

1 Supplementary Material - A Submersible Phosphate 2 Analyzer for Marine Environments based on Inlaid 3 Microfluidics

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12 **S1. CuSO₄ averaged calibration voltage**

13 The CuSO₄ calibration was performed as described in the methods section of the main paper.
14 Starting with three blanks of pure water, the order in which the fluids were injected through the
15 standard port was:

16 B × 1, 500 μM × 3, B × 1, 250 μM × 3, B × 1, 125 μM × 3, B × 1, 62.5 μM × 3, B × 1, 31.25 μM × 3

17 Voltage data from both the short path length (SP) and long path length (LP) were
18 collected, and the last 5 seconds of each blank and sample was averaged and plotted in Figure
19 S1.

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21 **S2 – S3. PO₄³⁻ averaged calibration voltage**

22 The CuSO₄ and PO₄³⁻ calibrations were performed as described in the methods section of the
23 main paper. Each pre-made standard was mixed through diffusion on the chip with the two
24 reagents at a ratio of 1:1:2 (R1:R2:Standard) and allowed to develop color for 10 minutes before
25 being displaced by the next pump cycle. Each blank was also given 10 minutes delay to monitor
26 for crossover from the samples to the blanks. Starting with three blanks of pure water, the order
27 in which the fluids were injected through the standard port was:

28 B × 3, 10 μM × 3, B × 3, 5 μM × 3, B × 3, 2 μM × 3, B × 3, 1 μM × 3, B × 3, 0.5 μM × 3, B × 3, 0.2 μM
29 × 3

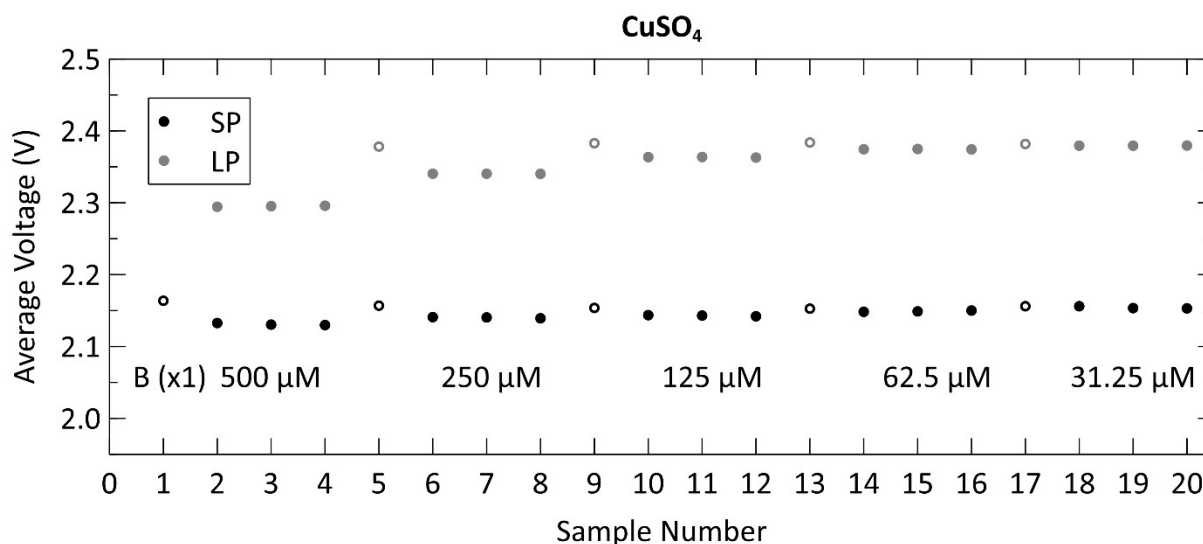
30 Voltage data from both the short path length (SP) and long path length (LP) were
31 collected, and the last 5 seconds of each blank and color development phase were averaged
32 and plotted in Figure S2. Figure S3 shows the color development curve of a 2 μM PO_4^{3-} standard
33 after mixing with both reagents. The 5 minute and 10 minute reaction times are indicated in the
34 plot.

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36 **S4. *In situ* verification test**

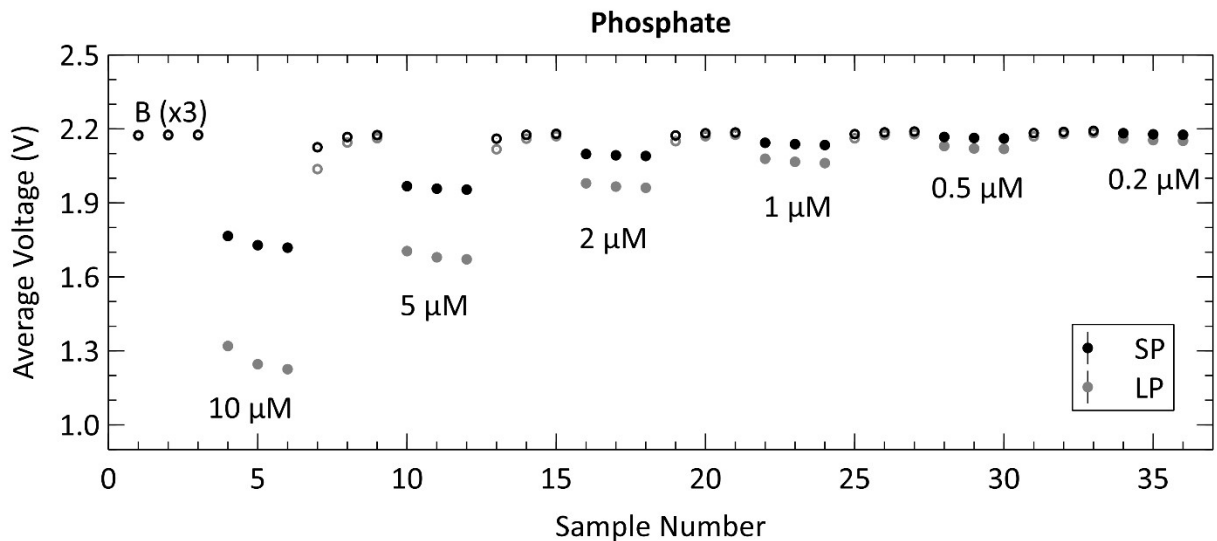
37 The *in situ* verification test was performed as described in the methods section of the main paper.
38 The sensor was submerged in water with an unknown phosphate concentration. It first took a
39 blank measurement of only water from the surrounding environment. It then took three sample
40 measurements, in which each sample was mixed with the two reagents on the chip at ratio of
41 1:1:2 (R1:R2:Sample) and allowed to develop color for 10 minutes before being displaced by the
42 next pump cycle. Between each sample measurement, the chip was thoroughly flushed and given
43 a 1-minute delay before the next sample began. Voltage data from both the short path length
44 (SP) and long path length (LP) were collected.

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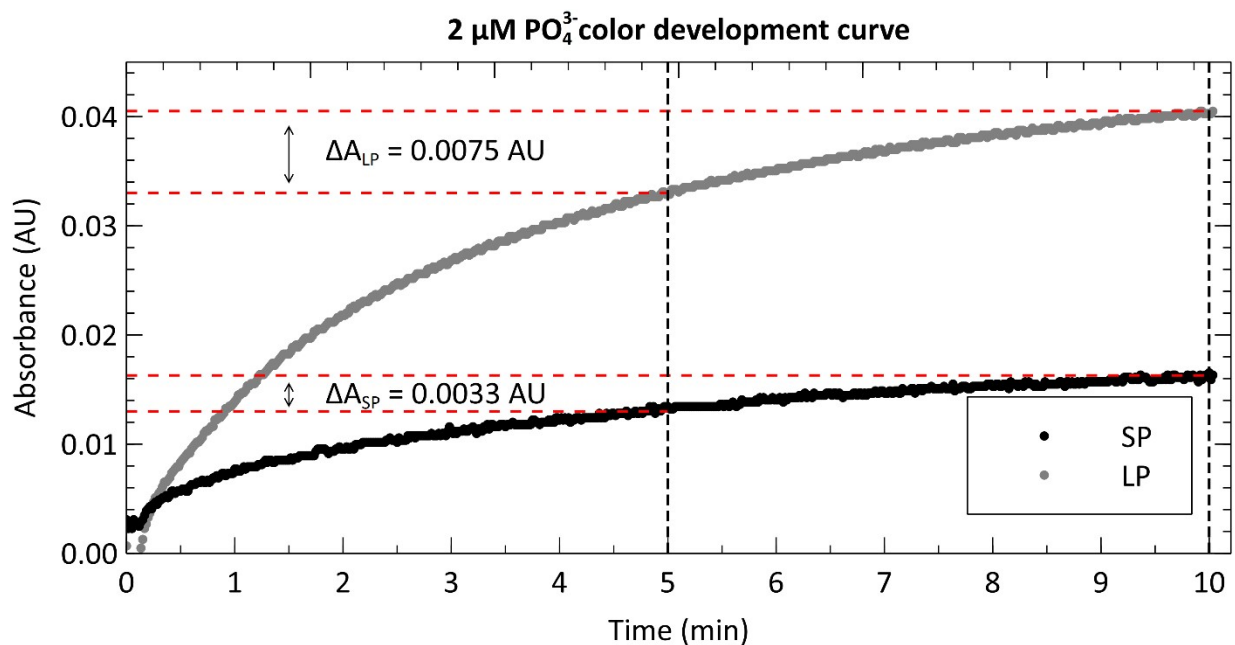
46

47 **Figure S1:** Averaged voltage data from the CuSO_4 calibration curve for both the long path (LP)
48 and the short path (SP). Each concentration is measured three times, preceded by three blank
49 measurements (represented by unfilled data points) to displace the previous concentration of
50 dye.



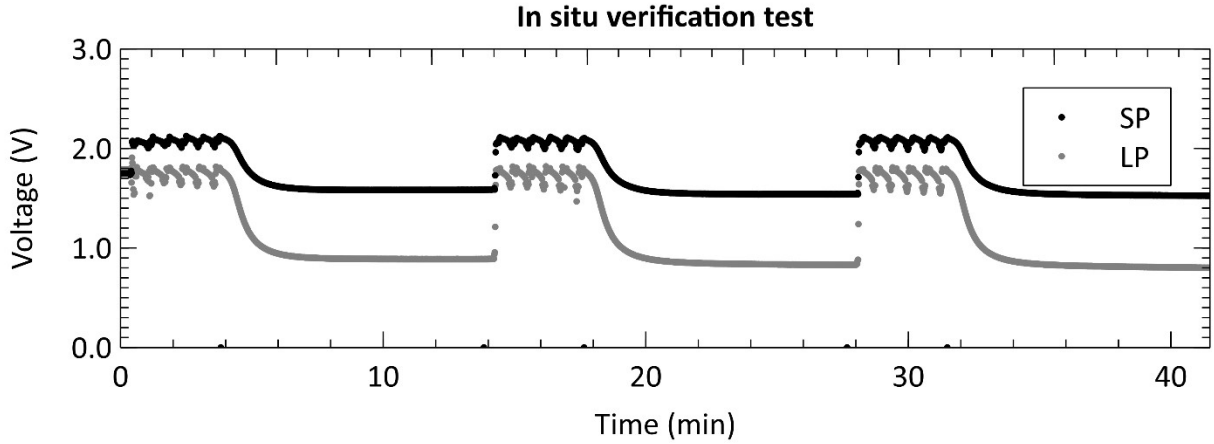
51

52 **Figure S2:** Averaged voltage data from the PO_4^{3-} calibration curve for both the long path (LP) and
 53 the short path (SP). Each standard is measured three times, preceded by three blank
 54 measurements (represented by unfilled data points) to displace the previous standard.



55

56 **Figure S3:** Absorbance measurements from the color development of a $2 \mu\text{M}$ standard as it reacts
 57 with the two reagents. The absorbances at 5 minutes and 10 minutes respectively are indicated
 58 by the dashed red lines for both the short and long path length. The increase in absorbance
 59 between the 5 minute and 10 minute point is noted.

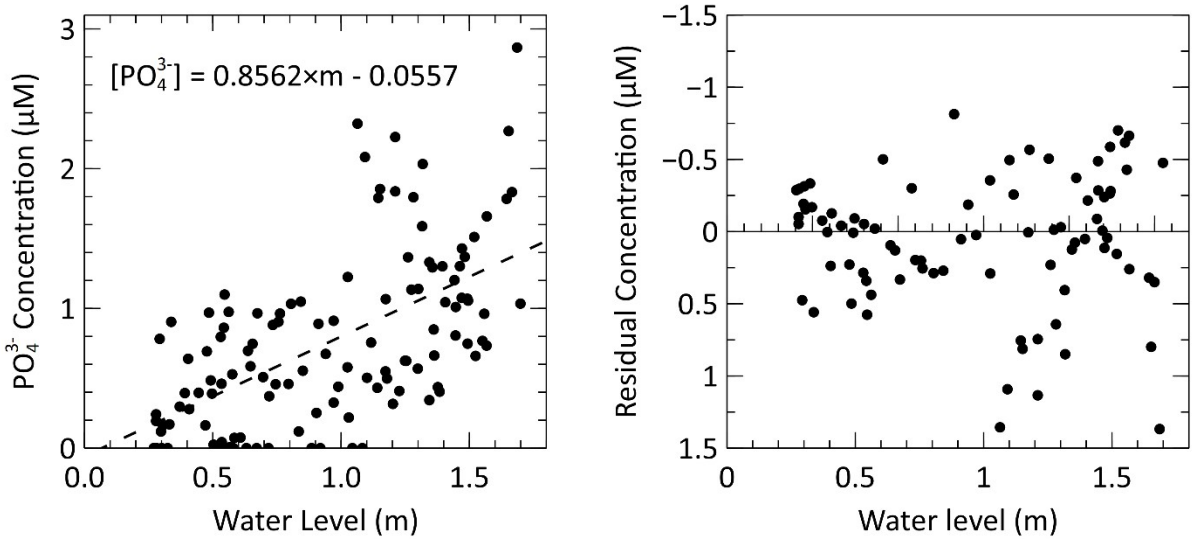


60

61 **Figure S4:** Raw voltage data from the *in situ* verification test. Voltage from both the short path
 62 (SP) and long path (LP) is displayed for the 3 consecutive sample measurements.

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66 **Figure S5:** Measured concentration data from the MSSP deployment plotted against the water
 67 level measured by the Bedford Institute of Oceanography. A linear correlation coefficient of
 68 0.59 was determined from the data. The right panel shows that the residual concentrations
 69 randomly distributed, indicating no systematic error in the measurements.