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Publication date:
2021

Document Version
Publisher's PDF, also known as Version of record

EUROCORR 2021

Solder mask surface properties and related PCBA failure due to build-up of water layer

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The electronics industry adopts an increased device miniaturization, and devices are expected to perform optimally in a multitude of climatic conditions worldwide, which adds to the list of possible failure modes. Changing temperature and humidity are a major driving force for failure, supported by device design elements and surface morphology.

Surface properties of the circuit board comprise the surface roughness of the laminate and the chemical coatings like solder masks etc., which are often overlooked.

Simulated high-humidity conditions at room temperature and Peltier cooling have been combined to induce condensation and resultant water layer build up on test PCBs with different solder masks.

The surface water layer formation on test specimens has been monitored using both qualitative (Digital Microscope) and quantitative (Impedance measurement) methods, in order to create a correlation to measured surface roughness parameters, solder mask surface morphology and chemical properties.

The results give an insight into the bridging of condensed water droplets on the solder mask surface, which can be confirmed by changes in measured impedance. Average Time-To-Failure of the specimens has also been recorded. Ultimately, a unified picture of the effect of surface parameters such as roughness values on potential PCBA failure has been created. Selection of the appropriate surface roughness parameter can be used to rank and potentially predict solder mask contribution to PCBA failures.

Keywords: Humidity, Impedance, Printed circuit board laminate, Solder Mask, Surface roughness, Temperature, Water layer formation