

Development of an *in situ* droplet microfluidic autonomous sensor for total alkalinity in sea water

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Single-Point Measurement

Discrete, single-point **total alkalinity** (TA) titrations are performed in microfluidic droplets. **Seawater** is combined with **titrant** (acid and a pH-sensitive, colour-changing dye) and measured **spectrophotometrically**.

Application

Fast-changing environments



This droplet sensor aims to improve on shortcomings of current continuous microfluidic alkalinity sensors



REDUCED WASTE



FASTER MIXING

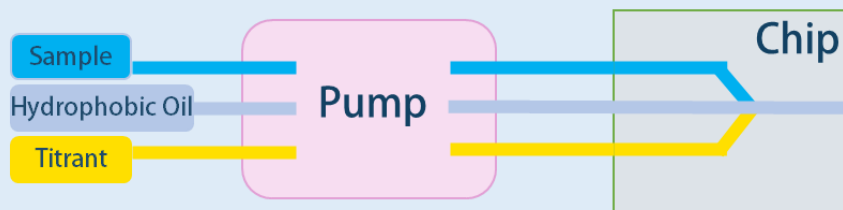


HIGH SAMPLE FREQUENCY



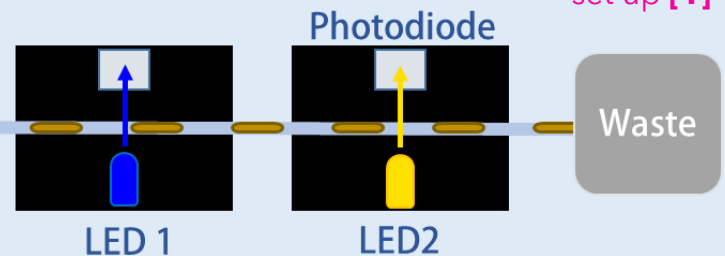
INCREASED RANGE

Droplet Generation in Sensor



Flow Cells

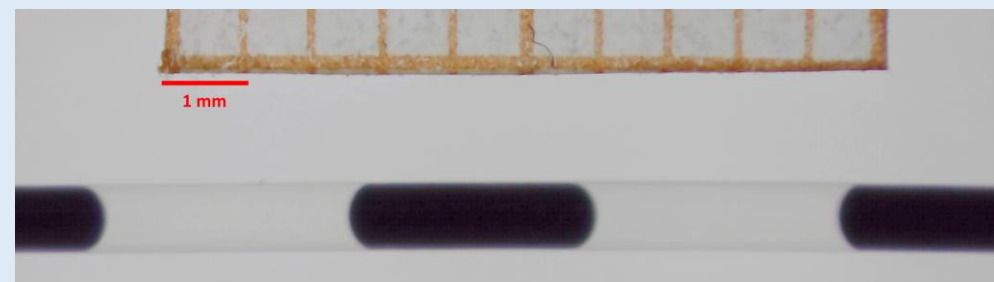
Droplet sensor set up [1]



Roller design with concave features that allow sample and titrant in a 1:1 ratio through pump tubing

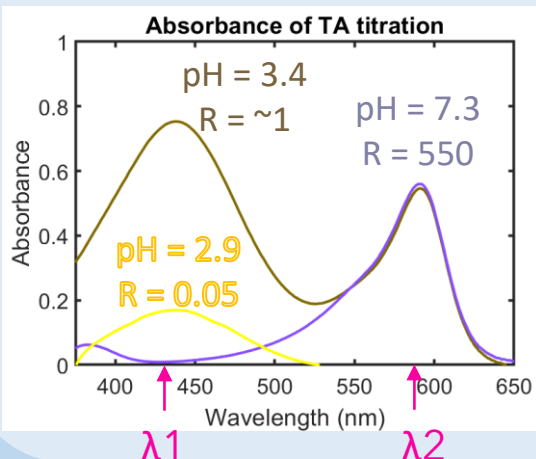


Pump Function



Uniform ~1.4 μL droplets are generated every 6 seconds.

Spectrophotometric Measurement



$$R = \frac{abs_{\lambda 2}}{abs_{\lambda 1}}$$

The R value is used, with dye-specific constants, to calculate TA. [2]

Future Work

Sensor Trials

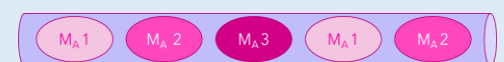
In situ trials in an **estuary**, to test the **high frequency** and **high measurement range** capabilities of the sensor

Sensor Development

Degassing



Increasing Measurable Range



M_A = Titrant Acid Molarity

References

[1] Nightingale, A.M., Hassan, S.U., Warren, B.M., Makris, K., Evans, G.W., Papadopoulou, E., Coleman, S. and Niu, X., 2019. A droplet microfluidic-based sensor for simultaneous *in situ* monitoring of nitrate and nitrite in natural waters. *Environmental science & technology*, 53(16), pp.9677-9685.

[2] Li, Q., Wang, F., Wang, Z.A., Yuan, D., Dai, M., Chen, J., Dai, J. and Hoering, K.A., 2013. Automated spectrophotometric analyzer for rapid single-point titration of seawater total alkalinity. *Environmental science & technology*, 47(19), pp.11139-11146.

Estuary Image | Image Source: RSPB | URL: rspb.org.uk/fun-and-learning/for-kids/facts-about-nature/facts-about-habitats/estuaries-and-mudflats/

Coral Reef Image | Image Source: Earth Blog | URL: earthspacecircle.blogspot.com/2016/07/coral-reef.html

CO₂ Seep Image | Image Source: UW News | Image Author: Jason Hall-Spencer | URL: washington.edu/news/2015/09/14/a-more-acidic-ocean-will-bend-the-mermaids-wineglass/

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