8:30 AM-12:00 PM Javits Convention Center -- 1A15/1A16

Environmental Management Science Program on Nuclear Waste Management

Facility Inspection, Decontamination, & Decommissioning; Materials Science

Presiding: Edgar Berkey

Organizer: Tiffany Zachry

8:30 AM		Introductory Remarks
8:40 AM	93	Serpentine robots for inspection tasks **Howie Choset**
9:00 AM	94	Investigation of nanoparticle formation during surface decontamination and characterization by pulsed laser **Meng-Dawn Cheng**, Doh-Won Lee, Baohua Gu
9:20 AM	95	Plasma technologies for detection and removal of transuranic elements from contaminated sites Xiawan Yang, Steve Babayan, Maryam Moravej, Gregory Nowling, **Robert Hicks**
9:40 AM	96	Development of biodegradable isosaccharinate-containing foams for decontamination of actinides **Dhanpat Rai**, Linfeng Rao, R. C. Moore, Nancy J. Hess, Mark D. Tucker
10:00 AM		Intermission
10:25 AM	97	Recent progress in the development of supercritical carbon dioxide-soluble metal ion extractants: Aggregation, extraction, and solubility properties of silicon-substituted alkylenediphosphonic acids **Mark L. Dietz**, Daniel R. McAlister, Dominique C. Stepinski, Peter R. Zalupski, Julie A. Dzielawa, Richard E. Barrans, J. N. Hess, Audris V. Rubas, Renato Chiarizia, Christopher M. Lubbers, Aaron M. Scurto, Joan F. Brennecke, Albert W. Herlinger
10:45 AM	98	Radiation effects in zeolites and clays for the sorption and release of radionuclides during transport through the geosphere **Lumin Wang**, Rod C. Ewing, Kim F. Hayes
11:05 AM	99	Impact of spent fuel alteration phases on neptunium mobility in Yucca Mountain **Peter C. Burns**
11:25 AM	100	New metal niobate and silicotitanate ion exchangers: Development and characterization **Yali Su**, Liyu Li, Tina M Nenoff, May Nyman, Alexandra Navrotsky, Hongwu Xu
11:45 AM		Concluding Remarks

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ABSTRACTS

NUCL 93 [660308]: Serpentine robots for inspection tasks

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Abstract

Serpentine robots are snake like devices that can use their internal degrees of freedom to thread through tightly packed volumes accessing locations that people or conventional machinery cannot. These devices are ideally suited for minimally invasive inspection tasks where the surrounding areas do not have to be disturbed. Applications for these devices are therefore inspection of underground tanks and other storage facilities for classification purposes. This work deals with the design, construction, and control of a serpentine robot. The challenges lie in developing a device that can lift itself in three dimensions, which is necessary for the inspection tasks. The other challenge in control deals with coordinating all of the internal degrees of freedom to exact purposeful motion.

NUCL 94 [657516]: Investigation of nanoparticle formation during surface decontamination and characterization by pulsed laser

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Abstract

Decontamination and decommission (D&D) of a large number of nuclear facilities is a major effort at the Department of Energy's (DOE) complexes across the country. Use of laser plasma for surface decontamination/cleaning is a new and effective technique. A large quantity of very small particles (nanoparticles of diameter £ 100-200 nm with peaks in the 50 nm range) is produced during the decontamination process. Effective production of particles is critical in determining the surface cleaning efficiency. However, the particles could contain surface contaminants such as toxic heavy metals (e.g., Cr, Hg, Pb, and Ni), radionuclides (e.g., Th, Cs, and U), and organic solvents that all might cause health concerns. In this project sponsored by DOE Environmental Management Science Program (EMSP), we investigated the relationships of nanoparticle formation by the laser decontamination process using laboratory prepared target surfaces made from Portland cement (concrete), stainless steel 316, and pure alumina. The first two samples are commonly found in DOE installations, while the last sample is used for understanding of fundamental processes. The data were correlated among the particles, surface chemistry, and the laser characteristics. It was found that the lattice energy of the surface material and the mean free path of the nanoparticles produced appear to influence the particle growth. The experiments conducted to determine the threshold energy needed to remove particles from the surface materials were important in understanding the cleaning efficiency and the photon-atom interaction at the material surface. The experimental design and results of data analysis will be discussed in the meeting.

NUCL 95 [656551]: Plasma technologies for detection and removal of transuranic elements from contaminated sites

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Abstract

Plasma technology can provide a vital role in the detection and removal of transuranic waste from DOE sites undergoing environmental restoration. A compact, portable spectrometer has been developed for analyzing uranium, plutonium and other hazardous elements in the field. A micro-plasma arc was used to vaporize and ionize the surface of a solid test sample. Then the heavy elements were identified by their characteristic emission spectrum. Plasmas may also be used to decontaminate radioactive waste. In this case, an atmospheric pressure plasma was fed with carbon tetrafluoride, oxygen and helium. Fluorine atoms produced in the discharge etched away uranium oxide films at rates up to 4.0 mm/min at 200 °C. At the meeting, we will describe the physics and chemistry of atmospheric pressure plasmas used for detection and removal of transuranic contaminants.

NUCL 96 [656189]: Development of biodegradable isosaccharinate-containing foams for decontamination of actinides

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Abstract

The objective of this project is to develop fundamental information that will lead to the development of a new, more environmentally acceptable technology for decontaminating Pu and other actinides. The key component of this technology is isosaccharinate (ISA), a degradation product of cellulose materials that is biodegradable and binds strongly with tetravalent actinides. We are developing fundamental constants for 1) the effect of a wide range in pH and Ca concentrations on the speciation and thermodynamic reactions of ISA and 2) thermodynamic and kinetic reactions of ISA with tetravalent actinides and other competing ions such as Fe(III). We have successfully formulated and tested several ISA containing foams and gels for their effectiveness in removing tetravalent actinides from concrete and steel surfaces. These data along with a comprehensive thermodynamic model developed for Np(IV) and Ca(II) and applicable to a wide range in pH, ISA concentrations, and ionic strengths, will be presented.

NUCL 97 [657332]: Recent progress in the development of supercritical carbon dioxide-soluble metal ion extractants: Aggregation, extraction, and solubility properties of silicon-substituted alkylenediphosphonic acids

Mark L. Dietz[1], Daniel R. McAlister[2], Dominique C. Stepinski[2], Peter R. Zalupski[2], Julie A. Dzielawa[1], Richard E. Barrans[1], J. N. Hess[2], Audris V. Rubas[1], Renato Chiarizia[1], Christopher M. Lubbers[3], Aaron M. Scurto[3], Joan F. Brennecke[4], and Albert W. Herlinger[2]. (1) Chemistry Division, Argonne National Laboratory, 9700 S. Cass Avenue, Argonne, IL 60439, Fax: 630-252-7501, mdietz@anl.gov, (2) Department of Chemistry, Loyola University Chicago, (3) Department of Chemical Engineering, University of Notre Dame, (4) Department of Chemical and Biomolecular Engineering, University of Notre Dame

Abstract

Partially esterified alkylenediphosphonic acids (DPAs) have been shown to be effective reagents for the extraction of actinide ions from acidic aqueous solution into conventional organic solvents. Efforts to employ these compounds in supercritical fluid extraction have been hampered by their modest solubility in unmodified supercritical carbon dioxide (SC-CO_2). In an effort to design DPAs that are soluble in SC-CO_2, a variety of silicon-substituted alkylenediphosphonic acids have been prepared and characterized, and their behavior compared with that of conventional alkyl-substituted reagents. Silicon substitution is shown to enhance the CO_2-philicity of the reagents, while other structural features, in particular, the number of methylene groups bridging the phosphorus atoms of the extractant, are shown to exert a significant influence on their aggregation and extraction properties. The identification of DPAs combining desirable extraction properties with adequate solubility in SC-CO_2 is shown to be facilitated by the application of molecular connectivity indices.

NUCL 98 [671375]: Radiation effects in zeolites and clays for the sorption and release of radionuclides during transport through the geosphere

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Abstract

Site restoration activities at DOE facilities and the permanent disposal of nuclear waste generated at DOE facilities involve working with and within various types and levels of radiation fields. The radiation exposure due to the release and sorption of long-lived actinides (e.g., ^{237}Np) and fission products (e.g., ^{137}Cs and ^{90}Sr) may cause changes in important properties of geological materials along transport pathways of radionuclides through the geosphere. Through a comprehensive study of the microstructure and ion exchange capacity under varying types of irradiation (electrons, ions and neutrons), dose rate, temperature and ion exchange conditions, we have developed a basic understanding of radiation effects on the ion exchange and retention capacity of clays and zeolites for Cs and Sr. The results provide an essential database for the long term effectiveness of clays and zeolite in radionuclide retention, as well as the mobility of the radionuclides in contaminated sites.

NUCL 99 [657187]: Impact of spent fuel alteration phases on neptunium mobility in Yucca Mountain

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Abstract

Spent nuclear fuel is unstable under the moist oxidizing conditions expected in the proposed geological repository at Yucca Mountain. Incorporation of radionuclides into the uranyl phases that will form due to alteration of spent fuel may significantly reduce radionuclide mobility in the repository, but this scenario is not included in current performance assessment models for Yucca Mountain. The potential impact of uranyl minerals on the mobility of Np-237, which is one of the most important radionuclides for long-term repository performance, is being studied by synthesis of uranyl phases in contact with solutions containing 10 to 500 ppm Np(V). The impacts of time, temperature, pH and counter-ions on Np incorporation are being addressed. Analysis of crystals using X-ray absorption spectroscopy (XAS), conducted at APS with a bent-Laue analyzer crystal to separate the signal of Np from that of U, and by ICP-AES (U, Na, Ca) and ICP-MS (Np), have established that incorporation of Np into uranyl phases is likely to significantly impact repository performance.

NUCL 100 [657024]: New metal niobate and silicotitanate ion exchangers: Development and characterization

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Abstract

We are evaluating new metal niobate and silicotitanate ion exchangers for Cs and Sr removal and their related condensed phases as potential ceramic waste forms. The goal of the program is to provide DOE alternative materials that can exceed the solvent extraction process for removing Cs and Sr from high level wastes and technical alternatives for disposal of silicotitanate and niobate based ion exchange materials. To date we have determined the structural property relationship and thermodynamic stability of new silicotitanate and niobate based ion exchangers and their thermally converted phases. Several new phases include $Na_2Nb_{2-x}M^{IV}{}_xO_{6-x}(OH)_x \cdot H_2O$ (M^{IV}=Ti, Zr, x=0.04~0.4, SOMS), $NaTi_xNb_{1-x}O_{3-0.5x}$, $Na_{2-x}M_xNb_{1.6}Ti_{0.4}O_{5.8+yx}$ (M=Sr, Y), $CsTi_xAl_{1-x}Si_2O_{6+x/2}$ (0£x£1), and C*c*-$A_2TiSi_6O_{15}$ (A=K, Rb, Cs) have been synthesized and characterized and results will be presented. Additionally, chemical, thermal, radiation, and thermodynamic stabilities of the new ion exchange materials and their related perovskites as potential ceramic waste forms will also be presented at the meeting.