Development of a Low Cost Microfluidic Sensor for the Direct Determination of Nitrate Using Chromotropic Acid

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Electronic Supplementary Information

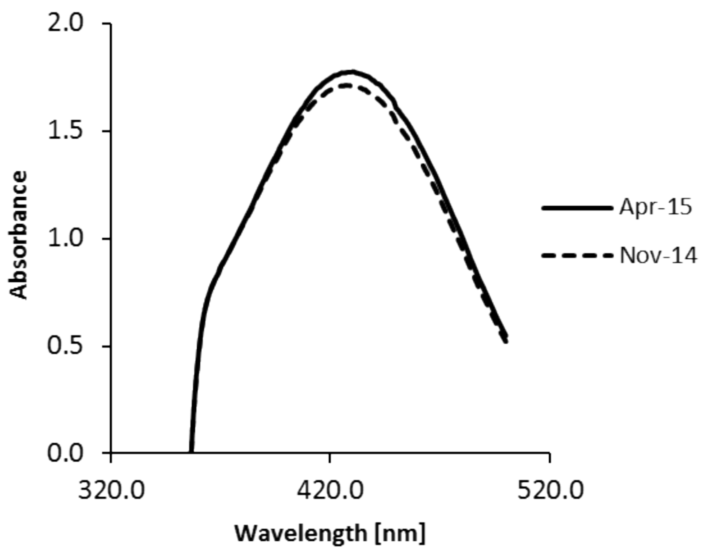

Fig. S1.

Spectra of 80 mg/L NO_3^- in the chromotropic acid reagent prepared in November 2014 and using the same reagent again in April 2015.

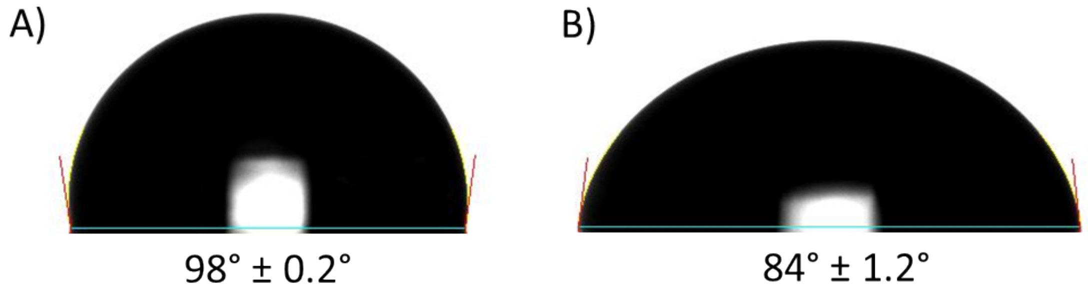

Fig. S2.

Contact angle measurments of water on COP surfaces before (A) and after (B) direct UV irradiation (n = 3).

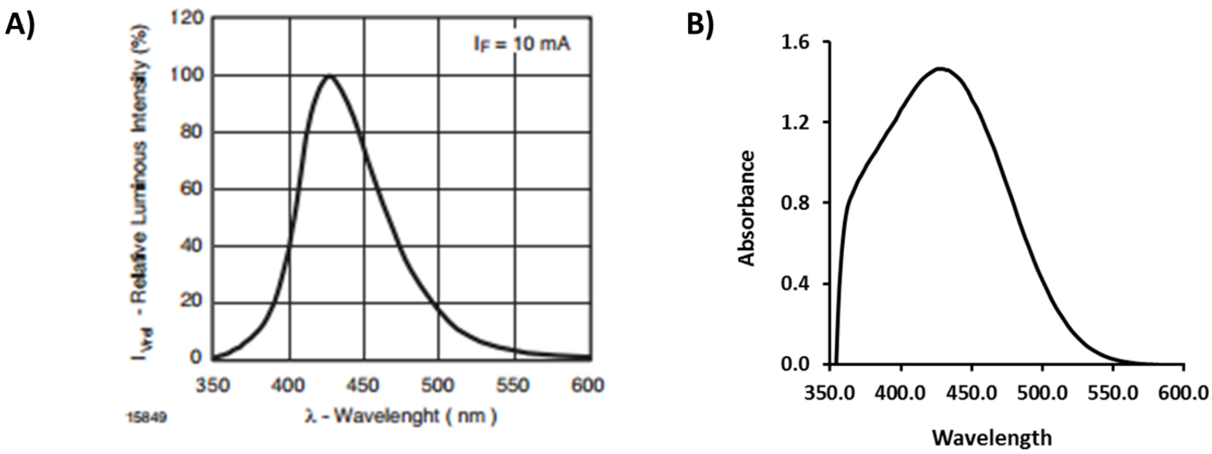

Fig. S3.

A) UV-LED light output (Vishay Semiconductors, 2004) and B) the UV spectrum of 80 mg/L NO_3^- - chromotropic reagent complex.

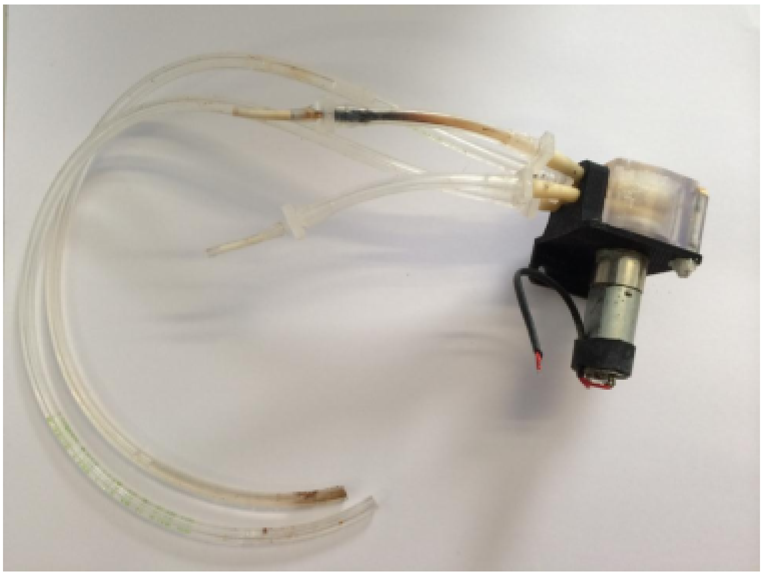

Fig. S4.

Peristaltic pump containing Tygon tubing showing degradation and discoloration, caused by decomposition of the polymer due to the highly acidic nature of the reagent (chromotropic acid and 98% sulphuric acid) and the high temperature caused by the exothermic reaction produced by the addition of the aqueous solution to the sulphuric acid. This unit had been in use for a period of three weeks.

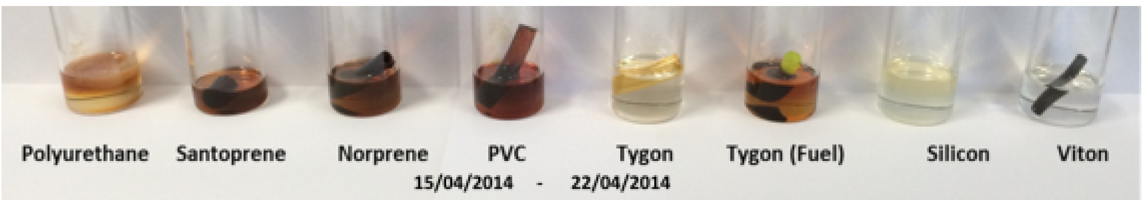

Fig.S5.a.

Range of elastomers exposed for a period of one week to 98% sulphuric acid. Polyurethane and silicon tubing have almost completely dissolved in the acid while Santoprene, Norprene, PVC and Tygon (fuel) show severe discolouration. Tygon shows slight discolouration while Viton shows no sign of discolouration or corrosion.

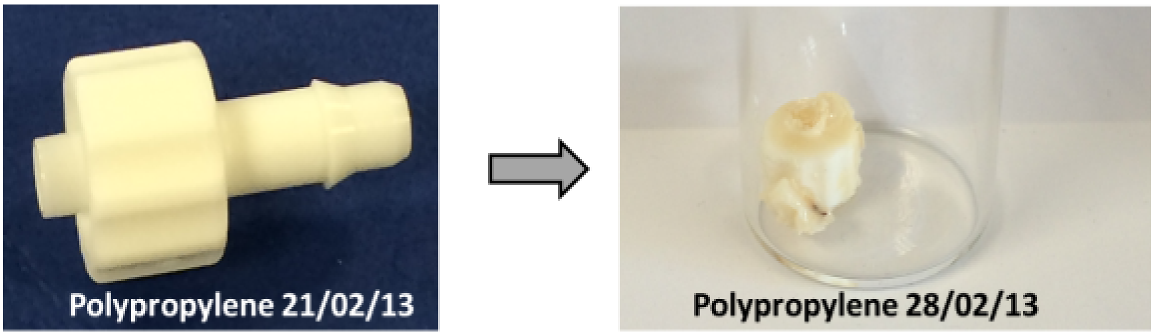

Fig.S5.b.

New polypropylene luer (left), and severe damage after exposure for a period of one week to 98% sulphuric acid (right).

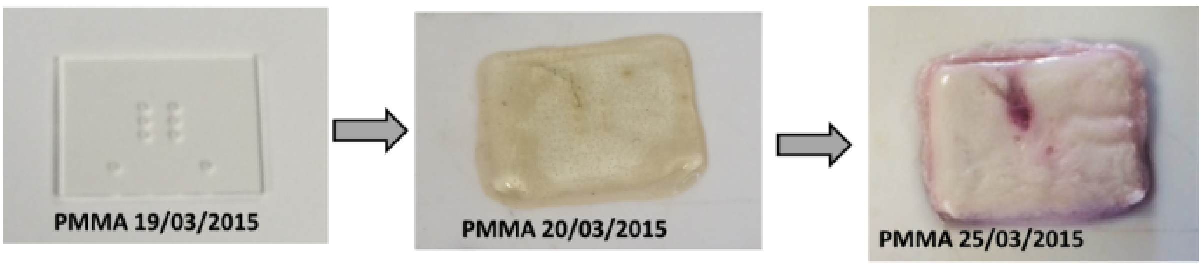

Fig.S5.c.

PMMA (Poly(methyl methacrylate)), a material commonly used for the production of microfluidics chips, showing severe effect of exposure for one week to 98% sulphuric acid.

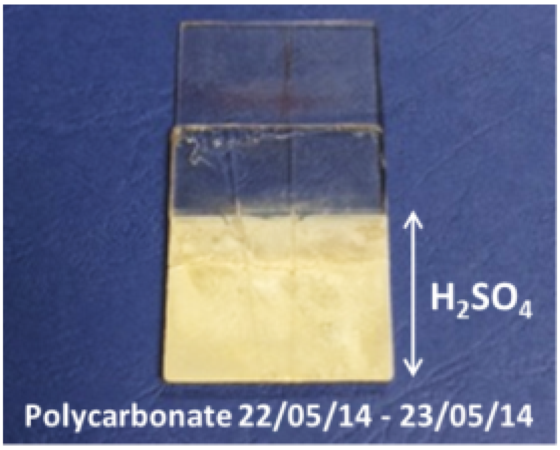

Fig.S5.d.

Polycarbonate (PC), a commonly used material for the production of microfluidics chips, showing severe effect of exposure for one week to 98% sulphuric acid.

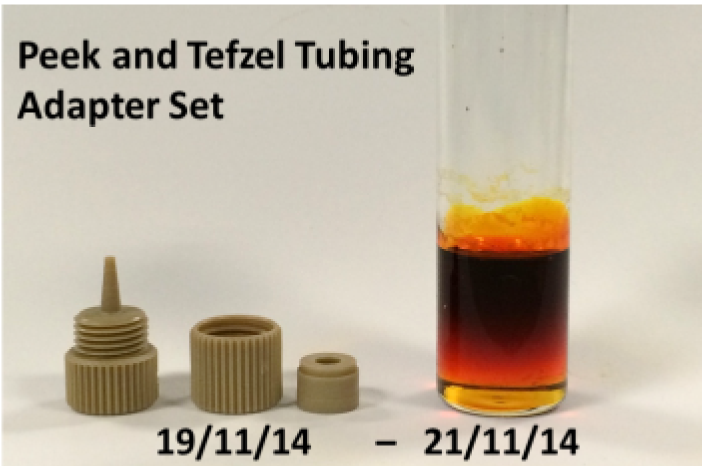

Fig.S5.e.

Polyether ether ketone (PEEK) and Tefzel tubing connectors for peristaltic pumps commonly used in flow analysis systems: new (left) and completely dissolved after exposure for three days to 98% sulphuric acid (right).

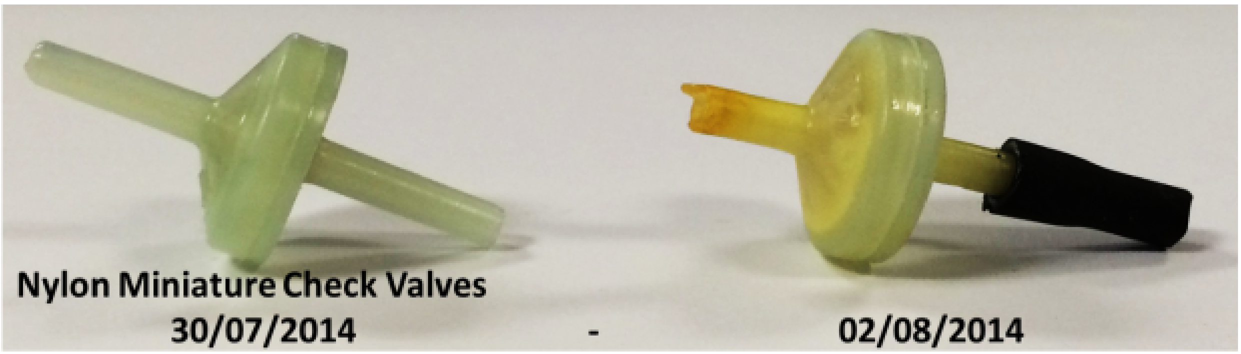

Fig.S5.f.

New nylon miniature check valve with fluorosilicone diaphragm (left), and a similar valve after being used in nitrate-chromotropic acid flow analysis system for a period of one week.

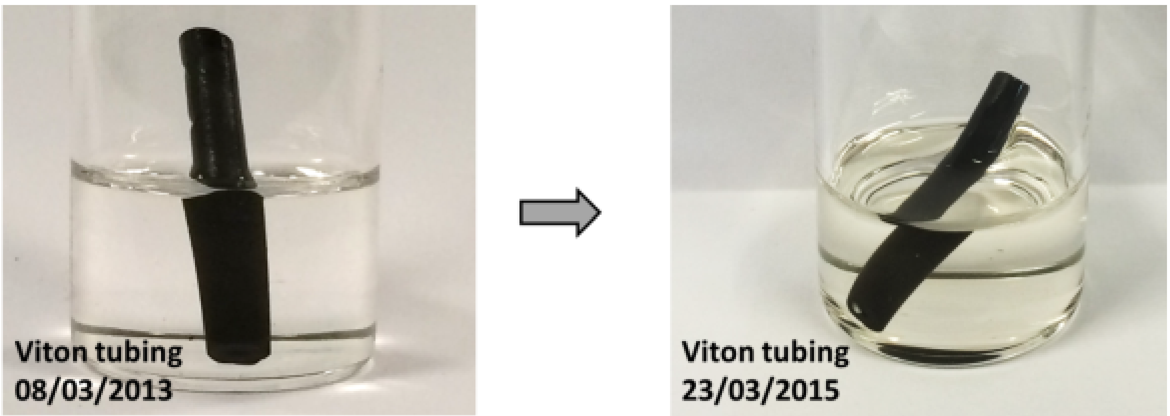

Fig.S5.g.

Viton tubing exposed for 2 years to 98% sulphuric acid showing no signs of discolouration of degradation.

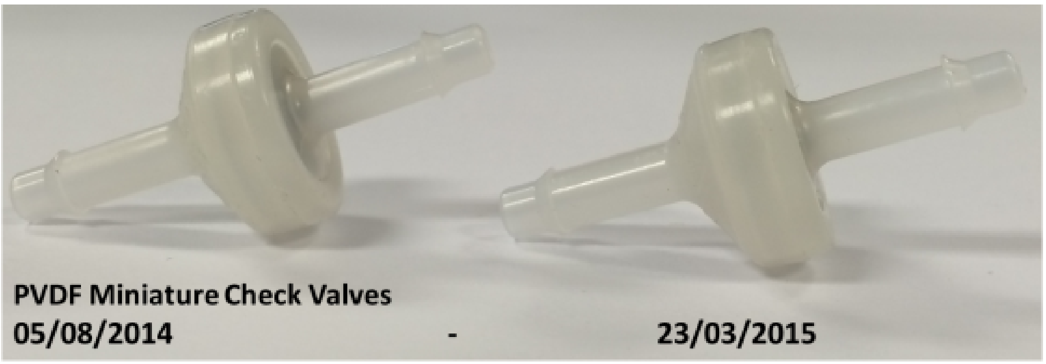

Fig.S5.h.

PVDF check valves with Viton diaphragm used in nitrate-chromotropic acid flow analysis system after a period of 9 months to 98% sulphuric acid showing no signs of discolouration of degradation.

Vid. S1.

Real-time response (3 min) of PEEK (commonly used in flow analysis platforms as tubing and tubing connectors) to 98% sulphuric acid demonstrating the immediate discolouration and degradation of PEEK on contact with the acid.

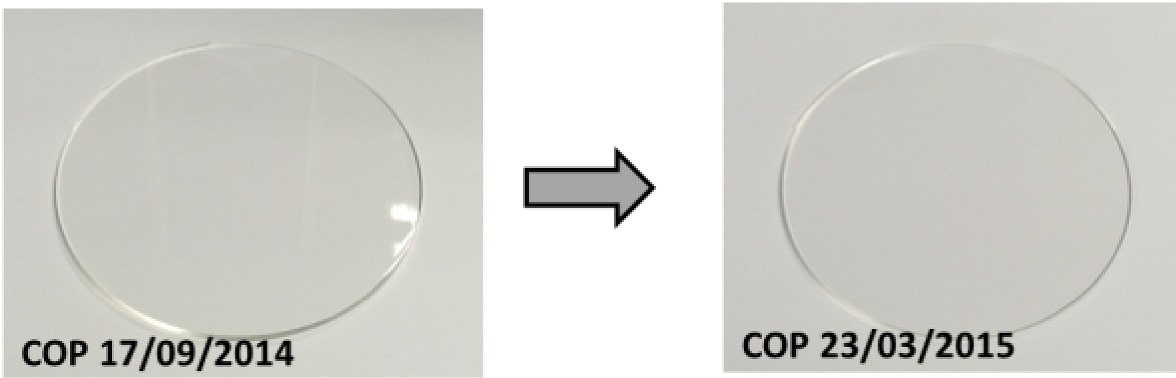

Fig. S6.

COP (Zeonex mcs- COP- 04) discs before (left) and after (right) immersion in 98% sulphuric acid (8 months) showing excellent chemical resistance to the highly concentrated acid.

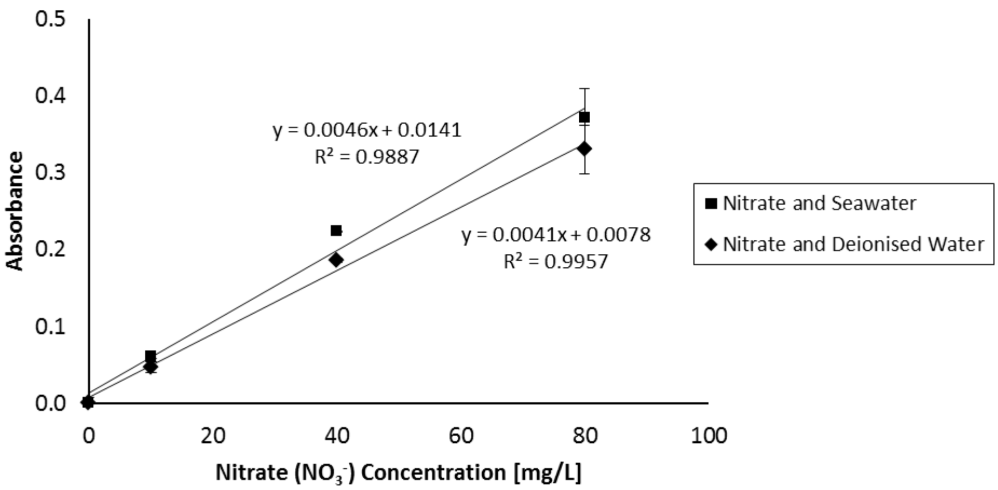

Fig. S7.

Calibration curves using microfluidic nitrate analyser, using nitrate standards ranging from 0 – 80 mg/L nitrate with the chromotropic acid reagent using both deionised water and seawater matrices. The error bars represent the standard deviations for n = 3 replicates.

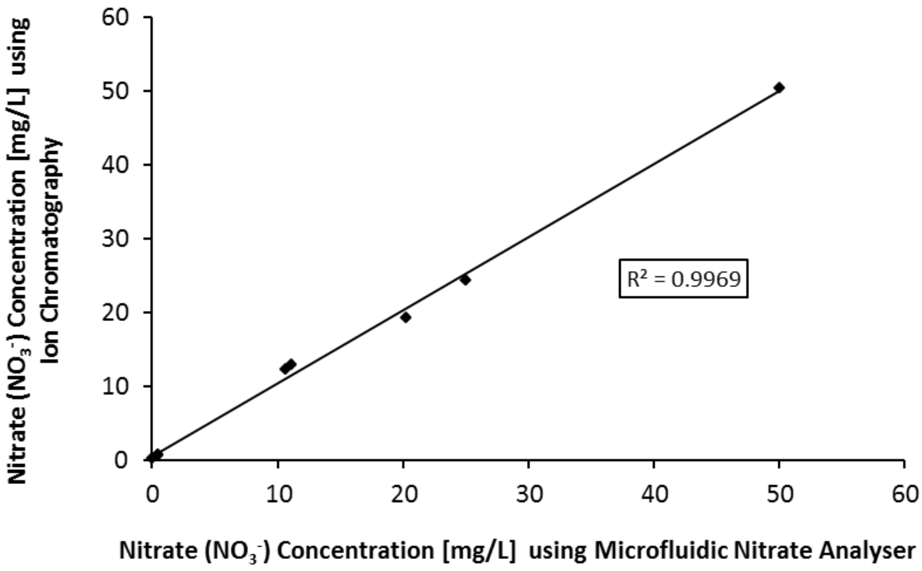

Fig. S8.

Correlation plot of sample concentrations obtained using the microfluidic nitrate analyser and ion chromatography.

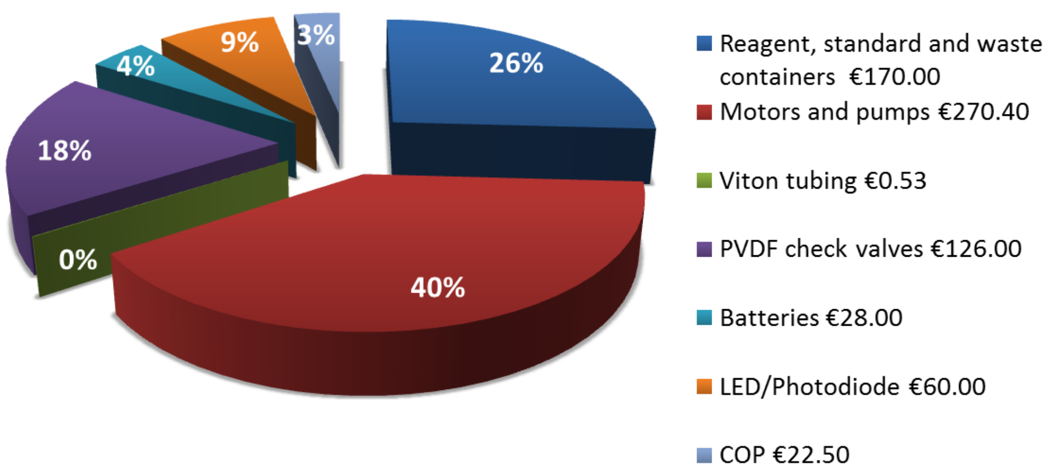

Fig. S9.

Cost breakdown of nitrate sensor components.