

Disposable, Digital Phosphate Sensor

(OTT ID 1513)

**Inventor: Dr. Woo-Jin Chang, Department of Mechanical
Engineering and School of Freshwater Science
UW-Milwaukee**

Smruti Patil, PhD, IPMM
Licensing Associate
1440 East North Ave.
Milwaukee, WI 53202
Tel: 414-906-4657
smruti@uwmrf.org

Why are Phosphates a Problem?

Increased levels of phosphates can lead to;

- ☐ Eutrophication (excessive plant growth such as algal blooms)
- ☐ At first plant growth may be stimulated, but over time excessive plant growth can choke the water way, and lead to death of the plants
- ☐ Low oxygen in waterways can occur and death of aquatic organisms
- ☐ Some algal blooms are toxic to humans

Sources of increased phosphates in the environment include;

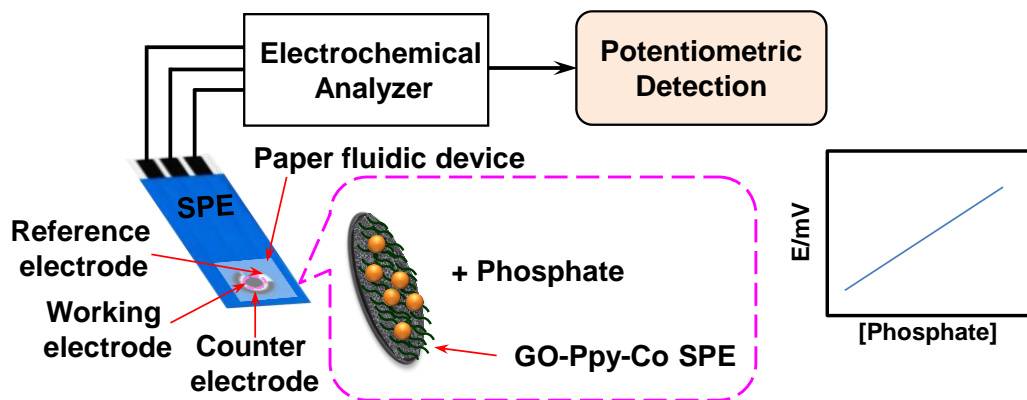
- ☐ Fertilizers and farm water run-off (and manufacturing of fertilizers)
- ☐ Sewage
- ☐ Pulp and paper industry
- ☐ Detergents
- ☐ Vegetable and fruit processing



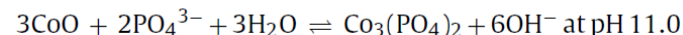
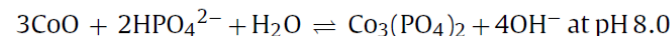
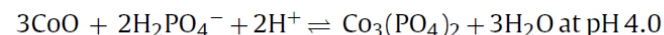
- ❑ The EPA notes that “Monitoring phosphorus is challenging because it involves measuring very low concentrations down to 0.01 mg/L or even lower....”
- ❑ Even such very low concentrations of phosphorus can have a dramatic impact on streams. Less sensitive methods should be used only to identify serious problem areas
- ❑ The EPA approved method for measuring phosphates involves the use of chemical reagents
- ❑ In some cases samples must be brought back to the lab for analysis

Low Cost, Disposable Phosphate Sensor

Schematic diagram of the setup



Chemical reaction using Cobalt (example)

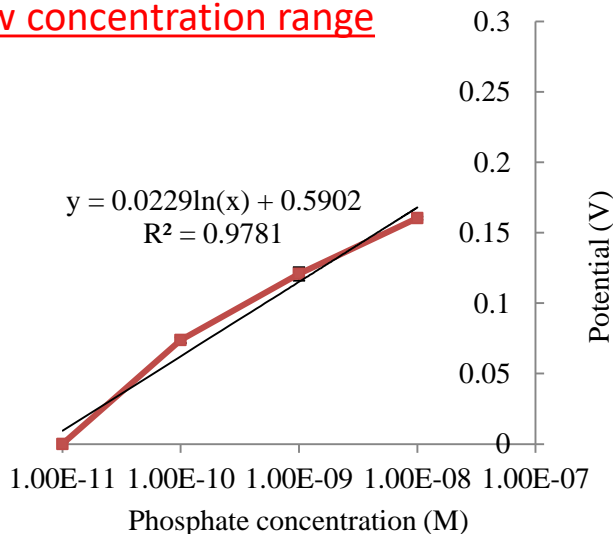


- ❑ Carbon working electrode surface of Screen Printed Electrode (SPE) modified by **selective combinations** of Graphene Oxide, Pyrrole, Cobalt Oxide nanoparticles, Tin (IV) Chloride, Diphenyltin Dichloride, or Ammonium Molybdate by drop-casting method
- ❑ Different concentrations of KH_2PO_4 aqueous solution used to determine the sensitivity and lower detection limit (LOD) of phosphate ion (PO_4^{3-}) of the developed sensor using open circuit voltammetry

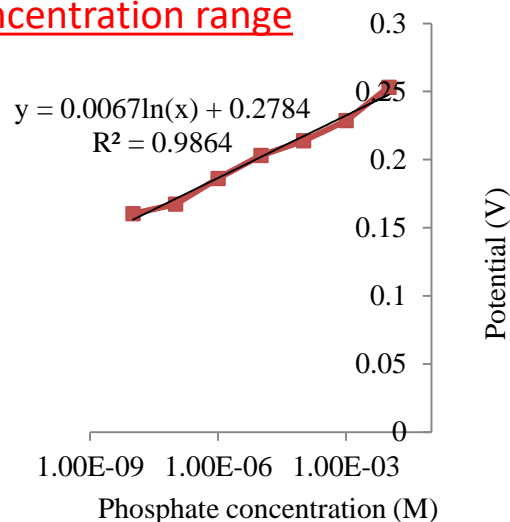
Phosphate Detection in Several Range

Phosphate detection using mixture of Pyrrole and Ammonium molybdate modified SPE in KH_2PO_4 aqueous solution at pH 4.5 (left)

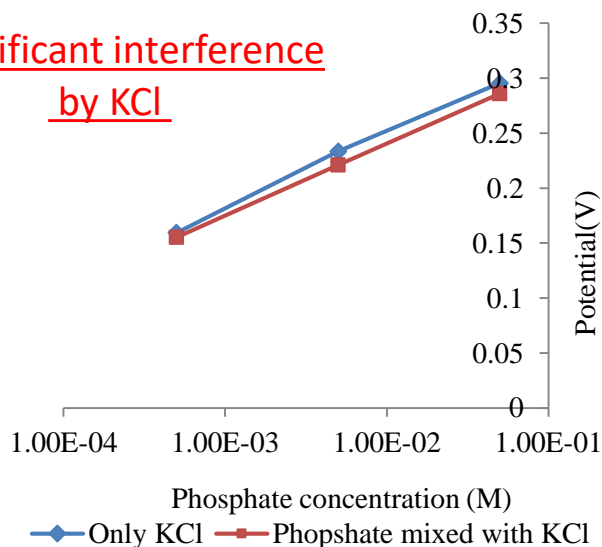
Low concentration range



High concentration range



Insignificant interference
by KCl

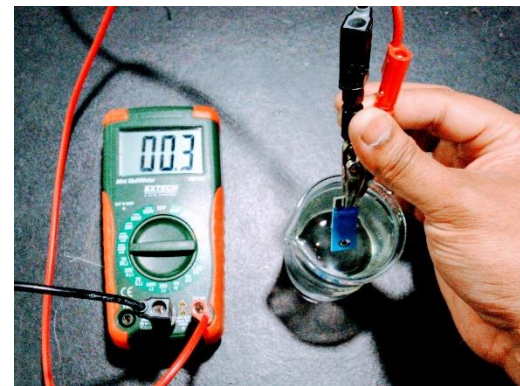
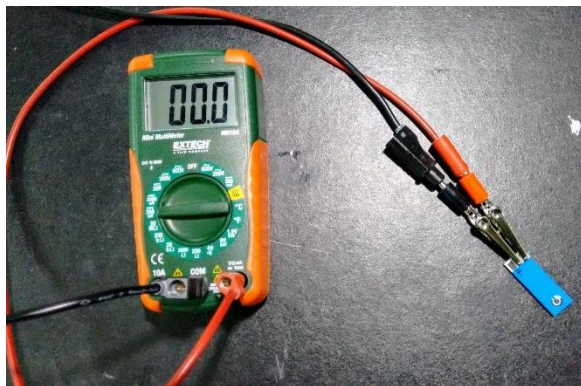


Interference test of Phosphate ions in presence of Cl^- ions using mixture of Pyrrole and Ammonium molybdate modified SPE in KCl solution and KCl in KH_2PO_4 aqueous solution at pH 4.5

☐ PCT Filed Oct. 2018, PCT/US2018/046322

Current Status

- ☐ Proposed technology is a part of active on going research program at UW-Milwaukee
- ☐ Seeking development partners for testing to aid in final end user prototype
- ☐ Technology is current available for licensing under non-exclusive terms



- ❑ Our team has demonstrated a highly sensitive phosphate sensor that can be used as a simple hand-held device
- ❑ The materials for manufacture are inexpensive and easy to obtain
- ❑ Extensive training will not be necessary to use the device
- ❑ Licensees can derive further profit from the use of one time disposable sensors

- ❑ Determine whether sensors can be used in longer term applications or continuous use:
 - Sensor will be submerged in standard solution for certain period of time, and then use it for the measurements to characterize the sensitivity change over time and robustness
- ❑ Test sensors further to characterize effect of temperature (5°C-50°C) on detection, as well as appropriate temperature range for the detection
 - The sensor will be tested in pressure chamber with pressure up to 80 psi (the pressure regulator in residential use is set between 40-50 psi)
- ❑ Find partner to manufacture and develop the final prototypes

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