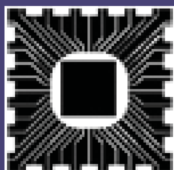


IeMRC

Abstract

Feasibility Project

Challenges for electronic manufacturing posed by new surface contamination related failure modes in the context of the wireless revolution.

Partners: Loughborough University, Henkel Technologies

The past decade has seen exponential growth in the market volume of wireless enabled products, offering functions such as data transfer, computer connectivity, remote sensing and AIDC (auto-identification and data capture). The UK electronics manufacturing sector is poised to benefit substantially from future growth in these and other emerging RF communications based sectors. Wireless products demand high impedances from circuit board materials and insulation, but at the same time due to their mobile nature see wider ranges of environmental conditions than products designed for fixed locations. In order to protect the circuit impedance against degradation due to environmental contamination, conformal coatings are frequently used. These coatings may be combined with assembly processes using “no-clean” flux based solder pastes, which have been widely adopted in order to reduce the use of environmentally damaging cleaning solvents.

There is anecdotal evidence of unexpected failure modes in conformally coated wireless products assembled with these no-clean solder pastes. No-clean processed wireless product circuit board assemblies must in fact be cleaned if a conformal coating is to be applied, but normal cleanliness level assessment techniques based on determining concentrations of soluble ionic species on the board surface cannot detect ionic species trapped under films of no-clean solder paste organic residues. A failure pathology is suggested in which an inadequate cleaning process results in trapped ionic contamination. In the field, water vapour diffuses through the conformal coating and interacts with the trapped ionic contamination. In sensitive locations a leakage path, sometimes called a low impedance short, may form, causing a subtle degradation in performance or reduced battery lifetime of a wireless product. If failure is not outright the underlying causes of the degradation in performance may never be recognised.

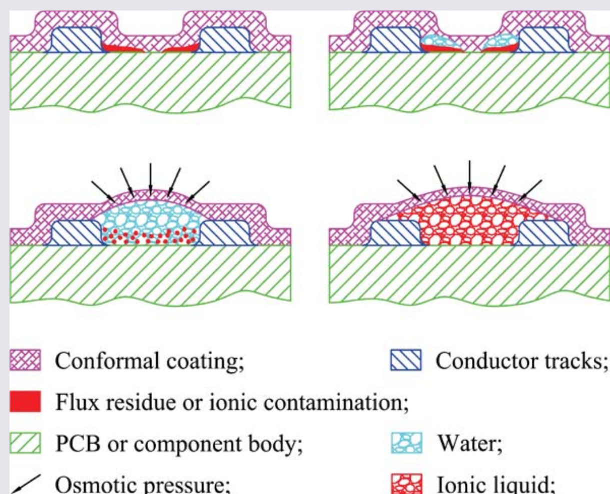
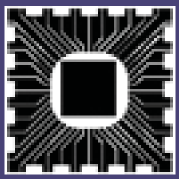


Figure 1. Potential failure mechanism: (a) Conformal coating covering soldering residue on a component, (b) diffusion of water through conformal coating to near component surface, (c) delamination of conformal coating and formation of fluid filled vesicle due to osmotic pressure, (d) formation of electrolyte and current leakage path between conductor tracks.



Susceptibility to this failure mechanism was tested in this project by damp heat insulation resistance measurements following a procedure similar to IPC standard surface insulation resistance (SIR) testing. The boards used were capacitor loaded test coupons reflowed with a low-solids solder paste and encapsulated with a two-part silicone based conformal coating. The boards were cleaned to differing levels to allow investigation of the effect of degree of surface contamination on the effectiveness of the conformal coating. A difference in the capacitor circuit resistances was seen at short time in the tests correlated with the degree of cleaning. The differences were seen despite ionic contamination tests yielding similar or identical levels. A qualitative test for the presence of organic resin residues from soldering was found to be a better predictor of the behaviour in the damp heat test. Discoloration of solder on comb structures was seen on encapsulated boards after the damp heat tests but not on unencapsulated boards.

The investigators would like to thank Zestron Europe for the board cleaning and board cleanliness assessments.

Figure 2. Discoloration on reflowed solder on bars of comb on uncleaned board after the damp heat test, seen through the encapsulation.

For more information contact:
Dr Patrick Webb, School of Mechanical and Manufacturing Engineering, Loughborough LE11 3TU
Tel: 01509 227675. E-mail: D.P.Webb@lboro.ac.uk