

ION-SELECTIVE OPTICAL SENSORS FOR THE CHARACTERIZATION OF EUROPA'S OCEANS



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EUROPA'S OCEANS

- Europa's oceans have the highest priority in the outer solar system to explore as a **potential habitat for life**.
- Characterization of its **internal ocean** and ice shell are key goals for the 2010-2020 decade [Planetary Science Decadal Survey, 2011].

OPTRODE APPROACH TO CHEMICAL CHARACTERIZATION

- Optrodes exhibit a change in optical properties in a manner that is selective to the analyte of interest.

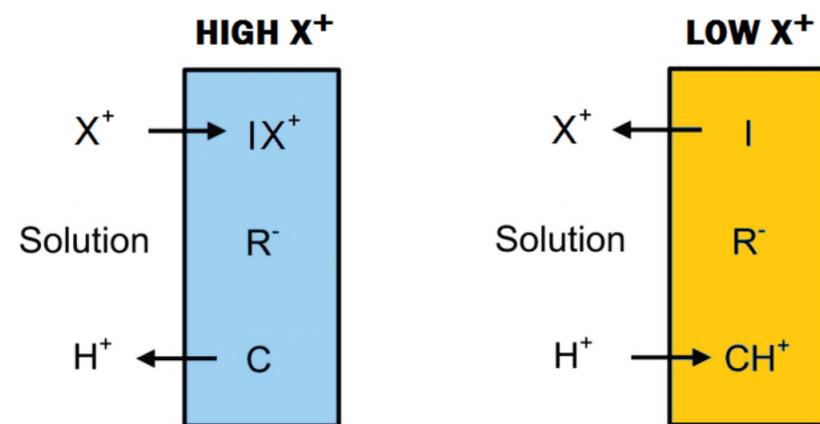
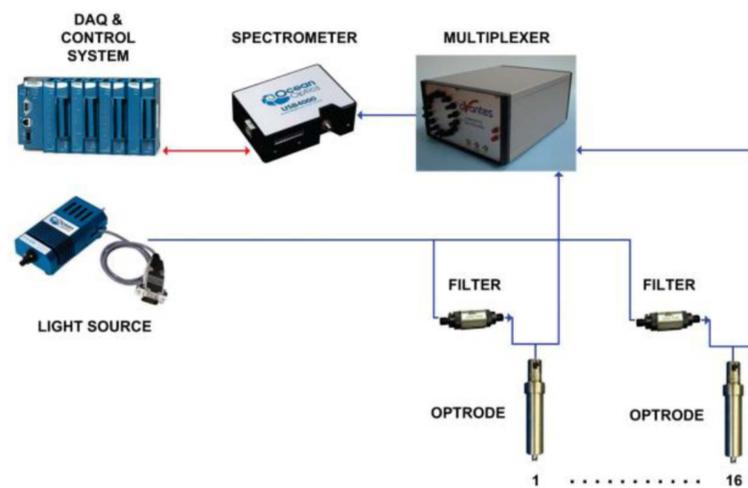


Figure 1. Simplified schematic of functioning of an optrode membrane for the measurement of analyte X⁺, incorporating an ionophore (I) for X⁺, chromoionophore (C) for H⁺, and negatively charged ionic sites (R⁻).

- We have implemented a system for **multi-ion sensing**.
- Initial tests were conducted using a **proof-of-concept instrument** featuring two sensing fibers.

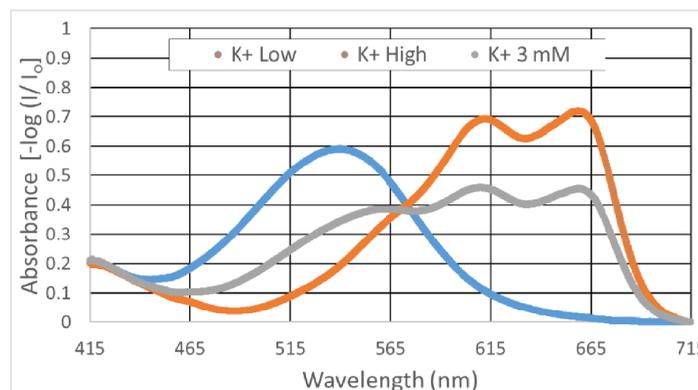
INSTRUMENT PROTOTYPE



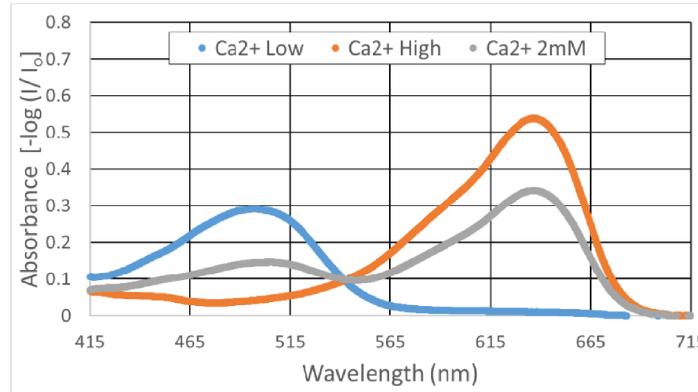
Key advantages:

- (1) Concurrent measurements of virtually all ionic species;
- (2) High time resolution –tens of seconds, and high spatial resolution –10 millimeters;
- (3) High measuring ranges: 2-4 orders of magnitude;
- (4) Low limits of detection (LOD) for most species ;
- (5) Does not require additional reference analyte
- (6) Minimal drift –no need for recalibration;
- (7) Low-cost, low-mass, and energy efficient optoelectronics;
- (8) No moving parts;
- (9) Easily miniaturized'
- (10) Immune to electromagnetic interference;
- (11) Little/no analyte consumption.

PRELIMINARY STUDY USING A MULTI-SENSOR SYSTEM



- Figures show the absorption spectra of the potassium and calcium optrodes in a 1/2 strength Hoagland's hydroponic solution (pH ~6) with [K⁺] = 3 mM and [Ca²⁺] = 2 mM.
- Overlaid are spectra recorded from solutions containing <0.1 mM and >50 mM K⁺ (low K⁺ and high K⁺, respectively), and <0.1 mM and >15 mM Ca²⁺ (low Ca²⁺ and high Ca²⁺, respectively).
- The low-high extremes can be defined for a given application, and the sensitivity range can be tailored to the science requirements of a Europa mission.



CONCLUSION

- We have demonstrated the feasibility of recording spectral information in sub-minute times from more than one optrode simultaneously in a given aqueous system.
- Future landed missions to Europa, Enceladus, or Titan, may benefit from our ion-selective sensing technology for characterizing the ionic composition of the liquid reservoirs and the organic content in these moons;

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