LA-UR- 11-04520

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Title:	Materials at Los Alamos National Laboratory (U)
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Intended for:	Material Data Management Consortium Meeting Santa Fe, NM August 2-4, 2011

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Form 836 (7/06)


MATERIALS
Materials at
Los Alamos National Laboratory
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MST Deputy Division Leader
August 2, 2011
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Materials Data Management Consortium
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Materials Science & Engineering is entering a new era

- **Traditional Era = Observe and exploit the properties of materials**
- **Future Era = Predict properties based upon fundamental understanding.**

The new approach enables:

- Optimizing properties for specific functions
- Creating new materials and new functionality

Materials Performance **is the traditional terminology to describe how a material fulfills the defined requirements.**

We use *Materials Functionality* to describe the actual design and tailoring of a material to perform beyond the traditional requirements and sometimes in new ways beyond the basic properties.

LANL Materials Pillar: Vision, Mission & Strategy

MISSION

We pursue the discovery science and engineering required to establish design principles, synthesis pathways and manufacturing processes for advanced materials to control functionality relevant to ensuring the U.S. nuclear deterrent, reducing global threats, and solving emerging national challenges.

VISION

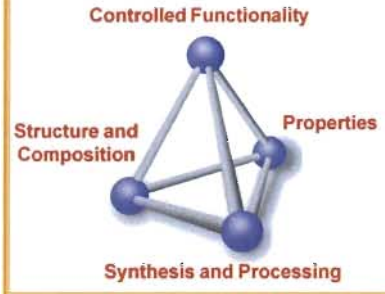
Controlled Functionality

STRATEGY

We predict and control functionality through forefront science and engineering across three themes:

- **Defects and Interfaces**
- **Extreme Environments**
- **Emergent Phenomena**

The Updated Materials Tetrahedron



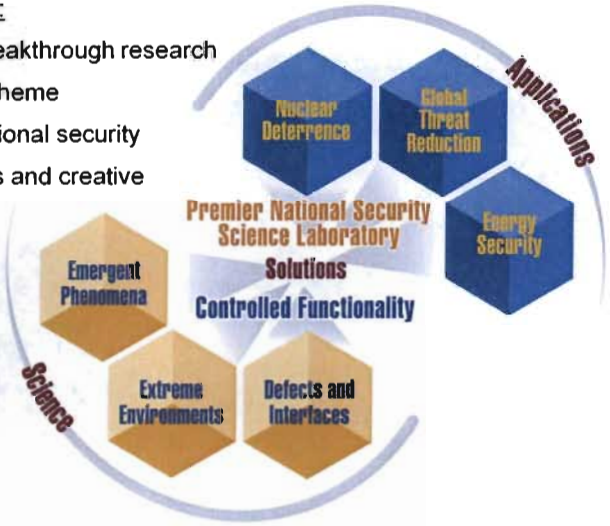
http://www.lanl.gov/orgs/adeps/VISTAS/docs/VISTAS-Winter2010-LALP-09-036.pdf

MATERIALS

The Materials Strategy advances LANL Vision and Missions, which in return advance our Capability

We are differentiated by:

- Outstanding quality, breakthrough research
- Integration across the theme
- Science relevant to national security
- People who are curious and creative



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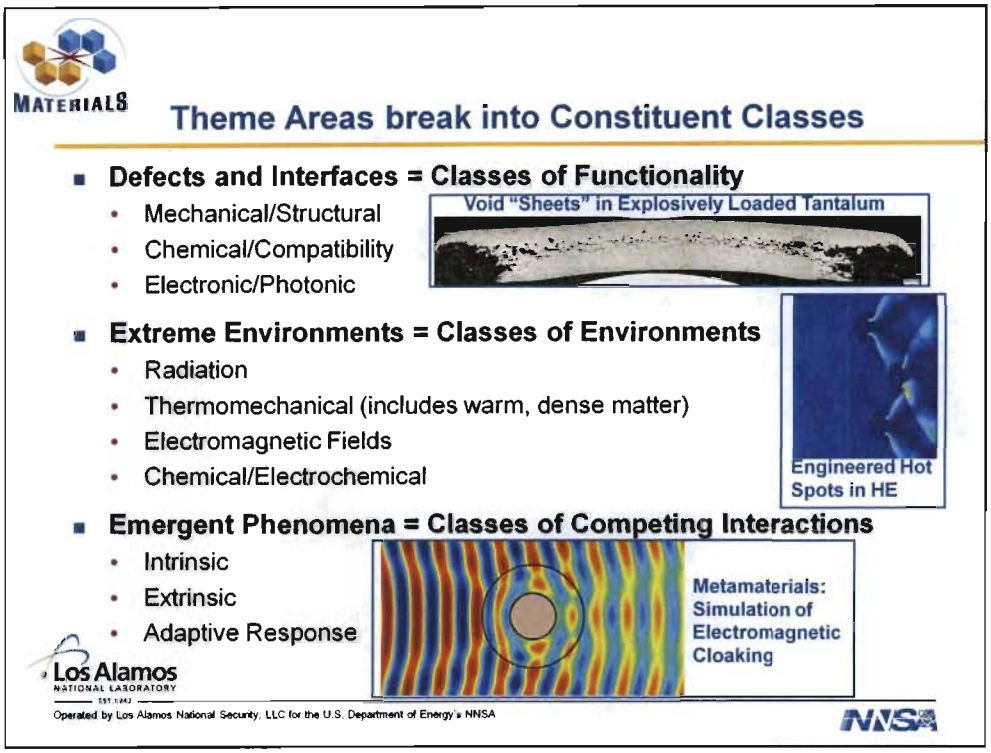
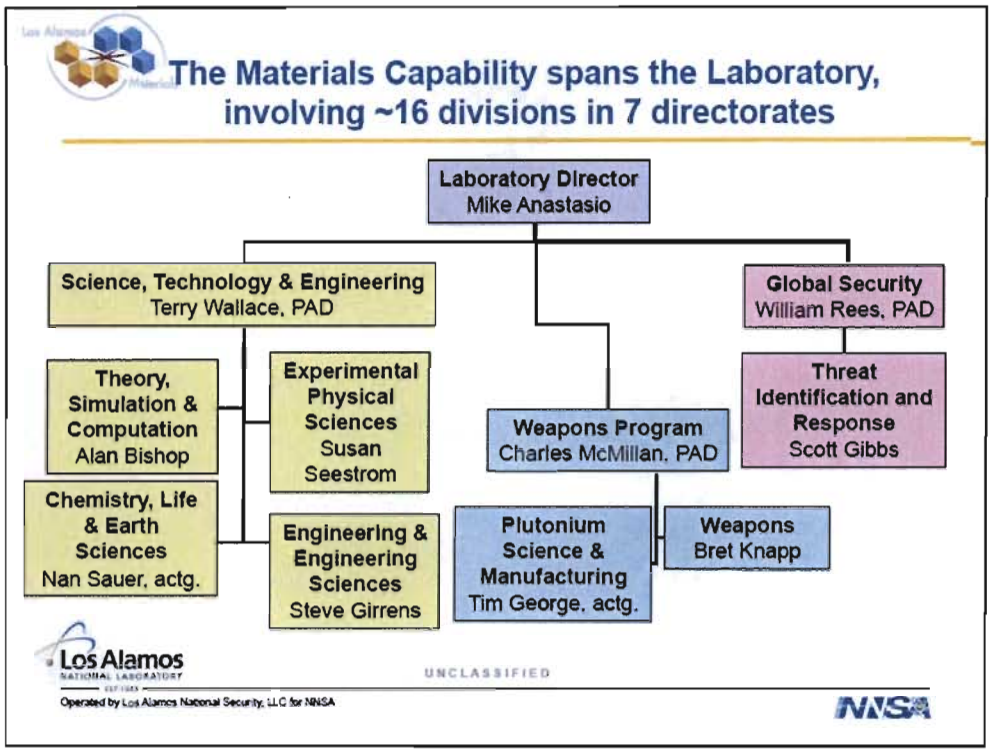


Top micrograph: Explosively Loaded Tantalum Experiment
6 mm thick PETN Beneath Sample – Center Detonated
Soft Sample Recovery
'Void sheets' are forming along grain boundaries in sample
(Mason, Bronkhurst)

•Middle: Energetic materials. New initiation behaviors have been observed using fabricated features in HE which give insight into time scales for cooperative interactions of hot spots. New temperature diagnostics have been implemented with laser shock experiments. Lays foundation for future initiation models based on microstructural features.(Dattelbaum)

•Bottom: Electromagnetic metamaterials are artificially constructed materials whose electromagnetic properties derived from their sub-wavelength structures, not from the materials from which they are made. The metamaterials image depicts a simulation of electromagnetic cloaking. (Taylor)


The Materials Capability spans the Laboratory, involving ~16 divisions in 7 directorates
Laboratory Director
Mike Anastasio
Science, Technology & Engineering
Terry Wallace, PAD
Global Security
William Rees, PAD
Theory, Simulation & Computation
Alan Bishop
Experimental Physical Sciences
Susan Seestrom
Threat Identification and Response
Scott Gibbs
Weapons Program
Charles McMillan, PAD
Chemistry, Life & Earth Sciences
Nan Sauer, actg.
Engineering & Engineering Sciences
Steve Girrens
Plutonium Science & Manufacturing
Tim George, actg.
Weapons
Bret Knapp
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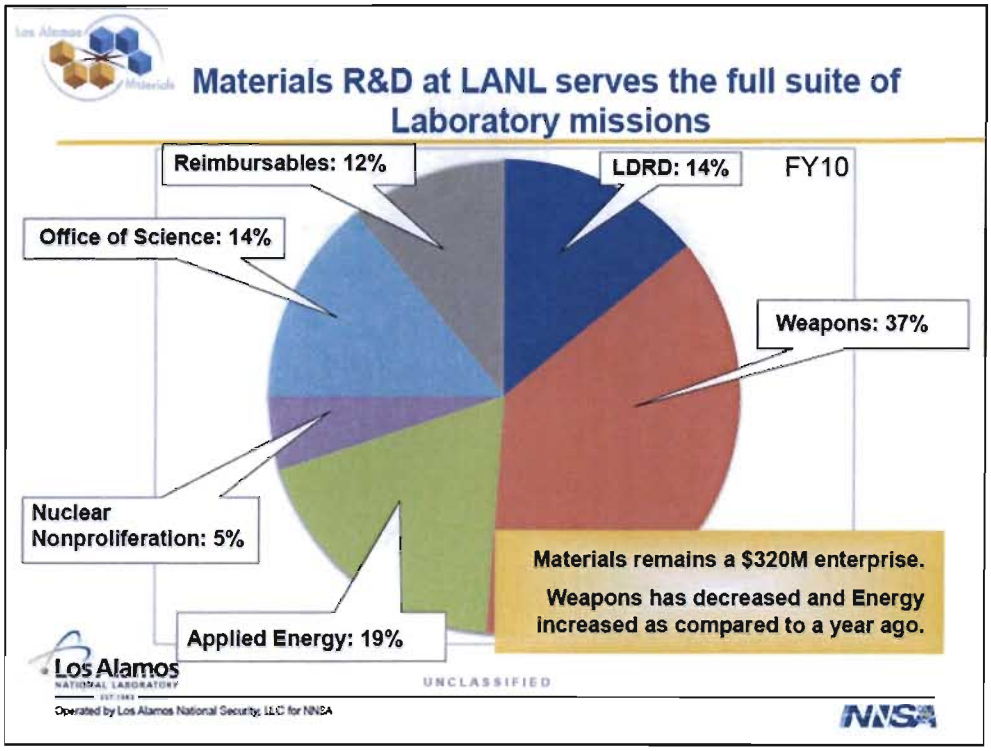
Materials R&D at LANL serves the full suite of Laboratory missions
FY10
Reimbursables: 12%
LDRD: 14%
Office of Science: 14%
Weapons: 37%
Nuclear Nonproliferation: 5%
Applied Energy: 19%
Materials remains a $320M enterprise.
Weapons has decreased and Energy increased as compared to a year ago.
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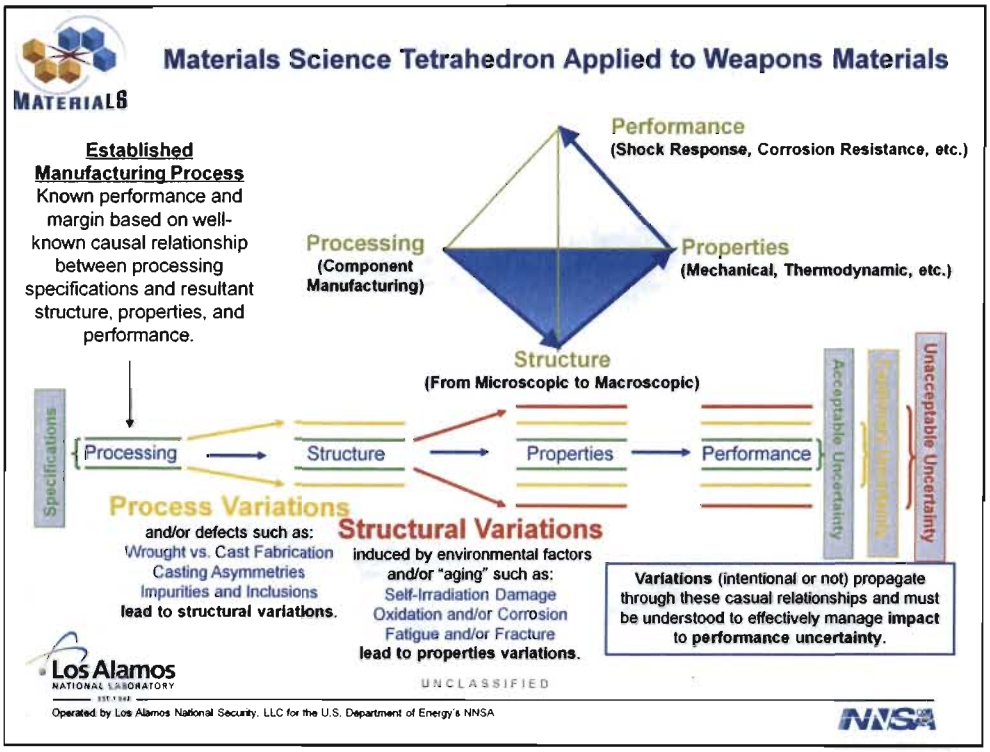
MATERIALS
Materials Science Tetrahedron Applied to Weapons Materials
Established Manufacturing Process
Known performance and margin based on well-known causal relationship between processing specifications and resultant structure, properties, and performance.
Performance
(Shock Response, Corrosion Resistance, etc.)
Processing
(Component Manufacturing)
Properties
(Mechanical, Thermodynamic, etc.)
Structure
(From Microscopic to Macroscopic)
Specifications
Processing
Structure
Properties
Performance
Acceptable Uncertainty
Unacceptable Uncertainty
Process Variations
and/or defects such as:
Wrought vs. Cast Fabrication
Casting Asymmetries
Impurities and Inclusions
lead to structural variations.
Structural Variations
induced by environmental factors and/or "aging" such as:
Self-Irradiation Damage
Oxidation and/or Corrosion
Fatigue and/or Fracture
lead to properties variations.
Variations (intentional or not) propagate through these casual relationships and must be understood to effectively manage impact to performance uncertainty.
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MATERIALS

Materials research is on the brink of a new era of science in which the traditional approach of observation & validation of performance is replaced by prediction & control of materials functionality

MaRIE builds on unique LANL capabilities to provide unique experimental tools needed to realize this vision:

In situ, dynamic measurements of real materials

Scattering & imaging simultaneously

in extreme environments

Dynamic & irradiation extremes

coupled to directed synthesis via predictive theory

Materials design & discovery

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