Accelerated Development of a Colorimetric Sensor using 3D Rapid Prototyping

Thomas Glennon[a], Conor O'Quigley[a], Eoghan Mc Namara[a], Kevin J. Fraser[a], Monika Czugala[a], Fernando Benito-Lopez[ab], Patrick Floris[a] and Dermot Diamond[a]

[a] Insight Centre for Data Analytics, National Centre for Sensor Research, Dublin City University, Dublin 9, Ireland

[b] CIC microGUNE, Arrasate-Mondrago´n, Spain

1. Overview

- Increasingly, we are witnessing a growing interest in, and demand for, real time in-situ monitoring of chemical or biological species, particularly for situations that demand rapid access to time-critical data. A critical bottleneck in the development process is optimisation of design concepts.
- 3D printing was used to rapidly develop an initial concept for a mobile system incorporating simple microfluidics and Paired Emitter-Detector Diode (PEDD) analysis into a fully integrated device.
- The result is the Centrifugal Microfluidic Analysis System (CMAS), a portable handheld system for in situ colorimetric analysis.

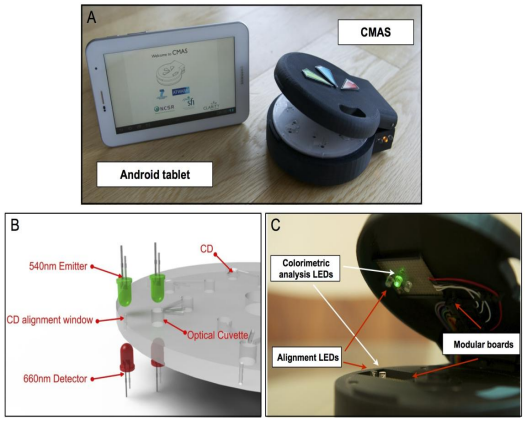

Fig. 1: (A) Portable Android controller and CMAS, (B) schematic representation of the alignment/emitter/detector LEDs and (C) CMAS LED configuration specific to the nitrite CD (bottom right) [1]

2. Detection Optimisation

- Initial tests were carried out on a 3D printed prototype capable of optimising and comparing PEDD and photodiode detection[2] on both microfluidic discs and standard cuvettes.
- The simple system consists of a stage with a removable module for two chambers for separate PEDD and photodiode analysis with a hollow base housing wiring and a microcontroller. The cuvette holder can be removed so the platform can hold and analyse a microfluidic disc with interchangeable LEDs/photodiodes.

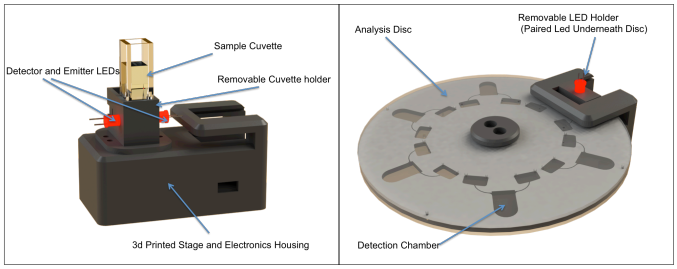

Fig. 2: 3D printed test prototypes for PEDD or photodiode detection on both cuvettes (left) and microfluidic discs (right). Water nitrite analysis using a bench-top UV-Vis spectrometer (blue) and the CMAS (red) and a map of the sampling locations

3. Final Device Development

- Subsequent to PEDD optimisation and proof of concept, a system was designed to incorporate and integrate the system components into a functioning prototype platform.
- The device consists of a motor to turn the microfluidic CD, a PEDD detection system and a Bluetooth module to connect to a remote Android device to control the whole system. With 3D printing a case was designed to hold all of the components neatly in a user friendly package.

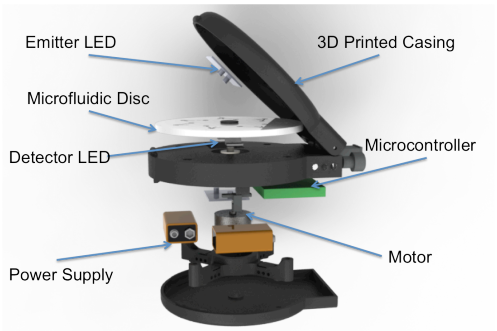

Fig. 3: Computer generated exploded view of the CMAS components

4. Outcome/Conclusions

- The use of 3D printing led to the rapid development of an integrated portable platform which was subsequently used to monitor and compare nitrite concentration at a number of sites in Ireland.
- Development will further be enhanced through close links with the Australian Research Council (ARC) Centre of Excellence for Electromaterials Science (ACES) at University of Wollongong who have specialist facilities for 3D printing. This coupled with a very active researcher exchange programme will provide new opportunities for rapid prototyping and exploration of new applications.

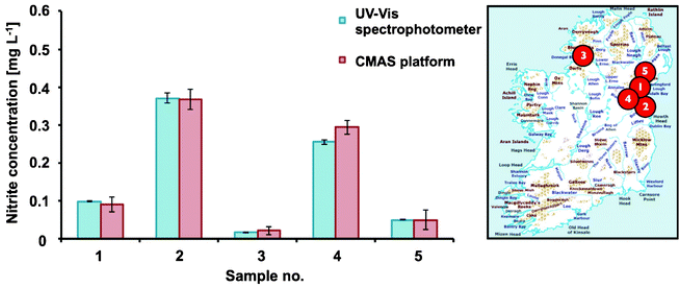

Fig. 4: Water nitrite analysis using a bench-top UV-Vis spectrometer (blue) and the CMAS (red) and a map of the sampling locations [1]

5. References

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[2] O'Toole, Martina, et al. "Novel integrated paired emitter-detector diode (PEDD) as a miniaturized photometric detector in HPLC." Analyst 131.8 (2006): 938-943.

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