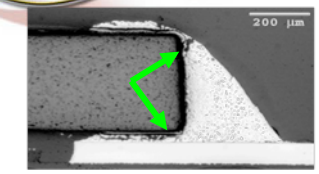
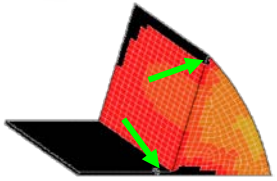
Simulations of Weld Aging

SAND2012-1554P

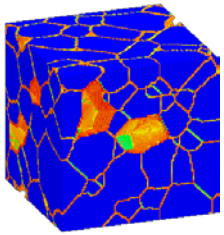


1000 cycles

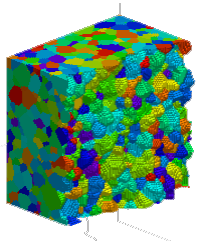


fatigue failure

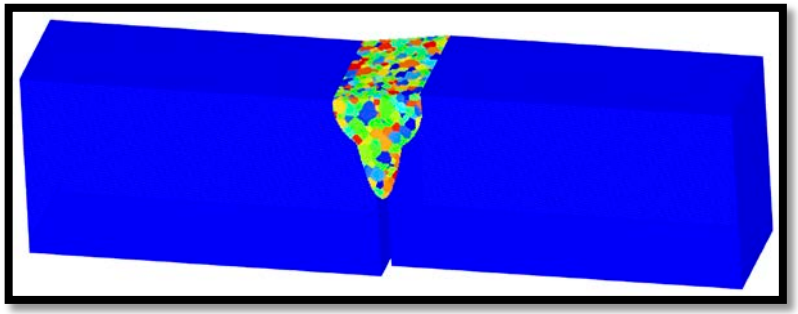
microscale plasticity



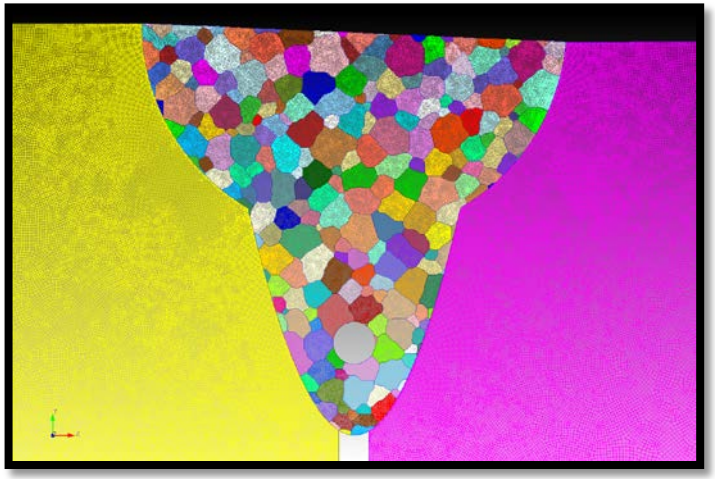
solute diffusion and pore migration



brittle fracture



Microstructure in a 3-D Weld



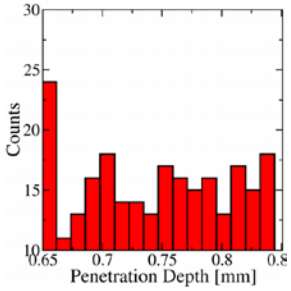
Microstructure and Pore in a 2.5-D Weld

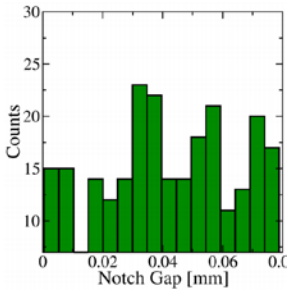
Goal: Optimize materials properties over the lifetime of the system

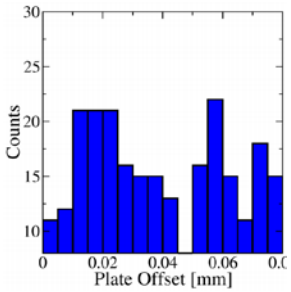
- **Processing:** ***shaping and forming, annealing, solidification, joining, …***
- **Service:** ***mechanical, electrical, and magnetic properties, hermeticity, …***
- **Aging and reliability:** ***substructure evolution, lifetime prediction, …***
- **Failure:** ***ductile and brittle fracture, fatigue cracking, breakdown, corrosion, …***

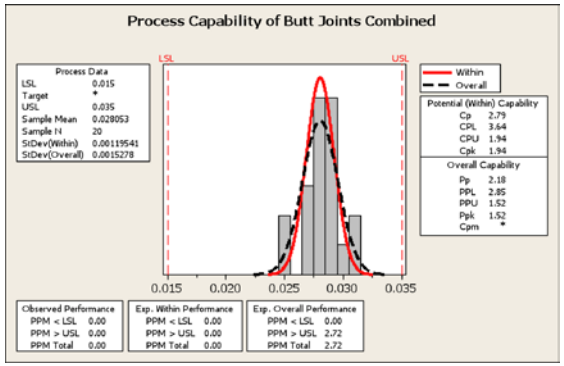
Simulations of 304L Weld Variability

- 250 simulations performed on randomized geometries
- Geometrical variables informed by measurements

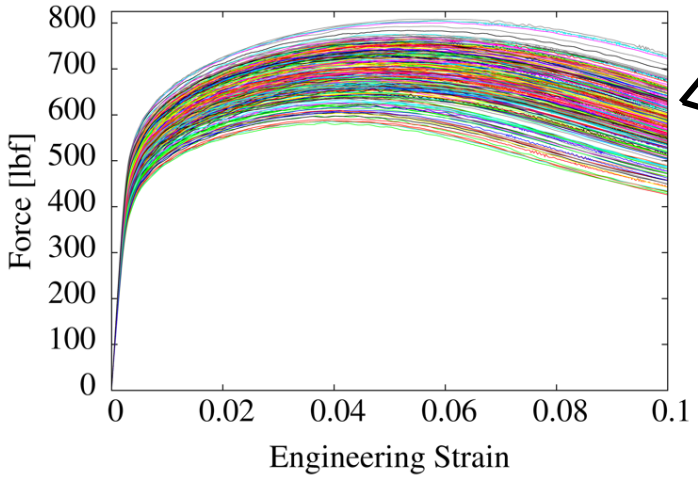


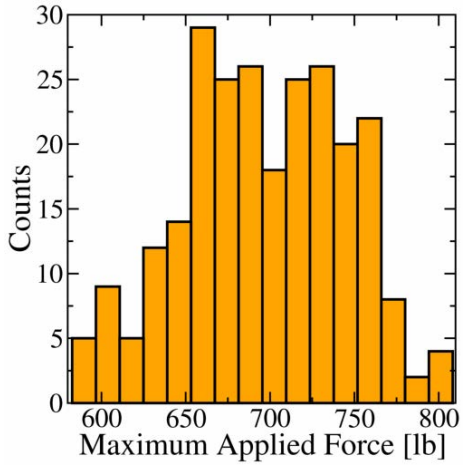


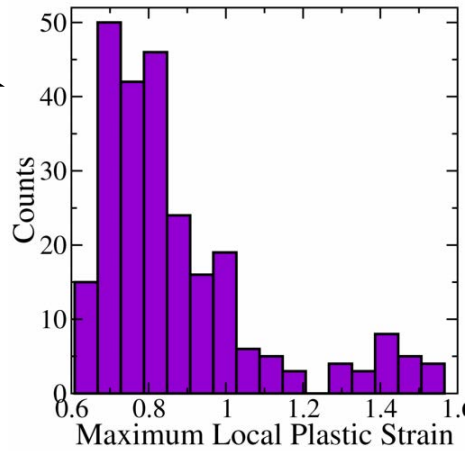




Typical penetration variance for production laser welds (*courtesy J. Samayoa, Kansas City Plant*)





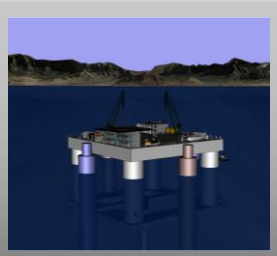


The method provides a means for quantification of property *variability*

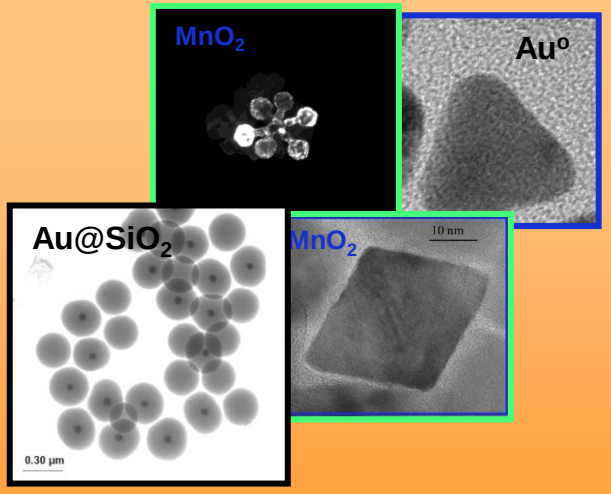
Sandia National Laboratories

Our ability to make a wide range of materials and morphologies allows a wide range of application

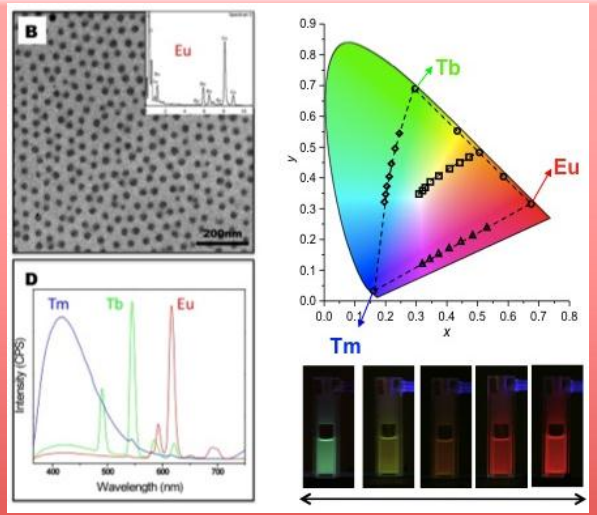




Corrosion resistant, anti biofouling coatings for Marine Hydrokinetic applications

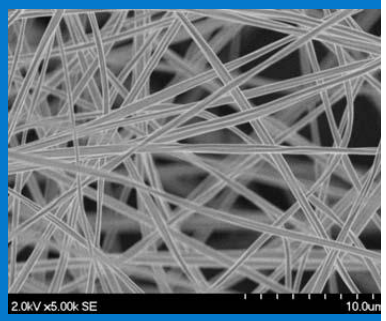


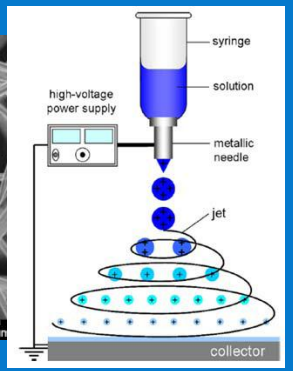
Nanoparticles for composite materials and as active sensors



Polymer nanoparticles with controlled additions of rare earth elements allow tunable emitted color

Electrospun fibers and fiber mats for battery electrodes

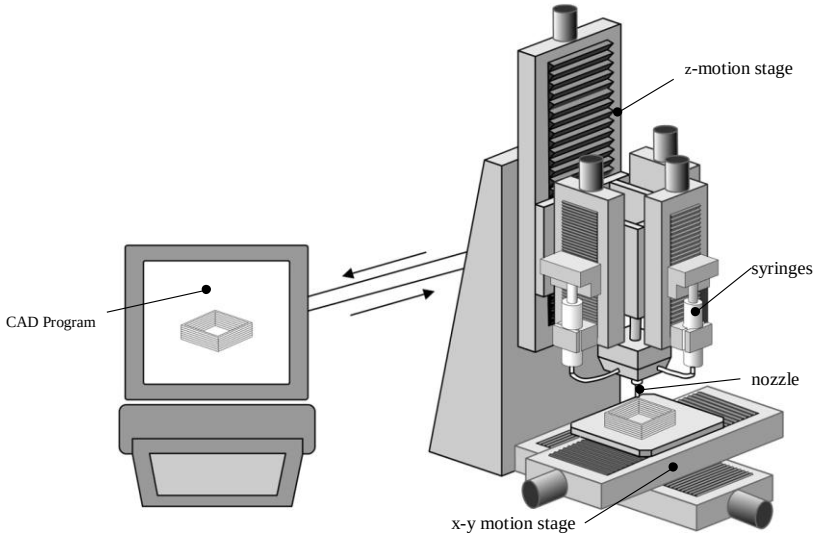




Sandia National Laboratories

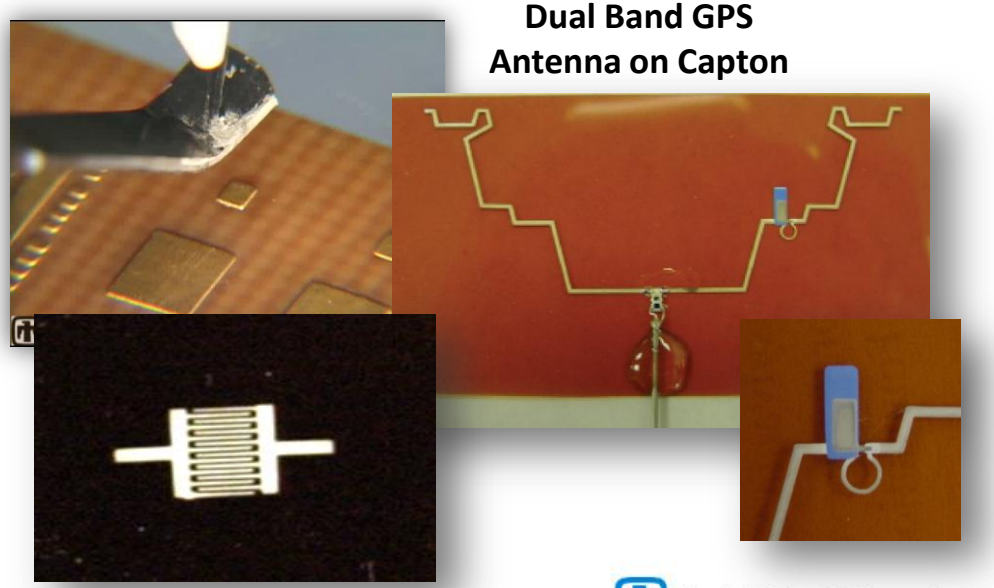
Our "Direct Write" capability is unique within the DOE complex

Computer controlled robotic deposition of custom and COTS ceramic slurries and metal "inks" allow fabrication of ceramic parts that could not be obtained through conventional ceramic processing.



Conductive lines and electrical components can be printed on almost any substrate with room temperature "curing." Features on the order of 20µm can be "printed" with only 4X bulk resistivity.

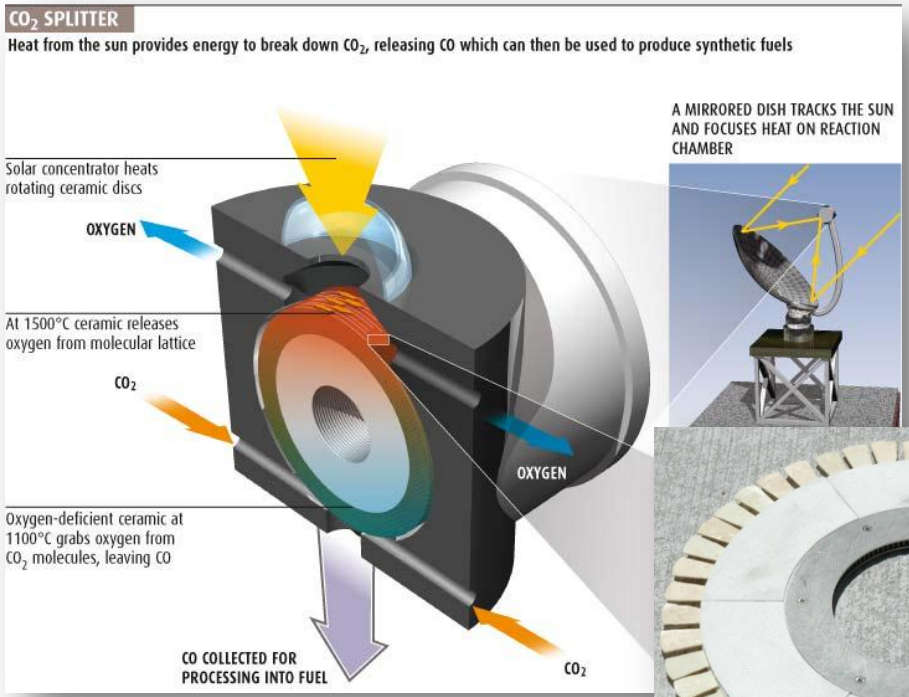
Dual Band GPS Antenna on Capton

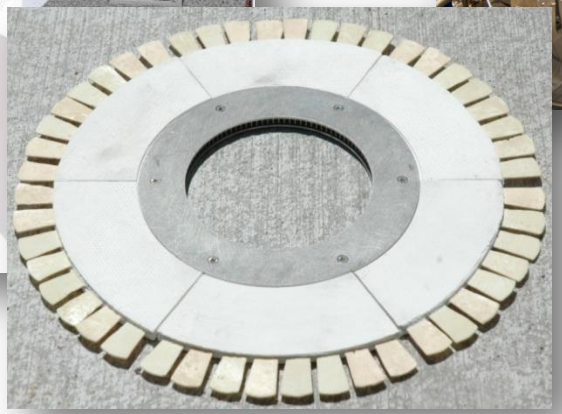


Sandia National Laboratories

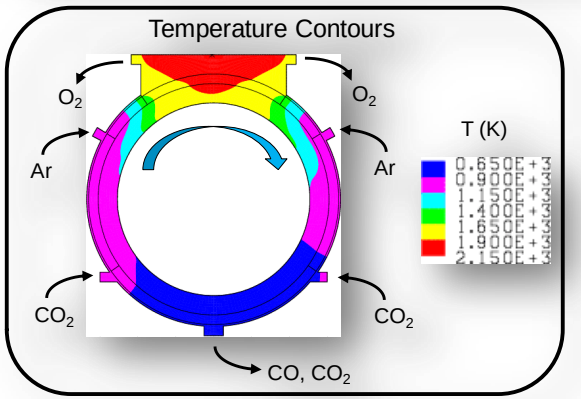
The "Sunshine to Petrol" (S2P) Grand Challenge brings together a variety of Sandia capabilities

Basic Premise: ***Sunlight + CO_2 + H_2O → Fuel + O_2***





Catalytic ceramic fins are the key to the necessary reactions



By collaborating with several universities and industry partners, we have assembled the capability to move this concept from the lab-scale to a commercial-scale demonstration.

Sandia National Laboratories

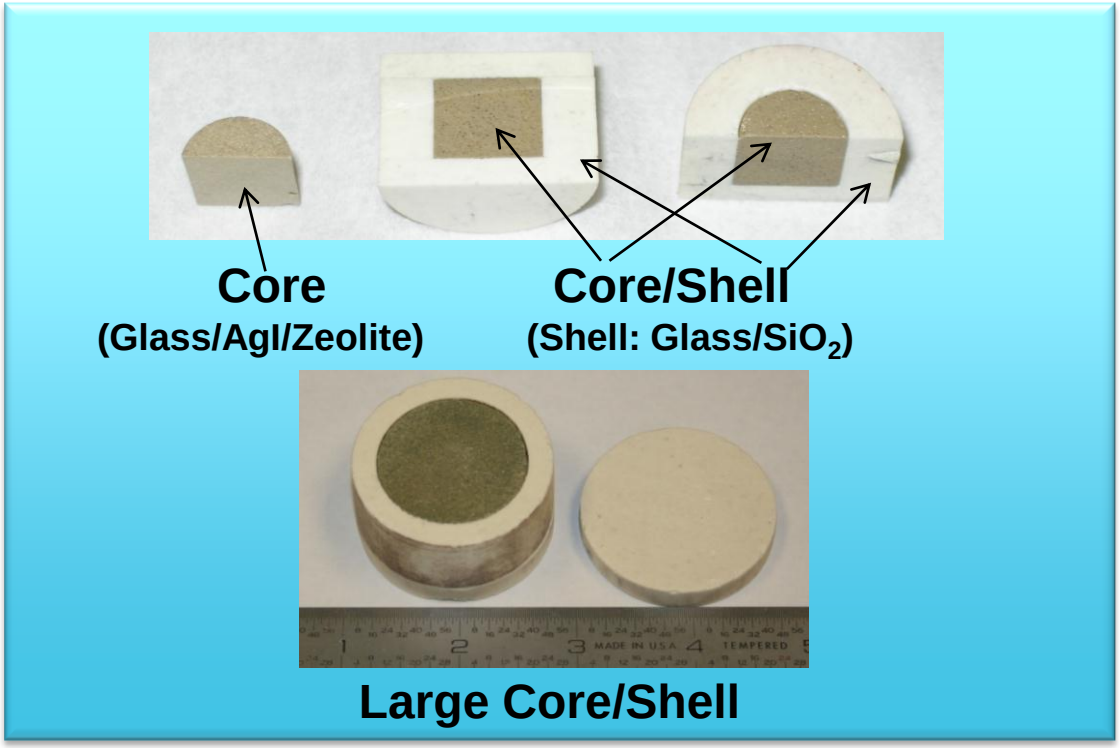
We have developed a new ^{129}I waste form by encapsulation in a low sintering glass and then forming a core/shell structure.

^{129}I from used nuclear power plant fuel must be safely stored for millions of years due to its long half-life (~17 million years) and its toxicity to human and other life.

Utilizing our ceramic processing expertise:

- ceramic fabrication
- constrained sintering
- composite processing

We have developed a waste form for ^{129}I that consists of a core containing the ^{129}I encapsulated with a durable glass that is surrounded by a shell of the same glass mixed with silica to match the CTE of the core. The shell protects the core from the environment. The structure is densified by sintering at a low temperature where AgI is stable.

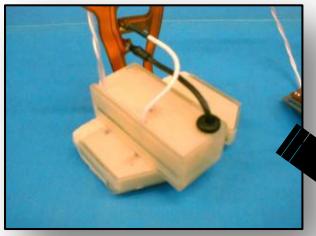


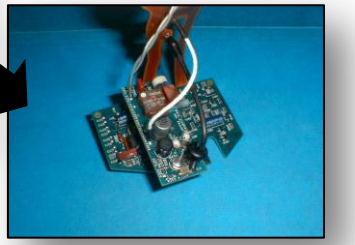
***accepted for pub. J. Am. Ceram. Soc.**

Sandia National Laboratories

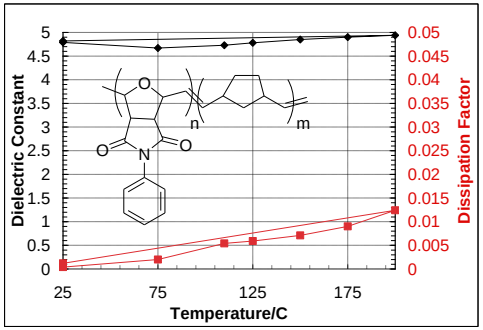
Polymer Materials

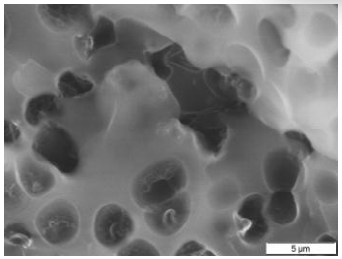
- Foams
- Encapsulants
- Porous Materials
- Polymer Gels
- Composites
- Deterrent materials
- Supercritical fluids
- Sensors
- Novel Dielectric Films
- Nanocomposites

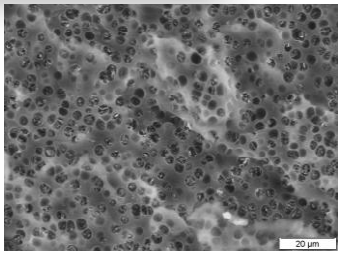




Removable Encapsulants

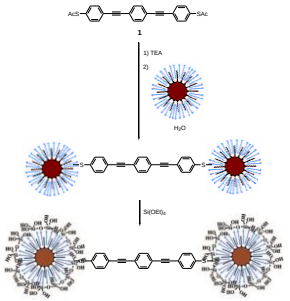






Phase Separated Foams for Sensors are studied using Combinatorial Chemistry

Foams For Nuclear Safety



Chemoselective Sensor Materials

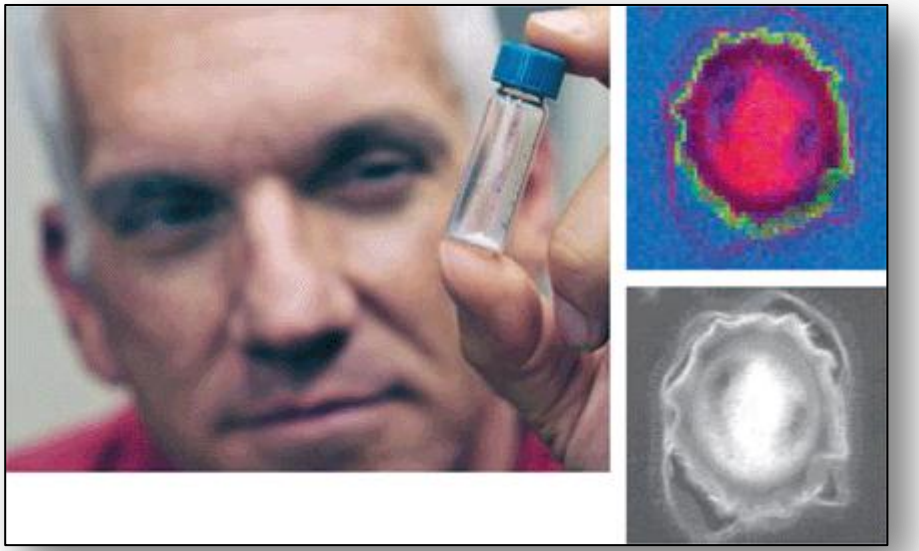
Sandia National Laboratories

Deterrent Materials

Sandia National Laboratories

Forensic Contributions to the Anthrax Investigation

When the attacks occurred, the FBI looked to the SNL characterization group for help.



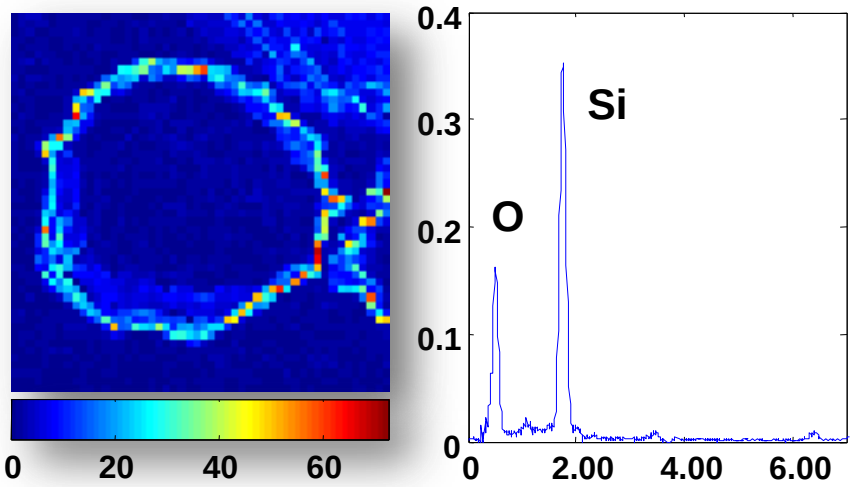
- **Nm-scale microanalysis linked production method of attack materials**
- **Microanalysis/spectral imaging was crucial evidence in the FBI's investigation**

Sandia National Laboratories Makes Key Contributions to Anthrax Investigation

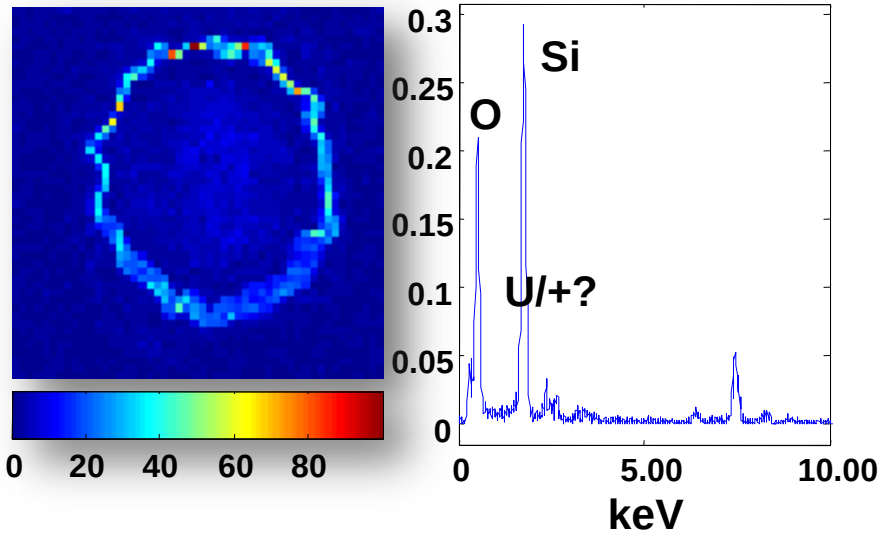
Sandia National Laboratories

FBI's Amerithrax Investigation (TEM)

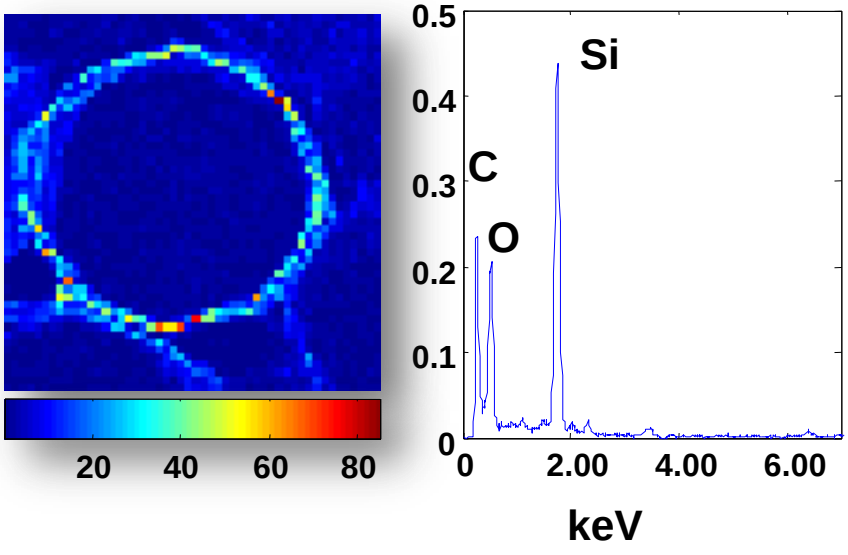
Leahy Material



Daschle Material



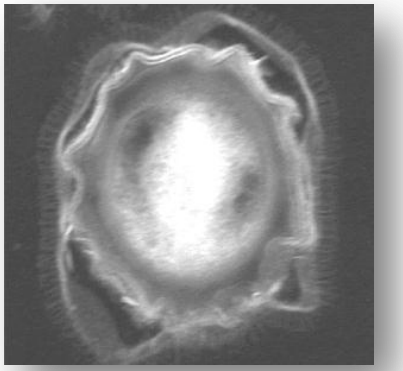
New York Post Material



nm-scale microanalysis links production method of attack materials

Microanalysis/spectral imaging gives us the context, the "where and what is it?"

No prior information needed



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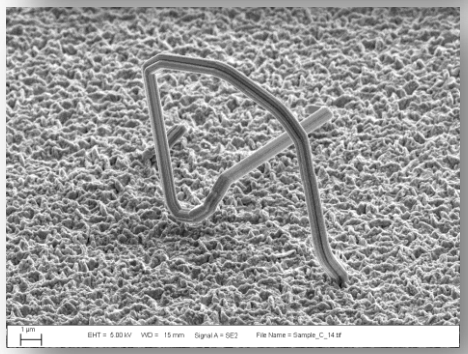
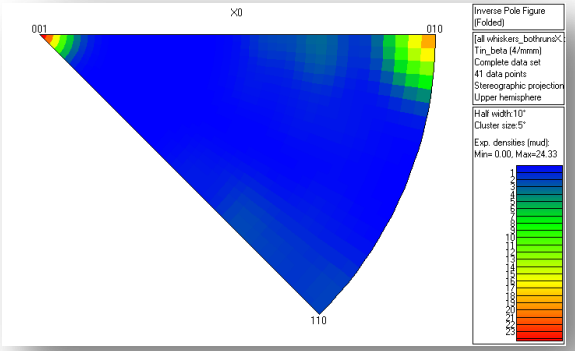
Tin Whisker Research

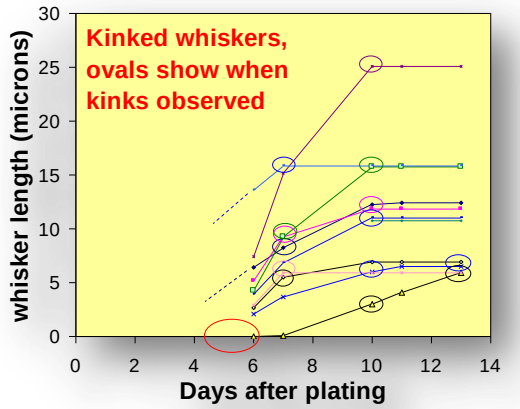


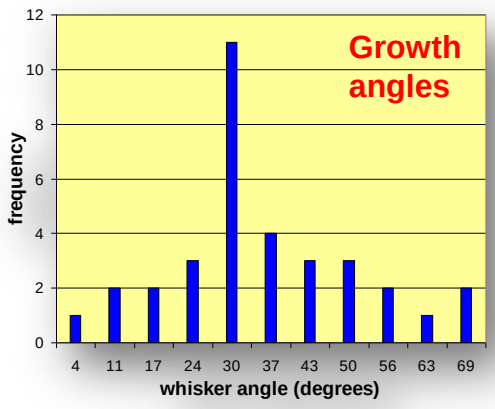


Crystallographic growth directions

Conductive Sn whiskers are a microelectronics reliability concern (possible short-circuits & debris generation). Their importance has increased with more use of Pb-free finishes. We are developing an understanding of the underlying mechanisms that control Sn whisker nucleation and growth.

- We determined the room temp. growth kinetics of whiskers through novel time-lapse SEM and found that *the kink process is associated with growth stoppage.*
- Electron backscatter diffraction (EBSD) was used to determine the major crystallographic growth directions.
- We developed techniques to measure growth *angles* by SEM and laser scanning confocal microscopy (LSCM). *30˚ growth angles appear important.*
- Developed conceptual model based on grain boundary diffusion anisotropy.
- Journal & conference papers/presentations.





Sandia National Laboratories

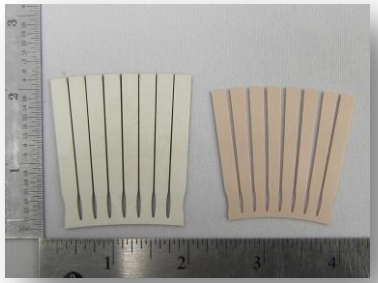
Ceramic and Glass Science & Technology

Technologies/Deliverables

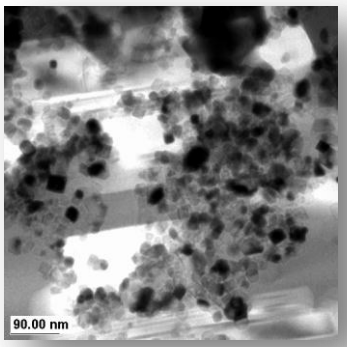
- Ceramic Materials and Processes R&D
- Dielectric Characterization
- Glass Melting and Sealing
- Sol-Gel Glasses
- Cermets
- Neutron Generator Process Development
- Neutron Generator Production Support

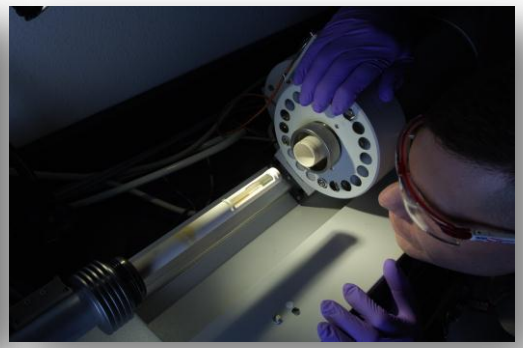
Tape Casting

CeO_2 fins for Sunshine to Petrol Prototype Reactor

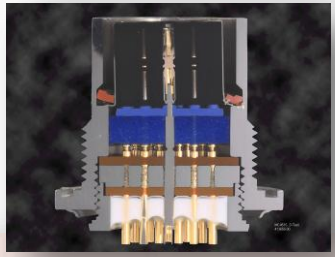


Ceramic Processing





Ceramic & Glass-to-Metal Seal Products



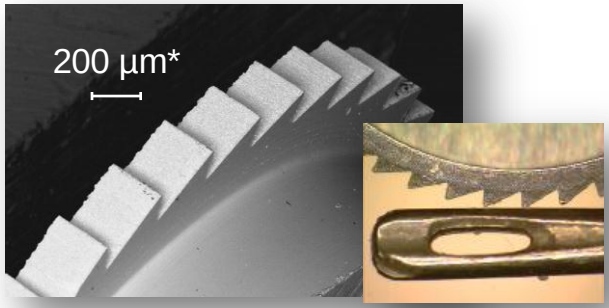
Sandia National Laboratories

Meso-Scale Manufacturing

Technologies/Deliverables

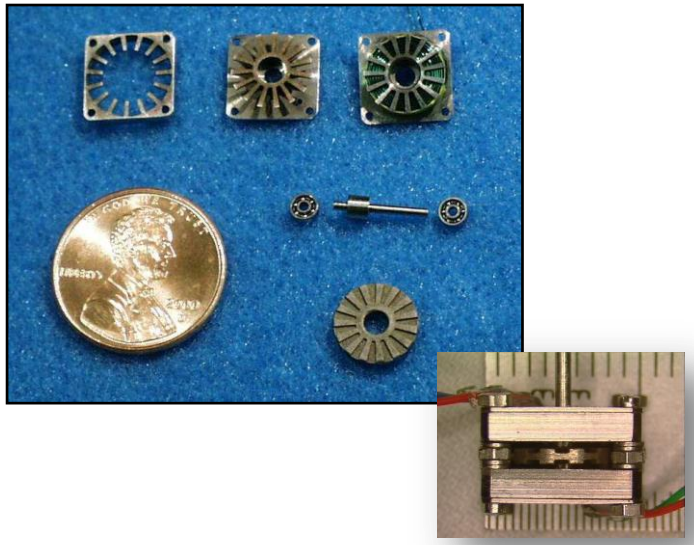
- Design/Fabrication of Miniature Devices
- Meso-Scale 2 ½ D Metal Components
  - ❖ *e.g.*, stronglink mechanisms
- Precision Diamond Turned Components
- Precision Electrical Discharge Machined Components
- Femtosecond Laser Machining
- Micro-Metrology
- Process & Materials R&D, Technical Consulting

Stainless Steel Gear

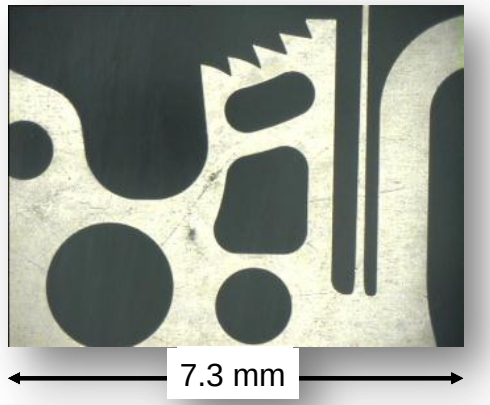


**** Typical human hair is 50-150 µm in diameter***

Miniature Stepper Motor



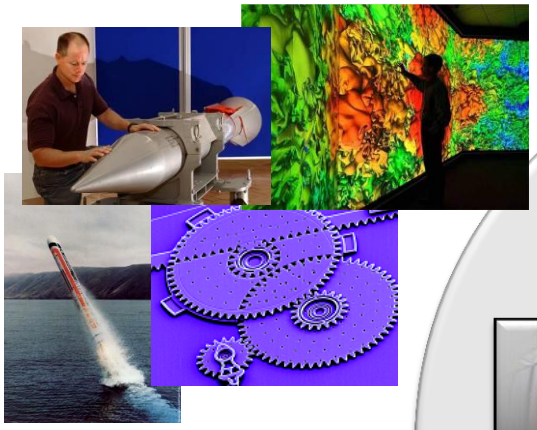
Miniature Parts



Sandia National Laboratories

Science, Technology, and Engineering Supports Sandia's Mission Areas

Nuclear Weapons



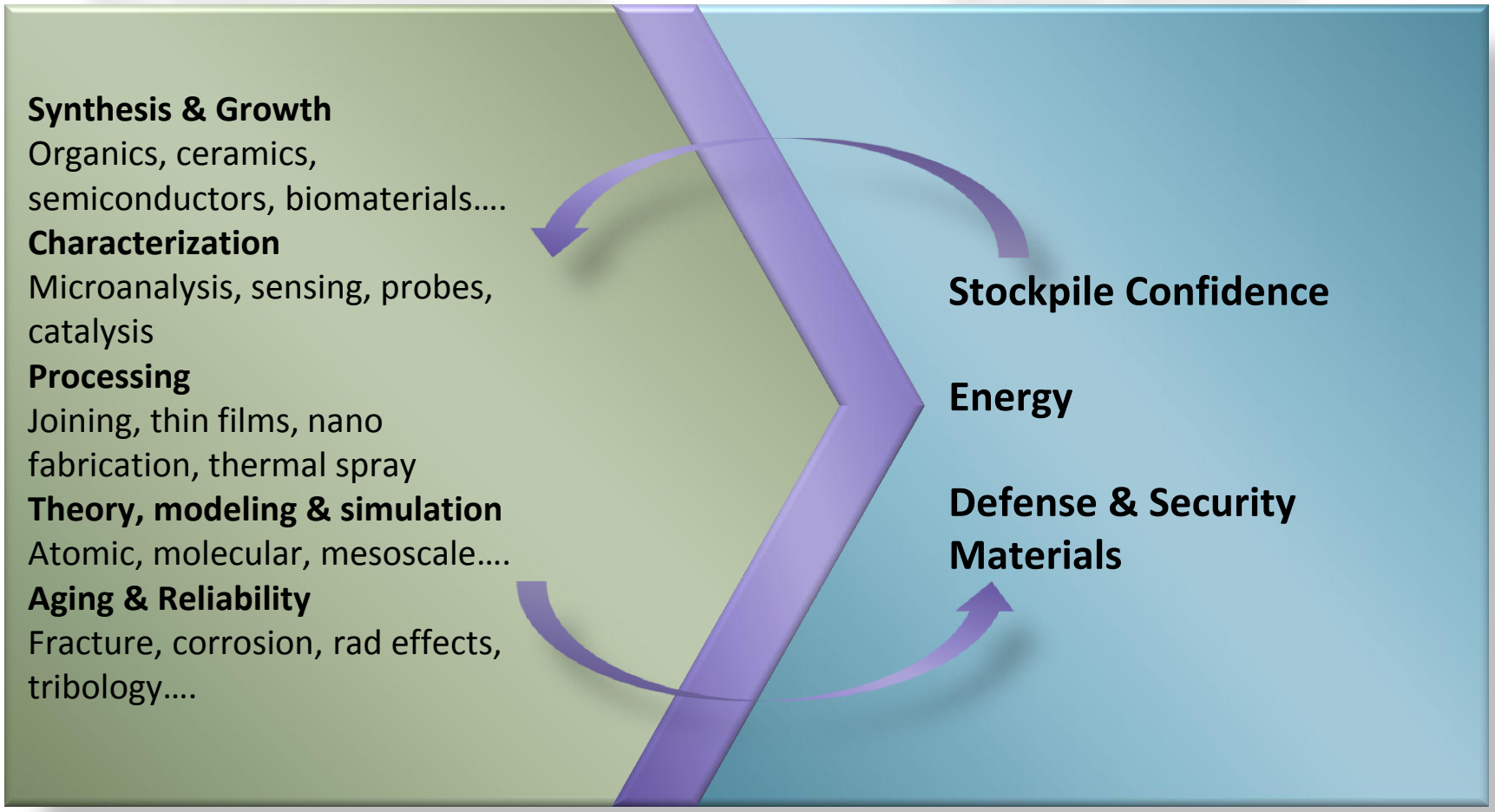
Defense Systems & Assessments

Science, Technology & Engineering

Energy, Climate, & Infrastructure

Homeland Security & Defense

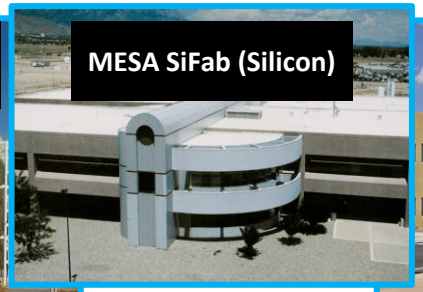
Our *Strategic Directions* build from our key competencies & inform our investment decisions



Sandia Materials Science and Engineering Facilities

Five main materials science locations, and related facilities, with extensive, state-of-the-art laboratory capabilities

MESA = Microsystems Engineering, Science, and Applications



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