SAND2010-6907C

SANDIA NATIONAL LABORATORIES

Overview of SNL Water Treatment Technologies

Dow Chemical Meeting
October 7th, 2010

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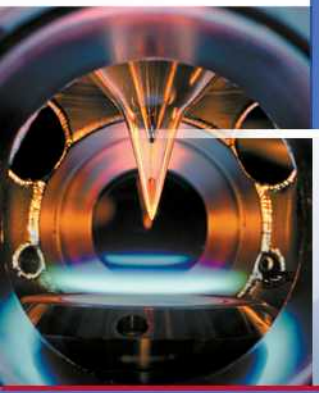

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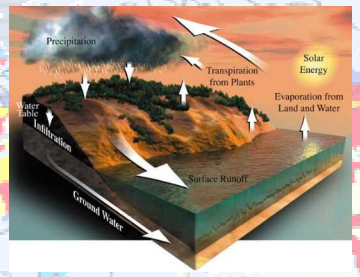
Sandia's Water Program has national and international impact in four focus areas

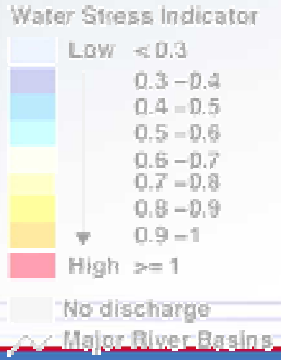
Treatment Technologies

Modeling & Management



Security Systems

Energy-Water



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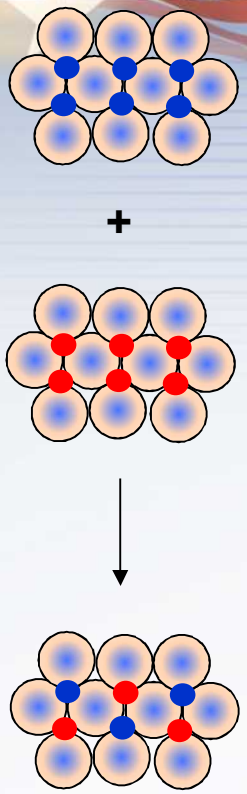
Outline

- El Monte Segrado, Taos, NM Kessler Resort
- Ga Modified Al Clusters
  - Patent status?
  - Publications Stewart et. al.
- Functionalized Surfaces for Pathogen Destruction
  - Patent Status ask Nyman
  - Publications-ask Nyman
- Biomimetic Membranes
  - Patent status-ask Rempe/Brinker
  - Publications status-ask Rempe/Brinker
- Ceragenins to inhibit Biofouling
  - Patent status-ask Altman
  - Noteworthy recent publication(s) ask altman
- As removal technology
  - SANS and in-situ SANs
  - Hedgehog
  - Patent Status
  - Noteworthy publications
- Others??
  - Inhibition of silica precipitation
  - Demonstration Pilots- highlight use of Dow membranes Will they work with us on optimzing performance, membrane selection etc.?

Spinel Based Getters for As Removal



Trivalent Metal (Hydr)oxide ($Fe(OH)_3$, Al_2O_3)

+

Divalent Metal (Hydr)oxide ($Mg(OH)_2$, $Cu(OH)_2$, $Zn(OH)_2$)

High surface area

+

High pH_{zpc} and anion sorption capacity

<u>High surface area Spinel with high anion (e.g. arsenate, chromate) sorption capacity</u>

POC: Patrick Brady pvbrady@sandia.gov

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).

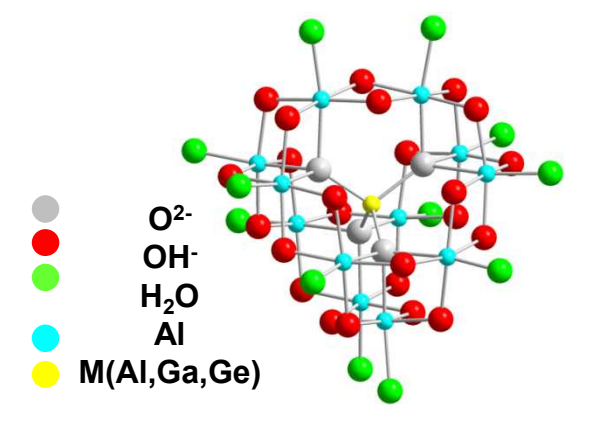
In Tank Recirculation Treatment System

Designed to reduce the levels of a variety of organic and inorganic contaminants in water storage tanks.

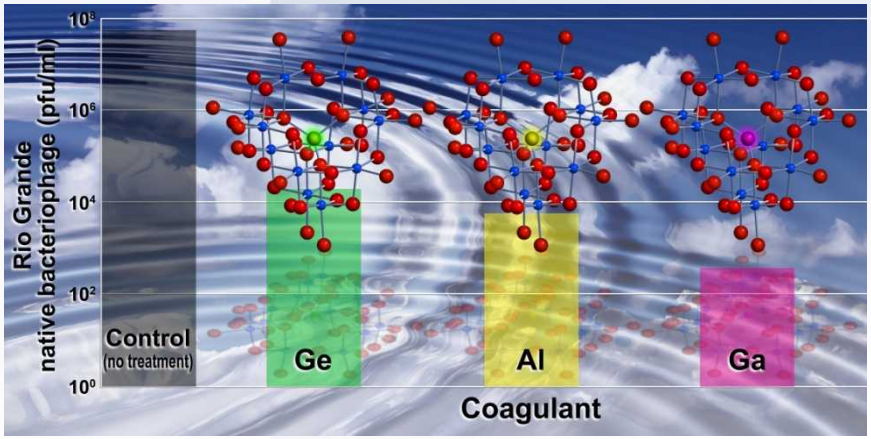
POC: Brian Dwyer bpdwyer@sandia.gov

Patent Status: US Patent #7514004 In-Tank Recirculating Arsenic Treatment System

Novel Flocculants for Removal of Anionic Contaminants: a Single Atom Makes the Difference

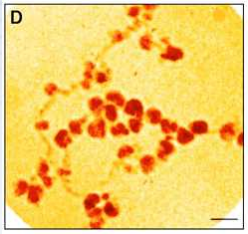


Ga-substituted alumina Keggin ion

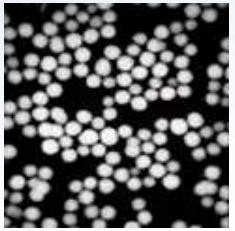


Cryptosporidium

Clays (turbidity)



Humics (DOC)



Colloidal silica

POC: May Nyman mdnyman@sandia.gov

Patent Status Pending: Optimized alumina Coagulants for Water Treatment, 2/20009.

Key Reference: "Enhanced Water Purification: A Single Atom Makes a Difference", T. Stewart et al., Environmental Science and Technol., 21(11), 2201-2208, 2009.

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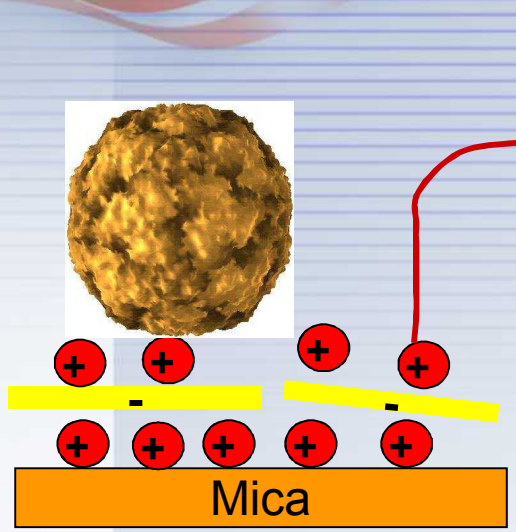
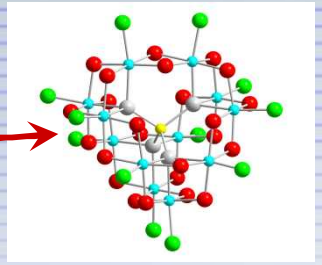
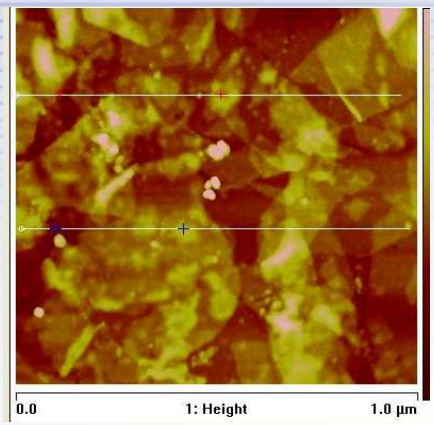
Multifunctional Surface for Adhesion and Photocatalytic Destruction of Water-Borne Contaminants

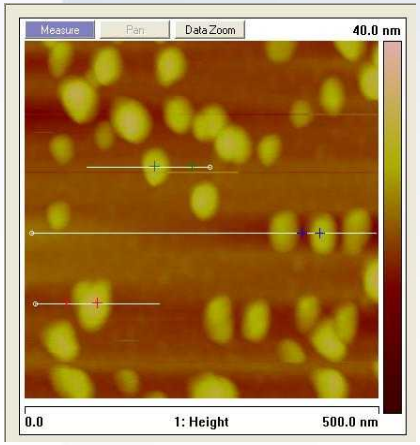




Polycationic 'glue'

AFM image of Titanate photocatalyst





AFM image of MS-2 adsorbed onto functionalized surface

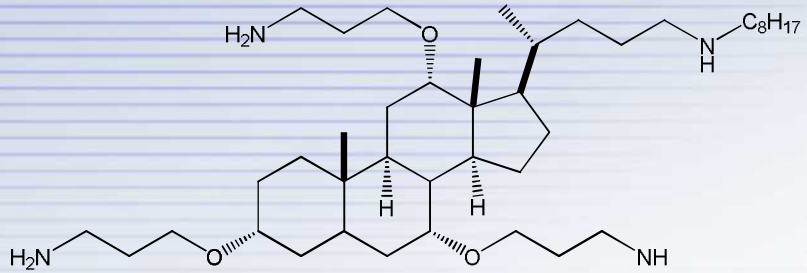
POC: May Nyman mdnyman@sandia.gov

Patent Status Pending.

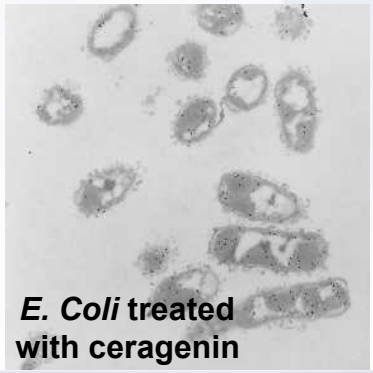
Ceregenins to Control Membrane Biofouling

Ceragenins Are Synthetic Antimicrobial Peptide Mimics

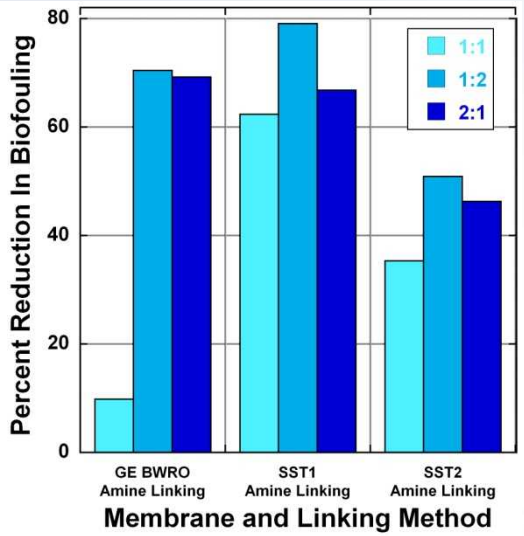
Mode of action is disruption of cell membranes due to polar/non-polar regions on peptide surface



Example ceragenin, CSA-13



Antimicrobial Activity Has Been Demonstrated



POC: Susan Altman sjaltma@sandia.gov

Patent Status Pending: Ceragenins for Biofouling Resistant Water-Treatment Membranes

Altman, S. J., et al., 2008, Use of ceragenins to create novel biofouling resistant water-treatment membranes, *SAND2008-7895*, Sandia National Laboratories, Albuquerque, NM.

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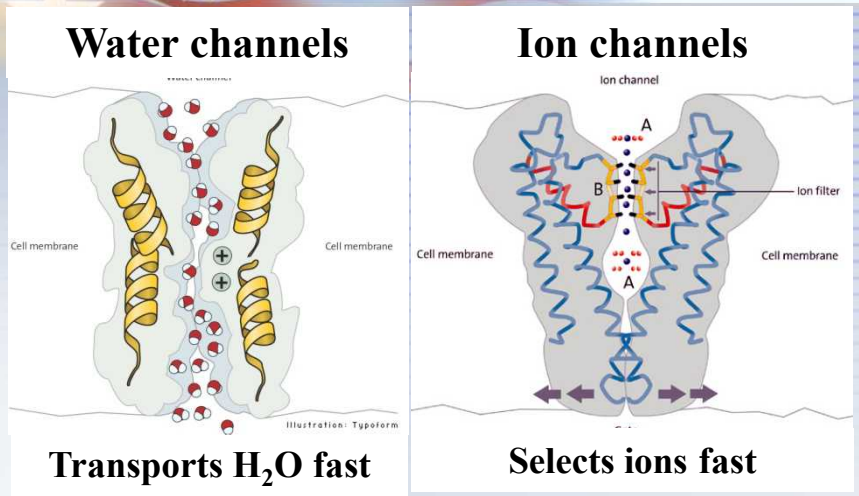
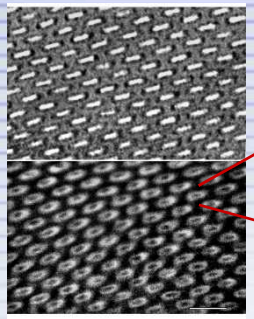
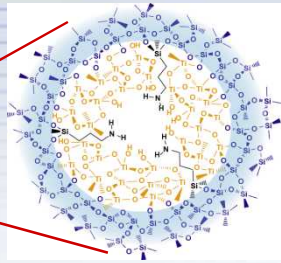
New Efficient Membranes: Porous
Understand, design, engineer nano-channels for desalination

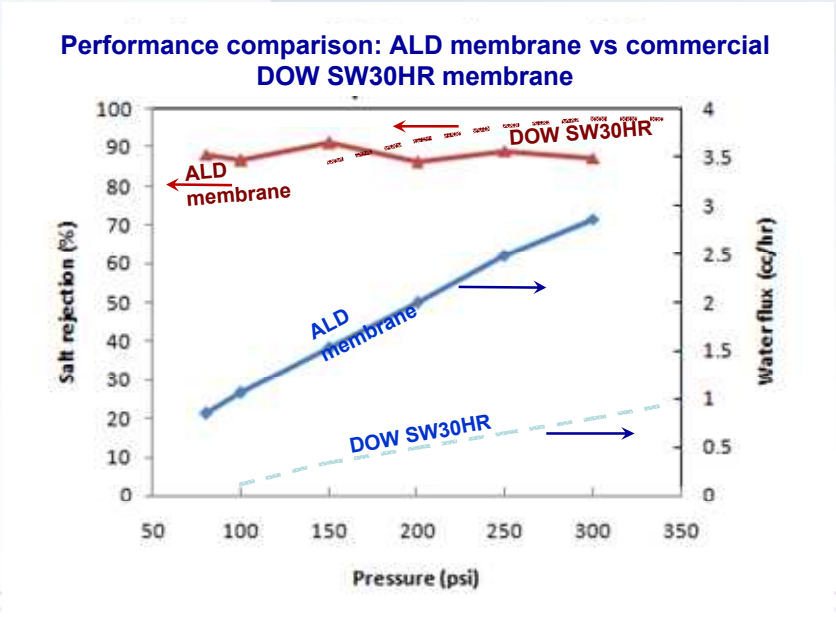


Bio-inspired design

Theory to reveal mechanism







- Silica membrane formed by evaporation-induced self-assembly
Combine silane surface derivatization and Atomic Layer Deposition (ALD) to control surface chemistry, pore size, and hydrolytic stability.

PI: Susan Rempe slrempe@sandia.gov

Patent Status Pending: Biomimetic Membranes for Water Desalination

Key Ref: Yang, et al, (2010). *In preparation.* Biomimetic high-flux desalination membrane based on self-assembled nanopores tuned by atomic layer deposition.

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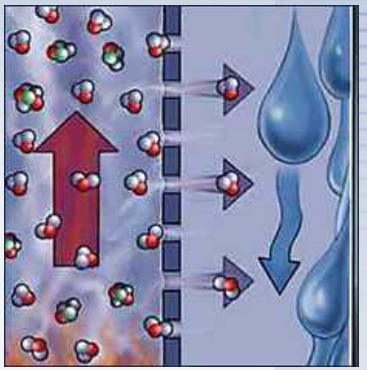
Other Water Treatment Activities

Waste Heat to Produce Water via Membrane Distillation



Contact:
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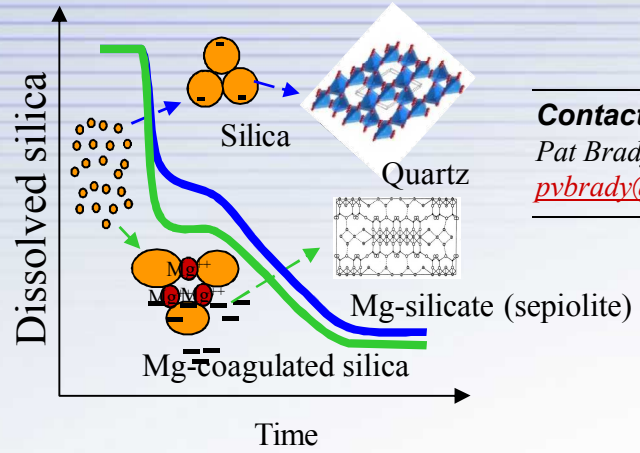
Controlling SiO_2 Precipitation in Cooling & Process Waters



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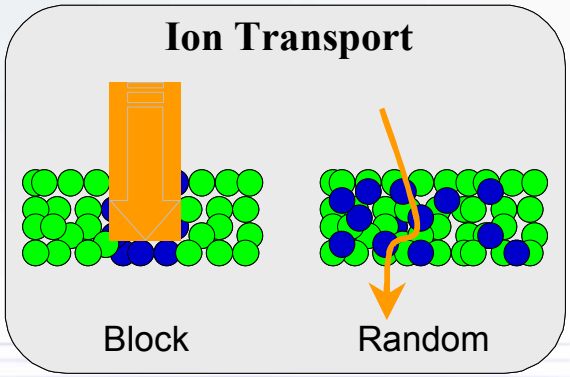
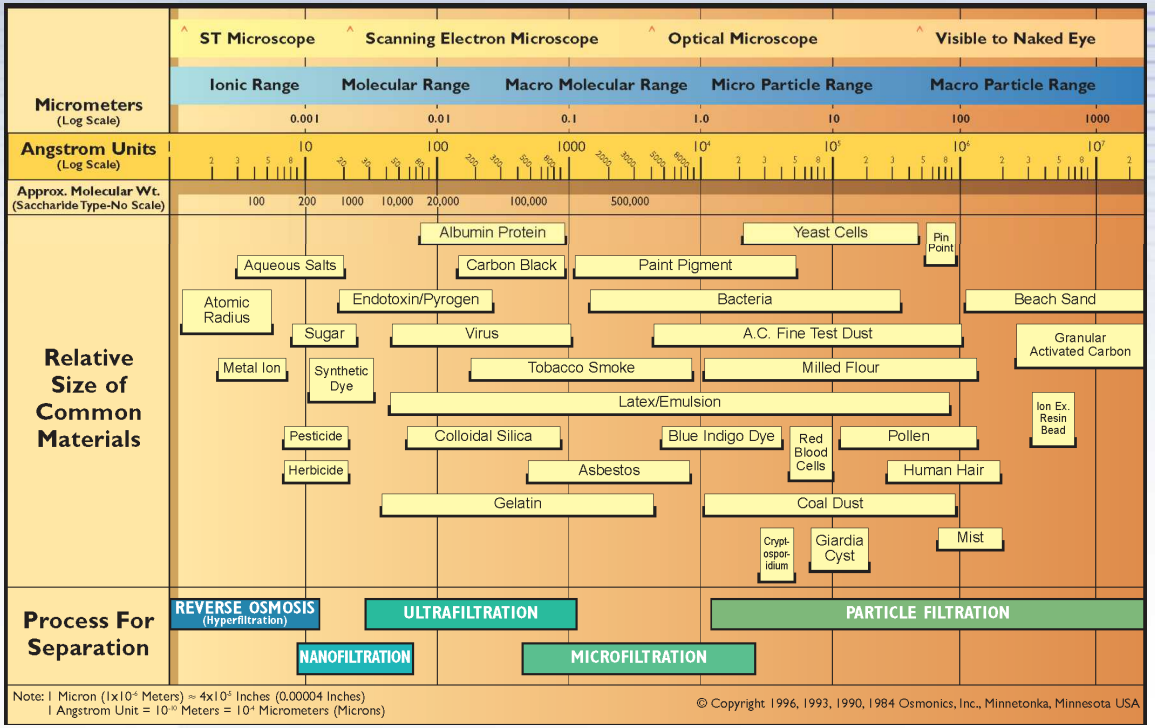
Nano-phase separated di-block copolymers enabling high conductivity ion transport in ED membranes



Contact:
Michael Hibbs-505-284-8790
mhibbs@sandia.gov

Evaluation of Nanofiltration for Water Reuse and Treatment of Impaired Water



Cooling Water Tower

CBNG Produced Water Site

- Capable of decreasing total dissolve solids significantly
- High rejection rate for divalent ions
- Generally less prone to fouling than reverse osmosis membranes
- Operate at lower applied pressures and thus save energy and cost than RO membranes
- Use of Dow Filmtec™ NF90-4040 Membranes

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Dow Membranes In Sandia's Pilot Work
Dow Filmtec™ NF90-4040

Use of Nanofiltration to Treat Cooling Tower Water

Parameter(mg /L)	Average Feed	Average Permeate	% Removal
Mg^{2+}	20.2	0.14	99.3
Ca^{2+}	103	0.90	99.1
HCO_3^-	422	17.6	95.8
Cl^-	91.3	13.7	85.0
F^-	20.9	0.87	95.8
SO_4^{2-}	131	0.19	99.9
SiO_2	118	12.8	89.2

Use of Nanofiltration to Treat Produced Water

Parameter (mg/L)	Average Feed	Average Permeate	% Removal
K^+	96.8	1.69	98.3%
Na^+	5,650	128	97.7%
Mg^{2+}	17.2	0.152	99.1%
Ca^{2+}	6.57	<0.01	>99.8%
HCO_3^-	10,300	102	99.0%
Cl^-	2,880	140	95.1%