EMSP Research Transfer

The EMSP provides research resources and results that are intended, in part, to "bridge the gap" between broad fundamental research that has wide-ranging applications such as that performed in the Department's Office of Science, and needs driven applied technology development that is conducted in Environmental Management's Office of Science and Technology. In support of this, the focused research performed in the EMSP is intended to be transferred for utilization by other programs within DOE or to end-users outside the Department.

As research within the EMSP matures, the results from this research should support development of new and innovative ways to reduce risk and cost within EM. In part, the research should address the early, focused research stage of the technology development/deployment cycle for development of new technologies to address cleanup problems within EM. Part of the focus of the EMSP is to integrate the program's research with EM Focus Areas, DOE sites, and commercial interests to support technology development. While much of the research is not yet at a stage of maturity to transfer, many successes have been reported. To date, the reported accomplishments include transfers to:

13 Commercializations
10 Deployments
15 Field Tests
3 Focus Areas and Crosscutting Programs
2 Processes.

Deactivation and Decommissioning

Inorganic Chemistry

Project: 54724

Title: Synthesis of New Water-Soluble Metal-Binding Polymers: Combinatorial Chemistry Approach
PI: Dr. Barbara F. Smith
Institution: LANL

Description: Polymer Filtration (PF), which uses water-soluble metal-binding polymers to sequester metal ions in dilute solution with ultrafiltration (UF) to separate the polymers, is a new technology to selectively remove or recover hazardous and valuable metal ions. We have focused on four areas including the development of: (1) synthetic procedures, (2) small ultrafiltration equipment compatible with organic-and aqueous-based combinatorial synthesis, (3) rapid assay techniques, and (4) polymer characterization techniques. We have entered into partnership to use Polymer Filtration in Electroplating industry.

Ultrafiltration unit used in field demonstration for removal of radioactive cations and anions.
[see Project #54724]

Transfer Type: Commercialization - Product *Fiscal Year:* 1999
Contact: NA
Transferring Organization: NA

Materials Science

Project: 60363

Title: Optimization of Thermochemical, Kinetic, and Electrochemical Factors Governing Partitioning of Radionuclides during Melt Decontamination of Radioactively Contaminated Stainless Steel

PI: Dr. James A. Van Den Avyle *Institution:* Sandia National Laboratories

Description: We have conducted a successful technology demonstration with the Russians at a site near Krasnoyarsk (K-26), where they electroslag remelted stainless steel reactor coolant piping that was contaminated with Pu and other radionuclides. The resulting metal ingot was fully analyzed and was clean enough to meet Russian criteria for outside reapplication (sale). We are working with them to obtain significant new funding to set up a full scale commercial melt decontamination facility there to recycle stainless steel. We are also paying for a few additional melts there to further characterize the process.

ElectroSlag Remelting (ESR) process for radioactive decontamination of stainless steel scrap for metal recycle. [see Project #60363]

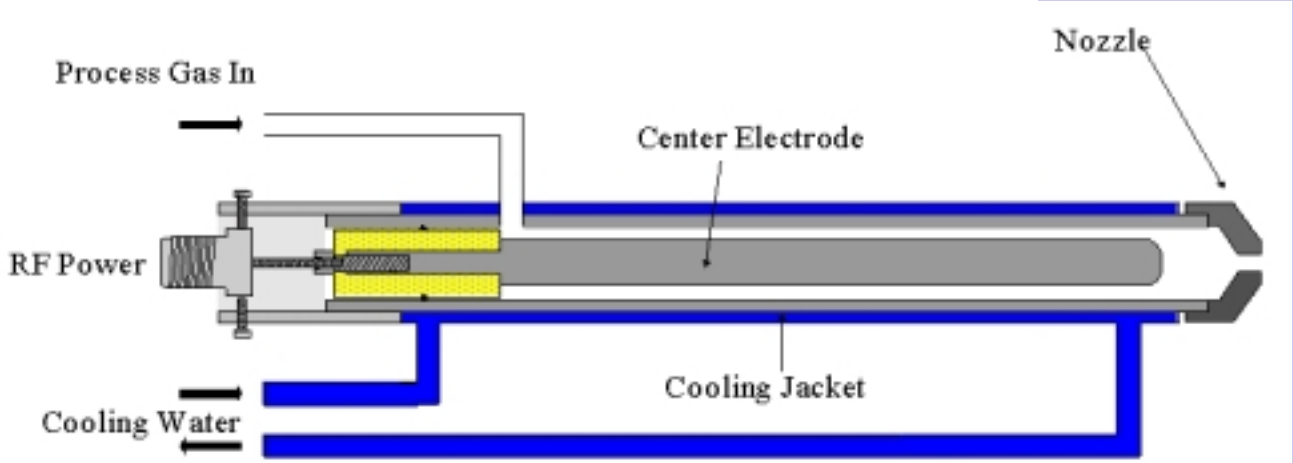
Transfer Type: Process
Fiscal Year: 1999
Contact: James Van den Avyle
Transferring Organization: Sandia National Laboratory

Project: 73835 (Renewal of Project No. 54914)

Title: Atmospheric-Pressure Plasma Cleaning of Contaminated Surfaces

PI: Dr. Robert F. Hicks *Institution:* University of California at Los Angeles

Description: After fabricating and testing a prototype plasma decontamination tool, the device will be shipped to the INEEL facility. One post-doctoral scholar will travel to the facility to oversee testing of the plasma device for a specific D&D application. One such application may be the removal of transuranic elements from 1-ft square concrete slabs. In this case, a series of etching experiments will be performed in which the process conditions are varied to obtain the maximum removal rates of TRUs. Air samples will be taken in the vicinity of the process and in the exhaust. These samples will be analyzed to verify that no radioactive waste was released to the surroundings.



Schematic of the first-generation atmospheric-pressure plasma. In this configuration, the process gas is ionized in the annular space between two coaxial electrodes. Then the reactive gas flows out through the nozzle and contacts a work piece placed downstream. [see Project #73835, renewal of #54914]

Transfer Type: Field Test *Fiscal Year:* 2000
Contact: Larry Whitmill
Transferring Organization: INEEL Decontamination and Decommissioning Program

Description: We have made arrangements with TA-55, PF-4 Plutonium Processing Facility and CST-12 Materials Testing Laboratory at LANL for additional testing of our device.
Transfer Type: Field Test *Fiscal Year:* 2000
Transferring Organization: LANL

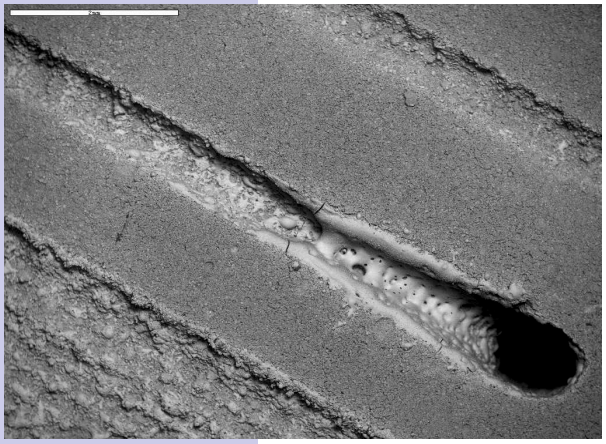
Description: The objective of this project is to identify the key physics and chemistry underlying the use of atmospheric pressure plasmas for etching removal of actinides and actinide surrogates. This includes understanding of basic discharge mechanism at atmospheric pressure, gas and surface phase chemistry, and optimization and scale-up effort of atmospheric pressure plasma jet (APPJ). The plasma source developed under this project has been licensed by Plasma Tech, LLC. The company is currently seeking venture capital financing to develop applications for the semiconductor equipment industry.
Transfer Type: Commercialization - Product *Fiscal Year:* 2000
Transferring Organization: Plasma Tech, LLC

Separations Chemistry

Project: 60283

Title: Waste Volume Reduction Using Surface Characterization and Decontamination by Laser Ablation

PI: Dr. Michael J. Pellin *Institution:* Argonne National Laboratory



Cement surface following Laser Ablation. [see Project #60283]

Description: The objectives of this research are to determine the mechanism and efficacy of laser ablation in removing contaminated surface layers, to understand the chemistry of contaminated concrete surfaces, and to chemically and physically characterize the captured ablation effluent which would become the stored waste. While the focus of this project is on concrete, the technology should be applicable to any surface requiring removal. Efforts are underway to establish a CRADA with Zawtech Inc.

Transfer Type: Commercialization - Product
Fiscal Year: 1999
Transferring Organization: Zawtech Inc.

Project: 64912

Title: Improved Decontamination: Interfacial, Transport, and Chemical Properties of Aqueous Surfactant Cleaners

PI: Dr. David W. DePaoli *Institution:* ORNL

Description: Laboratory-scale experimentation has been aimed at determining improved means for removal of organic contaminants using aqueous surfactant cleaners. We have found that through a simple modification of process conditions, the rate of oil removal can be significantly increased. We have communicated, through a non-disclosure agreement, an invention based on our findings with a leading company that produces industrial cleaners. That company has agreed to collaboratively participate in testing of the technology through guidance and evaluation.

Transfer Type: Commercialization - Product *Fiscal Year:* 2000
Contact: David DePaoli
Transferring Organization: Undisclosed at this time

HEALTH/ECOLOGY/RISK

Health/Risk

Project: 74050 (Renewal of Project No. 59882)

Title: Measurement of Radon, Thoron, Isotopic Uranium and Thorium to Determine Occupational and Environmental Exposure at US DOE Fernald

PI: Dr. Naomi H. Harley *Institution:* New York University Medical School

Description: The research is directed to developing state-of-the-art personal and environmental exposure assessment for inhaled radionuclides. The research is conducted at Fernald and the specific nuclides of interest are radon (Rn-222), and thoron (Rn-220) emission from the silos, and thorium-230, 232 airborne aerosol particles from the waste pits. Two new instruments are being used at Fernald, and have been deployed for about 1 year. Together they permit the air concentrations of the gas, the airborne particulates, and their particle size distribution to be measured on a continuous basis. The new instruments developed can have wide application at other DOE sites.

The first insturment is a radon, thoron passive alpha track detector that can be worn or used as an area detector to obtain research quality measurements for modeling or personal exposure assessment. Thoron measurements are not commonly made and little data are available. Measurements at Fernald with simultaneous measurements at research homes in the New York, New Jersey area show that essentially all radon measurements contain a fraction of thoron. NYU is currently seeking a patent for this detector. Plans are to modify the existing model to have 4 detection chambers rather than 3, so that duplicate measurements of both radon and thoron can be made simultaneously.

The second insturment is a particle size analyzer. Although the inhaled particle size is the major determinant of bronchial dose, Fernald is the only site attempting to do particle size distribution measurements. Prior to the development of this instrument, the labor intensive effort needed, as well as the cost, precluded the measurement. The particle size analyzer presently supplies airborne particulate concentration and size data at the waste pits, the soil dryer, and at buildings being removed. A wider network of analyzers is being deployed to study resuspension and transport of particles.

Radon thoron detector, as it would be used in the field of personal monitoring. [see Project #74050, renewal of #59882]

Transfer Type: Deployment - Product
Fiscal Year: 2000
Transferring Organization: Department of Energy - Fernald

HIGH-LEVEL WASTE

Actinide (Heavy Element) Chemistry

Project: 73749 (Renewal of Project No. 54621)

Title: Chemical Speciation of Strontium, Americium, and Curium in High Level Waste: Predictive Modeling of Phase Partitioning During Tank Processing

PI: Dr. Andrew R. Felmy *Institution:* Pacific Northwest National Laboratory

Description: EMSP research has yielded thermodynamic data that is the instrumental developing the Pitzer Model in Environmental Simulation Program (ESP). This new thermodynamic model predicts the dissolution and precipitation of solids important in tank processing and cross-site transfer line plugging. The Pitzer model is more robust in terms of the thermodynamic approach used and also allows the model database to be upgraded in a much more efficient and systematic fashion. The database upgrade is possible since virtually all scientific publications throughout the world now interpret and publish their aqueous thermodynamic results using the Pitzer theory. Access to such a wealth of available data generated under numerous DOE and other programs including the EMSP, the Waste Isolation Pilot Plant (WIPP), and the Office of Science (OS) will significantly improve tank process modeling at Hanford. ESP used by all of the contractors at the Hanford and Savannah River sites.

Transfer Type: Deployment - Product *Fiscal Year:* 2001

Transferring Organization: Savannah River and Hanford Sites

Analytical Chemistry & Instrumentation

Project: 60424

Title: High Temperature Condensed Phase Mass Spectrometric Analysis

PI: Dr. James E. Delmore *Institution:* INEEL

Description: The goal of this project was to develop an integrated mass spectrometric analysis system capable of analyzing materials from room up to high temperatures, with the practical upper temperature limit to be experimentally determined. A primary objective of the program was the development of techniques to analyze waste materials during vitrification processing to produce waste forms. As a result of this research, this analytical tool is now being used here at INEEL to support subsurface science research. The tool is capable of performing mass spectral analysis on solid surfaces. It performs multiple analyses in rapid succession versus the current tools which utilize single analytical techniques.

Transfer Type: Deployment *Fiscal Year:* 2001

Transferring Organization: Idaho National Engineering and Environmental Laboratory

Engineering Science

Project: 60143

Title: Foaming in Radioactive Waste Treatment and Immobilization Processes
PI: Dr. Darsh T. Wasan *Institution:* Illinois Institute of Technology

Description: The new antifoam has proved to be superior to the current antifoam agent. A series of recent tests was completed to determine whether radioactivity would make the antifoam ineffective by fragmenting it. However, it seems to be resistant to the radiation fields expected in radioactive operations. A vendor has been identified who will produce the antifoam agent for Defense Waste Processing Facility (DWPF). DWPF expects to implement the new antifoam agent before the end of CY00. There is a need for new or improved antifoam agents in a variety of SRS processes including Waste Tank evaporation, Sludge processing, and Salt processing. Other DOE sites with similar evaporation processes, primarily Hanford, ORNL, and INEEL are all in need of better antifoam agents. We need to work closely with them to accomplish these goals.
Transfer Type: Deployment - Product *Fiscal Year:* 2000
Transferring Organization: Department of Defense - Defense Waste Processing Facility

Description: The improved antifoam agent developed by the IIT researchers based on a better understanding of the chemistry, rheology, and physics that lead to the formation of foam during waste processing was successfully tested in laboratory scale experiments at both IIT and SRS and in a pilot plant at SRS. The methodology for developing a new antifoam agent for Defense Waste Processing Facility (DWPF) can now be used to develop other antifoam agents to support other DOE sites, especially Hanford.
Transfer Type: Field Test *Fiscal Year:* 2000
Contact: Dan Lambert
Transferring Organization: Savannah River Site

Project: 65371

Title: Numerical Modeling of Mixing of Chemically Reacting, Non-Newtonian Slurry for Tank Waste Retrieval
PI: Dr. David A. Yuen *Institution:* University of Minnesota

Description: Under this project, PNNL has successfully integrated a computational fluid dynamics code with state-of-the-art equilibrium and kinetic chemical models and non-Newtonian rheology. This new transport code, ARIEL, is a state-of-the-art non-Newtonian reactive transport computer code that is applicable to a time-varying, three-dimensional hydrothermal field with multi-phase, multi-component, high ionic-strength, and highly basic chemical conditions. This is unique and is already being applied to the complex phenomena of tank waste retrieval. The ARIEL code explicitly accounts for interactions of aqueous chemical reactions, adsorption/desorption, and dissolution/precipitation under high ionic-strength conditions and associated rheology (viscosity and yield strength) changes.

Developments in this project including computer code and staff expertise are being applied directly to TFA needs. The ARIEL code was used to model the mixing of waste with two 300-hp mixer pumps in Hanford's Double-Shell Tank 241-AZ-102 and is currently being applied to 241-AN-104 and 241-AN-105 for Hanford's W211 (Tank Waste Retrieval) Project.

Transfer Type: Deployment - Product *Fiscal Year:* 2001
Transferring Organization: Hanford W211 (Tank Waste Retrieval) Project

Project: 81897 (Renewal of Project No. 65435)

Title: Millimeter-Wave Measurements of High Level and Low Activity Glass Melts
PI: Dr. Paul P. Woskov *Institution:* Massachussettes Institute of Technology

Description: This project is organized as a collaborative effort that can serve as a model for the EMSP program. It includes a University (MIT) with experience in innovative diagnostic technologies, a national laboratory (PNNL) with expertise in glass and materials science, and a national end user laboratory (SRTC) which develops and operates waste glass vitrification facilities. Furthermore, we participate with the Tank Focus Area in pilot scale testing, i.e. the recent melter tests at Clemson Environmental Technology Laboratory (CETL). Future field tests of the Milliwave Viscometer are being planned.

The cross fertilization of expertise of the research partners on this project is resulting in award winning innovation that is highly focused to the EMSP mission. In addition, there may be significant commercial spin off applications to the glass manufacturing and metals refining industries.

Transfer Type: Field Test *Fiscal Year:* 2001
Transferring Organization: Tanks Focus Area

Separations Chemistry

Project: 73803 (Renewal of Project No. 55087)

Title: Next Generation Extractants for Cesium Separation from High-Level Waste: From Fundamental Concepts to Site Implementation
PI: Dr. Bruce A. Moyer *Institution:* ORNL

Description: The role of the EMSP project in my lab entailed performing a fundamental investigation of the mechanism of cesium extraction so as to understand the nature of the complexes formed between the cesium ion and the extractant molecule. This fundamental information played a crucial role in the successful process development under ESP funding. Indeed, without the fundamental information providing the needed insight at just the right time, the process development would have failed to advance fast enough to meet the emergency need to test new technology at the SRS.

Transfer Type: Focus Area - Process *Fiscal Year:* 1999
Contact: Bruce Moyer
Transferring Organization: ORNL

Description: Owing to the high levels of radiation and heat generated by the fission-product Cs-137, efficient cesium separation from high-level wastes (HLWs) has been elevated to extreme importance at Hanford, the SRS (SRS), and Idaho Falls, where multi-billion dollar projects will carry out this and other HLW separations. Referred to as Alkaline-Side CSEX (Cesium Solvent Extraction), the ORNL invention (U.S. Pat. Appl. 60/057,974, September 3, 1998) provides the first practical application of calixarene-crown extractants to treatment of HLWs by solvent extraction. An effective form of the extractant was first synthesized at ORNL and recently transferred to the commercial sector. Batch tests on actual HLW by collaborators at both Hanford and the SRS in the past year have confirmed the effectiveness of the ORNL process, and a 24-stage centrifugal-contactor demonstration at Argonne National Laboratory proved economic viability. Results from the batch and engineering tests showed that stringent requirements of a 40,000-fold reduction in Cs-137 activity in the waste and a 12-fold concentration can be readily met. In addition to meeting these SRS decontamination and concentration needs, key advantages of the ORNL process include the following: (1) The process does not require adjustment of the waste feed stream. (2) Extraction is very selective. (3) Scrubbing and stripping of the solvent can be accomplished with very dilute acidic solutions. (4) The process is compact and involves liquid streams. These advantages reduce costs by minimizing consumption of chemicals, secondary waste production, volume of vitrified waste form, and plant space. The cesium-concentrated stream produced by the process is expected to be so pure that it will require negligible downstream processing and will have negligible impact on the volume of the final vitrified waste form, which is costly to produce and store.

Transfer Type: Commercialization - Process *Fiscal Year:* 1999
Transferring Organization: IBC Advanced Technologies

Description: Westinghouse Savannah River Corporation is conducting tests of alternative technologies for the removal of cesium from its high-level waste and has evaluated the alkaline-side CSEX process as an alternative technology for replacement of the in-tank precipitation process. Successful evaluation will result in further development, scale-up, demonstration, and pilot-scale testing. Ultimately, the goal is implementation in a billion-dollar plant.

We are supplying this customer with information on the alkaline-side CSEX process and responding to customer requests for tests and report results (Note that the PI's ESP task was leading this activity. EMSP's role was in supplying basic scientific information that was useful in development of the process and in understanding process behavior.).

In Nov. and Dec. 1999, the customer at the SRS has shown intense interest in further development of the alkaline-side CSEX process by requesting input for creation of a work-scope for engineering evaluation at the $2-4M level in FY 2000 and FY 2001. In Feb. 2000, DOE approved a $3M task funded through WSRC and led by ORNL for accelerating the development and testing of the alkaline-side CSEX process for possible

application in the removal of cesium from high-level salt waste. ORNL, WSRC, and ANL have assembled teams, organizational structure, and plans to carry out this task. This project has been in progress and will continue through June, 2001. Interaction among the ORNL, WSRC, and ANL teams has been daily, with several conference calls each week, numerous reports, numerous presentations, and daily individual interactions. As of September 2000, test results are very positive, and the CSEX process appears competitive with the other two alternative technologies.

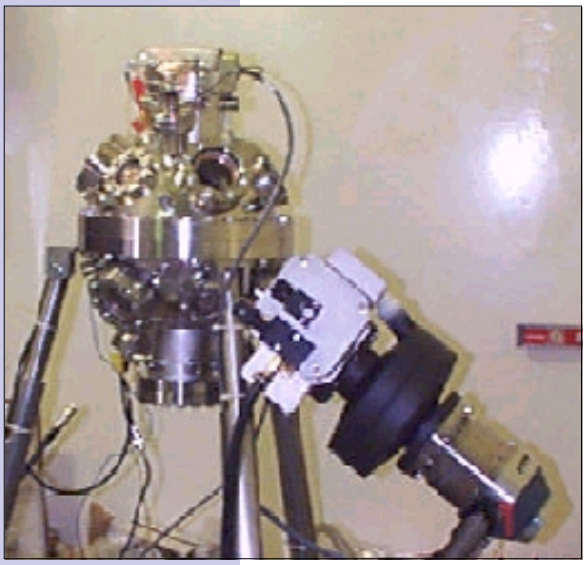
Transfer Type: Focus Area - Process *Fiscal Year:* 2000
Transferring Organization: Westinghouse Savannah River Corporation

MIXED WASTE

Analytical Chemistry & Instrumentation

Project: 54751

Title: High Fluence Neutron Source for Nondestructive Characterization of Nuclear Waste
PI: Dr. Mark M. Pickrell *Institution:* LANL



Two commercial partners have applied for a license for the High Fluence Neutron Source, shown here in the laboratory. [see Project #54751]

Description: We are addressing the need to measure nuclear wastes, residues, and spent fuel in order to process these for final disposition. One of the primary methods for waste assay is by active neutron interrogation. We plan to improve the capability of all active neutron systems by providing a higher intensity neutron source (by about a factor of 1,000) for essentially the same cost, power, and space requirements as existing systems. We have received 2 request from commercial vendors to commercialize this technology once available.

Transfer Type: Commercialization - Product
Fiscal Year: 1999
Contact: Manfred Frey, Michael Hurwitz
Transferring Organization: MF Physics, Inc., Gamma Metrics, Inc.

Project: 73844 (Renewal of Project No. 60231)

Title: Miniature Chemical Sensor Combining Molecular Recognition with Evanescent-Wave Cavity Ring-Down Spectroscopy
PI: Dr. Andrew C. R. Pipino *Institution:* National Institute of Standards & Technology - Maryland

Description: A entirely new class of chemical sensors is being developed that will enable qualitative and quantitative remote, real-time, optical diagnostics of chemical species in hazardous gas, liquid, and semi-solid phases through a

completely novel implementation of cavity ring-down spectroscopy. Negotiations with a commercial partner are in progress.
Transfer Type: Commercialization - Product *Fiscal Year:* 1999
Transferring Organization: Not disclosed at this time

Description: A Cooperative Research and Development Agreement (CRADA) is being negotiated to develop and build prototype, portable, miniature spectrometers, which will be fiber-optic-coupled to inexpensive diode laser sources.
Transfer Type: Commercialization - Product *Fiscal Year:* 1999
Transferring Organization: Informed Diagnostics, Inc

Description: Discussing deployment of miniature spectrometer at the SRS for groundwater monitoring.
Transfer Type: Focus Area -Product *Fiscal Year:* 1999
Contact: Michael G. Serrato
Transferring Organization: SRS

Separations Chemistry

Project: 54571

Title: Removal of Heavy Metals and Organic Contaminants from Aqueous Streams by Novel Filtration Methods
PI: Dr. Nelly M. Rodriguez *Institution:* Northeastern University

Description: Graphite nanofibers are a newly developed type of material that can be synthesized by the decomposition of selected hydrocarbons over selected metal particle surfaces. The structural characteristics of the solid can be manipulated by a careful selection of parameters including the catalyst, the reaction conditions and the temperature. Both the size and the morphology of the metal particle have been found to play an important role on the cross-sectional area as well as the orientation of the graphene sheets. It is therefore possible to produce materials where the platelets are aligned either parallel, perpendicular, or at an angle with respect to the fiber axis. The consequence of the interplay between particle and morphology is that a variety of conformations are possible including tubular, ribbon-like, or structures where only edges of the basal plane are exposed. Graphite nanofibers are usually produced in bulk quantities using unsupported metal powders, having an average particle size of ~1 nm. The cross-sectional area of the resulting fibers exhibit a large range usually between 5 to 100 mm, as a result of uneven fragmentation of the original particles during the reaction. In our current program, we have attempted to generate nanofibers of controlled dimensions in order to produce material having both a high surface area and a high electrical conductivity that results from a long range crystallographic order.


Researcher characterizing sample by TEM. [see Project #54571]

Discussions have been conducted with both Corning Inc. and W. R. Grace, who have expressed an interest in the commercial prospects of the technology being developed in the program at Northeastern University. The synthesis of carbon nanostructures has been optimized at the laboratory scale and it is anticipated that the large scale production of the material will be undertaken by various companies.

Transfer Type: Commercialization - Process *Fiscal Year:* 2000
Transferring Organization: Corning, Inc. and W. R. Grace

Description: Due to the potential for applications in a variety of energy related areas, Catalytic Materials Ltd., a small company based in Pennsylvania has decided to undertake the further development of these materials.

Transfer Type: Commercialization - Product *Fiscal Year:* 2000
Transferring Organization: Catalytic Materials, Ltd.

NUCLEAR MATERIALS

Engineering Science

Project: 60077

Title: Development of Nuclear Analysis Capabilities for DOE Waste Management Activities
PI: Dr. Cecil V. Parks *Institution:* OR NL

Description: It is desired to fully implement the computational techniques developed in this project for global distribution through the Standardized Computer Analyses for Licensing Evaluation (SCALE) code system. SCALE is widely used throughout the nuclear safety community. Several nuclear criticality safety organizations have expressed interest in using the SEN3 analysis tool in conjunction with the S/U methodology developed under NRC and DOE Nuclear Criticality Safety Program projects. Both the NRC and DOE OCRWM/YMP are very interested in the application of the SAS2D depletion sequence developed based on NEWT for spent nuclear fuel analysis.

Several nuclear safety organizations have expressed interest in using these new analysis tools and techniques for their applications. Some work has already been performed by ORNL for INEEL for the storage and transport of DOE-owned highly-enriched uranium fuels, and INEEL has expressed interested in obtaining this software for in-house use involving classified systems when a release version is available. Interest in the use of these methods has been specifically expressed by those associated with the Yucca Mountain Project and the Savannah River Site.

Transfer Type: Deployment - Product *Fiscal Year:* 2001
Transferring Organization: Department of Energy - ORNL

SUBSURFACE CONTAMINATION

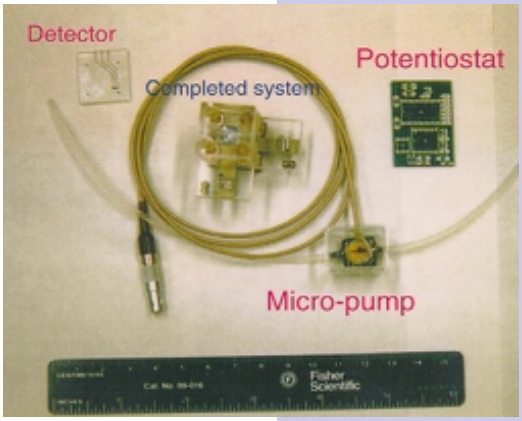
Analytical Chemistry & Instrumentation

Project: 54639

Title: Development of an In-Situ Microsensor for the Measurements of Chromium and Uranium in Groundwater at DOE Sites

PI: Dr. Joseph Wang *Institution:* New Mexico State University

Description: This project has led to the replacement of conventional, lab-based, electrochemical stripping protocols and systems with new innovative strategies for field monitoring of trace chromium and uranium, based on micromachined hand-held total stripping analyzers, in-situ sensing devices, and submersible microsystems. These efforts have resulted also in two joint (NMSU-PNL) patents covering the remote-sensor and probe technologies which have been licensed Instrumentation Northwest Inc. (of Richland). New Mexico State University and PNL are working closely on transferring these in-situ metal technologies and realizing their rapid commercialization.



NMSU / PNNL Electrochemical Metal Microanalyzer [see Project #54639]

Transfer Type: Commercialization - Product
Fiscal Year: 2000
Transferring Organization: Instrumentation Northwest Inc., Richland, WA

Biogeochemistry

Project: 55388

Title: Stable Isotopic Investigations of In Situ Bioremediation of Chlorinated Organic Solvents

PI: Dr. Neil C. Sturchio *Institution:* ANL

Description: The purpose of this project was to investigate the potential applications of stable isotope ratio measurements in characterization of the source terms, the transport, and the fate of chlorinated solvents in groundwater aquifers. The approach to this research was threefold: (1) to develop methods for the sampling and isotopic analysis of chlorinated solvents in groundwaters; (2) to perform laboratory experiments to measure equilibrium and kinetic isotope effects associated with biological and physical transformation processes of chlorinated solvents; and (3) to perform field investigations at well-characterized, contaminated aquifer sites to demonstrate the applicability of the isotopic approach in real-world situations. A method for stable isotope analysis of carbon and chlorine in chlorinated aliphatic hydrocarbons developed through this project has been adapted by several laboratories (e. g., University of Nevada, Reno, NV; University of Waterloo, Canada; University of Reading, U.K.; Environment Centre of the Joint European Commission, Ispria, Italy).

Transfer Type: Process *Fiscal Year:* 2000
Contact: (see description)
Transferring Organization: (see description)

Description: Methods developed during this project were applied in conjunction with remedial activities for TCE-contaminated groundwater aquifers carried out by Lockheed-Martin Energy Systems, Inc. at the Paducah Gaseous Diffusion Plant in Kevil, KY.
Transfer Type: Field Test *Fiscal Year:* 2000
Contact: Jay Clausen
Transferring Organization: Lockheed-Martin Energy Systems, Inc.

Description: Methods developed during this project were applied in conjunction with remedial activities for TCE-contaminated groundwater aquifers carried out by ENSR, Inc. (Westmont, IL) at locations in the Chicago, IL; Kansas City, MO; and Greer, SC areas.
Transfer Type: Field Test *Fiscal Year:* 2000
Contact: Greg Smith
Transferring Organization: ENSR, Inc. (Westmont, IL)

Engineering Science

Project: 70088

Title: Interfacial Reduction-Oxidation Mechanisms Governing Fate and Transport of Contaminants in the Vadose Zone
PI: Dr. Baolin Deng *Institution:* New Mexico Institute of Mining & Technology

Description: Laboratory investigations conducted over the last several years indicate that reduction and immobilization of chromium in contaminated soil can be achieved in situ through treatment with a diluted hydrogen sulfide gas mixture. The primary chemical reaction of interest associated with these tests involves the reduction of Cr(VI)to Cr(III),with subsequent precipitation as a nontoxic solid product. Immobilization of radionuclides, such as technetium and uranium, and heavy metals, such as mercury and lead are other potential applications of the In Situ Gaseous Reduction (ISGR)approach to vadose zone remediation.

The application of diluted hydrogen sulfide to chromium reduction in the field can be accomplished through the injection of the gas mixture into waste site soils in a central borehole. The gas mixture is then drawn through the waste site by vacuum applied at extraction boreholes located at the site boundary. A successful small scale demonstration of the ISGR approach has been completed at White Sands Missile Range in a joint DOE-DoD field test. This test showed:

- 70%of Cr(VI)in the vadose zone immobilized
- H S gas mixture can be safely handled
- Excess H 2 S is largely consumed by interaction with soil,no releases to the environment

Transfer Type: Field Test *Fiscal Year:* 2001
Transferring Organization: Department of Energy and Department of Defense

Project: 73793 (Renewal of Project No. 55013)

Title: Biofiltration of Volatile Pollutants: Solubility Effects
PI: Dr. Brian H. Davison *Institution:* Oak Ridge National Laboratory

Description: We have had several requests from researchers and practitioners for access to our Biofilter software, primarily so they can apply it to the particular systems with which they work. Examples include Gero Leson of Berkeley, California, who is an independent contractor specializing in industrial biofilter applications and William Apel of the Idaho National Environmental and Engineering Laboratory, who conducts directed research in degradation of industrial VOCs.
Transfer Type: Deployment - Product *Fiscal Year:* 2000
Contact: (See description)
Transferring Organization: (See description)

Geophysics

Project: 55332

Title: A Hybrid Hydrologic-Geophysical Inverse Technique for the Assessment and Monitoring of Leachates in the Vadose Zone
PI: James R. Brainard *Institution:* Sandia National Laboratories - Albuquerque

Description: The objective of this study is to develop and field test a new, integrated Hybrid Hydrologic-Geophysical Inverse Technique (HHGIT) for characterization of the vadose zone at contaminated sites. This new approach to site characterization and monitoring can provide detailed maps of hydrogeologic heterogeneity and the extent of contamination by combining information from 3D electric resistivity tomography (ERT) and/or 2D cross-borehole ground penetrating radar (XBGPR) surveys, statistical information about heterogeneity and hydrologic processes, and sparse hydrologic data. The project is involved conducting a field test of the HHGIT at the Sandia/Tech Vadose Zone Facility in Socorro, New Mexico. We are currently processing the data and will be publishing results later this year. Investigators in the project also participated in the Advanced Characterization Workshop at Hanford in January of 2000, and have been in contact with the Tank Focus Area about performing a similar test at the Hanford Reservation.
Transfer Type: Field Test *Fiscal Year:* 2000
Transferring Organization: Sandia National Laboratory

Project: 60162

Title: Enhancements to & Characterization of the Very Early Time Electromagnetic (VETEM) Prototype Instrument & Applications to Shallow Subsurface Imaging at Sites in the DOE Complex
PI: Dr. David L. Wright *Institution:* U.S. Geological Survey - Denver

Description: The U.S. Geological Survey and the University of Illinois propose to improve the state-of-the-art electromagnetic imaging of the shallow (0 to 5 m) subsurface in conductive media with potential applications to subsurface characterization, landfill stabilization, decontamination/decommissioning, and waste characterization at sites in the DOE complex. We plan to accomplish the research objectives by a combination of hardware and software enhancements to the existing Very Early Time Electromagnetic (VETEM) prototype instrument, physical modeling experiments, numerical forward and inverse modeling, and field demonstrations. We will enhance the existing system with additional antennas, transmitter options, and most likely one or more gradiometer configurations, as well as a modified receiver. The VETEM prototype system has been to INEEL twice since the beginning of our EMSP funding. The first trip, in July 1998, entailed a demonstration at the Cold Test Pit. The second trip was in Nov-Dec of 1998 to do a survey of Pit 9.

Transfer Type: Field Test *Fiscal Year:* 1999
Contact: Aran Armstrong & George Schneider
Transferring Organization: INEEL

Project: 73836 (Renewal of Project No. 55300)

Title: Induced Polarization with Electromagnetic Coupling: 3D Spectral Imaging Theory and Field Tests
PI: Dr. F. Dale Morgan *Institution:* Massachusettes Institute of Technology

Description: The Earth Resources Laboratory (ERL) has made recent advances in applying the Induced Polarization (IP) method for detection and mapping of contaminant plumes. The project encompassed laboratory studies of microgeometry and chemistry effects on Induced Polarization (IP), an investigation of electromagnetic coupling (emc) noise, and development of 3D modeling and inversion codes. In a competitive review of number of EMSP characteriztion projects this projects was selected to demonstrate plume mapping capabilites. The field effort proved to be very difficult, but seems to have yielded good results. The processed data has matched well with some lab results and picture. Continutation work is planned for this effort.

Transfer Type: Field Test *Fiscal Year:* 2001
Contact: Brian Looney
Transferring Organization: Savannah River Site

Project: 73962 (Renewal of Project No. 60115)

Title: Advanced High Resolution Seismic Imaging, Material Properties Estimation and Full Wavefield Inversion for the Shallow Subsurface
PI: Dr. Alan Levander *Institution:* Rice University

Description: The objective of this project is to develop and test advanced near vertical to wide-angle seismic methods for structural imaging and material properties estimation of the shallow subsurface for environmental characterization efforts. We have conducted a high resolution seismic profile for

subsurface characterization at a DNAPL site at a DOD facility in August 1998. Currently, the data is being processed and we are planning to return to the site for additional work.

Transfer Type: Field Test *Fiscal Year:* 1999
Transferring Organization:

Hydrogeology

Project: 55036

Title: Colloid Transport and Retention in Fractured Deposits
PI: Dr. John F. McCarthy *Institution:* ORNL

Description: The rates and extent of colloid and water movement was determined in fractured porous media at Waste Area Group 5 of the ORNL and at a site in Bear Creek Valley near waste disposal areas of the Oak Ridge Y-12 Plant. The data are directly relevant to assessments of risk from the migration of transuranic radionuclides, and in evaluation of remedial options.

Transfer Type: Field Test *Fiscal Year:* 2000
Contact: Dr. John McCarthy
Transferring Organization: ORNL

Project: 55196

Title: In Situ, Field Scale Evaluation of Surfactant Enhanced DNAPL Recovery Using a Single-Well, Push-Pull Test
PI: Dr. Jonathan D. Istok *Institution:* Oregon State University

Description: An innovative new site-characterization technology termed the single-well, "push-pull" test method was used for this study. This technology has been the recent subject of development at Oregon State University because it can be used in the field to determine a wide range of aquifer physical, chemical, and biological characteristics. A push-pull test consists of the controlled injection of a prepared test solution into a single monitoring well followed by the extraction of the test solution/groundwater mixture from the same well. This technology was field tested at the Idaho National Engineering and Environmental Laboratory in the FY01 and the data gathered is being analyzed. An other field test is scheduled in the spring of 2002.

Transfer Type: Field Test *Fiscal Year:* 2001
Transferring Organization: INEEL

Project: 60158

Title: Development of Radon-222 as a Natural Tracer for Monitoring the Remediation of NAPL Contamination in the Subsurface
PI: Dr. Lewis Semprini *Institution:* Oregon State University

Description: The objective of this research is to develop a unique method for using naturally occurring radon-222 as an inexpensive partitioning tracer for locating and quantitatifying nonaqueous phase liquid (NAPL) contamination in the subsurface, and assessing the effectiveness of NAPL

remediation. Laboratory, field, and modeling studies are being performed to evaluate this technique and to develop methods for its successful implementation in practice. We have conducted Radon-222 and Surveys at Site-300 at the LLNL. This site is highly contaminated with TCE. The radon results were encouraging, and indicated a zone of NAPL likely existed.

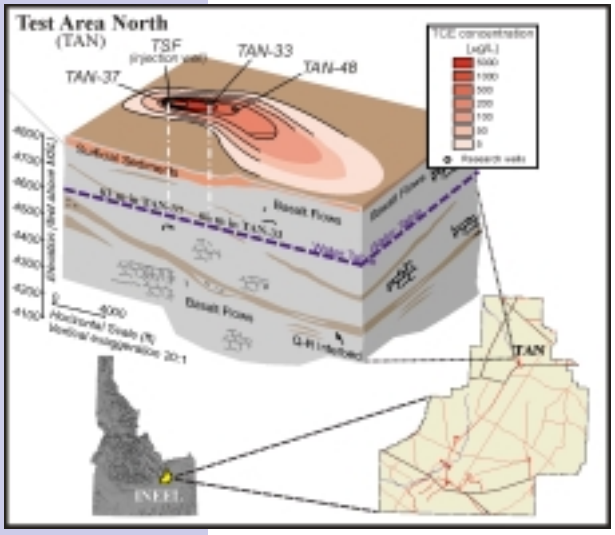
Transfer Type: Field Test *Fiscal Year:* 1999
Contact: Rolf Halden (925-422-0655 or halden1@llnl.gov)
Transferring Organization: LLNL

Microbial Science

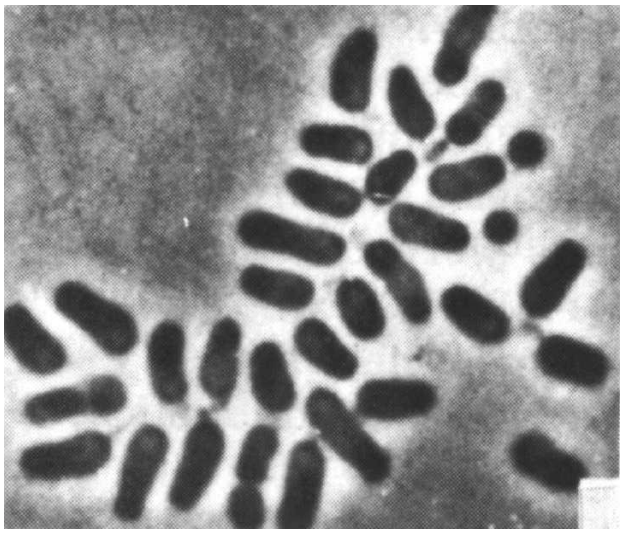
Project: 55264

Title: High Resolution Definition of Subsurface Heterogeneity for Understanding the Biodynamics of Natural Field Systems: Advancing the Ability for Scaling to Field Conditions

PI: Dr. Ernest L. Majer *Institution:* LBNL



Microorganisms with the capability of degrading dissolved TCE in the fractured basalts beneath the INEEL Test Area North are being studied to determine their vertical distribution and to assess how geohydrological factors associated with this complex subsurface environment control their activities. [see Project #55416]



Naturally-occurring TCE-degrading microorganisms may naturally attenuate the TAN TCE plume at low concentrations. [see Project #55416]

Description: We have been using our technology at the TAN site at INEEL to aid in defining the plume movement and location.

Transfer Type: Field Test *Fiscal Year:* 1999
Contact: Tom Woods and John Bukowski
Transferring Organization: Parsons

Project: 55416

Title: Control of Biologically Active Degradation Zones by Vertical Heterogeneity: Applications in Fractured Media
PI: Dr. Frederick S. Colwell
Institution: INEEL

Description: The key objective of this research is to determine the distribution of biologically active contaminant degradation zones in a fractured, subsurface medium with respect to vertical heterogeneities. To determine whether microbial degradation is spatially correlated to preferred flow paths for the contaminant and required electron donors and acceptors we will characterize the biological and abiological properties of cores and samples from multi-level samplers placed in the same borehole. We will use a combination of traditional microbiological methods (e.g., enrichments) and molecular tools to characterize the indigenous microbial communities. During a project that involved coring and well completion of TAN-48 (INEEL) the effect of lactate-induced bioremediation were characterized.
Transfer Type: Field Test
Fiscal Year: 1999
Contact: Lance Peterson, Kent Sorenson, and Joe Rothermel
Transferring Organization: LMITCO and Parsons

Plant Science

Project: 70054 (Renewal of Project No. 54837)

Title: Phytoremediation of Ionic and Methyl Mercury Pollution
PI: Dr. Richard B. Meagher
Institution: University of Georgia

Description: Our long-term goal is to enable highly productive plant species to extract, resist, detoxify, and/or sequester toxic heavy metal pollutants as an environmentally friendly alternative to physical remediation methods. We have focused this phytoremediation research on soil and water-borne ionic and methylmercury. We engineered several plant species (e.g., Arabidopsis, tobacco, canola, yellow poplar, rice) to express the bacterial genes, merB and/or merA, under the control of plant regulatory sequences. These transgenic plants acquired

Mercury-eating plants developed by this project absorb mercury through their roots, then release it in a less toxic form through their leaves. [see Project #70054, renewal of #54837]

Hygromycin selection of merA and merB transformed rice shoots and plants from embryogenic calli. A growth comparison of a wild-type to a hyg resistant (HygR) transformed plantlet left two weeks on 30 mg/l hygromycin. [see Project #70054, renewal of #54837]

remarkable properties for mercury remediation. Our project has been so successful that a private company, PhytoWork Inc., has been created.

Transfer Type: Commercialization - Business
Fiscal Year: 1999
Contact: Richard Meagher
Transferring Organization: PhytoWork Inc.

Separations Chemistry

Project: 54926

Title: Novel Ceramic-Polymer Composite Membranes for the Separation of Hazardous Liquid Waste

PI: Dr. Yoram Cohen *Institution:* University of California at Los Angeles

Description: Growing interest by industry in the PolyCer membrane concept is encouraging. With additional optimization work, we are confident that PolyCer membranes will emerge to meet the demand for membranes that retain their structural integrity and longevity under harsh conditions while maintaining the desired selectivity and permeate flux. The approach will pave the way for a rapid tailor-design of pervaporation and UF membranes for organic-aqueous separations. We are currently negotiating with a company called Spinktek Filtration regarding the use of our technology for making non-fouling membranes.

Two other companies (Pervatech in the Netherlands and Asahi Chemical Industry in Japan) signed secrecy agreements with UCLA in connection with our project.

Transfer Type: Commercialization - Product *Fiscal Year:* 2000
Transferring Organization: Spinktek Filtration