Microelectronic Packaging Failure Modes and Analysis

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COURSE SUMMARY

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 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

INSTRUCTOR BIOS

Trevor Devaney has been President of Hi-Rel Laboratories, Inc. for the last 21 years and has been involved in DPA Testing, Materials Analysis, and Failure Analysis of electronic components and for 41 years. He has a BSc. In Metallurgical Engineering from Cal Paly San Luis Obispo. He has been highly contributive to the development of Industry testing specifications such as Mil-Std-1580 Revisions A, B, and C respectively, as well as various Mil-Std-883 and 750 test methods over the last 30 years. Trevor is an ardent supporter of educating the newest generation of component engineers for the Space and Hi-rel industries. Trevor has been an annual presenter at SPWG for the last 21 years and routinely lectures on DPA findings and techniques on a regular basis.

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.