pH optodes for CO_2 leakage detection

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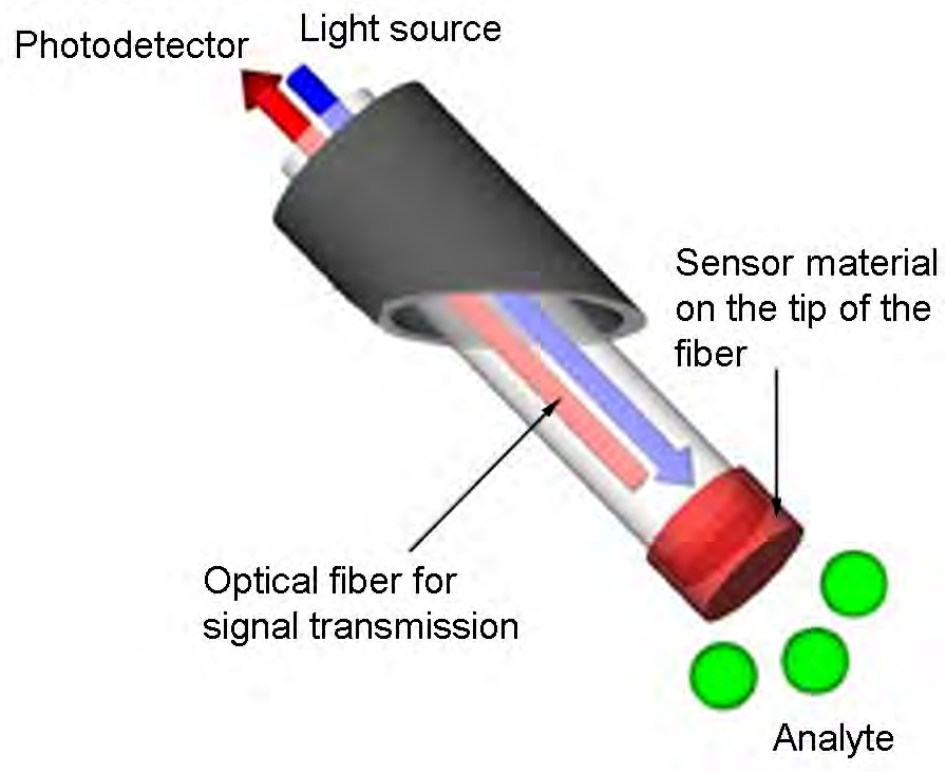
Optodes



Optical sensors (optodes) are sensors measuring a certain parameter with help of an optical chemical transducer

- Oxygen optodes are state-of-the-art: PreSens, PyroScience, Aanderaa etc.

- pH optodes are less established particularly for oceanographic applications

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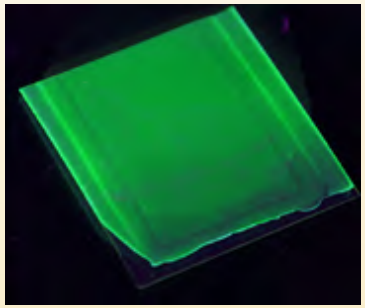
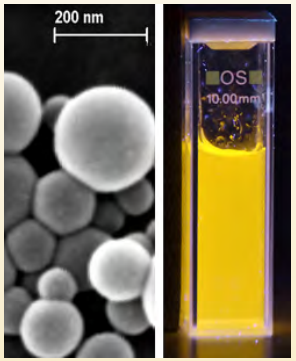
General advantages of optodes

- simple fabrication and potentially low cost
- no electrical interferences
- multi-analyte sensing
- contactless sensing
- versatility of formats





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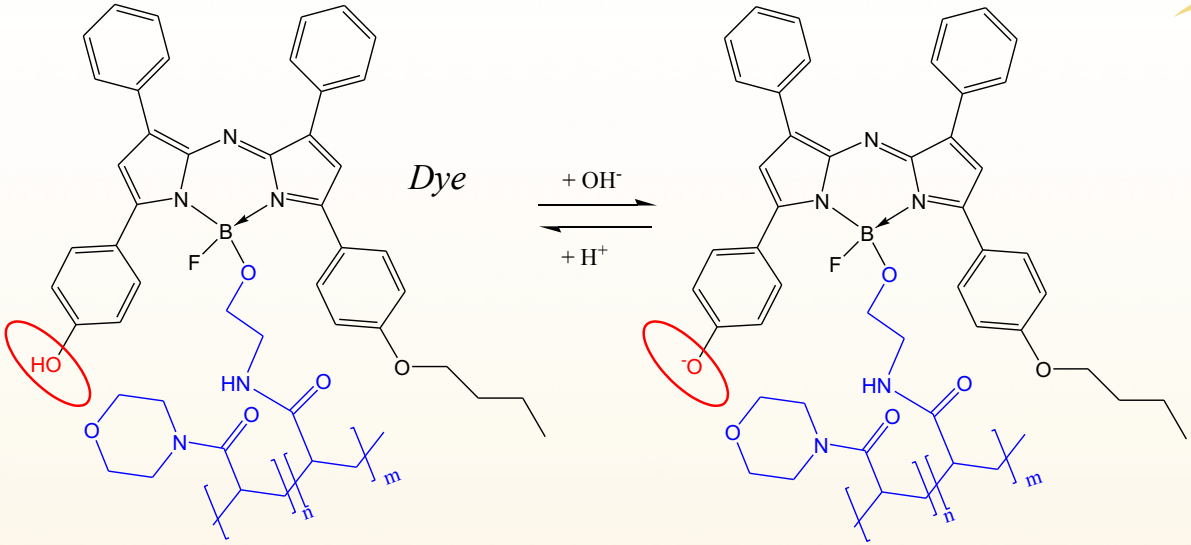
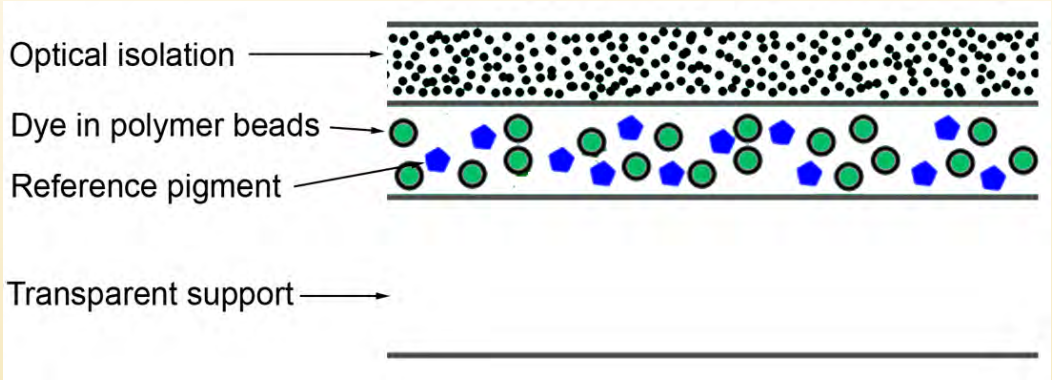
pH Optodes



Strong fluorescence

No fluorescence



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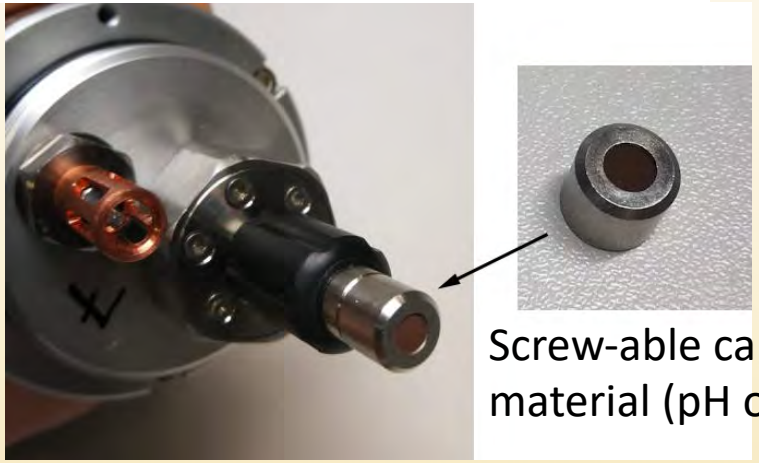
Sensors for CO_2 release experiment

I. Optodes for measurements in water column

- Length: 270 mm (with protective cap), ∅ 63 mm
- Aluminium/Titanium housing
- Integrated battery and logger
- Resistance thermometer for T compensation
- Can be used in combination with pH or O_2 sensors



Screw-able cap with sensing material (pH or O_2)

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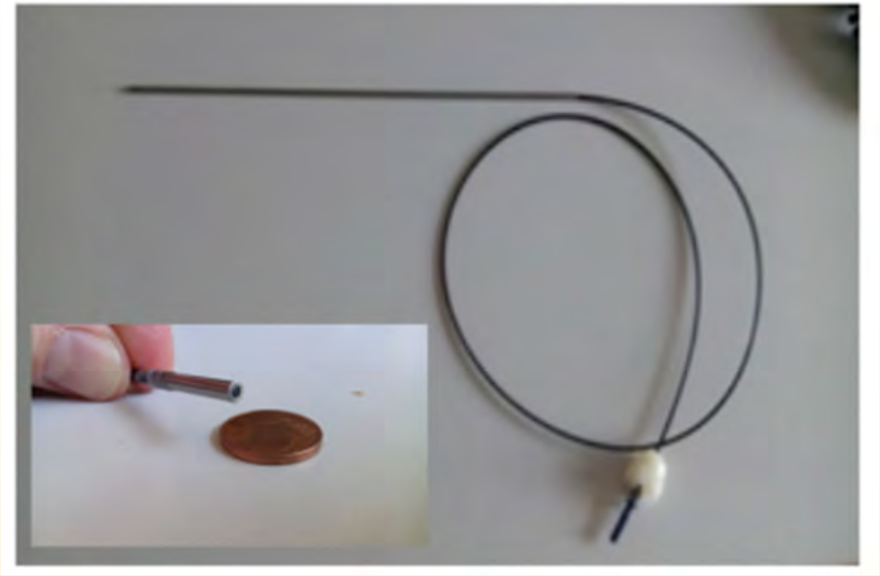
II. Sediment optodes



Fiber-optic sensor type

- Plastic optical fiber (core ∅ 1 mm) with SubPort connector
- 25 cm stainless steel sleeve to prevent bending in sediments
- Logger designed by MPI Bremen

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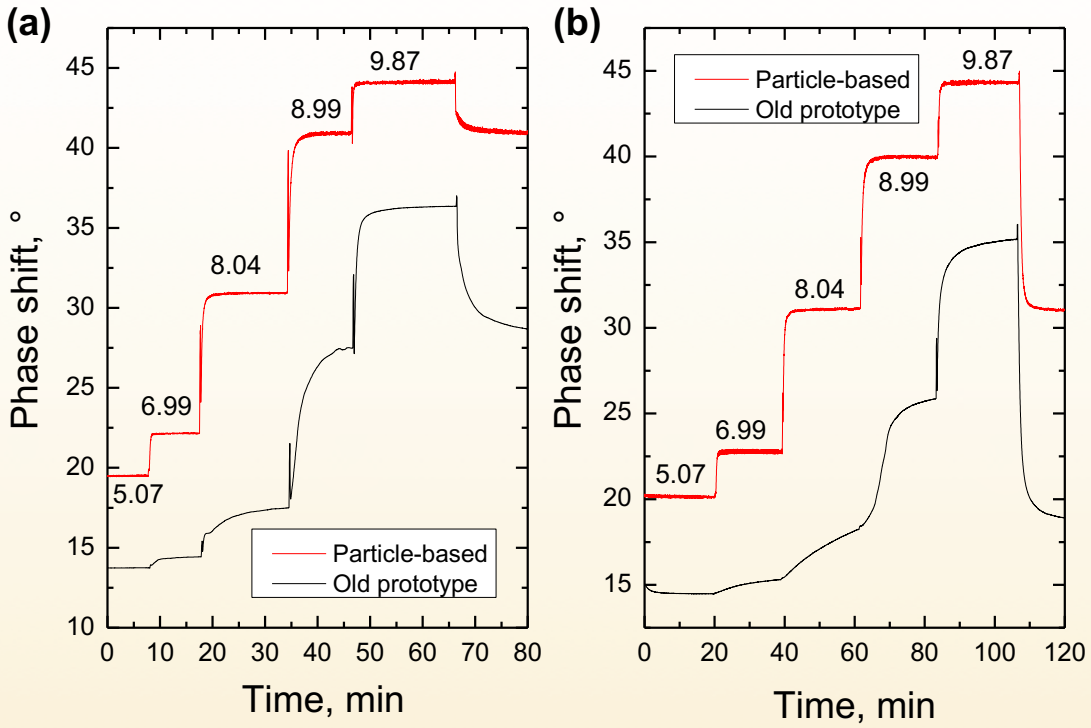
Challenges in material development



a and **b** – before and after 12 h exposure to the sediment

Some of the sensor materials showed drastic performance decrease in Sediment from Goldeneye ⇒ new particle-based material for both water column and sediment measurements

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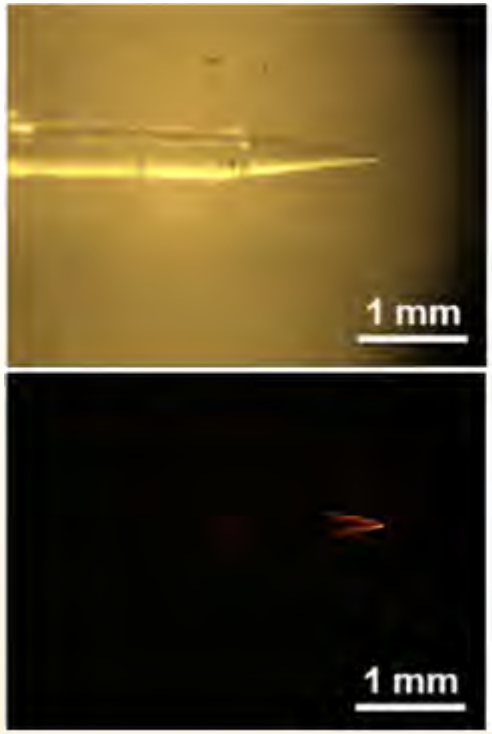
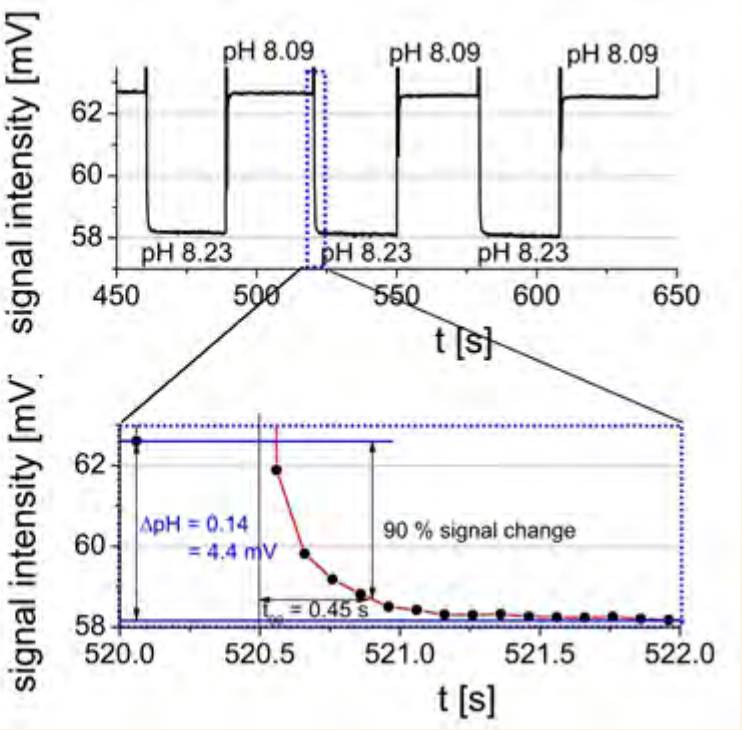
III. Fast microoptodes for eddy covariance





Tapered 430 µm glass fiber

Characteristics

- ☺ Small size
- ☺ Very fast response
- ☹ Time consuming manufacture procedure
- ☹ No referencing yet, more difficult to calibrate
- ☹ Much faster drift due to photobleaching

- The sensors have not been used during the release experiment
- Promising analytical tools if the performance is further improved

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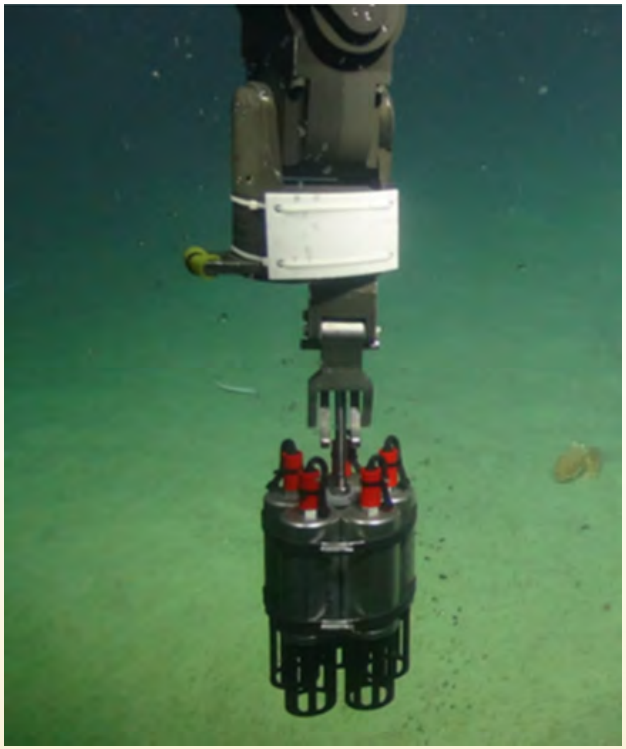
Release experiment: detection in water column



Optode bundle operated by ROV

3 pH and 2 oxygen optodes deployed simultaneously

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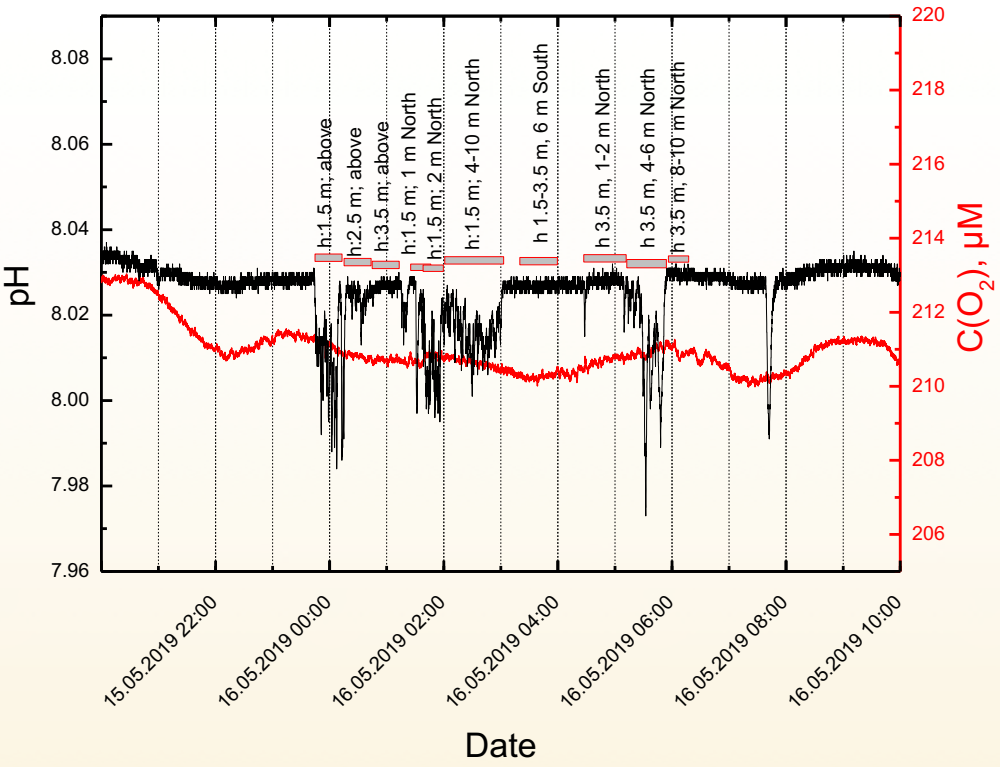

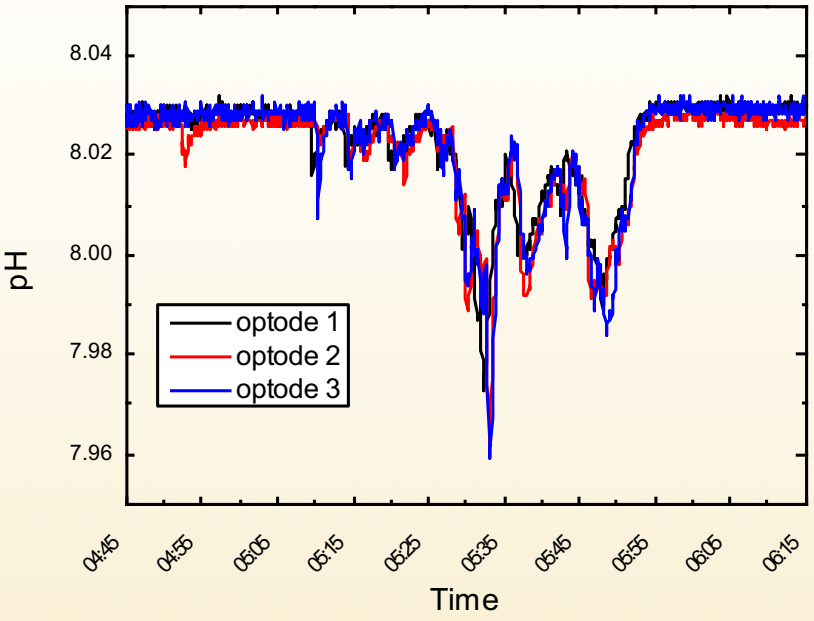

Response of 3 pH optodes during 10l/min gas flow

- noise of the pH optodes ±0.002 pH units
- abrupt pH increase is up to 0.05 pH units during CO_2 release
- oxygen optode does not show significant variations of $C(O_2)$

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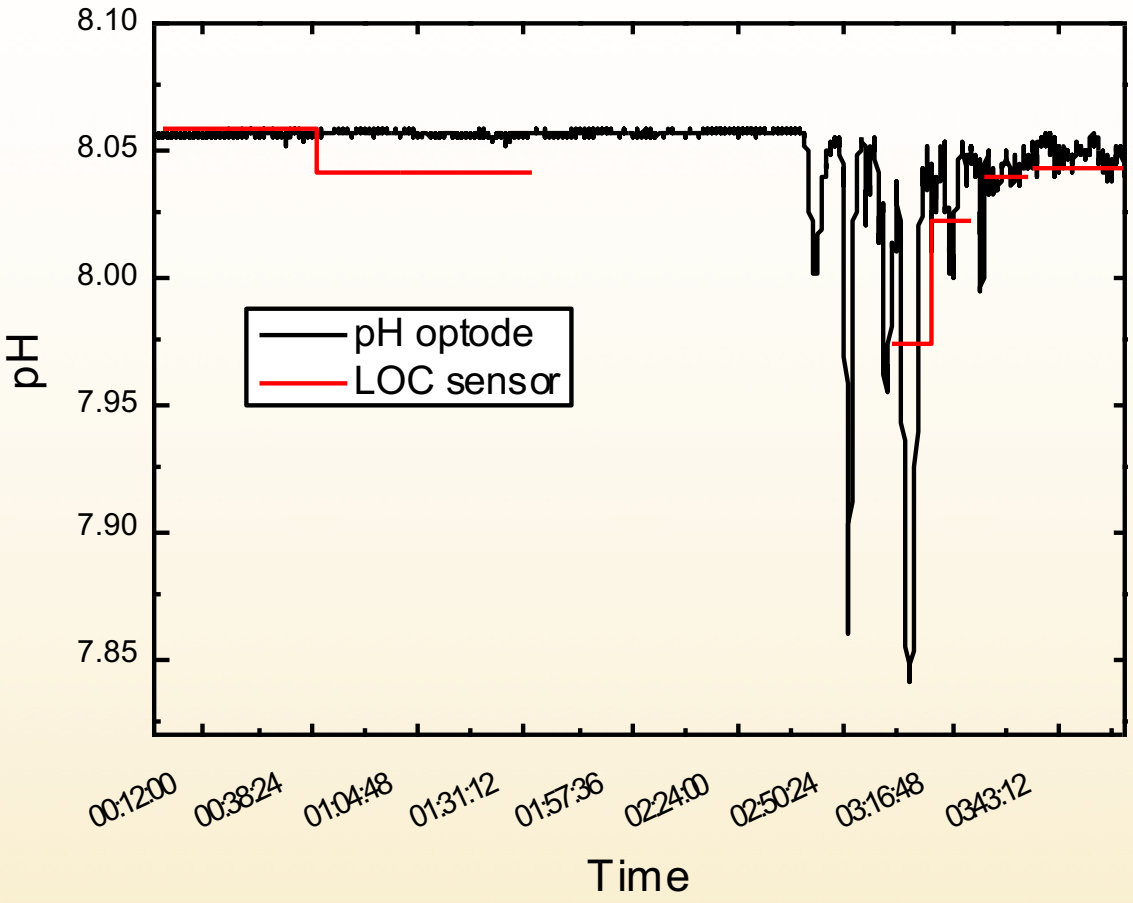

30l/min gas flow

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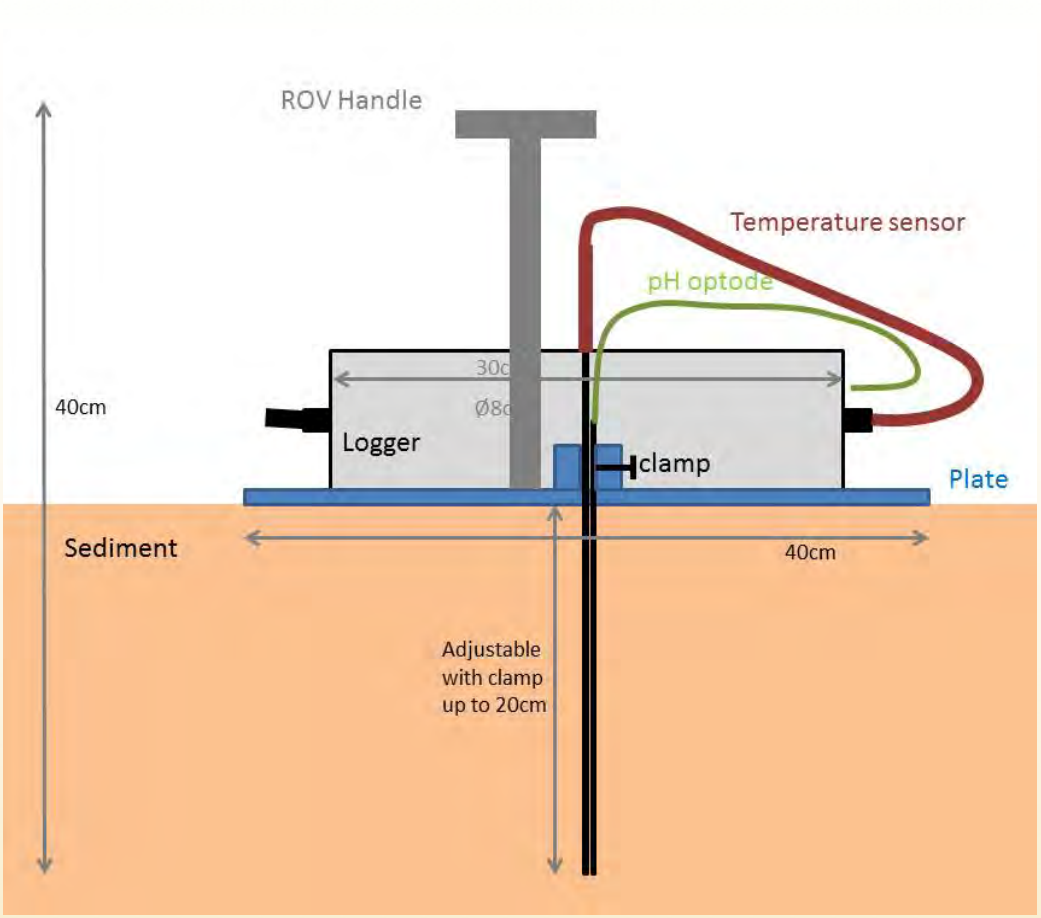
Release experiment: detection in sediment



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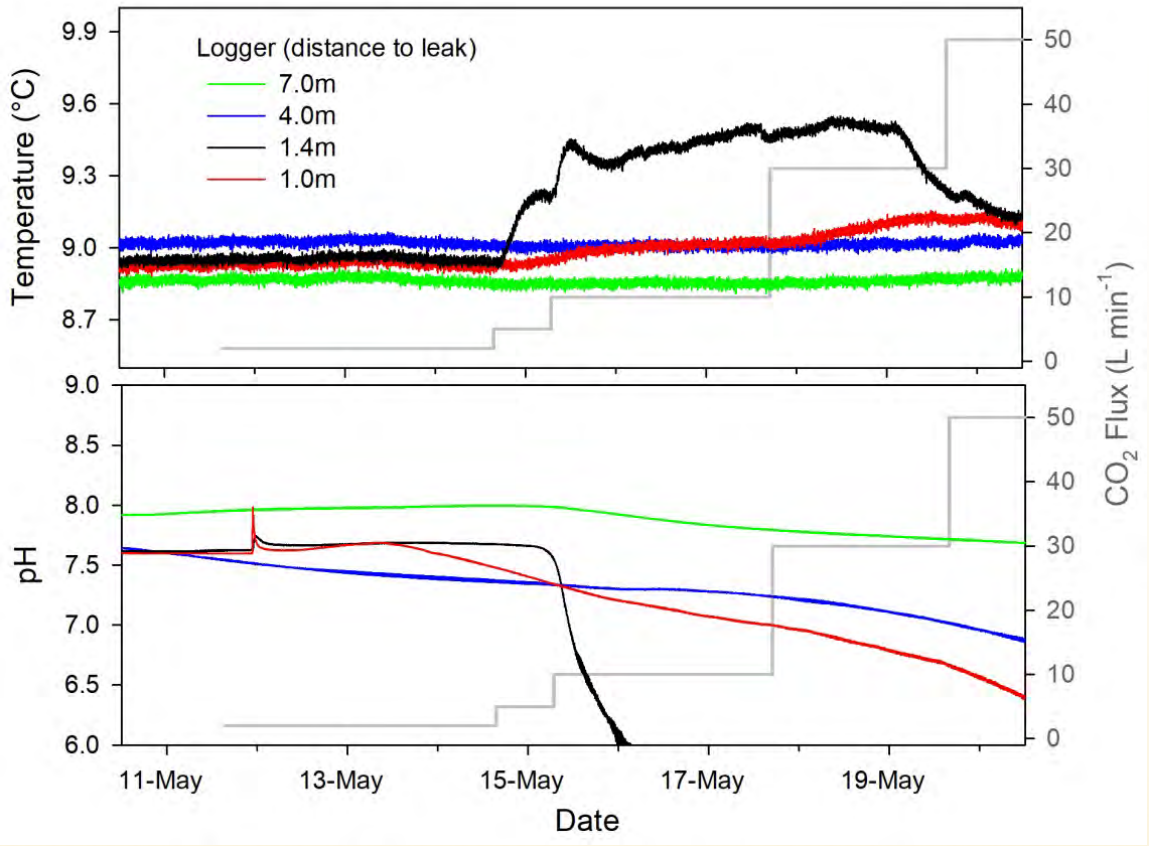

- Two closest sensors show drop of pH accompanied by temperature change
- Both effects are stronger for the 1.4 m sensor
- No change in parameters for the 4.0 and 7.0 m sensors, slow change may be due to drift of the pH sensors

☹ - damage of fibers during recovery ⇒ no recalibration and drift correction

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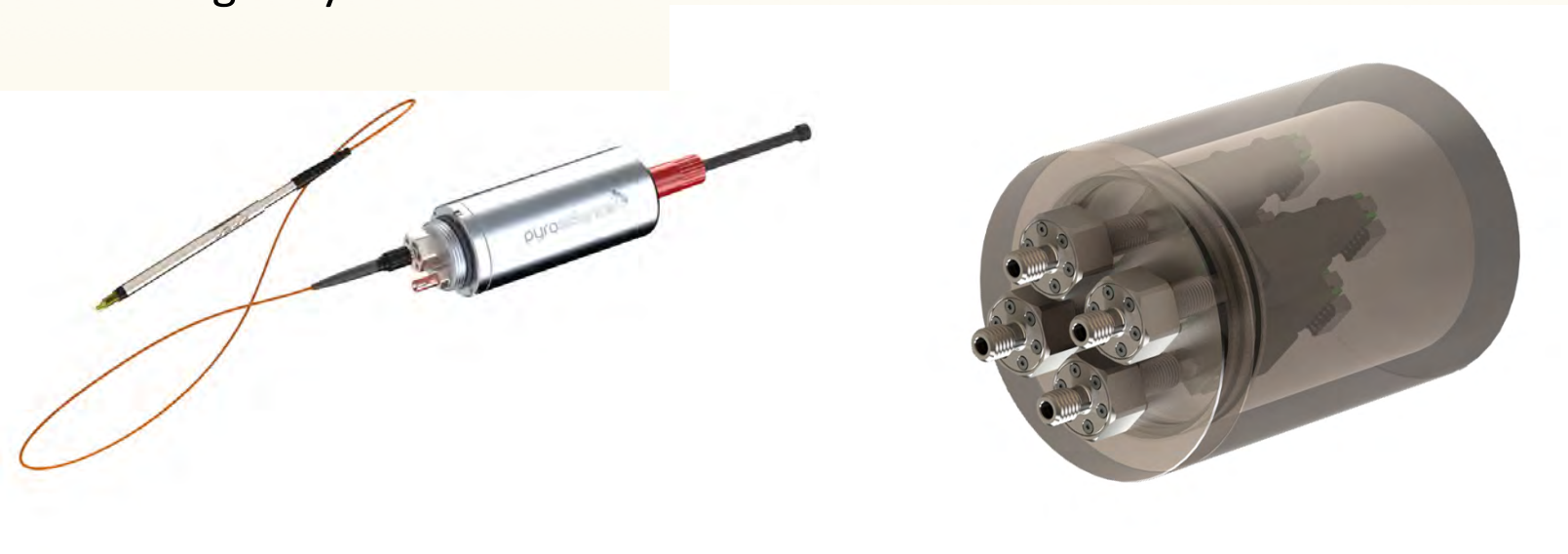
Conclusions and perspectives

- pH optodes are promising tools for detection of CO_2 leakage
- Versatility of formats enables monitoring in water column and in sediment
- Further miniaturization and multiplexing is desirable and technologically is feasible



www.pyroscience.com

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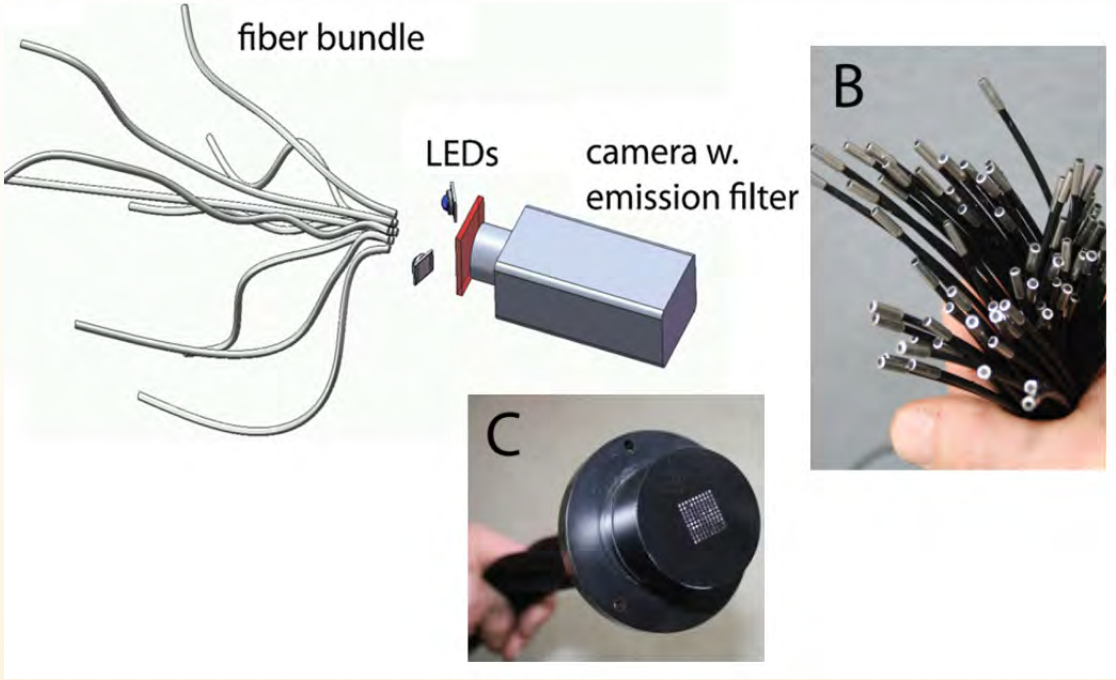

Multi fiber optode: J. Fischer, K. Koop-Jakobsen, Sens. Actuators B, 2012, 168, 354-359

SDR SensorDish® from PreSens

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