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Towards nanomolar nutrients sensors for the marine environment.

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The warming of the oceans and consequent enhanced stratification will have significant consequences for ecosystem functioning and carbon sequestration. Nutrient supply will reduce as a result of stronger stratification, reducing its availability to microbial ecosystems. Oligotrophic ocean regions are therefore predicted to increase in size as a consequence of global warming. This strengthens the need for analytical techniques with low limits of detection for nitrate and phosphate. Conventional methods are unable to detect the nanomolar nutrient concentrations in the upper water column of oligotrophic ocean regions. In recent years, sensitive techniques with a high sample throughput have been developed for shipboard nutrient analysis at nanomolar levels. These techniques are however not suitable for autonomous deployment in oceans for long-term observations.

The work presented focuses on the optimisation and miniaturisation of analytical systems for the determination of nutrient concentrations using novel Lab-on-a-chip devices. The aim is to develop systems that are small, low-power and can be used autonomously and remotely to provide in situ real-time data on processes with high temporal and spatial resolution. Microfluidic technology is being used as it enables minimization of reagent and power consumption through the use of micro-scale measuring channels. These systems allow the implementation of wet-chemical methods to meet the analytical requirements within the constraints of in situ deployments.

A microfluidic analyzer was deployed in the marine environment and compared with reference methods. The micro-system was automated with an electronic package assembled on a chip milled into a polymer. LEDs and photodiodes have been integrated to allow direct phosphate detection using a conventional spectrophotometric technique. Analytical parameters can be adjusted depending on the conditions of deployment: the limit of detection to reach, the concentration range to cover and the sampling throughput required. Further developments are optimising high performance methods on chip for measuring phosphate on different sensing platforms.