Development of Cost-Effective Sensors for the In-Situ Monitoring of Heavy Metals

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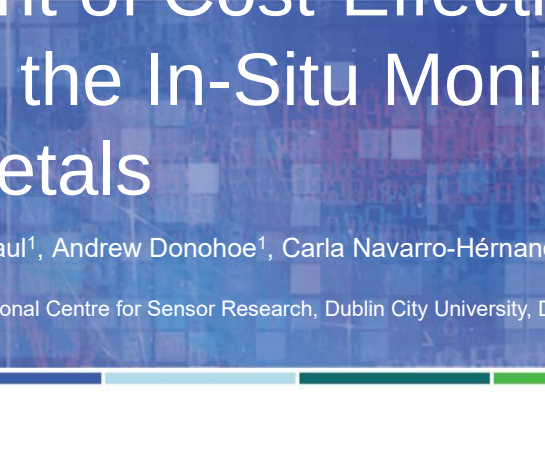
Insight Centre for Data Analytics

Introduction.

Heavy metals such as lead, mercury, cadmium, zinc and copper are among the most important pollutants because of their non-biodegradability and toxicity above certain thresholds. This work is carried out as part of the COMMON SENSE FP7 project. The design and construction of a precompetitive prototype of an electrochemical sensor for the detection of heavy metals made possible through the use of rapid prototyping as the principle manufacturing process. The system has been tested on several field deployments to areas of environmental interest.

Development of The Heavy Metal Prototype.

① BioProcessing Containers
② 3D Printed Peristaltic Pump
③ 2/2 Solenoid Valves
④ Mixing Microfluidic Chip
⑤ Stainless Steel 316L and PMMA Chassis
⑥ Marinized Housing
⑦ FDM 3D Printed Ramps
⑧ Wall-Jet Flow-Cell and Carbon-Bismuth Electrode
⑨ PolyJet Printed Electrode Adaptor Clamp
⑩ Potentiostat



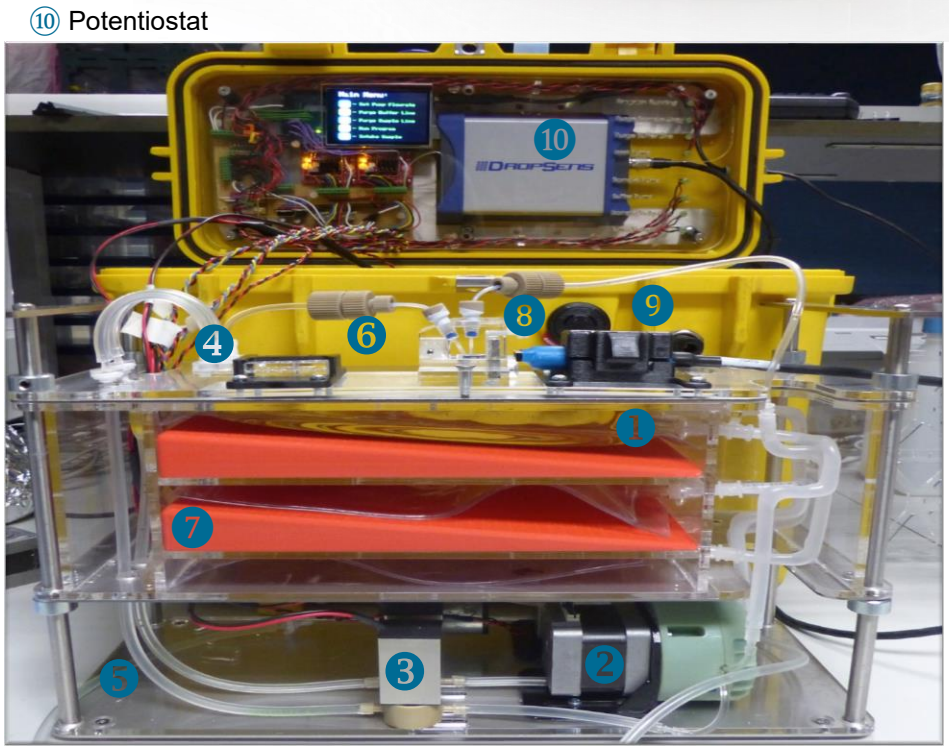


Figure 1. Rendered image and image of the heavy metal analyser

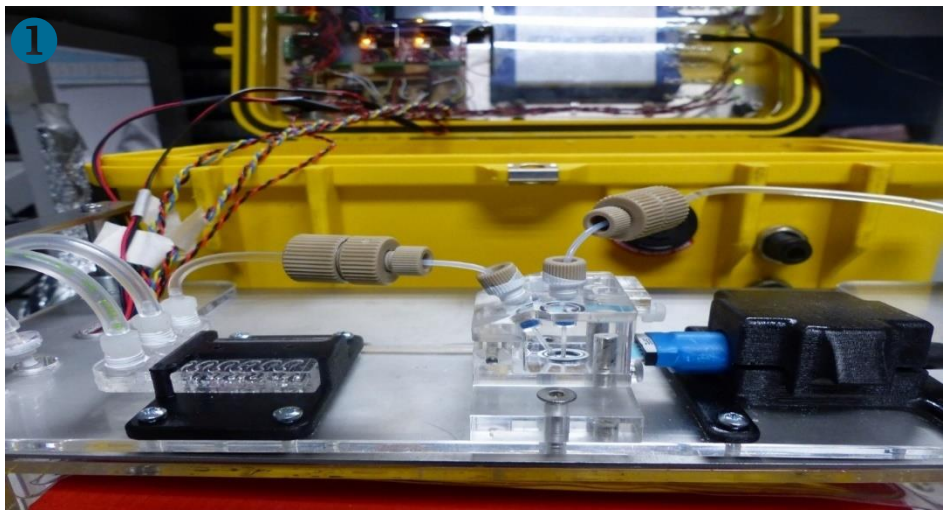
Figure 2. Touchscreen Interface

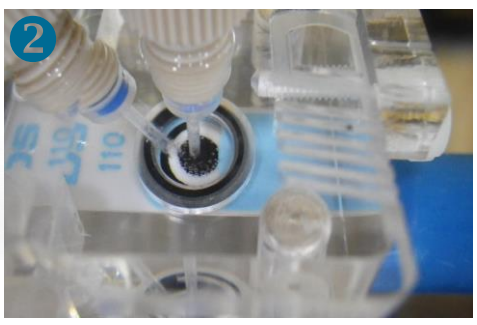
Operator Interface.

- Touchscreen allowing operator to vary flowrate over electrode, purge individual fluid pathways, intake sample and analyse sample.
- LED lights to indicate which operation is currently occurring and which electrical components are operating.

Fluid Handling.

The heavy metal system incorporates a diaphragm inlet pump, highly compliant BioProcessing Containers, two peristaltic pumps, 2/2 solenoid vales, a mixing microfluidic chip and a wall-jet flow-cell.





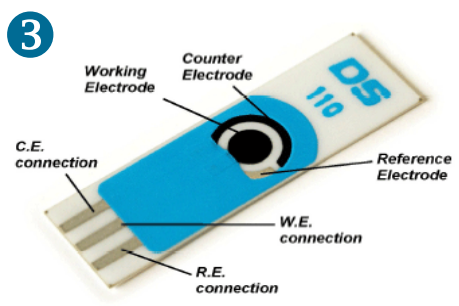


Figure 3. ① Mixing chip, flow cell, electrode and clasp ② Sample and buffer flowing over electrode ③ C-Bismuth electrode

Detection.

- Buffer and sample are delivered to the mixing microfluidic chip by the peristaltic pumps and mixed in a 1:1 ratio.
- The mixture enters the flow-cell and passes over the Carbon-Bismuth screen printed electrode.
- The electrochemical data is then received by the potentiostat through the electrode adaptor
- The square wave anodic stripping voltammetric signals were recorded in acetate buffer solutions with different concentrations of Pb(II) and Cd(II) from bottom to top 25, 50, 75, 100 ppb, respectively. Shown in the figure below.

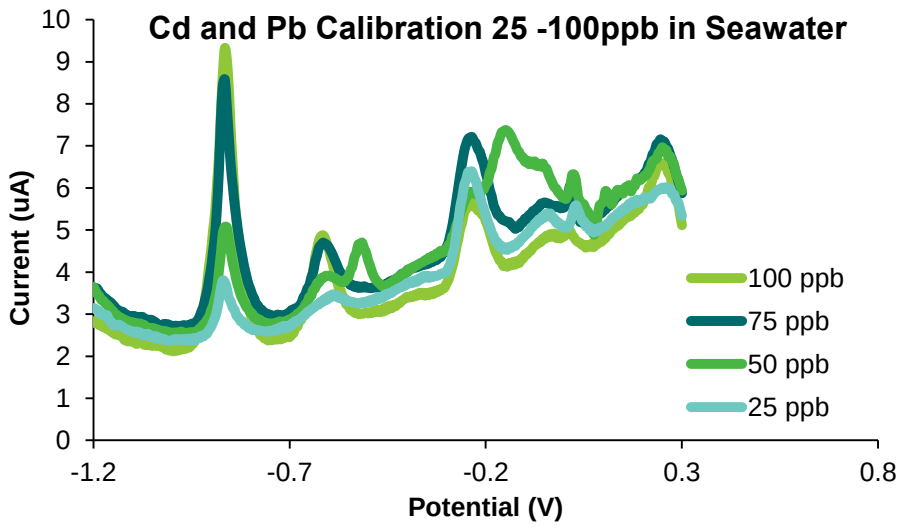


Figure 4. The square wave anodic stripping voltammetric signals were recorded in acetate buffer solutions with different concentrations of Pb(II) and Cd(II) from bottom to top 25, 50, 75, 100 ppb, respectively

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