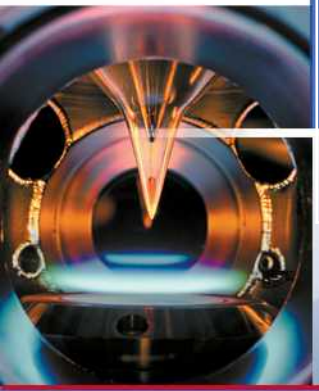
SAND2014-17627PE

SANDIA NATIONAL LABORATORIES

Overview of Sandia Radioactive Waste Management and Remediation Capabilities and Technologies



BASF Visit
June 26th, 2014

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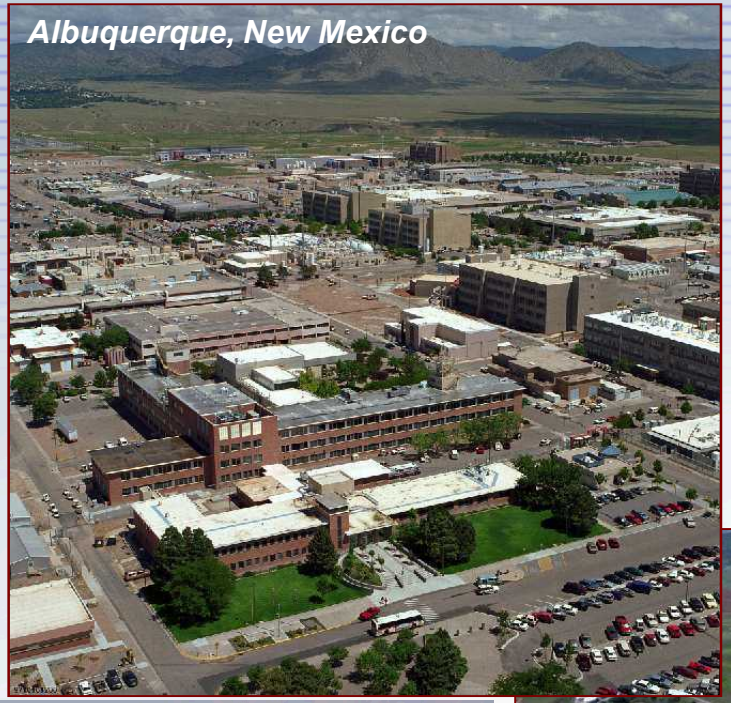
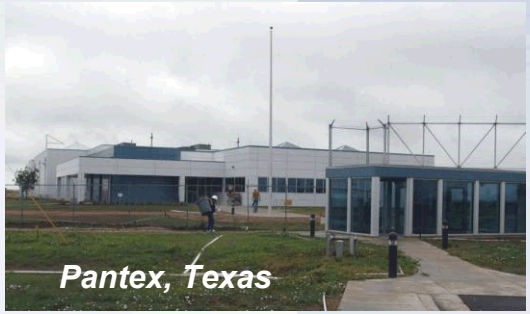
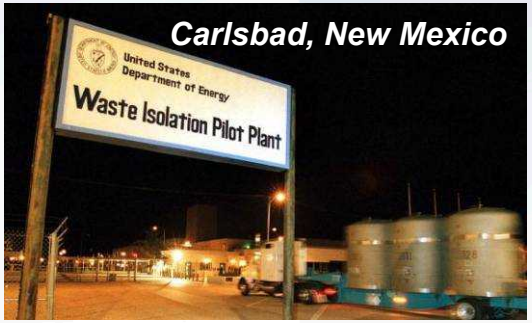
Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Sandia National Laboratories

Sandia National Laboratories is Geographically Distributed







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Sandia's Strategic Management Units Solving Complex National Security Problems

Energy Climate & Infrastructure Security

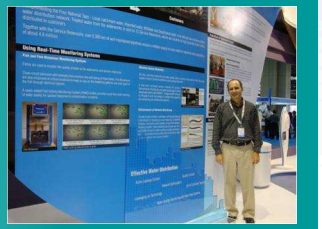




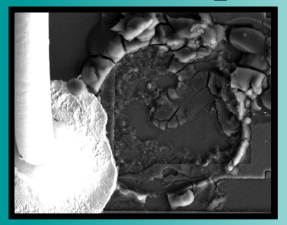

International, Homeland & Nuclear Security

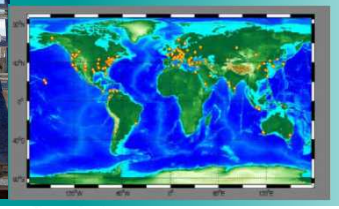
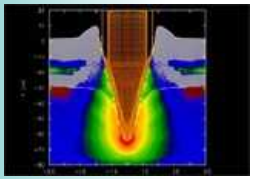




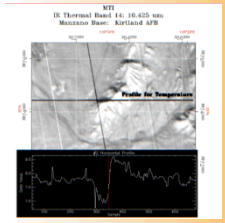



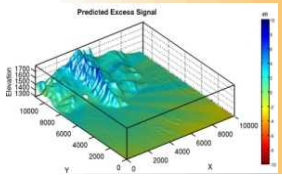
Nuclear Weapons

Defense Systems and Assessments



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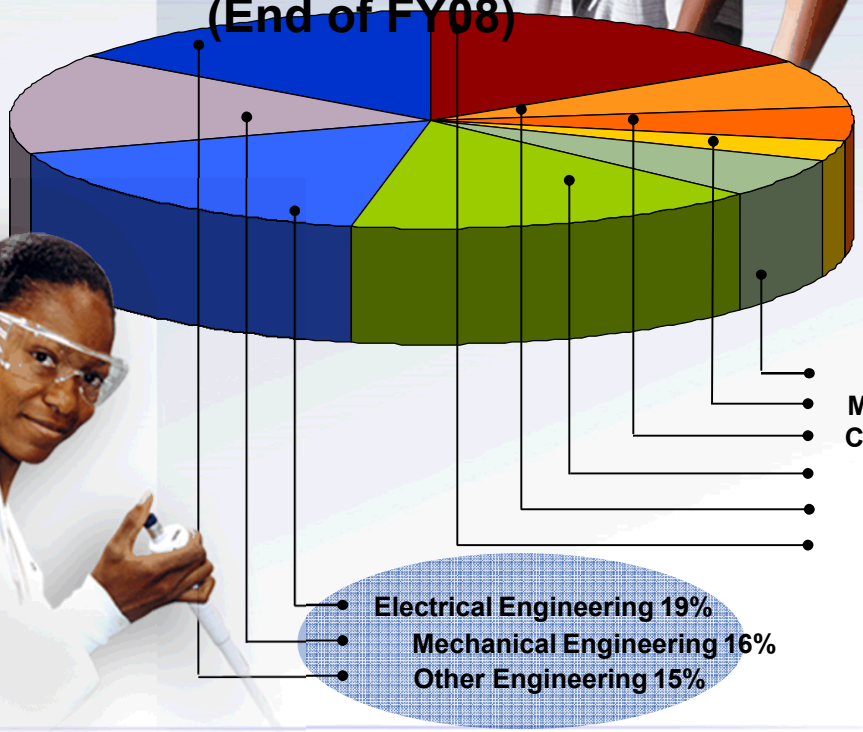
Sandia's People

- On-site workforce: 11,200
- FY08 permanent workforce: 8,400
- FY08 gross payroll: $886.1M
- FY08 budget: $2.3B

Technical Staff (3,844) by Degree (End of FY08)



Disciplines of Most Technical Hires (FY03 – FY05)

Top 3 hire fields comprise approximately 55% of technical hires

- IT
- ME
- EE

Top 5 hire fields are approximately 70% of technical hires

- Physics
- Chemistry

Top 11 hire fields represent approximately 90% of technical hires

- Chemical Eng
- Materials Science
- Math
- Biology
- Nuclear Eng
- Aerospace Eng

Sandia National Laboratories

Energy Climate Infrastructure Security:

Nuclear Energy

"Renew U.S. leadership in 'Nuclear Energy' . .

National Technical and Policy Leadership

- Safety and Security
- Transportation
- Repository Science

Nuclear Fuel Cycle Science

- Advanced Fuel Cycle Technologies
- Advanced Modeling and Simulation

Key System Demonstrations

- Nuclear-Solar Hydrogen
- Small Reactor Development
- International Fuel Return Demonstration
- Transparency Technology Demonstration

Sandia National Laboratories Overview

- **SNL is a Federally Funded Research and Development Center**
  - Government-owned/contractor operated facility
  - DOE Laboratory
  - Corporately managed (Lockheed Martin)
  - "Exceptional Service in the National Interest"
- **SNL's Principal Customers include:**

USDA

United States Nuclear Regulatory Commission

NNSA
National Nuclear Security Administration

Department of Energy
United States of America

Department of Defense
United States of America

Department of State
United States of America

Office of Civilian Radioactive Waste Management
OCRWM

NASA

NE

Office of Science
U.S. Department of Energy

U.S. Department of Energy
Energy Efficiency and Renewable Energy

United States Environmental Protection Agency

Department of Transportation
United States of America

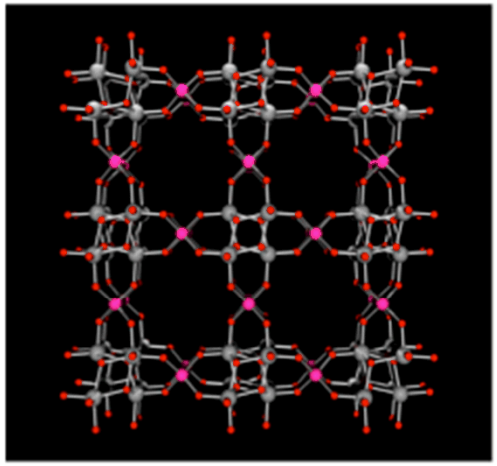
Sandia's Water Treatment Programs – From "Nanoscale" to Field Test

- Molecular dynamics simulations to understand surface adsorption phenomena at a fundamental level.
- Wide experience in developing element-specific scavengers that remove trace levels of "pollutants" from waters: As, V, Se, U, Th, Ac, Tc, Sr, Cs, Ra, assorted radioisotopes, etc. - on an industrial scale.
- Design and fielding of intermediate-sized water treatment systems for applications in remote areas
- Field tests that compared performance of various sorptive media in differing groundwater chemistries
- Ongoing programs to validate treatment technologies for waters which are co-produced during oil and gas recovery operations.
- Systems dynamics models that show how to minimize treatment costs and optimize the benefits that might be derived from multiple uses of produced waters.
- Reduce uncertainty in remediation phase costs

Crystalline Silico-Titanates (CSTS)
A Tech Transfer Success Story

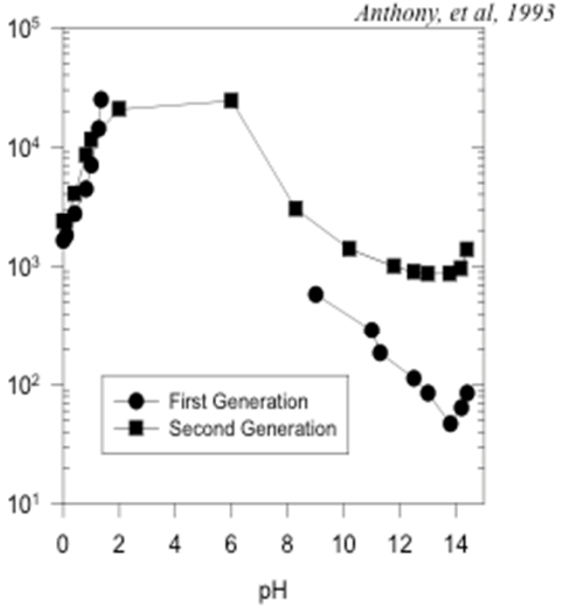
CST ion exchanger

Nenoff, 1996



Distribution Coefficient of Cs on CST

Anthony, et al, 1993



CST properties:

- Removes 1 part Cs per 100,000 parts Na
- Stable over entire pH range
- Stable in extreme environments

1996 R & D 100 award
1996 Team ERA

Technology Transfer License to Honeywell UOP in 2010
>120M Gallons of Cs contaminated water treated (2013)

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Reactive Barriers: *In Situ* Formation of Apatite

An effective reactive barrier for Sr, U, Pu, Np, Am, and possibly Co and Pb.

Very economical; all reagents are commercially available.

Technical POC: Robert (Bob) C. Moore

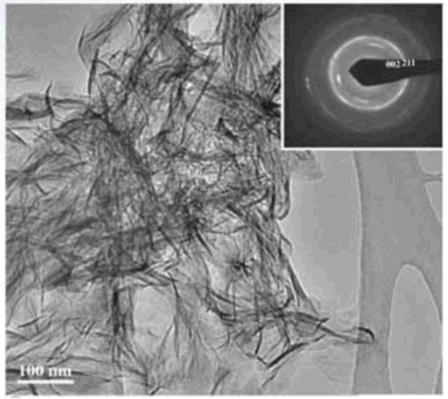
TRL: 8

Patent Status: U.S. Patent 6,592,294.

Commercialization Considerations:

- Need to establish performance envelope for Co and Pb.
- Site specific characteristics including porosity and permeability of sediments, phosphate concentration, need to be considered to insure successful application of technology.
- Experimental phase for implementation at Fukushima site.

Injection of apatite forming solution at Hanford 100N site for immobilization of Sr-90. June, 2006.



Calcium apatite crystals formed in sediment.

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Layered Bismuth Oxide Getters for Anion Removal

Sorbent is a layered bismuth oxide.

Highly selective for As, Se, I^-, IO_3^- and moderately selective for TcO_4^- and ClO_4^- (Kd = 10-100) in drinking water matrix.

Inexpensive and easily prepared using commercially available materials.

Technical POC: Jim Krumhansl

Patent Status: Public Disclosure in 2006.

TRL: 2 (Multiple varieties and preparations)

Barriers to Commercialization:

- As synthesized, the material is a fine powder requiring binder for column use;
- Some interference from groundwater anions - notably carbonate.

Log[Kd - As]
4.2 - 6.3

Log[Kd - I^-]
2.9 - 5.2

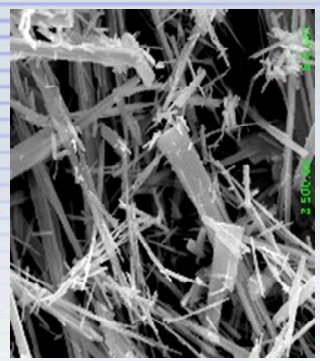
Log[Kd – IO_3^-]
1.7 - 4.9

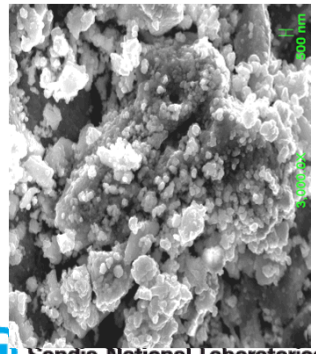
Log[Kd - I-]
2.9 - 5.2

Log[Kd - Se]
1.4 - 3.9

Log[Kd – TcO_4^-]
1.2 - 2.5

Kd – ClO_4^-
0-20





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Contaminant Getters: Peroxide Modified Mono-Sodium Titanates

Modified MSTs are tailored materials for optimal Sr and Actinide (Pu, Am, Np) sorption

Technical POC: Robert Moore

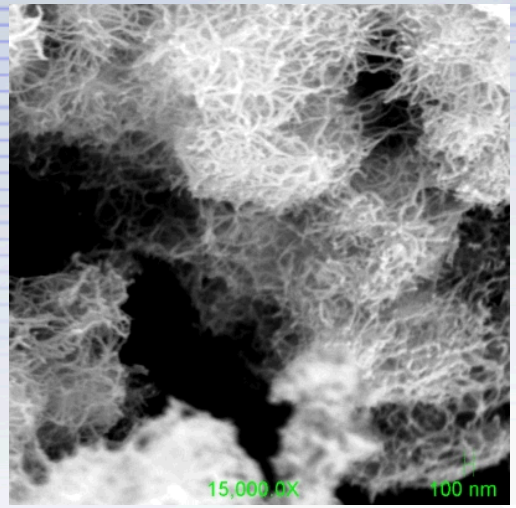
Patent Status: Hydrogen Peroxide Modified Sodium Titanates with Improved Sorption Capabilities (U.S. Patent 7,494,640 Issued 2/24/2009).

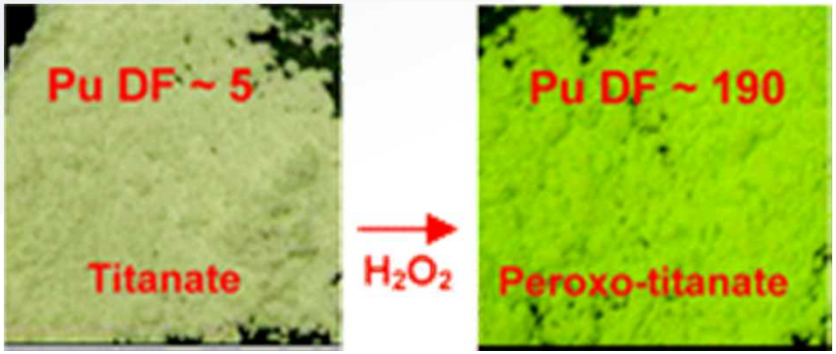
Publication: May Nyman and David T. Hobbs Chem. Mater.; 2006; *18*(26) p. 6425-6435

Technology Readiness Level: 6

Commercialization Considerations:

Requires a binder.
Of considerable interest for SRNL waste treatment in combination with CSTs and potential application to Fukushima clean-up as well as fuel reprocessing.





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Contaminant Getters: Zirconium modified sorbents

Sorbent is a zeolite, clay mineral, activated carbon or other support material modified with zirconium.

Highly selective for removal of arsenic species as As(V), As(III) and organoarsenic from groundwater.

Inexpensive and easily prepared using commercially available materials.

Technical POC: Robert (Bob) C. Moore

TRL: 3

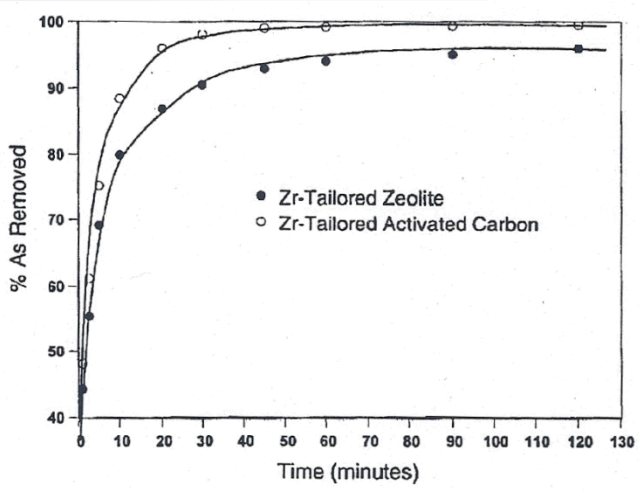
Patent Status: U.S. Patent 6,824,690.

Commercialization Considerations:

Larger scale pilot testing is required to verify laboratory performance data.

Arsenic Removal from Synthetic Groundwater Using Zr modified Montorillonite

Arsenic conc. initial (ppb)	Arsenic concentration final (ppb)		
	As(V)	As(III)	organoarsenic
100	0.92	not detectible	not detectible
250	1.7	not detectible	not detectible
500	5.4	not detectible	not detectible
1000	19.2	38	160
2000	30.1	101	420



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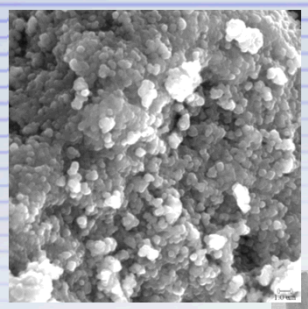
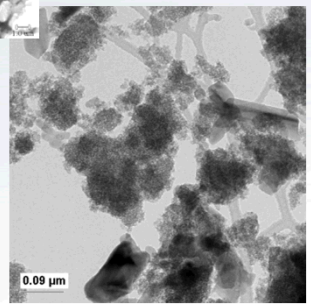
Contaminant Getters:
Specific Anionic Nano-Engineered Sorbent (SANS)

SANs, a spinel-based sorbent (Me(II)O:Me(III)2O3) that combines high anion sorption from the divalent cation oxide component, and high surface area from the trivalent cation oxide component.





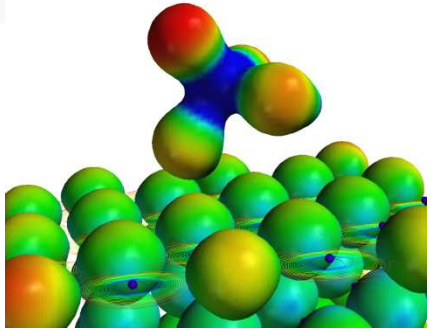
Effective for As species and numerous other anionic species commonly found in ground waters.

Sandia's patents cover all spinels and anionic contaminant: in fixed bed filtration, in lime softening, in coagulation, and in-situ aquifer remediation.

POC: Patrick Brady pvbrady@sandia.gov

TRL: 6

Patent Status: Arsenic-sorbing spinel: used as filter media (U.S. Patents 7074336 B1, 7122502 B1, and 7244359 B1), coagulant and lime softening aid (U.S. Patents 7138063 B1 and 6802980 B1), and can be formed *in situ* to decontaminate soils/aquifers (U.S. Patent 683695 B1).



Inner-sphere sorption $HAsO_4^{-2}$ on SANS

Commercialization Considerations:

Needs effective binder for granularization.

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Other Sorbents and Barriers

Contaminant	PRB	Sorbent	Kd	TRL
Tc	Yes	Yes	>100,000	3
Hg	TBD	Yes	>10,000	2
Se	Yes	Yes	>1,000	2
REE	No	Yes	TBD	2