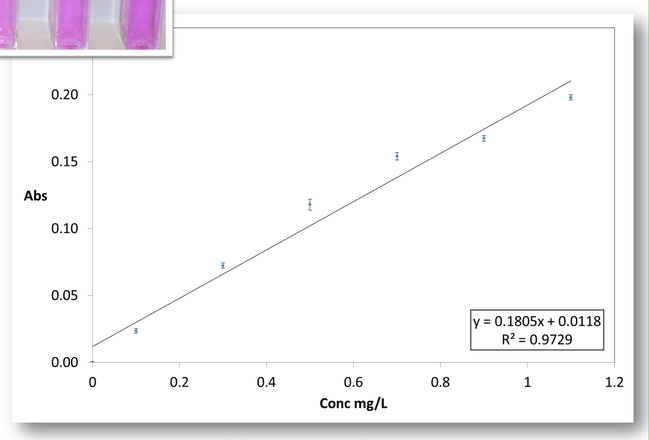

Fig 9: Prototype Calibration of Nitrite Standards 0-1.2mg/L

• Nitrate (NO_3^-) Colorimetric Analysis Based on Chromotropic Acid

A yellow colour is developed when nitrate is treated with chromotropic acid in the presence of concentrated sulphuric acid (fig 10). The absorbance, measured at 430nm, is proportional to NO_3^-. Calibration was done (fig 11) using UV-Vis followed by a novel Paired Emitter-Detector Diode (PEDD) as a photometric detector (fig 3) .

Fig 10: Cuvettes showing the change in colour intensity of nitrate samples with chromotropic acid.

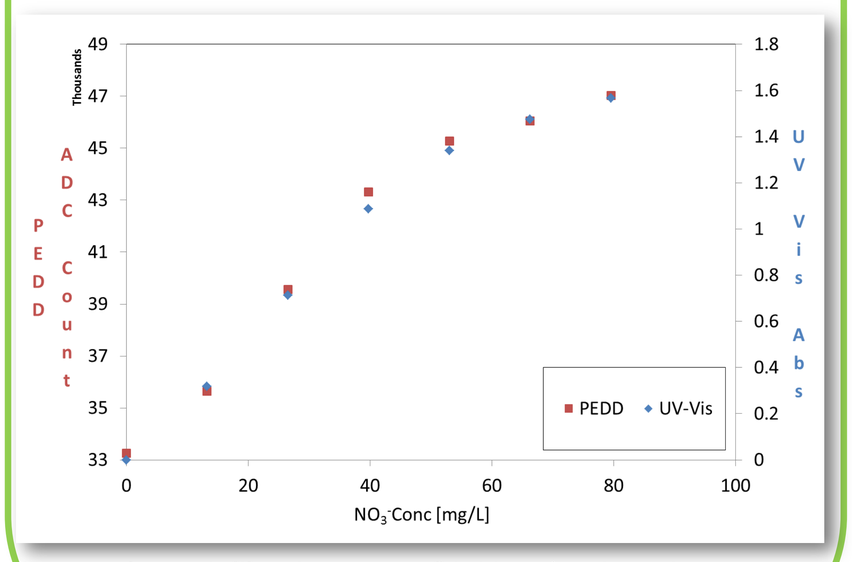

Fig 11: Calibration curve of 0-80mg/L NO_3^- using UV-Vis and compared to Paired Emitter-Detector Diode.

References
- Diamond, D., Cleary, J., Maher, D., Kin, J. and Lau, K.T. 2011. Autonomous Analyser Platforms for Remote Monitoring of Water Quality.
- O' Toole, M., Shepherd, R., Lau, K.T. and Diamond, D. 2007. Detection of Nitrite by flow injection analysis using a novel Paired Emitter-Detector Diode (PEDD) as a photometric Detector.

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