Moisture in Microelectronics…
Physics and Chemistry of Volatile Species in Hermetic Devices*

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Course Summary

This tutorial is intended to enlighten the student on the negative, sometimes catastrophic consequence of too much moisture inside a hermetic enclosure designed for use in hi-rel military and aerospace systems. The class begins with a definition of hermeticity and a description of the latest hermeticity test methods in MIL-STD-883 TM 1014 (e.g. OLT, Kr-85, HMS including Condition A5) and associated mil/space spec limits, along with RGA (Residual Gas Analysis) and the latest developments in TM 1018. The tutorial includes a basic review of the test methods in place to prevent moisture related failures in military and other systems where functional reliability is of utmost importance.

Moisture failure case studies with significant consequences in terms of cost, schedule, loss of mission and system downtime will be reviewed. These case studies include:

- Moisture in Minuteman transistors
- Electronic component failure in missile systems onboard US submarines
- Space shuttle launch pad abort incident
- Moisture interference in a CO_2 sensor system
- Exceedingly high moisture in components in a defense missile system
- Moisture in transistors installed in avionics braking systems
- Elevated moisture in laser system components, moisture source unidentifiable!
- Noncompliant moisture in satellite components, that still did not fail!

A critical review of past failures is intended to highlight the FA protocols, cause and corrective actions, and from this help guide new engineers in this field in understanding internal water vapor measurements, interpreting data, and avoiding similar mistakes. Emphasis is placed on the methodology used to understand the underlying physics and chemistry that caused the failures and appropriate design and mitigation strategies required to prevent future failures.

*This is also the title of a recent book written by Philipp wh Schuessler and each student in attendance receives a complimentary copy.

Instructor Bios

Thomas J. Green has more than 36 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.