Miniature, Multiple Sensor Systems for Continuous Detection of Metals, pH, and Other Parameters

Conservation
CS-1266

Background:

Sources of copper (Cu) from Navy activities, such as antifouling agents on ship bottoms and dredging operations, require active monitoring and sensing of Cu(I) and Cu(II) individually to ensure environmental compliance and protection. Due to the toxicity of copper, especially in estuary environments, all sources of copper must be monitored to account for the relative impacts of the various sources. Current methods (i.e., atomic absorption using Methods 7210 and 7211) measure total copper [Cu(I) and Cu(II)] including soluble and particle bound and do not measure the true toxicity known to result from Cu(I). Other methods have been developed that rely on colorimetric or electrochemical analysis. These procedures require grab-samples of the water column and are thus difficult to implement across an entire harbor.

Objective:

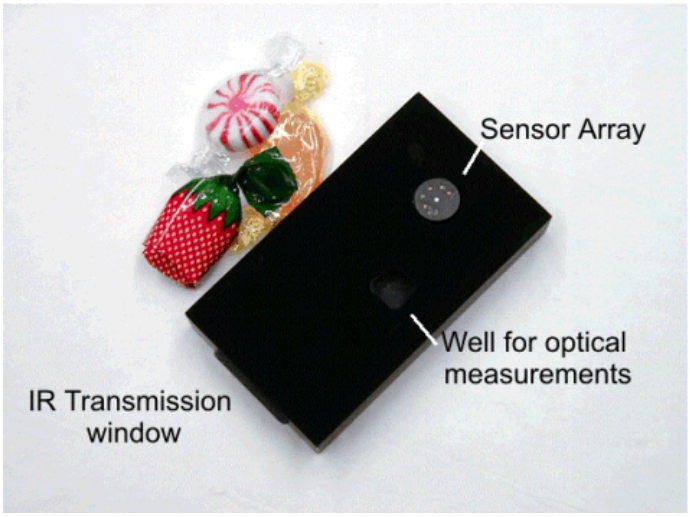
This one-year effort will develop a miniaturized sensor system based on ion-selective electrodes and other electrochemical measurements that individually detect Cu(I), Cu(II), pH, temperature, conductivity, chloride (or sodium), and turbidity. Because the measurements are determined in seconds, this sensor package will be suitable for rapid surveying of the marine environment.

Summary of Process/Technology:

A number of sensor systems will be developed and packaged together. Copper(I), Cu(II), chloride, and pH will be detected by modification of membrane ion-selective electrodes. Conductivity, oxidation/reduction potential, temperature, and turbidity will be detected through miniaturization of existing technology such as alternating current measurement absorbance for turbidity, a voltage divider, and pH electrode. Of the desired sensor systems, only Cu(I) requires extensive experimentation. To demonstrate that Cu(I) ion-selective electrodes are feasible, a hydrophobic (a requirement for membrane electrodes) carrier molecule for Cu(I) was synthesized and incorporated into a liquid-filled electrode. Data from preliminary experiments using this ion-selective electrode show a limit of detection of about 20 ppb with a response time of 30 to 60 seconds. Based on the performance of other ion-selective electrodes, the sensitivity and response time of the prototype electrode is expected to increase with experimentation. The actual selectivity for this electrode will be fully characterized. A stable reference electrode will be tested and evaluated. Laboratory studies have shown these electrodes to be stable, relatively non-fouling, cost-effective, and easily manufactured.

Benefit:

This platform sensor system will allow a number of important parameters for the marine environment to be rapidly mapped. It will also provide a demonstration platform for the development of other miniaturized sensor systems.



Environmental monitoring device being built by NRL.

Accomplishments:

This SEED project began in FY 2002. Accomplishments will be noted upon completion of the project

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