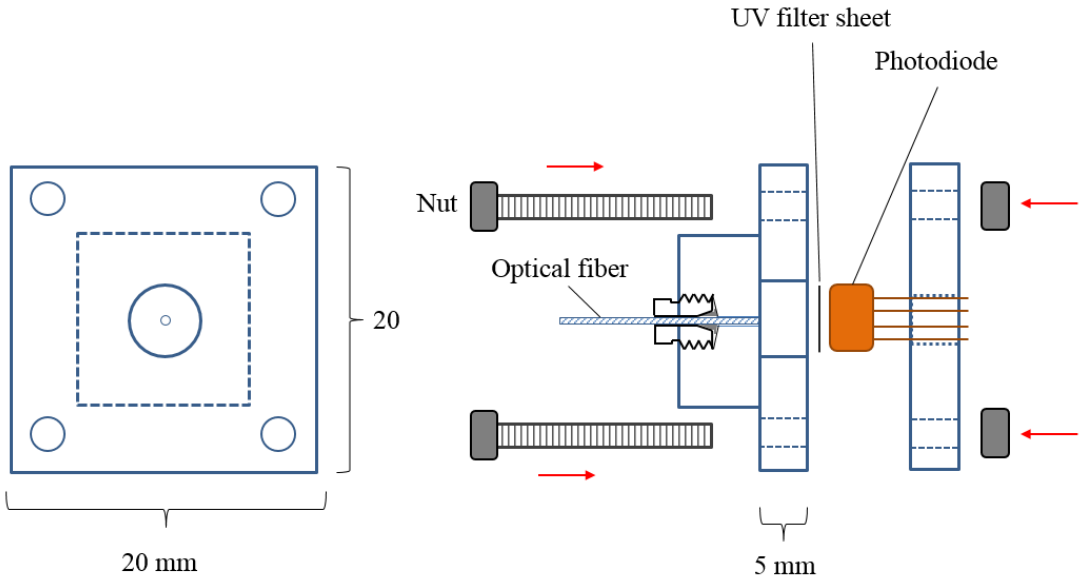
APPENDICES

APPENDIX A

The acrylic block for holding a photodiode



Top view **Side view**

Figure A1 The acrylic block design and components for holding the integrated photodiode and built-in amplifier (OPT301)

APPENDIX B

Paired t-Test

$$t = \frac{\bar{X}_d \sqrt{n}}{S_d}$$

$$S_d = \sqrt{\frac{\sum (X_d - \bar{X}_d)^2}{n-1}}$$

Where, X_d the difference of concentrations from both methods

$\bar{X}_d$ the mean of the difference

S_d the standard deviation

n a number of sample

n-1 a number of degree of freedom

Table B1 The concentration of DIC form the DC conductivity detector and commercial pulse conductometer (712 Metrohm) for evaluation of paired t-test

Sample	**DIC concentration (mM)***		X_d	$X_d - \bar{X}_d$	$(X_d - \bar{X}_d)^2$
	DC conduct.	**Pulse conduct.**			
1	7.26	6.94	-0.32	-0.3	0.0702
2	7.72	7.41	-0.31	-0.3	0.0650
3	7.76	7.35	-0.41	-0.4	0.1260
4	8.55	8.56	0.01	0.1	0.0042
5	9.21	9.24	0.03	0.1	0.0072
6	9.58	9.6	0.02	0.1	0.0056
7	4.35	4.59	0.24	0.3	0.0870
8	5.81	6.11	0.30	0.4	0.1260
Sum	60.2	59.8	-0.44	0.000	0.4912
AVE	7.5	7.5	-0.05		

*Average of triplicate concentration

The calculated t value is 0.587 and less than the theoretical t value (2.365) at 95% confidence intervals. Therefore, the proposed DC conductivity is not significantly different method with the commercial pulse conductometer for DIC determination using the GD-FI system.

Table B2 The theoretical t value for levels of confidence interval

Degree of freedom	**Confidence interval**			
	80%	**90%**	**95%**	**99%**
1	3.078	6.314	12.71	63.66
2	1.886	2.92	4.303	9.925
3	1.638	2.353	3.182	5.841
4	1.533	2.132	2.776	4.604
5	1.476	2.015	2.571	4.032
6	1.44	1.943	2.447	3.707
7	1.1415	1.895	2.365	3.499
8	1.397	1.86	2.306	3.355
9	1.383	1.833	2.262	3.25
10	1.372	1.812	2.228	3.169
20	1.325	1.725	2.086	2.845
60	1.296	1.671	2	2.66
100	1.29	1.66	1.984	2.426

APPENDIX C

Standardized DIC by titration

1. Preparation of solutions for Standardized DIC

- Potassium hydrogen phthalate stock standard solution

The potassium hydrogen phthalate (KHP) stock standard solution of 20.00 mmol L^{-1} was prepared by dissolving 0.4100 g of potassium hydrogen phthalate salt in DI water and adjusting to 100.00 mL in volumetric flask.

- Sodium hydroxide standard solution

The sodium hydroxide standard solution was prepared by dissolving 0.1200 g of sodium hydroxide salt in 100 mL of DI water (~30 mmol L^{-1}) and standardizing with KHP standard solution.

- Hydrochloric acid standard solution

A 0.2 mol L^{-1} hydrochloric acid solution was prepared by adding 1.6 mL of 37% hydrochloric acid in 100 mL of DI water. A 20 mmol L^{-1} hydrochloric acid solution was prepared by diluting 10.0 mL of 0.2 mol L^{-1} hydrochloric acid solution with DI water and adjusted to be 100 mL and standardizing with sodium hydroxide standard solution.

2. The procedure of analysis

- Standardized sodium hydroxide solution

The 25.00 mL of KHP primary standard was pipetted to a flask and adding a few drops of phenolphthalein as indicator. The KHP standard was titrated by adding a NaOH solution. The end provides a pink solution and calculating the concentration of NaOH according to stoichiometry and repeating 2 times.

- Standardized hydrochloric acid solution

The 25.00 mL of HCl solution was pipetted to a flask and adding a few drops of phenolphthalein as indicator. The HCl solution was titrated by adding a NaOH standard solution. The end point provides a pink solution and calculating the concentration of HCl according to the stoichiometry and repeating 2 times.

- Standardized DIC stock solution

The 25.00 mL of DIC stock standard solution was pipetted to a flask and adding a few drops of phenolphthalein as indicator. The DIC stock was titrated by adding the HCl standard solution. The first end point provides a colorless solution and then recording the first end point volume. A few drops of bromocresol green solution was added to be a second indicator and continuously titrating with standard HCl. The solution color would change from blue to green and then heating the solution. The solution color would return to be blue and then cooling the solution at room temperature. The second end point was obtained when the solution color changes to be yellow. The DIC stock concentration was calculated from both end points.

APPENDIX D

Indophenol blue procedure

1. Preparation of solutions for indophenol blue method

- Sodium salicylate solution

A 24% sodium salicylate solution was prepared by dissolving 12.0 g of sodium salicylate in 50.0 mL of DI water.

- Sodium nitroprusside solution

A 0.2% sodium nitroprusside solution was prepared by dissolving 0.020 g of sodium nitroprusside in 10.0 of DI water.

- 12% salicylate working solution (Solution A)

A 12% salicylate working solution was prepared by adding 2.0 mL of 0.2% sodium nitroprusside solution into 50.0 mL of 24% sodium salicylate solution and adjusting to 100.0 mL of volumetric flask with DI water.

- 4% hypochlorite working solution (Solution B)

A 1.8% hypochlorite working solution was prepared by adding 15.0 mL of 12.5% sodium hypochlorite in 45.0 mL of DI water and adjusting to 100.0 mL of volumetric flask with 6.7 mol L^{-1} NaOH.

2. The procedure of analysis

The 0.2 mmol L^{-1} NH_4^+ standard solution was pipetted with the volume of 0.0, 1.0, 2.0, 3.0, 4.0 and 6.0 mL into 50.0 mL volumetric flask as well as the NH_4^+ sample was also pipetted with the volume of 10.0 mL into 50.0 mL volumetric flask. Next step, a 0.1 mol L^{-1} H_2SO_4 was added to the flasks, a total volume of all flasks would be ~20 mL. Then the working solution A and B were added to the flasks with a volume of 10.0 mL (both solutions) and adjusting the total volume as 50.00 mL with 0.67 mol L^{-1} NaOH.

The reaction is slow and waiting for 1 hour. All solutions were measured by spectrophotometry at 630 nm.

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