DEVELOPMENT OF A PORTABLE MULTI-PARAMETER CENTRIFUGAL MICROFLUIDIC ANALYSIS SYSTEM (CMAS) FOR WATER QUALITY MONITORING

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1. Overview

• Increasingly, we are witnessing a growing interest in real time in-situ monitoring of chemical or biological species, particularly for situations that demand rapid access to time-critical data.

• 3D printing was used to rapidly develop a mobile Centrifugal Microfluidic Analysis System (CMAS, shown in Fig. 1) for in situ colorimetric analysis.

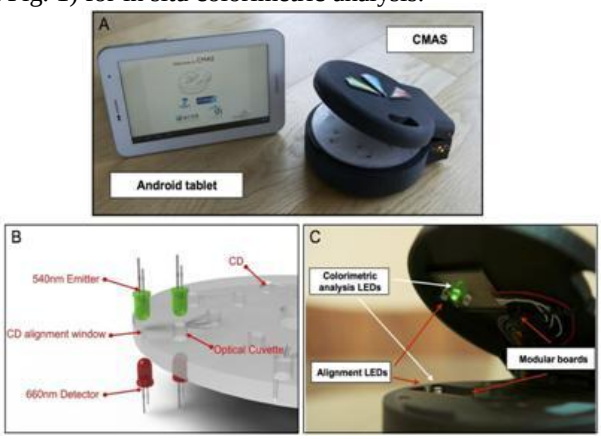


Fig. 1: (A) Portable Android controller and CMAS, (B) schematic representation of the alignment/emitter/detector LEDs and (C) CMAS LED configuration specific to the nitrite CD (bottom right) [1].

2. CMAS hardware fabrication

• A 3D-printed housing, shown in Fig. 2, was produced for hosting the microfluidic discs. A low-cost LED-photodiode optical sensor was used for colorimetric detection and a stepper motor generated the centrifugal force necessary to carry out the tests.

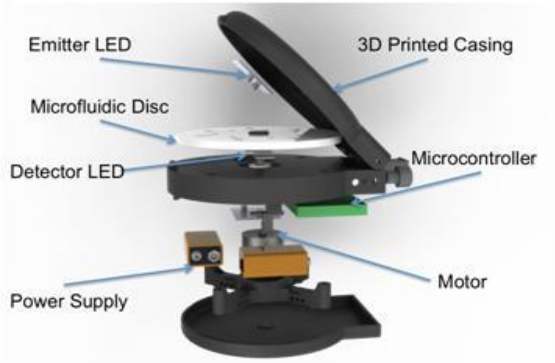


Fig. 2: Computer generated exploded view of the CMAS components.

3. Design of microfluidic disc

• Each disc was designed with six test areas consisting of a sample chamber and either single/dual reagent chambers connected to a common reaction/detection chamber as shown in Fig. 3.

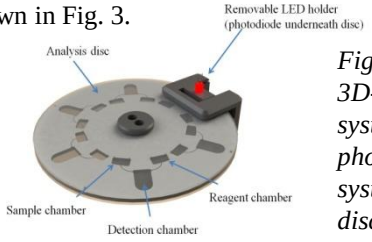
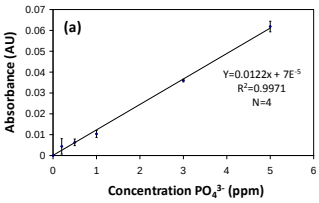


Fig. 3: Image showing a 3D-printed prototype system for LED-photodiode detection system on microfluidic discs.

4. Analysis of nutrients on microfluidic discs

• Standards of nitrite, ammonia and orthophosphate were aliquoted on individual discs and calibration curves were plotted (see Fig. 4).



• Microfluidic discs were spun for delivering sample and reagent to the detection chamber. Different time intervals were required for full color development as summarised in Table 1.

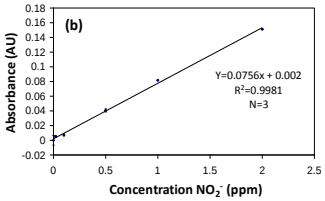


Table 1: Summary of data for the analysis of nutrients on microfluidic discs.

Target analyte	Calibration range (ppm)	LOD (ppm)	Reaction time (min)
NH_3	0-2	0.233	20
NO_2^-	0-2	0.050	15
PO_4^{3-}	0-5	0.189	5

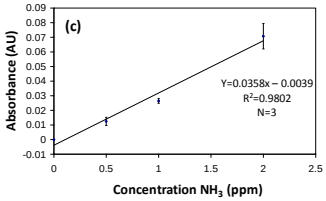


Fig. 4: Calibration plots for the determination of (a) orthophosphate, (b) nitrite and (c) ammonia on microfluidic discs.

5. Future work

• Further research is in progress to develop a single disc capable of performing automatic simultaneous detection of these analytes from a single sample aliquot.

6. References

[1] M. Czugala, D. Maher, F. Collins, R. Burger, F. Hopfgartner, Y. Yang, J. Zhaou, J. Ducree, A. Smeaton, K. Fraser, F. Benito-Lopez and D. Diamond, RSC Adv., 2013, 3, 15928 - 15938.

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