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Virtual Training Course Outline

Design and Test of Non-Hermetic Microelectronics

(3 Sessions)

This virtual training course is divided into three 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

Packages made from polymeric materials as opposed to traditional hermetic materials (i.e. metals, ceramics, and glasses) require a different approach from a design, production, testing, and qualification standpoint. The problem is now one of moisture diffusion through the barrier and package interfaces. Fick's law of diffusion and the interaction of moisture and other gases with the plastic package, with or without a cavity, is of primary importance.

This course begins with a brief overview of hermetic packaging and associated testing methods that have been developed over the years, some of which are applicable to cavity style non-hermetic enclosures. Then the focus is primarily on the materials used to build non-hermetic packages and the variety of testing methods available to evaluate the non-hermetic package. A review of the techniques and methods to evaluate a "non-hermetic" approach is discussed with a special emphasis on cleaning of the device prior to encapsulation and alternate test methods to evaluate reliability.

This course is intended for process engineers, designers, quality engineers, and managers responsible for design, test and production of cavity and non-cavity style non-hermetic packages intended for use in high reliability military and Class 3 medical implants.

Course Outline

- What is "hermeticity" and how to test for it (brief overview)
- How is it different from "non-hermetic" packaging
  - Cavity and non-cavity non-hermetic packages
  - Drivers for lower cost high reliability "non-hermetic" packages
  - Applicable MIL-STD-883 test methods
- Moisture problems in microelectronics
  - Review of classic moisture related failure mechanisms in both mil and high reliability Class 3 medical products

- Surface Cleanliness
  - Importance of ionic contamination and control
  - Cleaning Methods
    - UV ozone, Plasma, “snow cleaning”, solvents
  - How to identify and evaluate surface contamination
    - Surface hydrophobicity testing (contact angle goniometry)
    - Water-soluble ionics in/on materials, extraction/ion chromatography
    - Other analytical methods e.g. Auger, SIMS, XRF etc.
    - UV and Blue light to identify organic surface contaminants

- Materials and Processes for Non-hermetic packages
  - Thin film/vapor deposited coatings
    - ALD (Atomic Layer Deposition), Adamantine
    - Parylene …materials and deposition processes
  - Kapton
  - Cavity/non-cavity packages
    - PEEK, LCP, PDMS, Epoxies
  - Silicones- bio-compatible organic coatings
  - Acrylics, Polyurethanes
- Coating material evaluation, testing and effectiveness
  - Conformance to surface topography
  - Permeability/diffusion properties
  - Pinholes/cracks/adhesion
- IPC -CC-830 Moisture and Insulation testing
- Moisture diffusion rate testing WVTR per ASTM F-1249
- Inherent moisture content of materials TGA/TML
  - Moisture uptake (absorption) by materials
- RGA for non-hermetic devices
  - Ampule Testing
- TM 5011 and NASA out gassing Specs
- Moisture sensors both wired and wireless

- Near- Hermetic Packaging and Testing
  - Ficks law of moisture diffusion
- Qualification test methods and standards
  - A Critical Review of Waterproof Testing Standards
  - IEC Standards and IP “Ingress Protection” ratings 67/68
  - ASTM, NEMA Specs
- Military Specs applicable to non-hermetics
  - The Class Y qualification program for Space qualified non-hermetics

- Mil-PRF-38534 Appendix D “non-hermetic” packages
- Mil-Prf-19500 JEDEC Task Group on Non-hermetics

- JEDEC STANDARDS
  - JESD22-A101/A102 and A110
- GEIA STANDARDS SSB-1 “Guideline for Using Plastic Encapsulated Microcircuits and Semiconductors in Rugged Applications”
- 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.