Development of a Lab-on-Chip Dissolved Inorganic Carbon Sensor for autonomous oceanic measurements

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Over the industrial revolution atmospheric CO_2 concentrations have increased from 280 ppm to over 400 ppm, and the oceans take up approximately 25% of annual emissions. This has had a measureable impact, increasing the acidity of the ocean. In order to quantify the marine carbonate system there are four variables that can be measured, these are dissolved inorganic carbon (DIC), pH, total alkalinity and partial pressure of CO_2. Of these, DIC is the only one missing both an underway and *in situ* sensor, despite being one half of the preferred pairs for observing the carbonate system. In order to address this an autonomous DIC sensor has been designed based on the microfluidic lab-on-chip platform developed by OTEG. This sensor utilises the conductimetric method. It operates by acidifying a sub 1 ml volume of seawater, converting the DIC to CO_2, which diffuses across a gas permeable membrane into an acceptor solution where the conductivity is measured using a Capacitively-Coupled Contactless Conductivity Detector (C4D). Each measurement takes under 15 minutes and the sensor can be set perform calibrations *in situ*. This system has been demonstrated to collect weather quality data, defined by the Global Ocean Acidification Observing Network as having an uncertainty of under 10 µmol kg^{-1}, and further developments are expected to reduce this to the 2 µmol kg^{-1} required to make climatically relevant measurements. The system has been demonstrated to operate down to a depth of 150m deep as part of a series of Lander deployments in the North Sea. Presented here will be results of several further deployments that will take place during Spring, 2019.