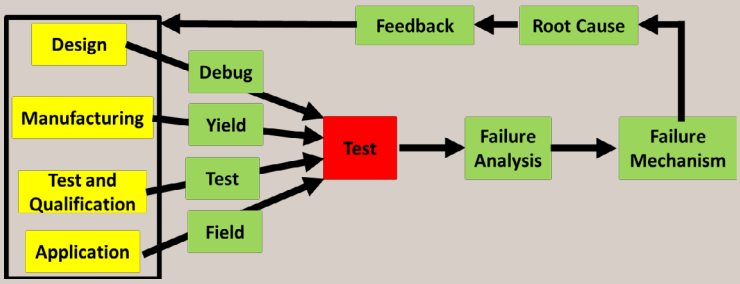
Failure Analysis/Test and Trust/Rad-Hard Assessment

Sandia's expertise in failure analysis (FA) has led to the development of many techniques currently used as industry standards. Our mission is to continue to develop expertise in Si CMOS, III-V semiconductors, photovoltaics, optoelectronics, MEMS, stacked dice, system and subsystem FA throughout the product lifecycle shown below.



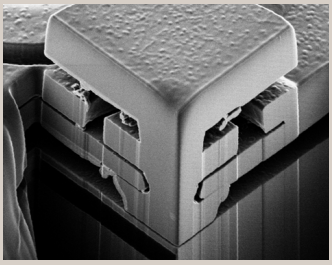
FA Techniques and Tools

- **Scanning Laser & Optical Microscopy Techniques:**
  - Thermally-Induced Voltage Alteration (TIVA)
  - Light-Induced Voltage Alteration (LIVA)
  - Soft-Defect Localization (SDL)
  - Seebeck Effect Imaging (SEI)
  - Optical Beam Induced Voltage (OBIV)
- **Scanning Electron Microscopy Techniques:**
  - Voltage Contrast (VC)
  - Passive Voltage Contrast (PVC)
  - Floating Substrate (PVC) (FSPVC)
  - Electron Beam-Induced Current (EBIC)
  - Resistive Contrast Imaging (RCI)
  - Charge-Induced Voltage Alteration (CIVA)
  - Low Energy CIVA (LECIVA)
- **Light Emission**
- **Nano-probing in SEM**
- **Electrical Testing/Characterization**
- **Thermal Imaging & Lock-In Thermography**
- **Device Deprocessing**
- **Focused Ion Beam & Front/Backside Circuit Edit**
- **Compositional Analysis (FIB & SEM)**

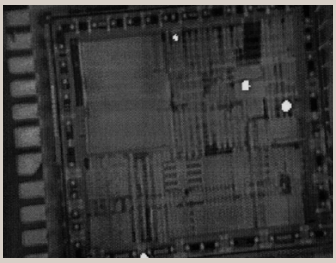
FA techniques such as TIVA, LIVA, SDL, FSPVC, CIVA and LECIVA were developed and patented by Sandia National Laboratories' Failure Analysis department.

Failure analysts often team with designers and process, test, reliability and product engineers to support semiconductor devices throughout the product lifecycle.

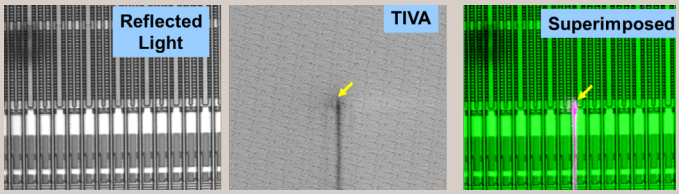
In product development and design, FA assists with debug to examine non-functioning or partial functioning devices. Product manufacturing requires failure analysis of test structures and full product in order to provide insight and resolution into manufacturing problems. In qualification and reliability testing, failure analysis provides critical information of failures at the qualification and reliability test operating conditions. Field failures and customer returns are typically one of a kind, requiring special handling and meticulous attention to detail. Successful resolution is critical to keeping consumer confidence in your product and company high.



Focused Ion Beam cross-section of a MEMS pin joint showing wear and debris at contacting surfaces



High current in a microcontroller emitting light at multiple sites



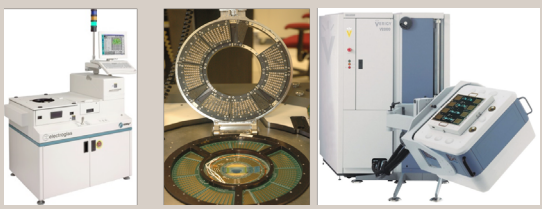
1064 nm light source scanned across an IC shows a signal in the middle of a circuit. The signal is the suspect failure site. When superimposed, the position of the failure site is mapped back to the reflected light image enabling defect localization for futher analysis.

Validation

Sandia's experienced in-house Test Engineering group develops custom test programs for electrical test of digital, analog and mixed signal semiconductor devices. The group performs semiconductor wafer-level electrical testing of individual dice, as well as packaged part electrical testing across the full specified temperature range. Additionally, the group performs prototype, characterization and production testing of custom ASIC devices and commercial off-the-shelf (COTS) devices. Sandia's capabilities include:

- Automated Test Equipment - Teradyne Catalyst and Advantest V93k mixed signal testers and EXA 3000 digital tester
- Associated probers (EG4090u+) and thermal forcing units (Temptronic Thermostream)

The electrical characteristics of each probed die as well as packaged devices are examined and results are disseminated to the product, process, packaging and manufacturing engineers.



Sandia's wafer probe capabilities include digital, analog, and mixed signal technologies.

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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Burn-In

Burn-in is a process where semiconductor components are exercised prior to being placed into service. This method of testing forces certain failures to occur under known environments and test conditions. The intention is to detect components that would exhibit a high failure rate and ensure they are not put into service. The photo below shows three MCC HPB5 ovens used for burn-in. Understanding the performance capabilities of the semiconductor components enables engineers to optimize functionality during service.

At Sandia, burn-in ovens are used to electrically stimulate and monitor devices at elevated temperatures. Three MCC HPB6 ovens and a pre-screen station are used for diagnostics and burn-in.

Trust

A fully trusted accreditation status and limited access control process may be utilized for national security projects via Sandia National Laboratories' Microsystems Engineering and Sciences Applications (MESA) facility.

The MESA complex has achieved Defense MicroElectronics Activity (DMEA) Category 1A Trust Accreditation for trusted services for design, fabrication, packaging, and testing of electronic microsystems for unclassified and classified integrated circuits.

ACCREDITATION OF TRUST

Microelectronics Trusted Source
CATEGORY 1A

By these presents the undersigned expresses the confidence of the Department of Defense, Defense Microelectronics Activity (DMEA) in the ability of the organization known as

Sandia National Laboratories

Microsystems, Science, Technology and Components

to deliver trusted foundry microelectronic goods and services to end users within the United States Government that correspond to Trusted Category 1A which meets Mission Assurance Category 1 as defined by Instruction 8500.2 of the Department of Defense Directives, effective this date.

146	14213	3 Jan 2013	3 Jan 2015	Ted Glum
Site Accreditation Number	Cage Code	Effective Date	Renewal Date	Director, Defense Microelectronics Activity

Rad-Hard Assurance and Assessments

Sandia National Laboratories has a long history, starting in the early 1960's, of discovering the physics and mechanisms of radiation effects in microelectronics, developing IC technologies that can survive in natural and man-made radiation environments, and developing hardness assurance techniques to predict the radiation induced response in microelectronics for electronics in space and strategic defense systems.

Sandia National Laboratories offers solution to tomorrow's challenges by providing rad-hard services such as:

- Rad Hardened ViArray ASICs
- Rad Hardened Custom ASICs
- Rad Hard Design and Layout
- Hardness Assurance
- Emerging Non-Volatile Memory Technologies
- Nanotechnology

Gamma irradiation equipment for Hardness Assurance and qualification.

For additional information, visit our website at:
www.sandia.gov/mstc

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