Pacific Northwest NATIONAL LABORATORY

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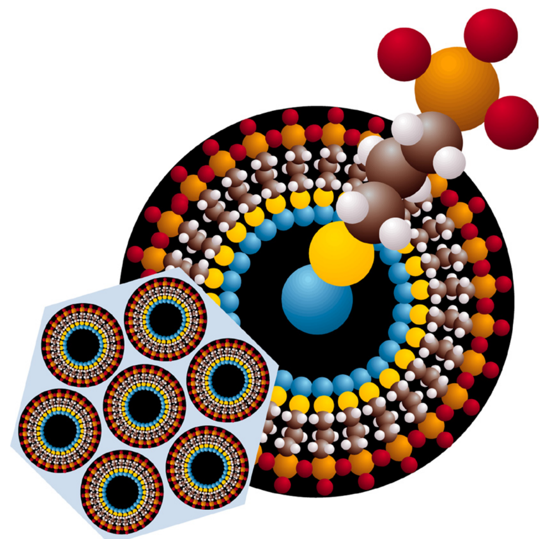
Self-Assembled Monolayers on Mesoporous Supports High Performance Nanoporous Sorbents

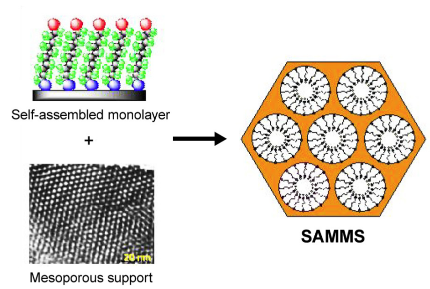
The high functional density and surface area of SAMMS produce a sorbent material with fast kinetics, high sorption capacity, and excellent selectivity.

SAMMS™—Self-Assembled Monolayers on Mesoporous Supports®—is an award-winning technology with broad applications in the remediation, water treatment, catalyst, sensor and controlled-release markets. SAMMS are created by attaching a monolayer of molecules to mesoporous ceramic supports. The larger pore size offered by the mesoporous materials (20-200 Å) enables attachment of the monolayer as well as access to the binding sites within the pores. The high surface area of the materials (~1000 m^2/g) also allows an extremely high density of binding sites. Together, these properties produce a material with fast kinetics, high material loading, and good selectivity. Both the monolayer and the mesoporous support can be tailored for a specific application. For example, the functional group at the free end of the monolayer can be designed to selectively bind targeted molecules while the pore size, monolayer length, and density can be adjusted to give the material specific diffusive and kinetic properties. The Pacific Northwest National Laboratory and Steward Environmental Solutions are teaming in the development and manufacture of this nanostructutred material.



Using nanotechnology, scientists at the Department of Energy's Pacific Northwest National Laboratory have developed a simple tool for absorbing large quantities of mercury without creating secondary waste.

Thiol-SAMMS was specifically developed for the removal of mercury from liquid media (both aqueous and non-aqueous). Thiol-SAMMS has shown the unique ability to bind cationic, organic, metallic, and complexed forms of mercury. Because of the high surface area, high binding site population, and tailored functionality, results of tests with mercury demonstrate high loadings (up to 635 mg Hg/g SAMMS), high affinity (distribution coefficient, or K_d, ~1 x 10^8) and rapid sorption kinetics (minutes); all made possible through the use of these molecularly-engineered materials. The efficiency of thiol-SAMMS in removing Hg from a non-aqueous system (e.g. vacuum pump oil) has also been successfully demonstrated.



SAMMS is a hybrid of two frontiers of materials science: self-assembly techniques and mesoporous materials

SAMMS was able to rapidly reduce the mercury concentration from 500 ppb to 0.5 ppb within 5 minutes; for the 10-ppm case, the mercury

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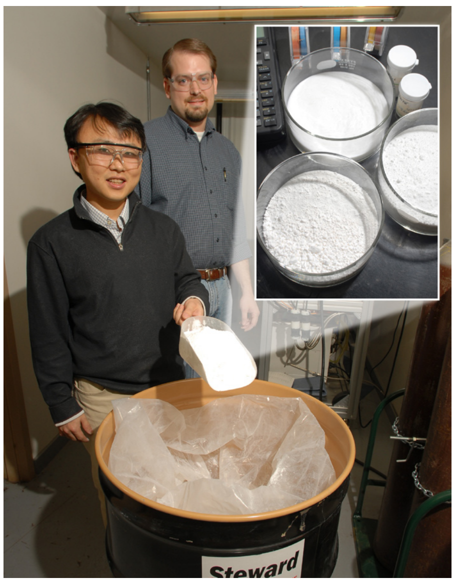
concentration was reduced to 3.1 ppb within 5 minutes. Thiol-SAMMS is roughly 500 times faster at sorbing Hg than is polymer-based ion exchange resins. This rate difference is directly attributable to the rigid, open pore structure of SAMMS leaving all of the binding sites available at all times to bind metal ions.

There have been a number of field demonstrations of SAMMS to address Department of Energy as well as commercial waste treatment problems. Steward Advanced Materials has established commercial production capacity for the manufacture of SAMMS, and are currently producing materials. Quantities of SAMMS are available for testing by potential end-users and resellers.



SAMMS is a simple, inexpensive and easy-to-use technology that absorbs mercury in liquids and can be easily disposed of afterwards. It is a derivative of Self-Assembled Monolayers on Mesoporous Supports, a nanostructured sorbent material developed by scientists at Pacific Northwest National Laboratory.

SAMMS OVERVIEW

- SAMMS was originally developed under funding from the U.S. Department of Energy to selectively bind mercury (Hg) from contaminated groundwater
- Very effective, can quickly soak up as much as 2/3 of its own weight in Hg
- Licensed to Steward Advanced Materials, Inc.
- Made using a "green" manufacturing process
- By varying the ligand chemistry, SAMMS have also been tailored for:
  - *Anions (e.g., chromate, arsenate)*
  - *Cesium (nuclear waste)*
  - *Actinides (e.g., U, Pu, etc.)*
  - *Iodide*
  - *Other metal ions*
- Can also be tailored for CO_2.

SAMMS ATTRIBUTES

- High binding capacity comes from the marriage of the extremely high surface area and dense surface coverage
- Fast sorption kinetics arise from the rigid, open pore structure
- Chemical specificity dictated by monolayer interface; easily modified for new target species
- Particle size can be tailored to fit application needs
- Good chemical and thermal stability.

ABOUT PNNL

Pacific Northwest National Laboratory, a U.S. Department of Energy Office of Science laboratory, solves complex problems in energy, the environment, and national security by advancing the understanding of science. PNNL employs more than 4,900 staff, has a business volume exceeding $1.1 billion, and has been managed by Ohio-based Battelle since the 1965 Lab's inception in 1965.

For information on price, availability, samples for testing, and commercial deployment of SAMMS, contact:

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