GREEN
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Virtual Training Course Outline

Microelectronic Packaging Failure Modes and Analysis

(2 Sessions)

This virtual training course is divided into two sessions, 2 hours each day with a 5 min break on the hour.

Instructors: **Thomas Green, TJ Green Associates, LLC, tgreen@tjgreenllc.com**
Robert Lowry, Electronics Materials Consultant, rlowry98@aol.com

The design and packaging of microelectronic devices such as hybrids, RF microwave modules, Class III medical implants and other types of packaged microcircuits intended for high reliability systems is a critical aspect of reliability engineering. This course is intended to review and highlight the typical kinds of microelectronic packaging related failures that occur during manufacturing, qualification and the unfortunate field failures. FA (failure analysis) tools and techniques that are utilized to understand root cause of failure and guide corrective actions will also be addressed by experts with years of experience working in FA labs.

The instructor shares his years of experience related root cause FA investigations of microcircuit packaging defects and failures. Mismatched CTEs and poorly designed packages geometries often lead to mechanical failure at the die and substrate interface or cracking at the heel of a wire or ribbon bond interconnect. Careful delid, visual inspection followed by SEM and EDAX/Auger are required to identify root cause. Reliability engineers must be cognizant of the full range of FA tools available to diagnose failures and, resist the temptation to rush to judgment, which often happens destroying valuable evidence along the way. The instructor will review real world specific examples of packaging failures and resultant FA analysis and problem resolution.

This course is intended for FA engineers, component engineers, reliability engineers, design, quality and process engineers involved in microelectronic packaging.

Course Outline

- Introduction to Microelectronic Packaging
- Terminology and Product Definitions
  - Hybrids, Microwave Modules, MEMS, Optoelectronic Devices, Class III implants
- Typical Package Related Defects and Failures
- Failure Analysis (FA) Process Flow
  - Review of common FA equipment and procedures
- Specific Examples of Package Related Failures and FA Investigation

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- Die, substrate and package compatibility issues
  - Coefficient of Thermal Expansion (CTE) problems
  - Voiding under the die
  - Sliver dendrites growing from silver loaded epoxy
- Wire and ribbon bond failures
  - Bond lifts due to contamination
  - Heel cracks
  - Excessive intermetallic formation
- Package plating issues
  - Plating issues that lead to wirebond failures
  - Au embrittlement
- Loose conductive particles and Murphy's law
  - Foreign material identification and control
- Hermetic package seal issues
  - Moisture related failures
- Non-hermetic molded package defects and failures

- Failure Analysis Tools and Techniques
  - Destruct and Non-destruct FA techniques
  - Physical and Chemical Analysis
    - Imaging
      - Optical Microscopy
      - SEM (Scanning Electron Microscopy)
      - Transmission Electron Microscopy
      - Scanning Acoustic Microscopy
    - Chemical Analysis
      - Energy Dispersive Spectroscopy
      - Scanning Auger Microscopy
      - Secondary Ion Mass Spectrometry
      - Microspot Infrared Spectrophotometry
- Course Summary
- Student Feedback and Course Critique

INSTRUCTOR BIOS

Thomas J. Green has more than 38 years combined experience in industry/academia and the Department of Defense, including years developing curriculum and teaching industry professionals about microelectronics assembly-related packaging and processes. Serving as a Research Scientist at the U.S. Air Force Rome Air Development Center, Tom worked as a reliability engineer analyzing component failures from fielded avionic equipment. As a Senior Process Engineer with Lockheed Martin Astronautics in Denver, Tom was responsible for materials and processes used to assemble hybrid microelectronic components for military and aerospace applications. While with Lockheed, he gained invaluable experience in wirebond, die attach, thick- and thin-film substrate fabrication, hermetic sealing, and leak test processes. For the last 15 years, Tom's expertise has helped position his company as a recognized industry leader in teaching and consulting services for high-reliability military, space, and medical device applications. Tom is a Fellow of IMAPS (International Microelectronics and Packaging Society).

Bob Lowry is an electronic materials consultant. After obtaining BS/MS degrees in Chemistry he worked for 32 years at Radiation, Inc., Harris Semiconductor, and Intersil Corp. He was responsible for materials analysis and was Senior Scientist in charge of Analytical Services at Harris and Intersil. He did failure analysis work on early moisture-related failures of NiCr and aluminum-metallized IC's. He patented a surface conductivity dewpoint sensor and helped draft Test Method 1018. He established a DSCC-suitable facility at Harris for statistical control of hermetic sealing capable of the moisture limit thereby assuring compliant product. He conducted extensive split-lot studies of correlations between two different mass spectrometers. He also helped characterize a "consensus standard" circulatable single sample cylinder using humidified gas to improve moisture measurement correlation between laboratories. His consulting work includes package hermeticity and sealed headspace-related failure mechanisms, gas gettering technology, process and materials improvements for manufacturing reliable electronic components, counterfeit component identification and avoidance, and applied electronic materials and components analytical methods to identify problems and improve product quality/reliability.