The Advanced Materials Laboratory; home to part of Sandia National Laboratories' Materials Science and Engineering Center

A Sandia facility in space leased from, and located on the campus of the University of New Mexico

Originally occupied in 1992 with UNM and LANL to collaborate on technologies, especially for Tech Transfer.

Currently, 20 regular Sandia employees and about 115 "non-regular" collaborators – many different levels of education, schools, expertise, and country of origin.

Our mission is to provide materials and processing solutions to issues of national interest.

Sandia National Laboratories

The "Center" model is an excellent strategy for collaboration

THE UNIVERSITY of NEW MEXICO

CENTER FOR EMERGING ENERGY TECHNOLOGIES

MISSION: CEET brings together scientists from various UNM Schools with Sandia National Laboratories and industrial partners.
Fostering the economic growth and providing conditions for integration in a collaborative manner with local, national and international companies is recognized as pivotal for this center success.
The academic component of the mission lays in training the labor force for energy-related businesses and labs by promoting excellence in research.

CHALLENGE: Energy Transfer at Multiple Scales.
What are the fundamental limits and enabling principles for the use and integration of molecular and material structures at atomic level, nano-scale, and macroscopic restrictions that such limitations impose on systems that transfer, and transduce energy? What are the physical limits of resulting power generating processes and efficiency for energy conversion?

GAIN: Understanding and controlling such energy transfer processes at multiple scales will have great benefit to technology, resulting in high efficiency conversion of chemical, thermal or solar energy into electrical or chemical energy.

ENERGY TECHNOLOGIES:

Materials devices and technologies for power generation based on energy conversion.

Energy storage technologies, devices and systems integrating these devices with power generation technologies.

Systems and networks for power distribution.

Fuels as energy carriers.

Photovoltaics

Fuel Cells

Capacitors

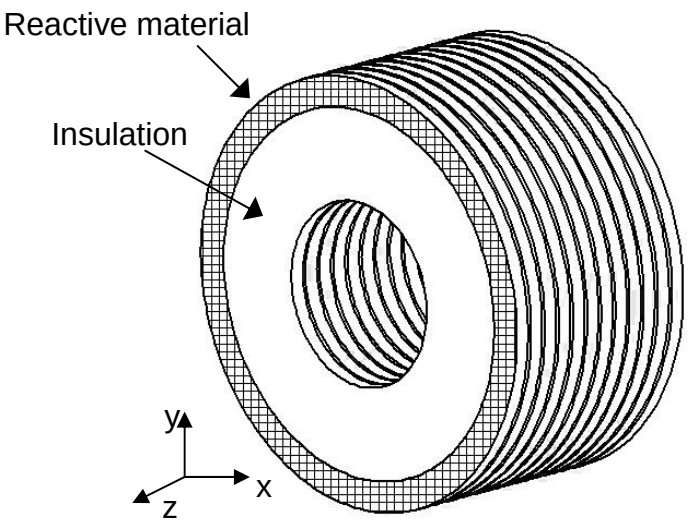
Batteries

Sandia National Laboratories

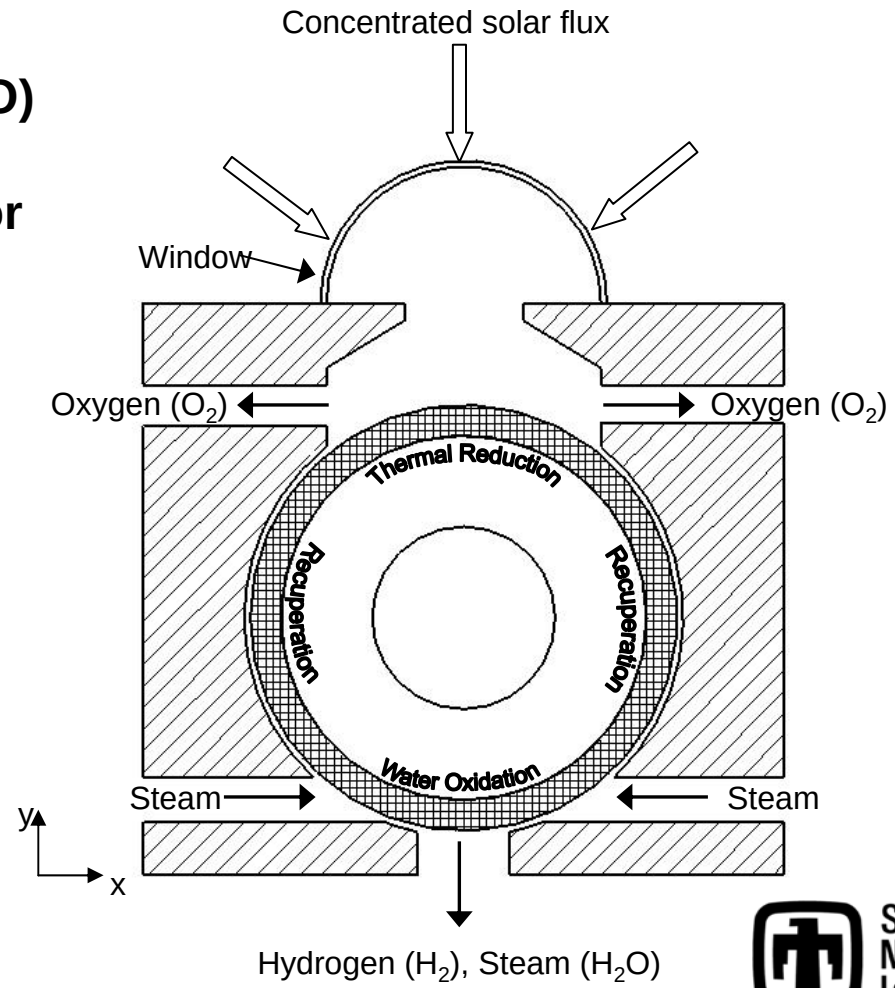
Counter-Rotating-Ring Receiver/Reactor/Recuperator (CR5)

- ***Countercurrent recuperation*** **of sensible heat.**
- **Intrinsic separation of H_2 (or CO) and O_2.**
- **Initial CR5 concept designed for a dish platform.**

Set of Counter-Rotating Rings

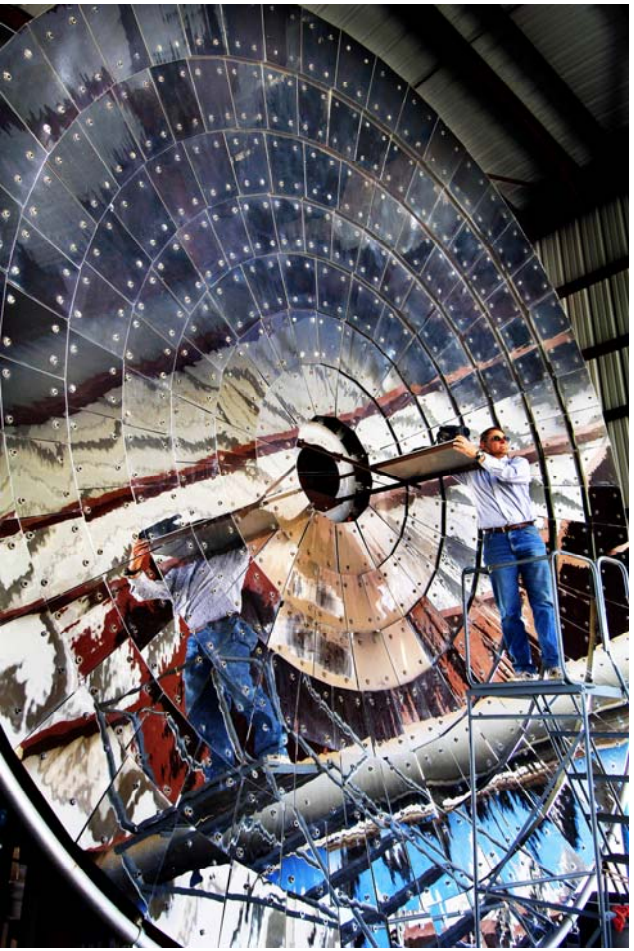


Cross-Section Illustration



Sandia National Laboratories

CR5 Prototype in Final Assembly Stages



35 m^2 dish
500 W/cm^2 peak

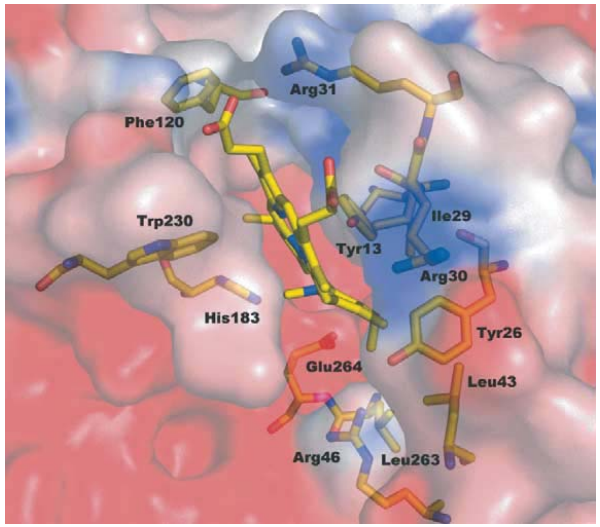
14 rings
168 segments
8 kg “exposed” composite
2 kg ferrite

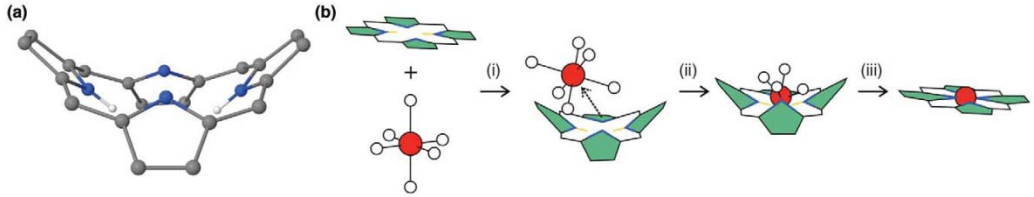
Sandia National Laboratories

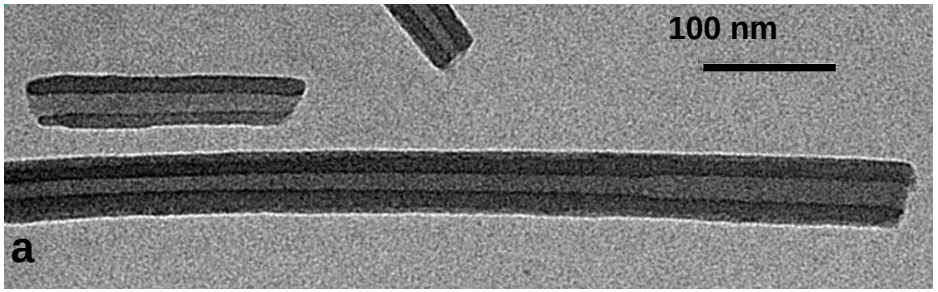
University of Porto/University Nova Lisboa (Portugal)

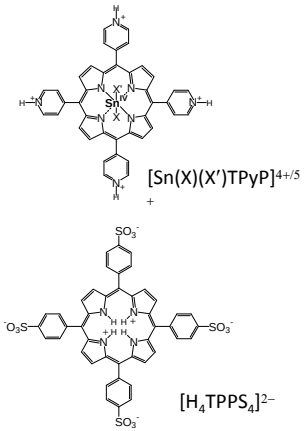
Prof. Ricardo Franco & Prof. Eulalia Pereira

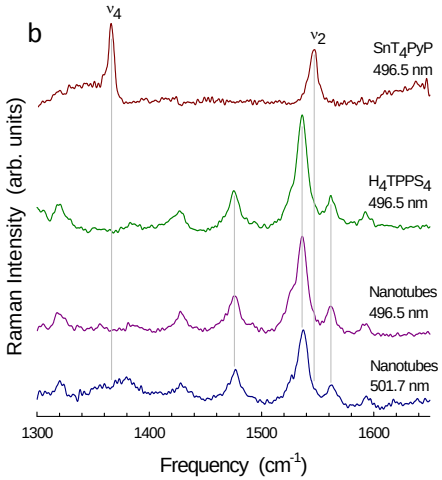
- Ferrochelatase: Investigation of catalytic mechanisms of metal-insertion enzymatic reactions of ferrochelatase & engineered mutants for metals other than iron using resonance Raman spectroscopy.



- 



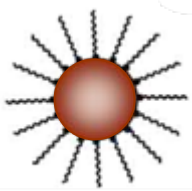




Soft Self-Assembly to Functionalize Nanoparticles and to Fabricate Robust, Ordered Nanoparticle Films

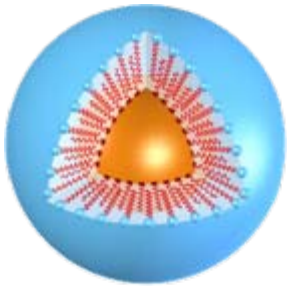
Soft self-assembly is a simple, economical process, enables the development of unique optical, electronic, and magnetic nanoparticle thin films in mild conditions, with architectures and properties unattainable by any other processing methods (CVD, sputtering, etc).

Metal nanoparticles
e.g., Gold, silver, etc.
Semiconductor nanoparticles
e.g., PbSe, Ge, CdSe etc.
Metal oxide nanoparticles
e.g., TiO_2, SiO_2, ZrO_2 etc.
Magnetic nanoparticles
e.g., FePt, $FeMnO_4$, etc.



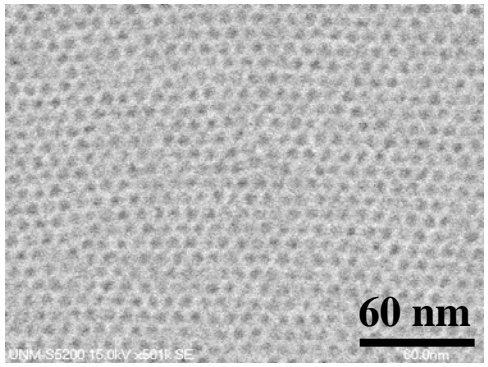
1, surfactant
2, lipid,
3, block copolymer

Water-Soluble & Biocompatible Building Block

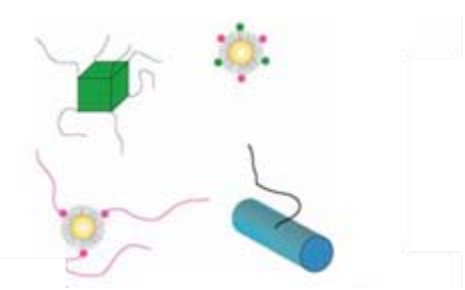


Engineering Process
-Self-assembly
-Directed-assembly
-Interfacial-assembly
-Rheological control
- more

Tunable coating properties:
-Optical property (n, etc)
-Electrical property (σ, etc)
-External field activated property alteration
-Hydrophobic



Robust, self-assembled nanoparticle films



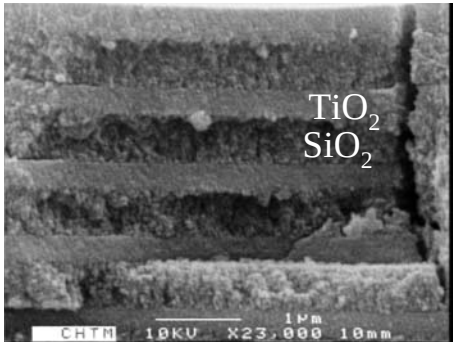
Building blocks with controlled size and shape

Sandia National Laboratories

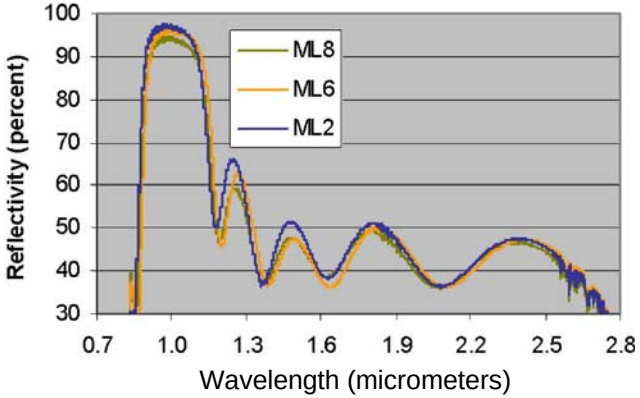
Application of Nanoparticle Coatings to Near Infrared Reflectors (LM-Sandia Shared Vision Project, 2007 R&D 100 Award)

Quarter wave stacking of self-assembled nanoparticle films for near infrared reflectors, overcomes the harsh conditions from conventional processing (CVD, sputtering, etc) with improved functionality.

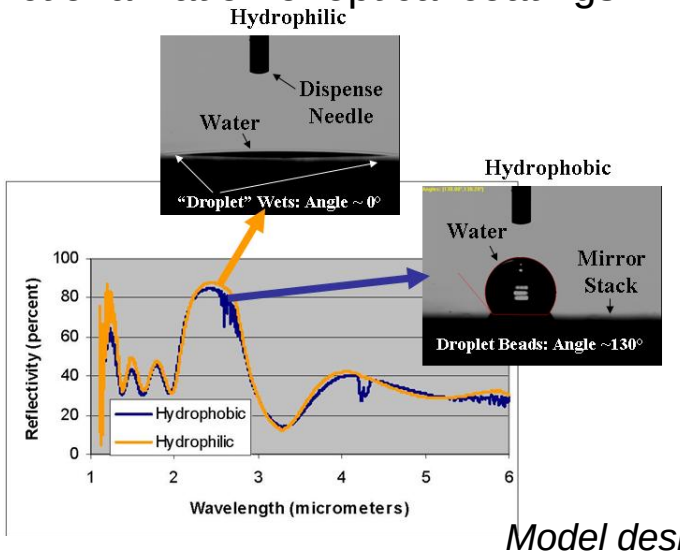
SEM image of quarter wave stacking of TiO_2 and SiO_2 reflector

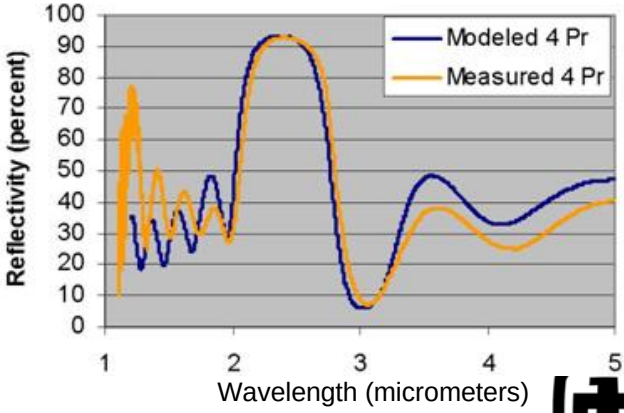


Reflectivity studies show high and reproducible reflectivity over controlled wavelength windows (1-2μm, 2-3μm, 8-12μm, etc)



Functionalization of optical coatings





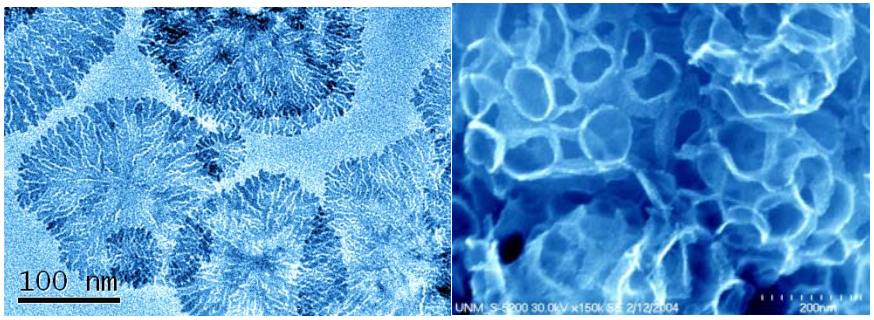
Model design show 99.9% and key manufacturing issue.

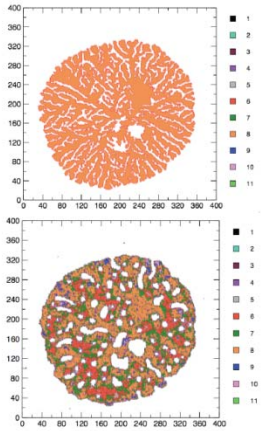
Sandia National Laboratories

Dendritic platinum nanomaterials

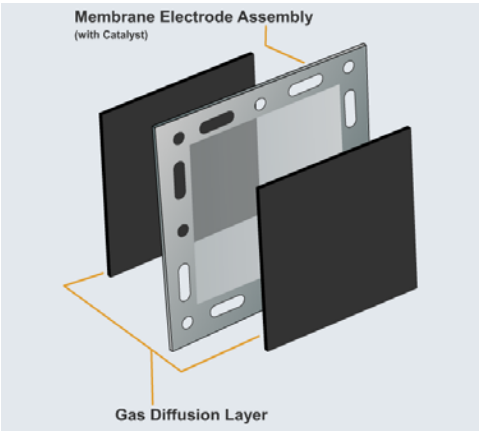
Toyota/UNM

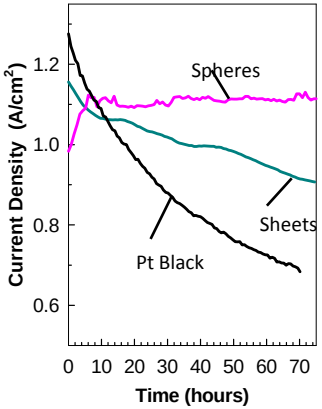
High Performance Electrocatalysts for PEM Fuel Cells





SGL Technologies

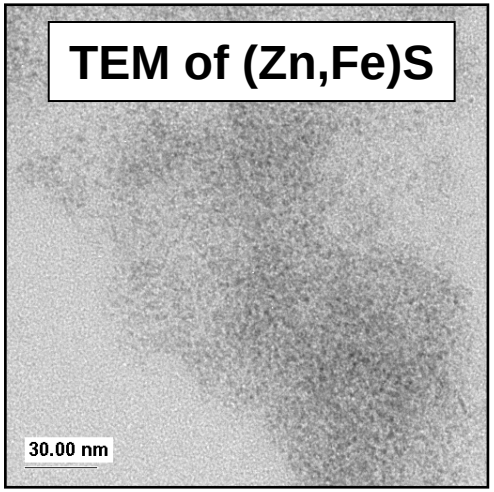




Sandia National Laboratories

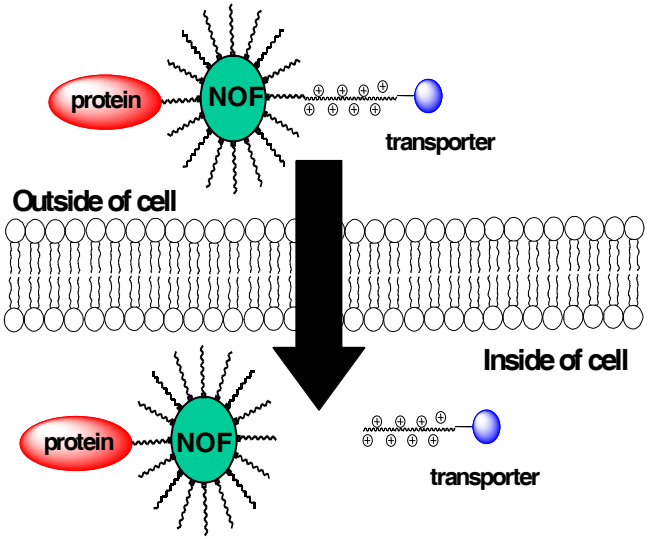
Naturally Occurring Florescent Minerals and Ceramic Probes

- Bio-imaging probes that are tunable, highly fluorescent, non-toxic, and bio-compatible.
- An alternative to quantum dots [CdE (E = S, Se, Te)]
- Collaborative effort between SNL (Boyle) and UNM-SoM (Oliver & Wilson)
- 1st SNL Lead NIH grant!



(ZnFe)S : Sphalerite

Sphalerite nanoparticles



Biofunctionalization & Imaging

Biofunctionalized QD: lipid specific?

***in vivo* studies will include:**

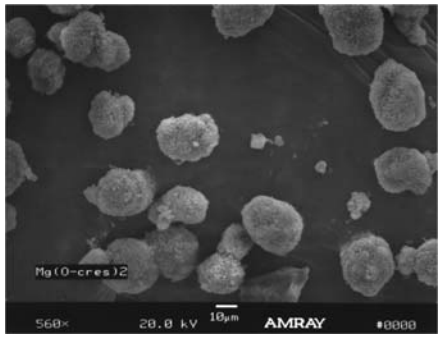
(i) detection of cancer sites, inflammation, and other disease processes

(ii) the delivery and specific release of drugs at disease sites by further manipulation of the chemistry.

UCC/Dow - SNL collaboration had surprising consequences

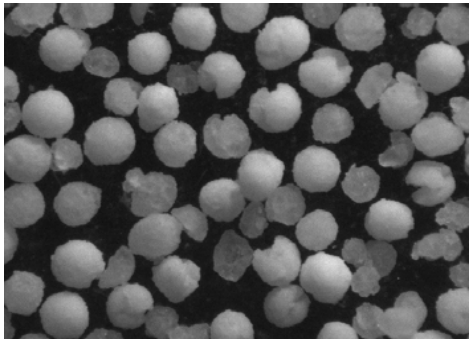
- **Project began with Rick Kemp (then at Union Carbide); Tim Boyle, Jim Voigt (SNL)**
- **Interest is in preparing morphologically-controlled catalyst supports (*i.e.*, spherical) from Mg alkoxides (TJB - chemistry; JAV - precipitation)**
- **UCC/Dow's interests/$$$ was leveraged using DOE-BES interest in metal alkoxides**
- **<u>Totally open relationship</u> between UCC/Dow and SNL on proprietary information**

$Mg(o\text{-}Cresol)_2$



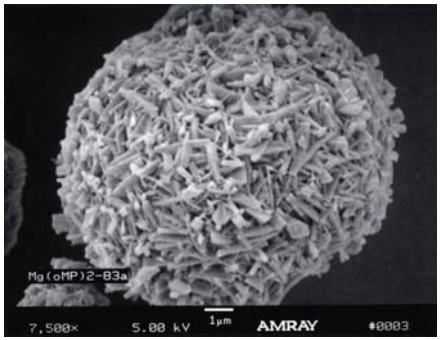
1. Convert to Catalyst
2. Polymerize Propylene

→



i-PP Resin

Closeup of $Mg(o\text{-}Cresol)_2$ Particles

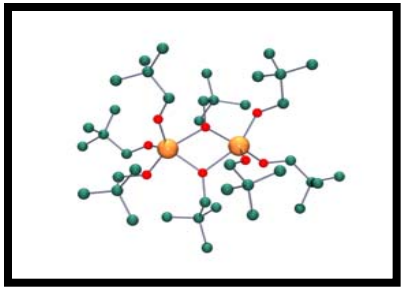


<u>Project Status:</u>

Spherical Catalyst Precursors
Meeting Dow Performance Targets
Prepared Using a Variety of Routes
Developed by SNL

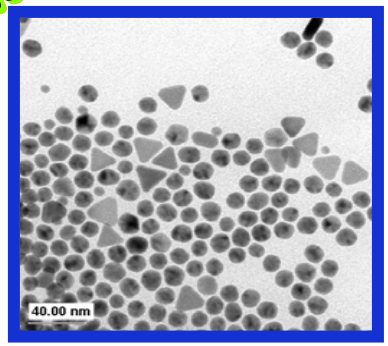
Sandia National Laboratories

Beaux, the wonder dog has been kidnapped – we need to use 'science' to find him



Chemistry

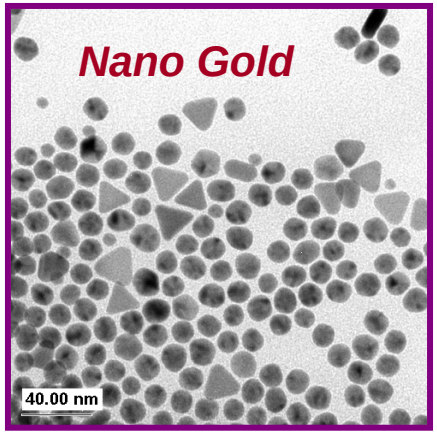
Glowing Materials

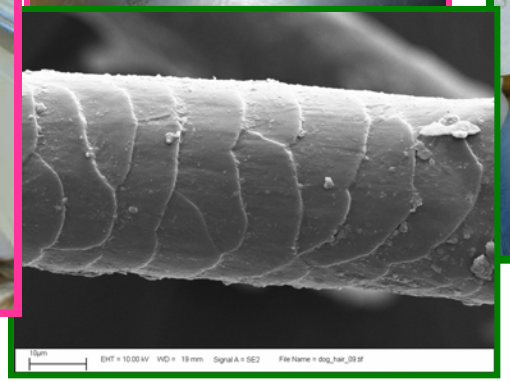


Nanomaterials

Sandia National Laboratories

Several scientific techniques are required to “solve” the crime





Sandia National Laboratories

Science is fun. Science is exciting. Science is used in many ways.

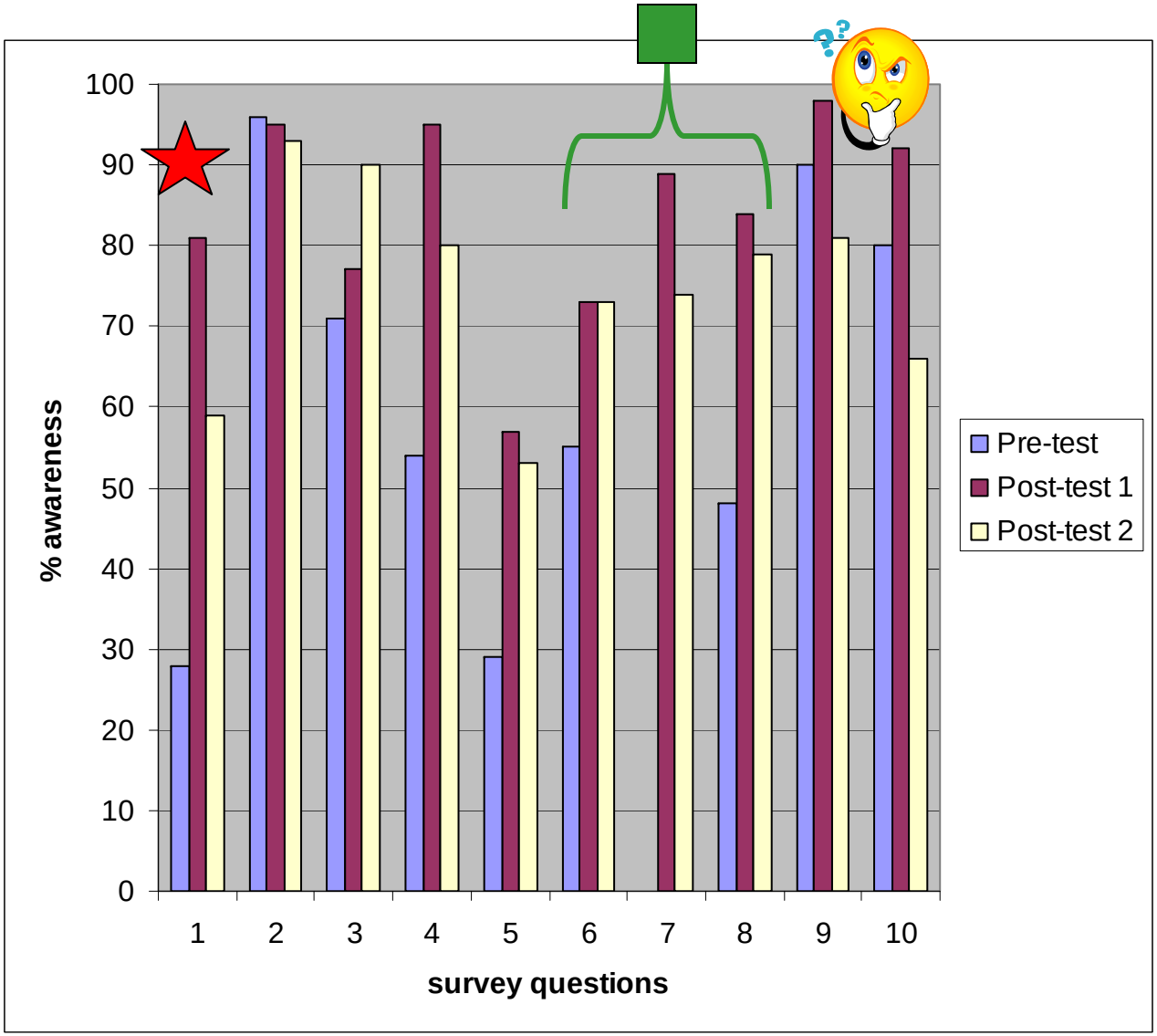
Liquid Nitrogen Ice Cream

NM Fire Training Academy

Sandia National Laboratories

We have "graduated" 130 3rd – 5th grade Junior Scientists

We have changed scientific awareness in 3rd – 5th graders



Questions:

1. SCI/ENG Community INTERACTION
2. SAFETY
3. SCIENTIFIC METHOD
4. ACID BASE
5. FIBERS
6. NANO: bigger
7. NANO: color
8. NANO: smaller
9. Likes Science
10. Good at Science

Sandia National Laboratories

Views on collaborations can be distilled from different experiences

Collaborations must be valued at every level of the corporation, university, laboratory, etc. *(the zipper analogy)*

Similar views on *(fill-in the blank)* enhance collaborations

Collaborations come in many different forms

Strong networking before, during and after the “collaboration” is essential

There is no single pathway toward a successful collaboration

For a successful collaboration, both partners need to contribute (equally)

Success breeds success

Sometimes, collaborations start with your office mate

Success in any endeavor requires collaboration!

Sandia National Laboratories

Thanks! - Questions?

Sandia National Laboratories

Sandia
National
Laboratories

Sandia
National
Laboratories

Electrostatic Microvalves

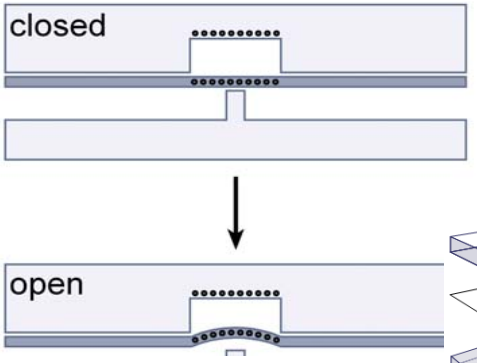
Goal:

COMBINE the speed and low power of electrostatic actuation with the performance of pneumatic actuation in microvalves

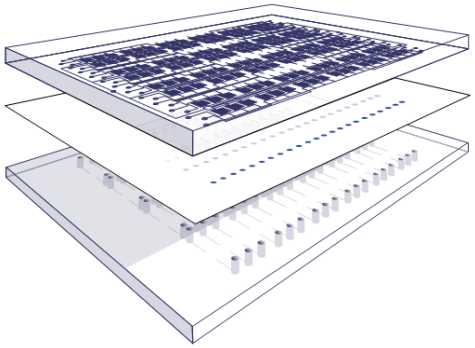
Key Features:

- **Computer analysis of microvalve actuation for optimal performance**
- **Fabrication of microvalves in single and array modes, focussing on continuous roll processing**
- **Use of Microvalves in microfluidic array to demonstrate superior speed and sealing**

Actutate-to-open



Putting new microvalve concept



With existing microflu platform for improved performance

Technical Approach:

Use of conductive nanoparticles within a flexible matrix to maintain high conductivity throughout range of valve motion

Technical Challenges:

- **Particle to particle contact must be maintained in order for valve to operate correctly**
- **Valve must be small and robust enough to be integrated into microfluidic platform**
- **Use of microarray to grow proteins for TEM analysis must survive TEM environment (microarray as well as proteins)**

Collaborative Effort

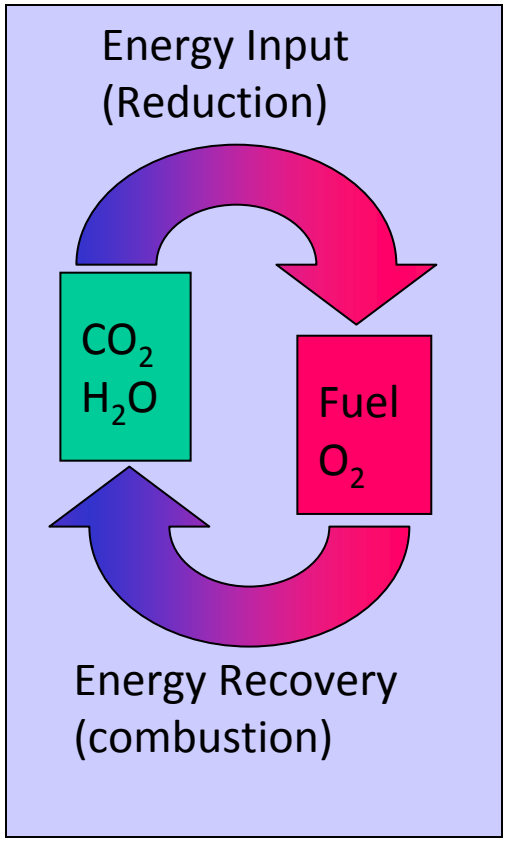
Sandia National Laboratories: Microdevice Fabrication Group, Materials Characterization Group, Multiphase and Nanoscale Transport Group

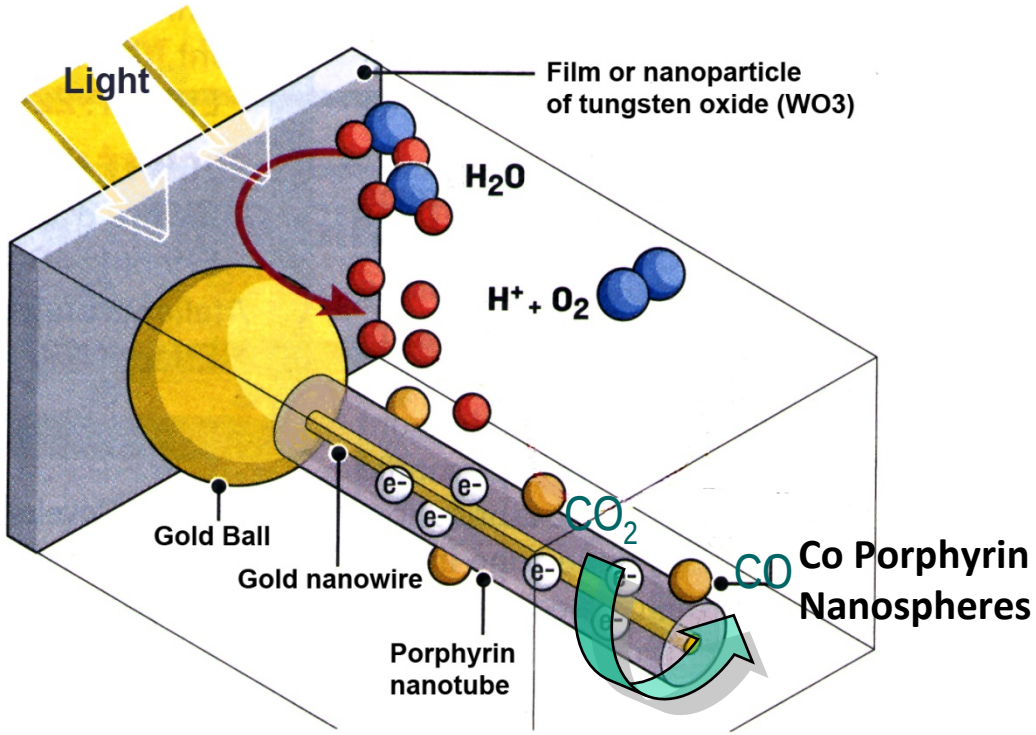
University of Illinois at Champaign-Urbana Kenis Microfluidic Group

ITN Energy Systems New Products Division

UC Davis/UNM

Prof. Neil Schore, Prof. Craig Medforth





- **Nanodevice for Conversion of CO_2 to CO and O_2.**

- **CO_2 to fuels**

Sandia National Laboratories