

THOMAS J. GREEN, PRINCIPAL

[TJ Green Associates, LLC](#)

Summary

Educator, consultant and expert witness in the broad field of microelectronics packaging with over 37 years of experience. Specifically, in the area of hermeticity testing, die attach, wirebonding and the materials and processes used to assemble Hybrids, MCMS (Multichip Modules), RF (Radio Frequency) and microwave modules, Class III medical implants, optoelectronics, and other types of packaged ICs, MMICs, microcircuits and sensors.



Fellow of IMAPS (International Microelectronics and Packaging Society) with extensive leadership duties including 20+ years as chair of the IMAPS National Professional Development Courses and National Technical Committee member. Extensive experience in failure analysis of microcircuits and national and international teaching and training experience. Retired Lieutenant Colonel, United States Air Force Reserve with 28 years combined active and reserve duty at research labs focused on microelectronics packaging.

Sample Consulting Projects

- Led a team of engineers that investigated and determined the root cause of failure in a COB (Chip on Board) plastic module that had failed in a steering module for a major TIER II supplier of electronics to the automotive industry.
- Developed a SSOB (Stand off Stitch Bond) wirebond process for a company that builds small SMT (Surface Mount Technology) boards used in the encoder industry.
- Hermeticity evaluation, testing, and product development for a Class III medical implant.
- Multiple projects coordinating and analyzing test results from MIL-STD-883 TM 1014 (Hermetic Seal) correlation studies using OLT (Optical Leak Test), Radioisotope Kr-85 and CHLD (Cumulative Helium Leak Detection Methods).
- Demonstrated “hands-on” expertise in wirebonding, component attachment, cleaning methods, hermetic sealing processes, leak test techniques, and substrate manufacturing processes.
- Worked with a major military OEM on a six-month project to identify root cause and corrective action of a hermeticity qualification failure on a critical military weapon system.
- Nine-month wirebond consulting project resulted in successful launch of a product containing an optimized stand-off stitch bond to IC and ball to ENEPIG (Electroless Nickel Electroless Palladium Immersion Gold) plated circuit board.
- For several major hybrid suppliers, performed an audit and “gap analysis” to determine company compliance to MIL-PRF-38534 and MIL-PRF-38535 QML (Qualified Manufacturer Listing) certification program. Included documentation review, on the floor interviews followed up with management briefings.

- Review and critique of hermeticity testing methods for a major supplier of implanted pacemakers, Class III medical device.
- Hermeticity evaluation and product development consultation for a hermetic small volume implanted medical sensor.
- Testing and data analysis of a “non-hermetic” glass window package. Ran a full series of DOEs (Design of Experiments) for a supplier of plating chemistries to maximize bondability of gold, aluminum and copper wires to various types of plated surfaces, such as ENEPIG
- Reviewed and updated design guidelines for a major supplier of LTCC (Low Temperature Co Fired Ceramic).
- Regularly attend the EIA (Electronic Industry Association) JEDEC (Joint Electron Device Engineering Council) meetings for a client in support of Hermeticity Testing per TM 1014 and Internal Gas Analysis per TM 1018.
- Drafted internal workmanship practices for a major LED (Light Emitting Diode) supplier.
- Technical consultant for a company that manufactures OLT hermeticity testing equipment since 2002.
- Characterized the reliability and moisture ingress in near hermetic cavity-style Teflon® laminate packages for RF and telecommunication applications.
- Developed a gold/tin die attach process for a 60 GHz SSPA (Solid State Power Amplifier).
- Developed hermeticity test techniques, using both wired and wireless moisture sensors to determine real time moisture build up inside a hermetic package. Results published at IMAPS and the Minnowbrook Conference.
- JEDEC chair for the task group responsible for rewriting the hybrid visual inspection criteria contained in MIL-STD-883 TM 2017 Hybrid Pre-Cap Visual Inspection.
- Investigated and developed a process to minimize hydrogen outgassing in hermetic cavities and minimize moisture problems in microelectronic packages.
- Analyzed and identified the failure mechanism (purple plague) for a heavy aluminum wire to thick film gold process in a microcircuit used in a critical aerospace system.
- Drafted and delivered a complete Hybrid Microelectronics Workmanship and Quality Manual for the NASA Jet Propulsion Laboratory in Pasadena, CA.
- Developed a critical 1 mil high temp wirebond process with full qualification and failure analysis.
- Developed a MMIC (Monolithic Microwave Integrated Circuit) wirebond process with complete documentation package.
- Developed a heated plasma edge cleaning process for laser cut gold metallized diamond heat spreading substrates used for mounting laser chips.
- Failure analyzed and implemented new processes for a 10 gigabit optical modulator line.
- Optimized a gold/tin eutectic process using the Palomar 3500 die bonder, GaN (Gallium Nitride) IC chip to CMC (Copper-Moly-Copper) heat spreader.

- Helped draft the most recent revision to Mil-STD-883 TM 1014.11, Seal. Studied outgassing behaviors of epoxies used in optoelectronics and high reliability military and space applications.
- Conducted a series of DOEs to optimize Au ball bonding to copper-clad PTFE (Polytetrafluoroethylene) for a telecommunications device. Successfully diagnosed and resolved a major heavy wire (7 and 15 mil aluminum) problem with a commercial power module manufacturer. Three-month consulting project included problem identification via analytical methods and wirebond optimization experiments.
- Installed RF thin film teaching laboratory overseas for the US State Department.
- Developed and taught an ESD (electrostatic discharge) training course at Ft. Meade, MD, Honda of America, and other major corporations.
- Installed an advanced Siemens pick-and-place line at the local college and taught numerous Siemens field service engineers how to operate and program the machines.
- Involved in numerous FA/process improvement activities: capacitor epoxy attach processes, seam welding issues, cracked glass seals, cratering of GaAs (Gallium Arsenide) wirebond pads.
- Conducted and analyzed numerous statistically designed experiments, which increased first pass yield, reduced costs, and improved product quality.

Teaching Experience

- Conducted an in-plant all-day technical seminar on hermetic and non-hermetic packaging at GOOGLE Inc. in 2015.
- Developed several one-day training classes on MIL-STD-883 visual inspection criteria in accordance with TM 2017, TM 2010 and TM 2032, and conducted the training at numerous locations around the globe.
- Designs, develops, and teaches professional engineering courses related to microelectronics (Hybrids, MCMs, RF microwave modules and medical devices) materials and processes for process engineers, designers, quality engineers, inspectors, and technicians.
- Recently developed and taught several 2-3-hour online webinars on the following topics: 1) Copper Wirebonding; 2) Microelectronics Packaging Failure Modes and Analysis; and, 3) Introduction to Microelectronics Packaging.
- Conducted a three-day wirebond certification training class for engineers and operators at seven different locations in 2015.
- Taught a one-day training class on microelectronics assembly and processes at the US Patent Office (USPTO) in Alexandria, VA.
- Developed over twenty hours of web-based course materials for internal use at a major aerospace company. Online training was targeted to designers, process engineers, component engineers and QEs (Quality Engineers) in the high rel military and aerospace community.

- Each year delivers over 15 hours of publicly available training webinars targeting the microelectronics packaging community (see <http://www.tjgreenllc.com/webinars>) for more details.
- Teaches the industry's only full-day public hermeticity course, "Hermeticity Testing, RGA, and Near Hermetic Packaging Concepts," available through IMAPS and taught in-plant at major companies around the globe.
- In 2008, developed and taught the first IMAPS "Lunch and Learn" webinar titled, "Hermeticity Packaging Concepts," attended by 28 students worldwide.
- Teaches a variety of multi-day industry short courses at major companies around the globe including Sandia National Labs, NASA/JPL, BAE Systems, Lockheed Martin, Northrop Grumman, MIT Draper Labs, MITEQ Inc., L-3 Communications, ILC/DDC, and many others. <http://www.tjgreenllc.com/clients>
- Developed the four-day "Process Certification and Defect Recognition for Hybrids, Microcircuits, and RF/MMIC Modules," and in close cooperation with engineers from Lockheed Sanders, developed the associated Workmanship Standards (250 color photos).
- International webinar series on "Hermeticity for Medical and Military," a three-part series attended by 35 students worldwide.
- Conducted three weeks of in-plant training and skills assessment for over seventy operators and inspectors at a major microwave component supplier on Long Island. "Hands-on" training program required development of a training piece, evaluation and testing to evaluate critical skills for HR Dept.
- Delivered a full day training seminar on microelectronics packaging to 35 engineers and patent examiners at the USPTO (United States Patent and Trademark Office) office in Alexandria VA.
- Developed and taught a one-day engineering training seminar on Optoelectronics Technology at Lucent, Allentown PA and DoD Ft. Meade, MD.

International Teaching and Training

- Pretoria, South Africa: Spent a week in plant at a major aerospace company teaching process/quality engineers how to build reliable microwave modules used in military aerospace equipment.
- Belo Horizonte, Brazil: CSEM two-day in-plant training seminar on LTCC for microwave applications.
- Singapore: Successfully completed a week-long series of courses related to microelectronic packaging, wirebond, DOE and internal visual inspection for high reliability microcircuits.
- Brisbane, Australia: Week-long training and consulting for a company that builds complex microwave hybrids for the defense and telecom industry worldwide.
- Clamart, France: Delivered a four-day training course for design and process engineers at a company that manufactures high reliability hybrid microelectronics for the oil and gas industry.

- San Jose, Costa Rica: Developed and delivered a tailored four-day training class on visual inspection criteria for complex chip and wire microwave module, working through an interpreter.
- Ankara, Turkey: Delivered over two weeks of training for quality and process engineers.
- Sittard, Netherlands: Taught 23 circuit designers, process engineers, and technicians a four-day course titled, "Process Certification and Defect Recognition for Hybrids, Microcircuits, and RF/MMIC Modules."
- Haifa, Israel: A week of tailored process and quality training for a company that builds RF/microwave products.
- Cork, Ireland: Taught 32 engineers/technicians a course titled, "Process Certification and Defect Recognition for Hybrids, Microcircuits, and RF/MMIC Modules."
- Lead instructor (1995-1998) for Siemens automatic SMT pick-and-place equipment. Instructed numerous process engineers from all over the world (France, Germany, Mexico) at the NTC facility.

Expert Witness Experience

- Experience in personal injury cases and product liability dealing with alleged Class III medical device failures.
- Experienced at providing expert witness testimony at both deposition and trial.
- Specific expert witness experience in implanted Class III medical products:
 - ICS cochlear stimulators that restore hearing to the profoundly deaf
 - Advanced Neuromodulation Systems for relief of chronic back pain

Previous Employment

- Retired Lieutenant Colonel, United States Air Force Reserve (28 years combined Active and Reserve duty). As a reservist, spent ten plus years working in a technical capacity at a microelectronics group.
- Adjunct Professor at the National Training Center for Microelectronics, Northampton College, Bethlehem, PA (1996-2002).
- Lockheed Martin Senior Staff Engineer, Denver, CO (1989-1996). Responsible for materials and manufacturing processes, including assembly and hermetic seal processes, used in building custom high reliability space qualified microcircuits (hybrids, MCMs, and RF microwave modules) for military and commercial aerospace applications.
- Reliability Engineer at USAF Rome Laboratories (1985-1989). Worked in a Reliability Physics group, analyzed component failures from AF avionic equipment, along with providing technical support for a variety of Mil specs and standards including MIL-PRF-38534 and MIL-STD-883

- Flight Test Engineer at the 6545th Test Group Hill AFB, Utah, (1982-1985). Provided technical engineering support and conducted research, test, and development of unmanned aerial vehicles (UAVs) for USAF military operations.

Education

- Masters of Engineering Administration, University of Utah, Salt Lake City, UT (1985).
- Bachelor of Science, Metallurgy and Materials Engineering, Lehigh University, Bethlehem, PA (1982).
- USAF Air Command and Staff College (1999).

Technical Publications

- White Papers and technical presentations available at [TJ Green Website](#):
 - New Release of Mil-Std-883 Visual Inspection Criteria
 - Minnowbrook 2014: "Hermeticity Testing Correlation Issues"
 - TM 1014 UPDATE and Hermeticity Spec Change
 - Practical Guide to MIL-STD-883 TM 1014 (SEAL)
 - Why Three Monolayers of Moisture Are Important
 - Howl and Mann Flex Method Calculator
 - Hermetic vs. "Near Hermetic" Packaging - a Technical Review
 - Non-Hermetic Packaging For Military And Aerospace
- "Moisture Sensing in Fusion Bonded Teflon Laminate Packages for RF Power Applications," IMAPS Military Space and Homeland Security Conference, (2007) Baltimore, MD.
- "Optical Leak Detection vs. Conventional Helium Leak Detection in a Production Environment," JEDEX Conference (2003), San Jose, CA.
- "Technology Insertion and Process Improvements - A Case Study," Proceedings of the International Society of Hybrid Microelectronics (1997), Philadelphia, PA.
- "Using DOE to Reduce Costs and Improve the Quality of Microelectronic Manufacturing Processes,"
- Proceedings of the International Society of Hybrid Microelectronics (1994), Boston, MA.
- "Using DOE to Optimize Hermetic Package Seam Welding," Proceedings of the International Society of Hybrid Microelectronics (1992), San Francisco, CA.
- "Helium Fine Leak Testing Using the Berquist Method," RADC/NIST Moisture Workshop (1992), Gaithersburg, MD.
- "Corrosion of Chip Resistors within a Hybrid," RADC/NIST Moisture Workshop (1992), Gaithersburg, MD.

- “Air Force Field Failure Return Program,” Government Microcircuit Applications Conference (GOMAC) (1989), Orlando, FL.
- “Air Force Field Failure Return Program,” International Reliability Physics Symposium (IRPS) (1988), Monterey, CA.
- “A Review of EOD/ESD Failures from AF Avionics Applications,” EOS/ESD Symposium (1988). Selected as one of the ten best ESD papers from the 1980s and published in book form.

Professional Affiliations

International Microelectronics and Packaging Society (IMAPS)

- Fellow of the Society.
- Keystone Chapter President and past Northeast Regional Director.
- National Professional Development Course Chair since 1993.
- Ira Custman Award Winner.
- General Chair of the Medical Device Advanced Technology Conference 2010 and 2011.
- General Chair of the Non-Hermetic Packaging Technology for Reliable Microelectronics Advanced Technology Conference, 2012.
- Founder and General Chair of the IMAPS Optoelectronics Packaging Conference in Bethlehem, PA (2001/2002).
- Past Northeast IMAPS Regional Director, National Technical Committee Chair, Executive Council Member.
- Chair of 2007 and 2008 Military and Homeland Security Conference (MASH).
- Founded and organized the IMAPS Regional Symposium at the National Training Center for Microelectronics (Northampton Community College), 1998-2002.
- National Technical Committee Chair.
- Initiated and produced “Hands-On” courses (Wirebond and Thick Film) at the Chicago, Boston, and Baltimore Symposia.
- Individual/Corporate Member since 1988.

Institute of Electrical and Electronics Engineers (IEEE)

- Invited to teach a short course at the 2015 IEEE CSICS (Compound Semiconductor IC Symposium) on the fundamentals of microwave materials and processes.
- IEEE member since 2004.