Title: **Integrated ChemFET Sensors for Real time Monitoring of Redox Sensitive Metals in Natural Water**

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Project Abstract:

Redox sensitive metals - chromium, iron, manganese, and others have attracted a great deal of attention around the world for their impact on human health and the environment. It is beneficial to study the temporal dynamics of metal ion concentrations and coupled biogeochemical reactions. To allow efficient monitoring of redox sensitive metal levels in water, a fast response, field deployable, sensitive and selective measuring instrument is required. Traditionally, there are several methods for heavy metal detection, including spectroscopic techniques such as atomic absorption spectroscopy, Auger-electron spectroscopy, and inductively coupled plasma-mass spectrometry. However, these methods are expensive to use with costly and bulky instruments, and are not suitable for field monitoring applications. The fundamental physical principles of ordered dielectric or metallic thin films formed by the electrostatic self-assembly (ESA) process have been investigated in our team's prior publications. Most importantly, research has demonstrated the ability of ESA to incorporate a wide range of materials including polymers, metal and oxide nanoclusters, cage-structured molecules, semiconductor nanocrystals, and other materials, into multilayered thin films. Applications of these chemically selective thin films in chemical field effect transistors (ChemFET) sensors and integrated systems are suggested.

Experimental data demonstrates miniaturized ChemFET sensors with chemically modified electrodes for the detection of redox sensitive metal ions such as Fe(II), Fe(III), Cr(III), Cr(VI), and others in surface and subsurface water. We have combined our electrostatic self-assembly thin film deposition process and stripping voltammetry enhanced ChemFET technology to produce an integrated chemical sensor network with tuned sensitivity and selectivity for *in situ* environmental monitoring. High selectivity is achieved by designing specific self-assembled binding interfaces for metal ions of interest. The team investigated the issues encountered in groundwater monitoring, which mainly include the difficulty in forming strong and reversible bindings between sensing materials and target metal ions, the interfering ion complexation from natural organic ligands and other chemicals, and the gradual accumulation of microorganisms/other materials on wet sensor surfaces. It leads to improved reversibility and reusability of the sensor systems. The wired/wireless sensor system would be capable of sensing multiple redox sensitive metal ions, improve upon conventional sampling methods, and benefit future environmental analysis programs.