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Materials Science and Technology Overview

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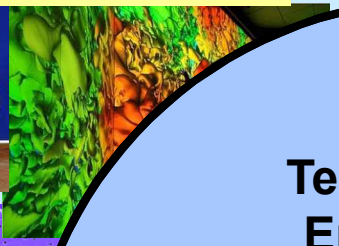
Science, Technology, and Engineering Supports Sandia's Mission Areas

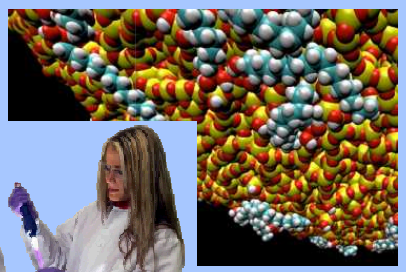
Nuclear Weapons

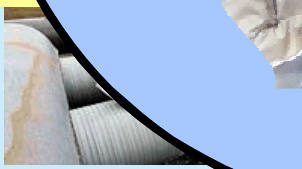
Defense Systems & Assessments



Science, Technology & Engineering


Energy, Clim… Infrastructur…

…land Security & …nse




Materials S&T is a critical foundational capability

What materials does for the Labs (value proposition)

- Provide the materials science, technology, and engineering necessary to support the broad range of lab programs (people, technical capabilities, facilities)
- Lead key programs for the Labs:
  - NW – Enhanced Surveillance, AAR Red Team, Enhanced Surety S&T, QASPR, DOI, B61 LEP Materials Reviews, AAR Materials S&T
  - ECIS – Office of Science: BES Materials, Center for Integrated Nanotechnologies, Joint BioEnergy Institute, Solid State Lighting Science EFRC; OE: Energy Storage
- Create new science and technology breakthroughs that can be the basis for developing new programs

New MS&T leadership, committed to multi-organizational partnership

MATERIALS SCIENCE & TECHNOLOGY COUNCIL

Materials Science & Engineering Center

Carol Adkins
1800 Director
Council Chair

Physical, Chemical & Nano Sciences Center

Charles Barbour
1100 Director
Council Co-Chair

Biological & Materials Sciences Center

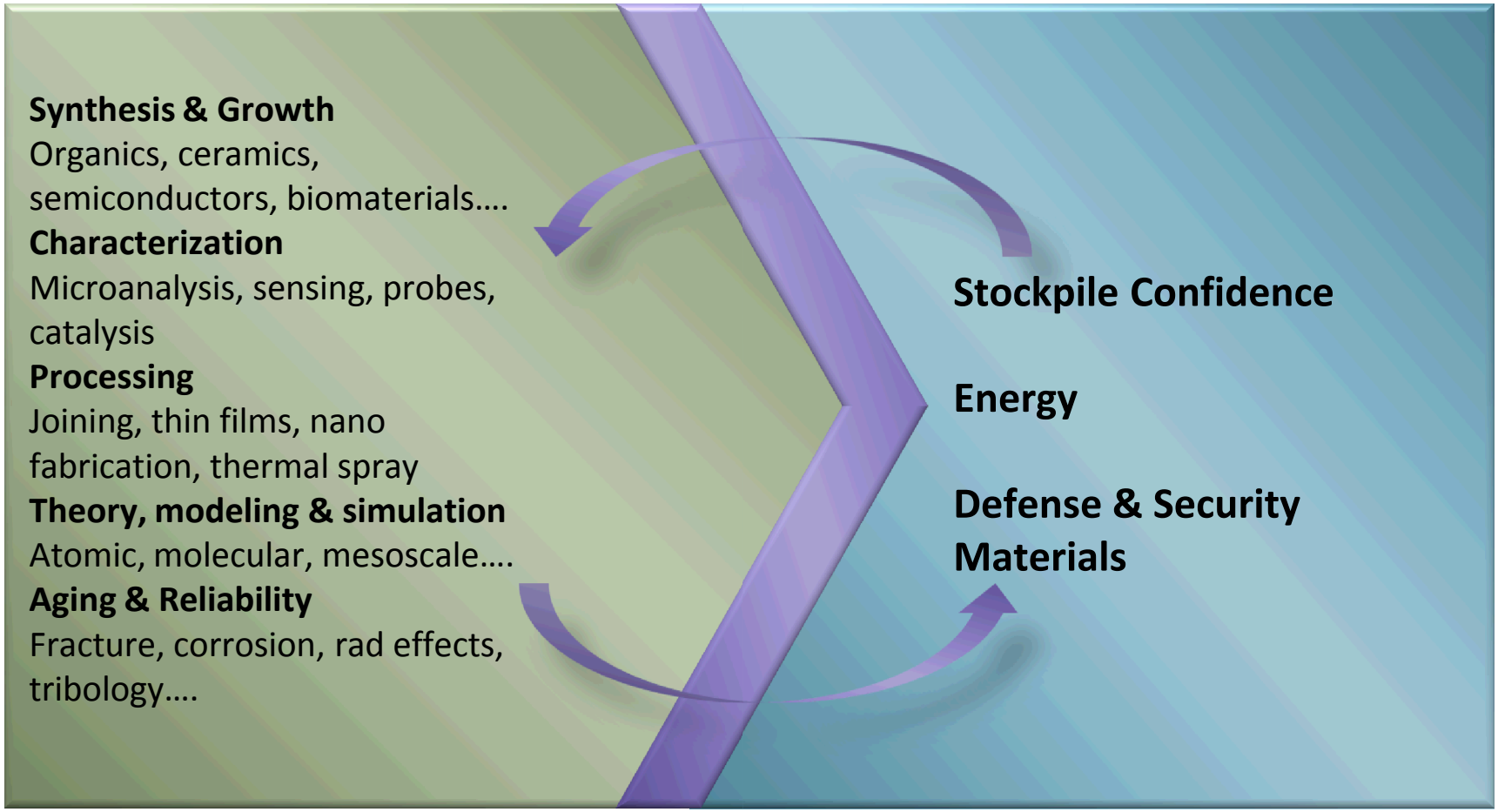
Glenn Kubiak
8600 Director*
Council Co-Chair

The Council stewards the materials effort to ensure our ability to meet current and future mission needs and sustain a robust capability

*Coordination for all CA materials S&T

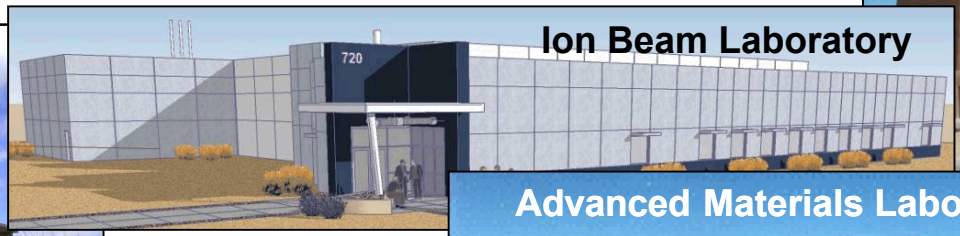
Sandia National Laboratories

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



Unique facilities have been established…

MESA = Microsystems Engineering, Science, and Applications



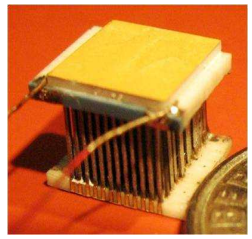
Sandia has extensive, in some cases unique, state-of-the-art laboratory facilities for materials growth, microsystems fabrication, semiconductor processing, and structural, electronic, and optical materials characterization

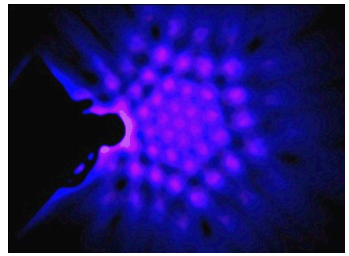
MS&T work increasingly supports ECIS strategy

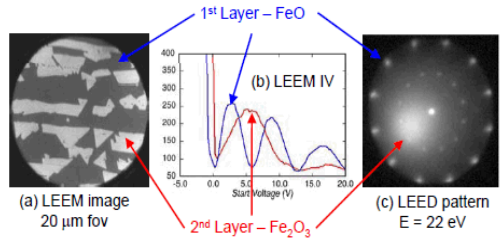
1. **Energy Conversion and Utilization**
   - High efficiency LED materials for SSL
   - Thermoelectric element for recovery of very low grade thermal energy
   - Unique Low Energy Electron Microscopy experiments give insight into materials for S2P reactor

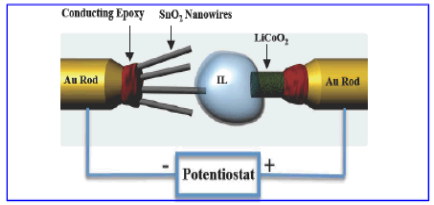
2. **Energy Storage Materials**
   - Coordinate multi-lab OE energy storage R&D
   - Single nanowire, Li-ion battery real time studies of electrochemistry at atomistic length scales in a TEM (*Science*, Dec 10, 2010)
   - Demonstrated new Na battery chemistries proposed for stationary storage: Na halide and Na insertion compound

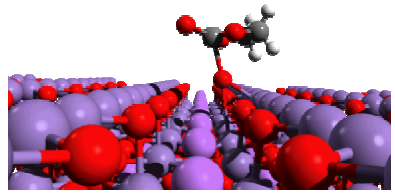
3. **Materials Reliability for Energy**
   - Multi-scale modeling for understanding of Li-ion battery response to abusive conditions
   - Materials for strain sensors for wind turbines







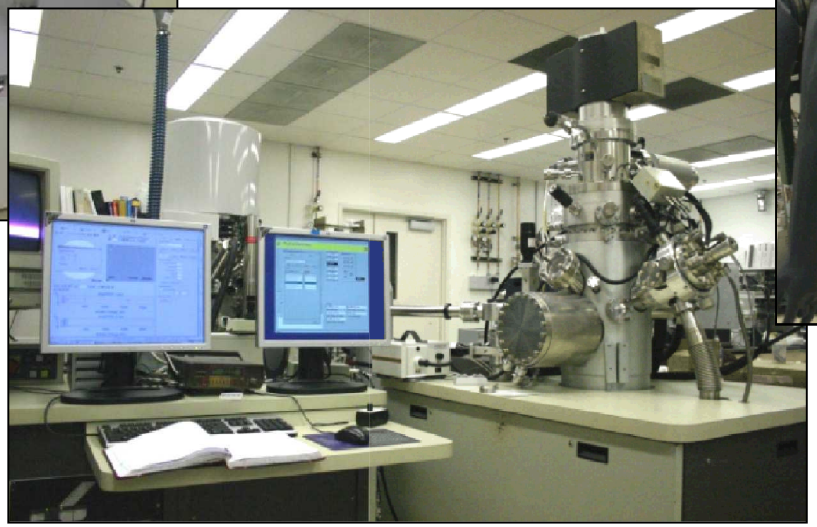




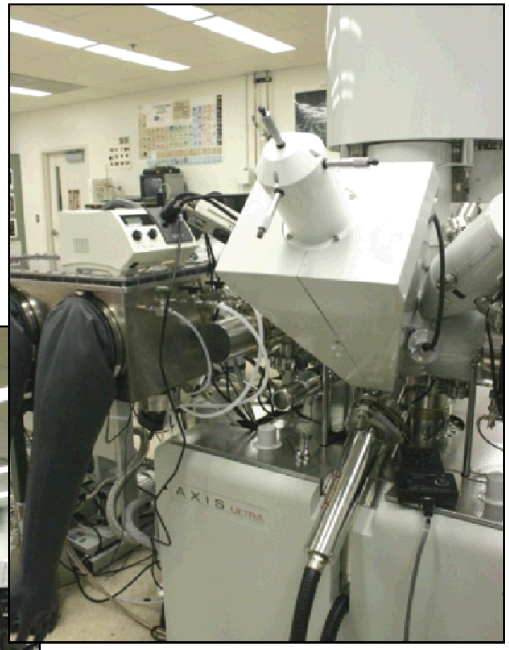
Sandia National Laboratories

Materials Characterization - Example: Surface Analysis Laboratory

Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS)
Tony Ohlhausen



Auger Electron Spectroscopy (AES)
Bill Wallace



X-ray Photoelectron Spectroscopy (XPS)
Mike Brumbach

State–of–the–Art capabilities to characterize surfaces/surface chemistry

Enhanced Capability Coming on line Next Year: Aberration Corrected-TEM

Sub-nm elemental analysis & Sub-Å imaging resolution

- ***Interfaces are often the locus of materials properties changes***
- Current instruments lack required microanalytical sensitivity and resolution ***below 1 nm***

  Early aging structural/chemical changes are likely manifested at such length scales

- **New AC-TEM instrumentation will allow:**
  - **Understanding of effects of aging sooner with more sensitivity**
  - **50-100x better sensitivity/resolution +30X faster analysis**
  - **Microanalytical spatial resolution limit of 1-2Å**

Sandia National Laboratories

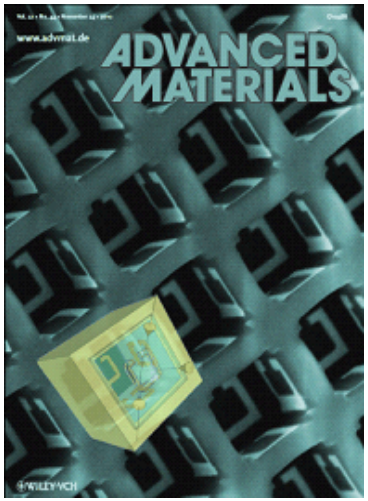
Innovation continues to drive the creation of new impacts and programs

Ion Beam Lab

Joint BioEnergy Institute

Sunshine to Petrol (S2P)

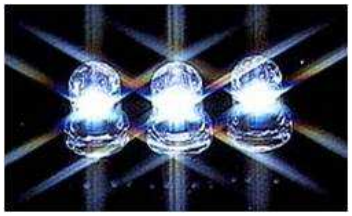
Center for Integrated Nanotechnologies



Metamaterials

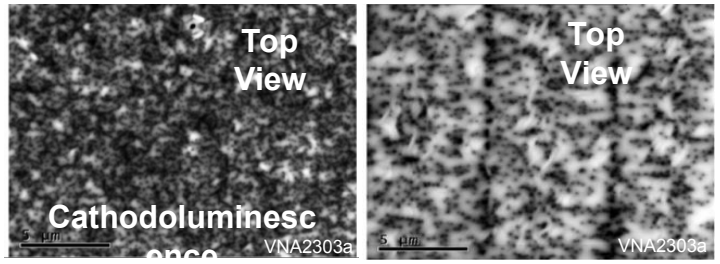
Consortium for Advanced Simulation of Light Water Reactors

8 R&D 100 awards in 6 years

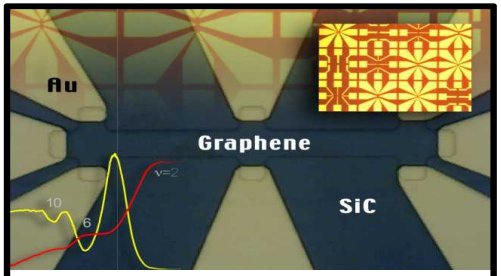


Solid State Lighting ERFC

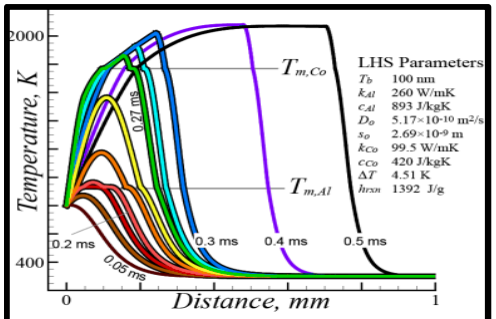
2010 was a year of significant technical accomplishments for MS&T



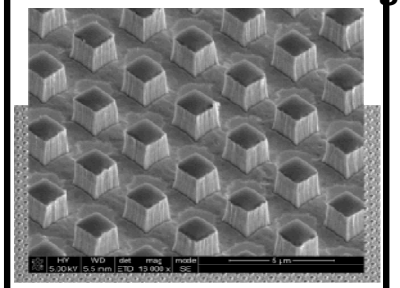
AlGaN grown on planar and patterned region



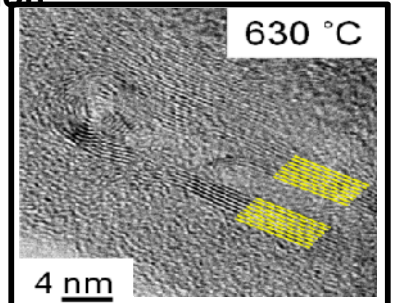
Graphene research



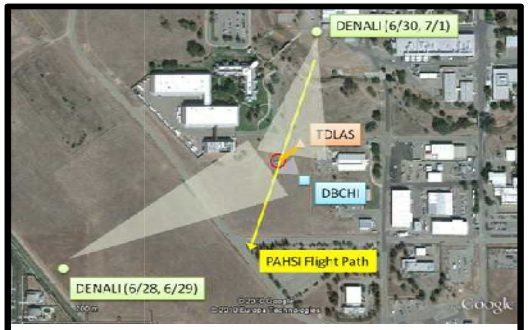
exothermic thin films



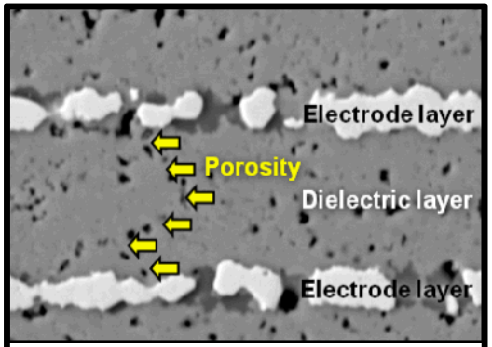
1st ever all-dielectric IR metamaterial



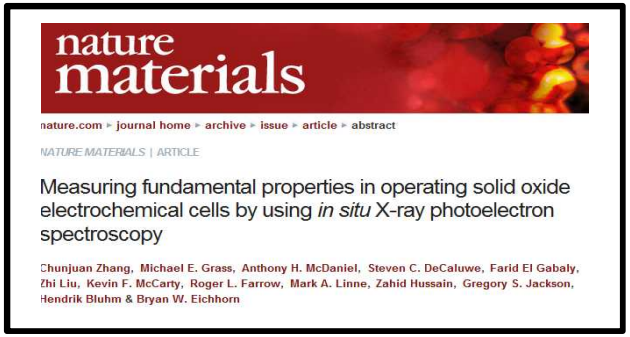
controlled carbon nanotube growth

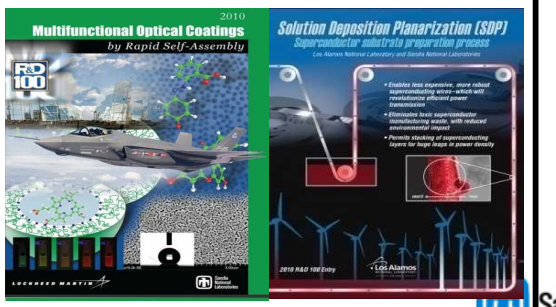


Chile cook-off



dendritic capacitor





R&D 100 Awards

Sandia National Laboratories

External partnerships are key to advancing and strengthening our capability base

- **LANL (CINT)**
- **Leadership of EFRC for Solid State Lighting**
- **Partnership in EFRC (University of MD) for nanostructures for electrical energy storage**
- **Partnership in EFRC (University of Texas) for hybrid solar cell applications**
- **PNNL & ORNL for energy storage**
- **Partnerships for S2P**
- **UC Davis - GTS**
- **Sandia coordinating $3M DOE Office of Electricity (OE) university call**