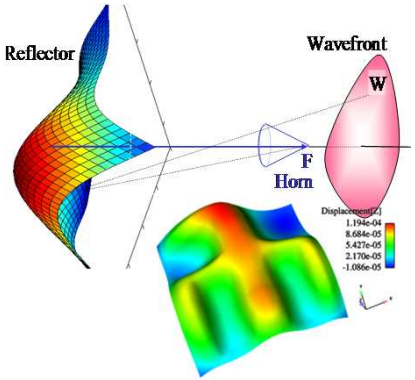
1526 – Applied Mechanics Development

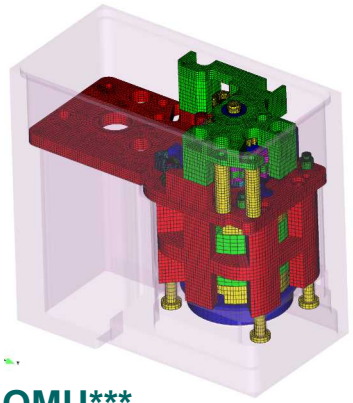
SAND2007-4345P

Mission: To provide research and development expertise in solid mechanics and structural dynamics to accomplish Sandia's goals in MESA* vision and SBE** process.

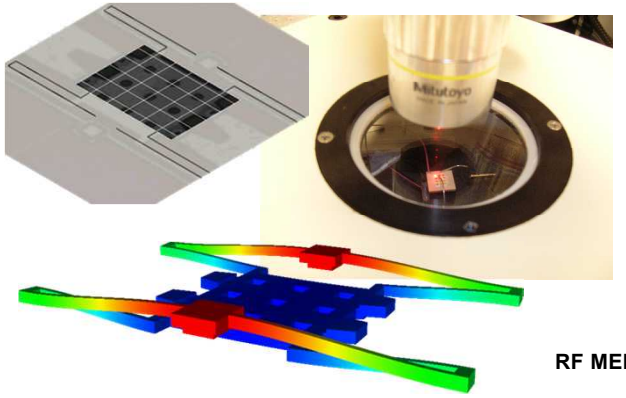
Adaptive Structures and Smart Materials



Component Design, Production and Packaging

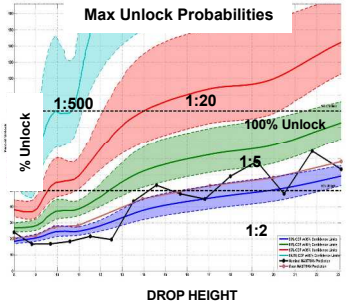


Microscale Diagnostics and Coupled-physics Response

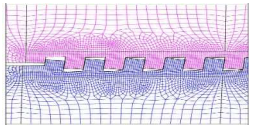


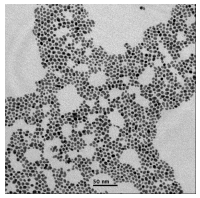
RF MEMS

Probabilistic Mechanics and QMU***



Mechanics of Interface and Nanosystems





Transmission electron micrograph of approximately 5 nm diameter silver nanoparticles. These filler particles are being used in thermal interface materials for microelectronic cooling.

* *MESA*: Microsystems and Engineering Science Applications;

** *SBE*: Science-Based Engineering;

*** *QMU*: Quantifying Margins and Uncertainty Analysis

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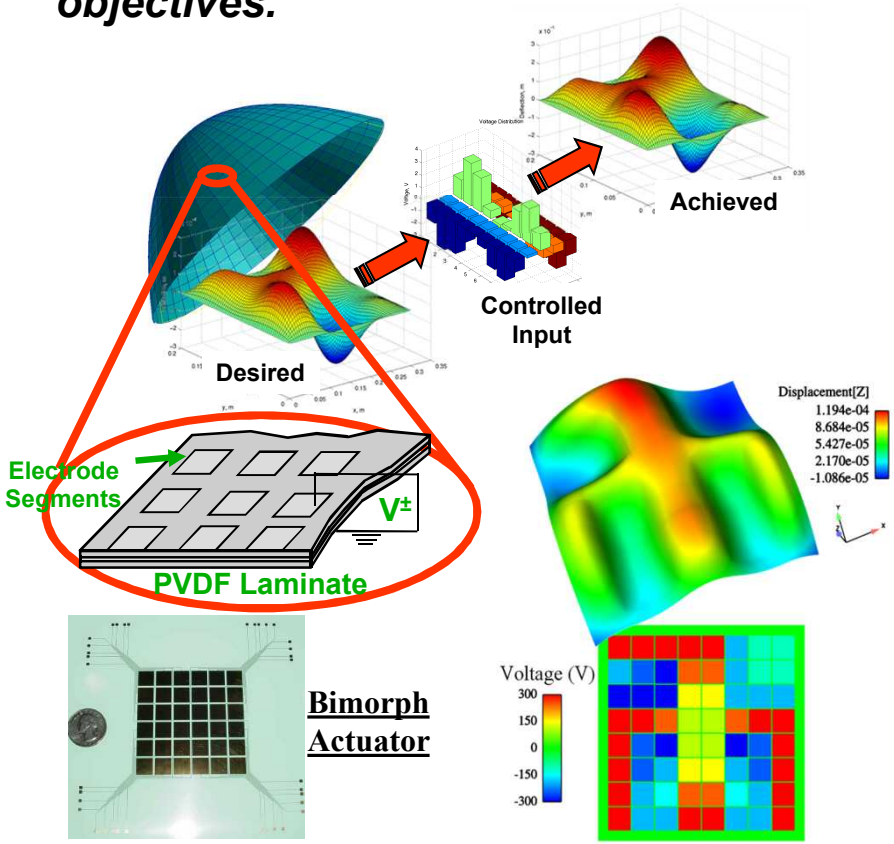
1526 – Adaptive Structures and Smart Materials

To develop smart structures that have ability to sense, analyze, and act according to prescribed performance objectives.



Capabilities

- Excellent, in-depth knowledge of behavior, performance, and limitations of smart materials:
  shape memory alloys;
  piezoelectric compounds.
- Expertise in smart structure design:
  DOD real-time reconfigurable mirrors.
- Constitutive models:
  capturing phase transformation, polarization reversal, and domain switching.
- Control algorithm development:
  shape control of an antenna membrane with distributed piezoelectric patches

Customers

- DOD, DOE, DHS

Contacts

- Pavel Chaplya (pmchapl@sandia.gov)
- Jordan Massad (jemassa@sandia.gov)

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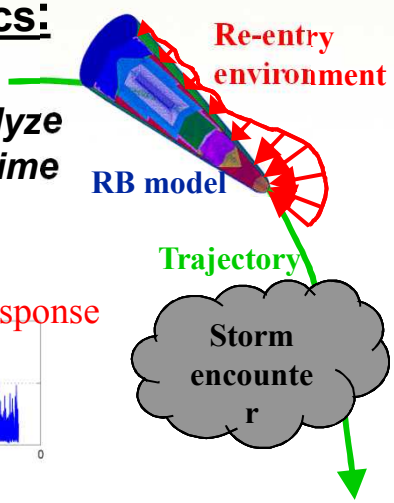
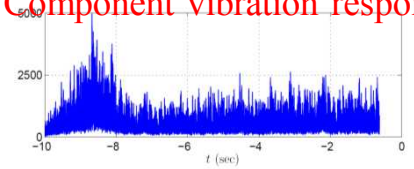
1526 – Probabilistic Mechanics and Quantifying Margins & Uncertainty

Probabilistic Mechanics:

Applying advanced stochastic models to analyze mechanical response to time and / or spatially random phenomena.

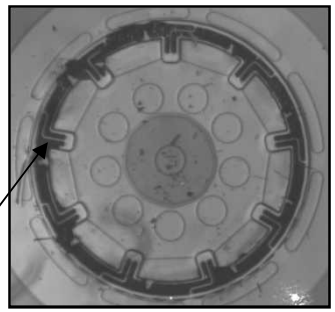


Component vibration response

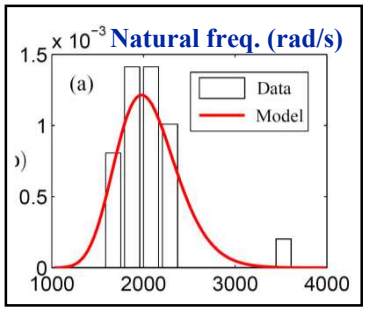


Margin & Uncertainty Analysis:

Developing and demonstrating methodology to quantifying and assessing margins and uncertainty.



support



MEMS Inertia Switch: observe significant unit-to-unit variability

Capabilities

- Expertise in random vibration, stochastic mechanics, Uncertainty Quantification, and Quantifying Margins & Uncertainty;
- Toolkit for simulation of Gaussian and non-Gaussian random variables, vectors, processes, and fields;
- Procedures to incorporate random samples with deterministic ASC codes;
- Stochastic model calibration and validation;
- Methods for reliability / margin assessment under limited data;
- Solution of stochastic differential equations
  Stochastic finite elements.

Customers

- DOE, DOD, DHS

Contacts

- Rich Field (rvfield@sandia.gov)

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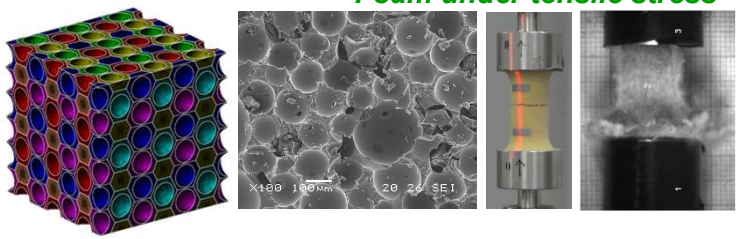
1526 – Component Design, Production and Packaging

Foam Constitutive Modeling:

- ***Is a focal point of collaborative efforts at Sandia;***
- ***Analyze foam behavior at cell level;***
- ***Develop models for variety of foams and densities.***

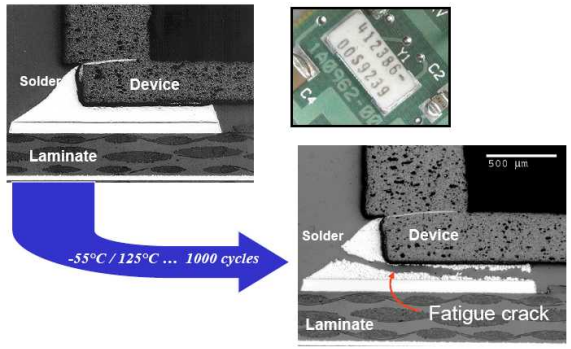
Foam under tensile stress

Foam models

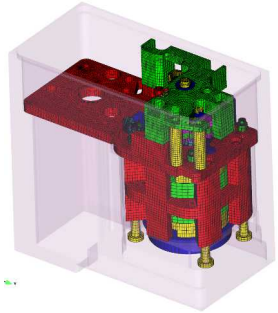


Soldered Interconnections:

To investigate and predict lifetime of solder joints.



Thermal Mechanical Fatigue



Component Responses:

To assess component responses under shock and vibration.

Capabilities

- Failure analysis:
  - *Modeling coarsening in solder joints;*
  - *Solder Interconnect Predictor (SIP) code;*
  - *Cracking in foams and yield surfaces;*
  - *Assessing performance of components and quantifying safety margin.*
- Constitutive models:
  - *Foam plasticity model;*
  - *Visco-plastic foam model;*
  - *Effect of coarsening in solder on strength.*

Customers

- DOE NW, DOD

Contacts

- Foam & joints: Mike Neilsen (mkneils@sandia.gov)
- Components: Clay Fulcher (cwfulch@sandia.gov)

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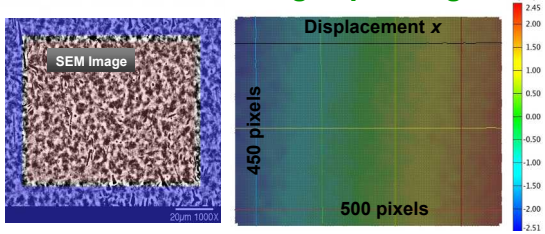
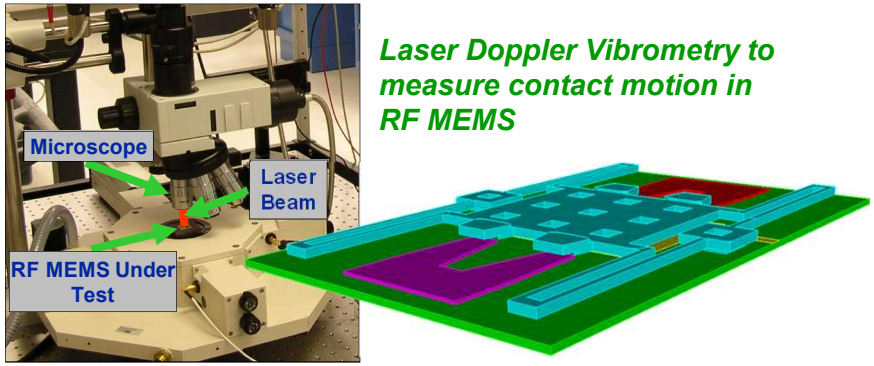
1526 – Microscale Diagnostics and Coupled-physics Response

To understand, predict and diagnose mechanical behavior of microsystems.

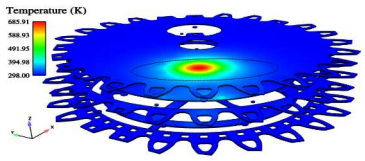
DIC: Material testing at μm lengths



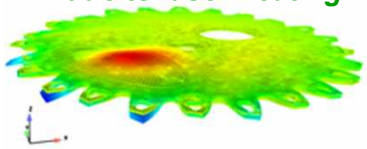


Laser Doppler Vibrometry to measure contact motion in RF MEMS

Laser heating of MEMS



Surface deformed due to laser heating



Capabilities

- Diagnostic techniques:
  Digital Image Correlation (DIC);
  Laser Doppler velocimetry (LDV).
- Coupled-physics analysis (Calagio):
  Electro-thermal mechanics;
  Opto-thermal mechanics.
- Micro-scale models:
  Size-dependent properties;
  Nonlinear dynamic responses;
  Lubrication and gas damping.

Customers

- DOE NW, DOD

Contacts

- DIC: Philip Reu (plreu@sandia.gov)
- LDV: Anton Sumali (hsumali@sandia.gov)
- Calagio: Channy Wong (ccwong@sandia.gov)

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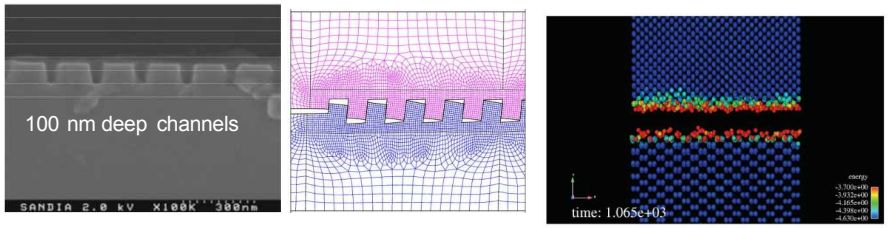
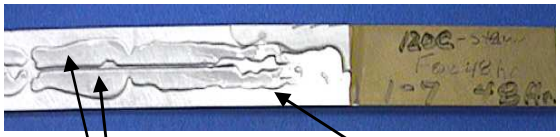
1526 – Mechanics of Interface and Nano-systems

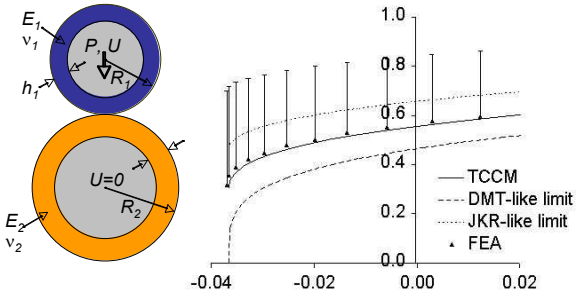
To understand, assess, and model the interaction at material interface and the mechanical behavior of nano-systems.

Patterned nanoscale interfacial roughness

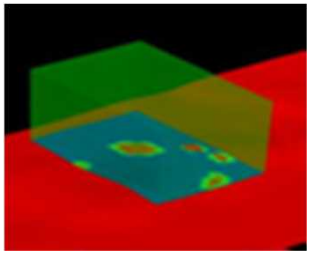


Unique test technique to age a bonded sample





Contact mechanics theory



Multi-asperity contact

Capabilities

- Expertise in interfacial engineering:
  Pattermed interface at nanoscale to enhance the toughness of a thin film;
  Applying cohesive zone model to analyze debonding of adhesive materials.
- Nano-scale models:
  Thin Coating Contact Mechanics (TCCM) for discrete asperity contact simulations;
  Contact algorithm and energy dissipation model for sliding friction.

Customers

- DOE NW, DOD

Contacts

- Interface: Dave Reedy (edreedy@sandia.gov)
- Friction: Mike Starr (mjstarr@sandia.gov)

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