RL/NIST Workshop on Moisture Measurement, 1993

List of Articles

A Historical Review of Residual Gas Analysis
By R. W. Thomas (Technology Expert Network) - Published in RL/NIST Moisture Workshop 1993, P1

Lab Correlation Study Status
By Benjamin A. Moore (Rome Laboratory / ERDR) - Published in RL/NIST Moisture Workshop 1993, P12

Low-Density Water Vapor Measurements; The NIST Primary Standard and Instrument Response
By Stuart A. Tison and Charles R. Tilford (National Institute of Standards and Technology) - Published in RL/NIST Moisture Workshop 1993, P19

Using Permeation Tubes to Calibrate Trace Moisture Analysers
By James J. McKinley (Kin-Tek Laboratories, Inc.) - Published in RL/NIST Moisture Workshop 1993, P30

Thermodynamic Properties of Moist Air Containing 1000 to 5000 PPMv of Water Vapor
By Peter H. Huang (National Institute of Standards and Technology) - Published in RL/NIST Moisture Workshop 1993, P43

Studies on a Solvent Resistant Humidity Sensor with High WaterVapor Affinity: Important Implications for Microeletronics
By Gerard Schultz and Christopher Polla (Phys-Chem Scientific Corp) - Published in RL/NIST Moisture Workshop 1993, P52

Hydrogen Desorption from Base and Processed Packaging Alloy
By Philipp wh Schuessler and Stephen G. Gonya (IBM / FSC) - Published in RL/NIST Moisture Workshop 1993, P67

By the late '80's various microelectronic device manufacturers had experienced the "Hydrogen Phenomenon" knowingly and unknowingly. This phenomenon occurs when residual or absorbed hydrogen has remained within microstructure trap sites of the ferrous alloy packaging materials that they had selected. But as a function of burn-in or other thermal stresses, the hydrogen is desorbed into the cavity of the device. A variety of chemical reactions are then potentially available by which the desorbing hydrogen gas can destroy device integrity and product reliability. To date, a multitude of subsequent chemical reactions have been identified which can be cause for the failure of the product. This paper identifies an in depth analytical routine which has allowed the supplier community to provide the user community with hydrogen free packages. Potential sources or traps for absorbed hydrogen have been theoretically identified. "Bake out" procedures, and the affects of annealing and plating are also reviewed, all of which have been found to ultimately impact device reliability, i.e., should product design, and process variables all align contrarily to the needs of the product type in question.

The phenomenon of Hydrogen Desorption was first observed on captive microwave devices made with Gallium Arsenide die. Titanium adhesion metallurgy also used as in-line resistors were noted to become bumpy and even lose adhesion. Meanwhile the circuits were noted to electrically drift. Residual Gas Analysis (RGA) of this device showed increasing concentrations of hydrogen as a result of thermal stress, e.g., burn-in.

Other device technologies were noted to acquire increasing concentrations of moisture such that in several cases Quality Conformance Inspection (QCI) criteria of Mil-Std-888 Test Method 5008 could not be met. Concurrent with the increase in moisture was the noted increase in hydrogen concentrations. In some cases residual traces of normal air were also noted to change as Argon concentrations remained low, e.g., 100 ppm, but the expected oxygen level at circa 2000 ppm was totally absent.

These incidents all drew their origin from the absorbed hydrogen slowly desorbing into the cavity of the respective devices. Hydride formation with metal systems, such as titanium, and metal oxide reduction, such as the reduction of silver solder glass die attach materials, are now understood to be the root cause for these problems.

IBM personnel set in place a team of industrial participants to help in clarifying the problem. A base metal supplier, packaging houses and an independent analytical facility participated in the study which is detailed in the following paragraphs.

Degreaser Fluid Induced Elecrical Assembly Corrosion; Failure Analysis of a Moisture Limited Mechanism
By David O. Ross (Rome Laboratory) - Published in RL/NIST Moisture Workshop 1993, P91

Moisture Effects on Interphase Conductivity
By J. E. Anderson and K. M. Adams (Ford Motor Co.), P. R. Troyk (Pritzer Institute for Medical Engineering) - Published in RL/NIST Moisture Workshop 1993, P115

Corrosion of Chip Resistors within a Hybrid Induced by Tantalum Chip Capacitor Outgassing Products
By Joe Abbott, Thomas J. Green, and Kerry Huntington (Martin Marietta) - Published in RL/NIST Moisture Workshop 1993, P121

Moisture Effect and Measurement on Semiconductor Gas Process
By Anthony F. Amato, Yadan W. Chen, Edward T. Flaherty (Matheson Gas Products, Inc.) - Published in RL/NIST Moisture Workshop 1993, P134

Military Specifications and Laboratory Suitability for MIL-STD-883 Method 1018
By Alan R. Clark (Defense Electronics Supply Center) - Published in RL/NIST Moisture Workshop 1993, P159

Hermeticity Specifications and their Effects on Method 1018
By A. DerMarderosian, Sr (Raytheon Company) - Published in RL/NIST Moisture Workshop 1993, P163

Hermeticity Package Moisture Control at Harris Semiconductor
By Robert K. Lowry (Harris Semiconductor) - Published in RL/NIST Moisture Workshop 1993, P172

Improving Device Reliability Through Residual Gas Analysis (RGA)
By Arun Kumar and James O. McClain, Jr. (Seal Laboratories) - Published in RL/NIST Moisture Workshop 1993, P185

Moisture Level Fluctuations within Hermetically Sealed Microeletronic Devices
By Larry Henke, Steve VanDerlick, Mark Alderton (Cardiac Pacemakers, Inc.) - Published in RL/NIST Moisture Workshop 1993, P194

High Reliability Sealed Chip Technology, What's Needed for Determining Corrosion Protection
By David O. Ross and James F. Reilly (Rome Laboratory) - Published in RL/NIST Moisture Workshop 1993, P203

Long Term Package Integrity in a Military Environment
By D. David Dylis and George H. Ebel (IIT Research Institute) - Published in RL/NIST Moisture Workshop 1993, P210

Recently there have been several papers presented on the detailed results of failure analyzed parts collected during the performance of the Field Failure Return Program (FFRP). The substantial payback for these efforts has been well documented (see references). There are also global issues that could have even larger returns on the investment. One of these is a study of long-term package integrity of microelectronics in a military envirorunent.

One of the major long-term failure mechanisms that exists in microelectronics are moisture-induced problems such as corrosion, electrochemical metal migration and electrical parameter shifts. Moisture can occur in a package by a lack of hermeticity, by outgassing of materials inside of the package or by poor processing controls during the manufacture of the device. The FFRP is gathering RGA (Residual Gas Analysis) data as part of a long-term package hermeticity study. This study should also yield valuable information on the outgassing of materials inside of a hermetically sealed-package.

Specific items that will be reported on in this paper are:

1) Differences in long-term outgassing of metal and ceramic packages
2) RGA data on polymer sealed hybrid microcircuits that have functioned properly for over 23 years on an airborne inertial navigation system
3) A comparison of two leak rate detection methods (Bergquist and standard helium bomb) for parts that functioned satisfactorily for over ten years in a military environment

Alternate Packaging Scheme to Guarantee Low Internal Moisture Content
By James C. Lau and Doug B. Nord (TRW) - Published in RL/NIST Moisture Workshop 1993, P222

Decreasing Moisture Content of Epoxy Alfter High Temperature Stress, by Altering Pre-Sealed Bake Times
By Bill Vigrass, Jack Linn and Jim Walling (Harris Semiconductor) - Published in RL/NIST Moisture Workshop 1993, P241

Effects of Process Variables on Moisture in Hermetic Packages Containing Organic Adhesives
By William H. Bardens (Beckman Industrial Corp.) and Terry E. Phillips and Richard C. Benson (John Hopkins University) - Published in RL/NIST Moisture Workshop 1993, P249

Low Moisture Polymer Die Attach Adhesive for Solder Seal Packages
By My N. Nguyen (Johnson Matthey Electronics) - Published in RL/NIST Moisture Workshop 1993, P262

Interpretation of RGA Data - Including Recent Observations on the Outgassing Characteristic of New Materials
By Donald T. Shuman (Oneida Research Services, Inc.) - Published in RL/NIST Moisture Workshop 1993, P275

Water Adsorption at a Polymide / Silicon Wafer Interface
By Wen-li Wu, William J. Orts, Charles J. Majkrzak and Donald L. Hunston (National Institute of Standards and Technology) - Published in RL/NIST Moisture Workshop 1993, P291

An Evaluation of the Moisture Content of Hermetically Sealed TO5 Metalic Cans as a Function of Analysis Temperature
By Jack H. Linn and Josh Daar (Harris Semiconductor) - Published in RL/NIST Moisture Workshop 1993, P313

Reliable Moisture Determination in the Presence of Hydrogen or Oxygen Using Method 1018.2
By Bruce J. Gollob (Atlantic Analytical Laboratory , Inc.) - Published in RL/NIST Moisture Workshop 1993, P326

Gas Composition Analysis of Hermetic Structures as a Non-Destructive Test
By John C. Pernicka (Pernicka Corp.) - Published in RL/NIST Moisture Workshop 1993, P327

New Microelectronics Package Atmosphere Analysis System : Sample Analysis and Calibration Standards
By Stephen A. Ruatta, Julius Perel and John F. Mahoney - Published in RL/NIST Moisture Workshop 1993, P332

Microcircuit Hermeticity Testing Using the Bergquist Method
By Scot K. Anderson and Thomas J. Green (Martin Marietta Astronautics Group) - Published in RL/NIST Moisture Workshop 1993, P338