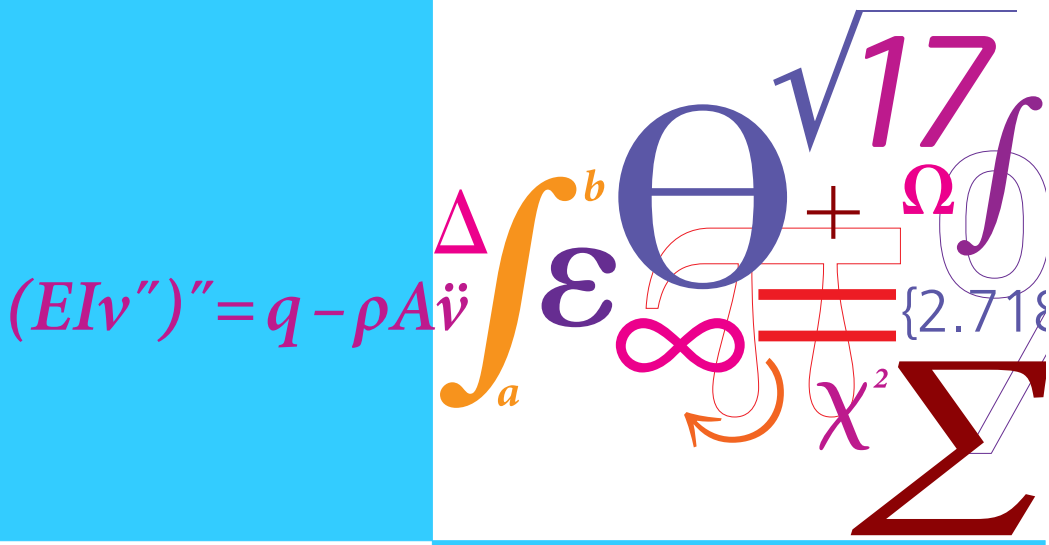
Humidity interaction with reflow residue and effect on corrosion reliability of SMT devices

MSc Thesis



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Abstract

The premise of this work is to determine the effects of reflow solder residue on water film formation and corrosion of PCBA components, under the influence a conductive water layer formed as a result of exposure to different levels of temperatures and humidity.

Out of all the constituents of solder paste, the flux package contains chemicals that have the most significant ionic activity in water when left behind on the surface of the PCBA. These substances, which include halides, halogen, carboxylic acids, etc. have the strongest effect on increasing surface conductivity and causing corrosion and failure by mechanisms such as electrochemical migration (ECM) and high leakage current. The flux additives have different levels of hygroscopicity and ionic activity in water, and thus have varying effects on PCBA surface corrosion depending on the ambient temperature and humidity conditions.

This thesis explores some of these conditions in a systematic manner, and is divided into 7 chapters, to reflect the same:

Chapter 1 gives some insight into the evolution of Surface Mount technology, the advent of reflow soldering and the use of the same. An introduction to corrosion of electronic devices is also included.

Chapter 2 gives the background for the entire thesis, based on a literature review. This chapter has contextually detailed insights into the nature of humidity, the interactions of humidity with the PCBA surfaces and the formation of water layer, and the failure mechanisms induced by the formation of this water layer. Also included are the nature and constituents of reflow solder, along with some corrosion-related and performance-related properties of these constituents, all of which are finally connected to PCBA failure mechanisms. These mechanisms need to be characterized and measured, which is why a section detailing the imaging methods of SEM and LOM has been included as the closing of this chapter.

Chapter 3 gives an insight into the various materials used for testing, such as the Test PCBs, solder pastes and various equipment. This chapter also details the methods of the 4 experiments that make up the research work- these experiments simulate different humidity and water layer conditions, and make measurements to determine the effects of the various additives under these simulated conditions.

Chapter 4 discusses the results of these experiments, along with connecting the observed phenomena to theory. Rankings of corrosion performance have been provided for each test.

Chapter 5 is a summary discussion of all the observations made from the experiments, along with reasoning to support these observations and build a narrative.

Chapter 6 includes the conclusions made from the experiments together.

Chapter 7 makes suggestions for future work, based on the results of the current work.