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Master Thesis

Sulfur Corrosion of SMD Resistors

Confidential

1 Abstract

Today, electronic equipment has become a major part of everyday life and has emerged across the globe and into various sectors where high concentration of corrosive gases is a concerning factor for failure-related issues of electrical components due to atmospheric corrosion. As the performance of a device is rather dependent on the circuitry, even the smallest degradation can affect the functionality of the device. Therefore, it is necessary to gain a better understand of the mechanisms behind corrosion-induced failures for electronics that are exposed to various gaseous pollutants in outdoor and indoor environments.

Over the years, the Battelle mixed flowing gas test has been widely used to simulate atmospheric corrosion on electronics by exposing products to corrosive gasses (such as hydrogen sulfide, nitrogen dioxide, chlorine, and sulfur dioxide) in a controlled environment. However, the specifications on the gas concentrations levels have shown to be rather low (in the ppb range), particularly for certain regions where modern-day concentrations are considerably higher. Moreover, long exposure time is also required for such tests before any failure mechanisms are seen. Therefore, the aim of this project was to modify and develop an accelerated test based on existing standards, such as ASTM mixed flowing gas (MFG) and flowers-of sulfur (FoS) tests. In addition, the test had to simulate corrosive results as found similar to those found in the field. This work includes detailed investigations of on SMD thick film resistors exposed to sulfur-bearing gases, despite that it is well known that silver is often used as the inner electrode and is highly sensitive to sulfur-containing gases, resulting in silver sulfide (Ag_2S) formation. Samples include both standard and anti-sulfur resistors, as well as coated resistors employed on a printed circuit board assembly (PCBA) of an electronic product provided by Volvo. The PCBA device was specifically tested to simulate similar results that were seen on the same failed PCBA device that was used in the field.

The results showed that the FoS test provided similar failure mode as seen after field use and more accelerated than the MFG based test. As a result, the standard SMD resistors revealed Ag_2S formation at the typical corrosion failure sites after only a few days exposed to FoS, while the ant-sulfur resistors remained robust and showed no significant signs of corrosion, even though the concentration of sulfur gas is much higher than according to MFG test standard specifications. Furthermore, investigations of conformal coated SMD resistors showed more corrosion than compared with uncoated resistors, suggesting that the conformal coating does not protect the component from sulfur containing gases and may even accelerate the corrosion process.