25th Annual Components for Military & Space Electronics Conference
April 26-28, 2022
LIVE CONFERENCE
Four Points by Sheraton (LAX), Los Angeles, California
Deadline for Submission: January 15, 2022

Getter Technologies for Improving Microelectronic Package Reliability

H. Xia*, R. Rockley, J. Vriens, S. Norris, and D. DeWire**

Hermetic Solutions Group, LLC
8 Neshaminy Interplex Suite 221, Trevose, PA19053, USA

ABSTRACT

Many microelectronic devices, modules, and packages that are used in satellites, aerospace equipment, and microelectromechanical systems (MEMS) require long-term operational reliability. The integrity of electrical power and signal transmission from the package depends on the packages ability to remain robust by maintaining hermeticity all while being subjected to harsh forces and conditions outside the package, meanwhile being able to effectively protect the packages components. Managing the conditions inside the hermetic enclosure include the capture of VOC's that can effectively reduce and the functionality of the device. All of these considerations must made during the design and development of the electronic packages. Since these hermetic enclosures are an integration of metals, polymers, epoxies, ceramics and glasses; it is known that entrapped moisture (H_2O), hydrogen (H_2), oxygen (O_2), carbon dioxide (CO_2), hydrocarbons (HCs), and volatile organic compounds (VOCs), can be released into the package enclosure under elevated operating temperature which could lead to serious degradation to the device reliability and functional life.

Polymeric materials, in particular in their amorphous structures, can dissolve huge quantities of gas and water vapor or moisture. Hydrogen (H_2) gas may be released from electroless nickel plated lids, polymer-based RF absorbers epoxy based thermal interface materials, and thermoset adhesives. In most cases, the total outgassed moisture from a package may accumulate up to 10 wt. % and the outgassed H_2 may be up to 3% of the gas volume from a device package during its 10-20 year operating lifetime. To build in reliability for various electronic packages, it has been demonstrated that gettering technologies could alleviate these undesirable outgassing challenges from any electronic or/and microelectronic devices, modules and packages. To provide assurances that hermetically sealed package components can survive these outgassed contaminants and their resultant failure modes, a getter technology could be a critical and practical solution.

Two types of getters have been developed for managing these outgassing challenges, thereby reducing the risk of premature failure within the electronic or/and microelectronic packages. The first type of getter is based on the combination of zeolite and Palladium Oxide (PdO) particles being dispersed in a silicone/varnish polymer matrix, which when combined can simultaneously scavenge both outgassed moisture (3-10 wt.%) and small amount (<10cc) hydrogen gas (H_2)

within the hermetically sealed package enclosure as primary functions. However, the different molecular sieve sizes (3A, 4A, 5A, 13X tec.) could accommodate various chemical gases, including O_2, CO_2, HCs, and VOCs, a desirable microstructure of the synthesized polymer composite materials could be used as a functional getter for capturing specific outgassing species. The second type of getters uses base metal materials, namely, Ti thin films and mill rolled Pd foils, which can be used as a getter by its intrinsic nature in forming hydride phase. This type of getter is used specifically for the scavenging large amount (>>10cc) of outgassed H_2 from a package. The manometric method based pressure amplitude measurement has demonstrated that Pd based H_2 getters have a higher uptake capacity (~960 cc/cc) and uptake rate (0.5-40 ppmv/min), that could be 2-3 orders higher than that of the package components medium and high outgassing package components/materials.

This presentation will introduce gettering technology for effective scavenging of outgassed moisture, hydrogen, O_2, CO_2, HCs, and VOCs that provide reliability assurance to any type of electronic or/and microelectronic devices, microwave modules, and MEMS device packages. Given the complexity and volumetric constraints of these electronic or/and microelectronic devices, modules, and packages, a getter element can be tailored in any sizes and shapes that can be fitted into a package lid/headspace or by attaching to interior surface or walls. To ensure desirable reliability for using a getter, this presentation also proposes a safety factor based methodology for package engineers to determine how to easily select a getter element designed to effectively remove the outgassing contaminants from any microelectronic packages, thereby ensuring long-term reliability during its expected operating life.

Keywords: Microelectronic devices packages, gettering technology, outgassing, reliability

Contact Information

*Dr. Hua Xia, hxia@hermeticsolutions.com, Mobile: (509) 881-5420
** David DeWire ddewire@hermeticsolutions.com, Mobile: (303) 921-2222