

## DIVISION OF ENVIRONMENTAL CHEMISTRY

238th ACS National Meeting  
Washington, DC  
August 16-20, 2009

### TUESDAY AFTERNOON

#### Emerging Environmental Technologies towards a Cleaner and Sustainable Society

P. Bishop, *Organizer*  
V. Shah, *Organizer, Presiding*

**1:30** — Introductory Remarks.

**1:35** —**59.** Emerging environmental technologies: An NSF perspective. **P. Bishop**

**2:05** —**60.** Using green nanotechnology for a cleaner and more sustainable. **B. Karn**

**2:35** — Discussion.

**2:50** — Intermission.

**3:00** —**61.** *In situ* formation of nanoparticles as an effective biocatalyst for environmental remediation. **D. Chidambaram**, J. P. Fitts, T. Hennebel, N. Boon, W. Verstraete, D. Van der Lelie

**3:20** —**62.** Aqueous ethanol modified nanoscale zero-valent iron in bromate reduction: Synthesis, characterization, and reactivity. **Q. Wang**, S. A. Snyder, H. Choi

**3:40** —**63.** Dithionite as a regenerant for the reducing capacity of nanoscale zero-valent iron *in situ* treatment zones. **D. M. Cwiertny**, Y. Xie

## ABSTRACTS

### ENVR 59

#### **Emerging environmental technologies: An NSF perspective**

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*Abstract text not available.*

### ENVR 60

#### **Using green nanotechnology for a cleaner and more sustainable**

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Nanotechnology can lead to environmental technologies for a more sustainable environment. This paper will present an overview of sustainability issues and how nanotechnology is applicable to these issues. Major sustainability issues to be discussed are climate change, energy, water, toxic materials and health. Sample technologies include nanotechnology applied to wastewater treatment, drinking water, site remediation, pollution prevention, medical problems, energy issues, and dematerialization.

### ENVR 61

#### ***In situ* formation of nanoparticles as an effective biocatalyst for environmental remediation**

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The catalytic properties of various metal nanoparticles have led to widespread interest in their use in environmental remediation. However, relatively fewer studies have

explored how *in situ* generation can be used to more effectively deliver the biocatalytic effect of these nanoparticles. We have developed a novel one-step technology in which palladium nanoparticles are generated *in situ* by members of the genus *Clostridium* and subsequently used as a biocatalyst for remediation of hexavalent chromium and organic contaminants. X-ray absorption spectroscopy and UV-visible spectroscopy were utilized to study speciation, atomic emission spectrometry was used to analyze metal concentrations, and imaging was performed using electron microscopic techniques. Hexavalent chromium was found to be reduced to a sparingly soluble trivalent state. This study has significant implications for both the fate and transport of nanoparticles in the environment, and the *in situ* generation and use of Pd(0) nanoparticle biocatalysts for contaminant remediation.

## ENVR 62

### **Aqueous ethanol modified nanoscale zero-valent iron in bromate reduction: Synthesis, characterization, and reactivity**

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Nanoscale zerovalent iron (NZVI) was evaluated for the reduction of bromate which is a highly persistent and carcinogenic oxyhalid formed as an ozonation by-product during oxidative disinfection in drinking water treatment. Solid-phase NZVI with different surface areas was controllably synthesized using a liquid phase reduction. Transmission electron microscopy (TEM), X-ray diffraction (XRD), and a Brunauer-Emmett-Teller (BET) surface area and porosity analyzer were utilized to characterize particle size, surface morphology, surface area, and corrosion layers formed onto NZVI before and after the reduction of bromate. Surface area of synthesized NZVI was found to be influenced strongly by ethanol contents during synthesis with a maximum surface area of  $67.51 \pm 0.35 \text{ m}^2/\text{g}$  in a 90% aqueous ethanol; additionally, capsule structures of NZVI with amorphous phase, in which tens of particles with diameters of 2–5 nm were packed into an iron oxide/hydroxide layer, were also synthesized using 100% ethanol as a solvent. Subsequent XRD and TEM results revealed that in a 20 min bromate reduction NZVI mostly converted to  $\text{Fe}_2\text{O}_3$  and  $\text{Fe}_3\text{O}_4$  corrosion products mixed with iron hydroxides. Compared to bromate reduction using micro-sized ZVI in a pseudo-first-order kinetic model, NZVI enhanced the reduction efficiency following a second-order kinetic model, with observed second-order rate constants ( $k_{\text{obs}}$ ) of  $2.57 \times 10^{-4}$  to  $2.19 \times 10^{-3} \text{ } \mu\text{g}^{-1} \text{ min}^{-1} \text{ L}$ . Humic acid was found to be the most influencing factor to decrease NZVI reactivity in bromate reduction. However, the effects of sonication pretreatment showed that the bromate reduction efficiency could be enhanced by increasing the actual

reactive surface area. Our results suggest that application of NZVI is a viable process for bromate reduction in water treatment.

## ENVR 63

### **Dithionite as a regenerant for the reducing capacity of nanoscale zero-valent iron *in situ* treatment zones**

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Nanoscale zero-valent iron (NZVI) represents a promising approach for groundwater remediation and pollutant source zone control, but concerns over its reactive lifetime or longevity in the subsurface may limit its development into a mature treatment technology. Here, we present a sustainable and cost-effective strategy to improve the longevity of NZVI treatment zones through the use of dithionite ( $S_2O_4^{2-}$ ) as a chemical regenerant. Results of laboratory batch systems show that dithionite can extend, and in some cases enhance, the removal of two model groundwater pollutants (1,1,1,2-tetrachloroethane and hexavalent Cr(VI)) in NZVI treatment systems. The efficiency of the dithionite regeneration process is strongly dependent upon the prevailing geochemical conditions (e.g., pH and redox state), which dictate the products of NZVI oxidation, as well as the redox active species generated from the reaction between passivated NZVI and dithionite. Notably, the regeneration process is sustainable, as multiple, sequential dithionite additions were employed to ultimately increase the overall removal of Cr(VI) by roughly a factor of 3.5 (70 mg of Cr/g Fe) relative to the total amount of Cr that could be removed by fresh NZVI (20 mg of Cr/g Fe) prior to reactivity loss.