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Enhancing Microelectronic Package Reliability through Getter Material Integration and Inner Gas Atmosphere Characterization

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Abstract

Hermetic packages are essential for many microelectronic and optoelectronic devices in order to protect the internal components from dust, moisture or other detrimental gases, and to ensure high reliability for all the lifetime. Metals, glasses and ceramics are the materials used to form the hermetically sealed packages and to prevent permeation of moisture and of external atmosphere gases that can negatively affect the system performances.

Besides, many devices may require even vacuum conditions in order to operate properly and this stringent feature must be guaranteed for 10-15 years in some applications. For example, typical devices sealed under vacuum are gyroscopes, accelerometers, IR detectors.

One of the main issues is related to the inner accumulation of undesired gases, which can have detrimental effects on the performances of the devices. In fact, gas generation and outgassing from the internal materials can induce an increase of the moisture, H_2, and Volatile Organic Compounds (VOCs) concentrations that may affect the functionality and the reliability of the components [1]. In case of hermetic vacuum packages, also outgassing of N_2, CO and CO_2 may cause a negative impact.

It is already known that hydrogen and moisture are the most detrimental gaseous contaminants in optical transceivers and in some electronic modules [2-5]. In fact, H_2 can be the cause of electrical performance degradation: it can diffuse through metal layers, causing electrical characteristic shifts; in addition inside hermetic packages it can favor the formation of moisture. Moisture can be responsible of corrosion mechanisms and of other issues. Photodetectors components in hermetically sealed Receiver Optical Sub-Assemblies may be affected by water that can induce dark-current increase. In laser diodes-based devices, like transmitters, water and VOCs are considered harmful gases. Problems are related to signal attenuation because of gas condensation. A well-proved solution to prevent the potential issues related to moisture and gas contaminants, inside hermetically sealed devices, is to integrate a getter material that is able to sorb the gaseous impurities and to keep a pure atmosphere or a proper vacuum level. Recently developed getter solutions, specifically engineered for optoelectronic devices, are based on special sorbing elements dispersed in suitable polymeric matrixes that can be easily integrated in the cavity packages or on the internal components walls.

Moreover thin getter films obtained by Physical Vapor Deposition, have been designed and optimized for vacuum hermetic requirements: they can be easily integrated at wafer level or lid level in the devices and

can be activated during the bonding or package sealing process. This getter solution can be applied and patterned according to specific needs and geometrical constraints. Another important aspect, complementary to the getter material selection, is the need to select the appropriate materials and processes for the sealed devices and to characterize the quality of the hermetic bonding. By employing suitable analytical techniques it is possible to measure the vacuum level and the gas composition, to assess the leak rate and hermeticity of the package, to investigate the outgassing of detrimental contaminants inside the package. The knowledge of these phenomena is fundamental in order to obtain different key information related to possible pressure rise inside a device, to perform a proper sizing of the getter material for the specific application requirements, to provide straight indications for the selection of materials and for their compatibility with the hermetic package.

The presentation will show which are the main gas contaminants generated in different electronic and optoelectronic modules and how efficient are the developed getter materials in sorbing moisture, H_2, VOCs, N_2, CO, CO_2 and Hydrocarbons . Besides this, it will be illustrated how the availability of analytical techniques to measure the gas impurity composition inside the devices is a key aspect to support the continuous efforts in developing suitable solutions for sealed modules with high reliability and stable performances.

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