Commentary

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Does Conformal Coating Stop Electrical Leakage Problems?

Conformal coating is used by many electronic manufacturers to minimize the issues of condensing and heavy moisture operating environments and its effect on electronic hardware. This protection system does a good job of being a physical barrier for condensing moisture, allowing the moisture to dry out naturally, not affecting electronic hardware performance. But over time conformal coating does allow moisture to pass through the material. If there is nothing to which the moisture can react, then this small amount of moisture has little effect on product performance.

However, a problem can occur when the surface of the assembly has conductive residues that absorb and hold moisture under the conformal coating. Today's use of water soluble fluxes using water only cleaning, and low stand-off components or the use of heavy no-clean fluxes with minimal thermal energy, can create areas that have moisture absorbing and conductive residues. When conductive and moisture absorbing residues are present below the conformal coating, at or around sensitive components or circuits, intermittent performance failures will occur as moisture builds below the coating. This may happen in as few as six months or as many as 18 months in high humidity conditions in the field.

Case Study
A Foresite customer was experiencing a problem with leakage issue on an SMT assembly. The site of the failure was next to an area selectively soldered using pallet wave soldering. The manufacturer was experiencing capacitor failures during a powered temperature cycling test at:

- -25 to 85C with 85% RH at high temperature.
- Cycle dwell >> three hours
- Half-hour ramp

All failures were occurring in less than 20 cycles. No visible dendrites were present on top or even below the conformal coating and all failures recovered after baking.

Sample Description
Samples analyzed were:

- Three conformally coated failed assemblies
- Three production units
- Three bare PCBs
- Nine capacitors from the reel used to assemble the boards.

The mixed-technology boards were processed with a no-clean (low solids) and the problem area was localized to an 0805 chip capacitor on the bottom side next to a selective pallet area. The board was processed with a double-side reflow process, then a wire harness was selectively soldered near the failed capacitor.

Analysis
The samples were tested using ion chromatography per IPC TM650-2.3.28. A localized steam extraction system was used to isolate the 0.1 in^2 area around the capacitor. The conformal coating around the capacitor was cut and lifted. Samples were taken from the capacitor area on the bottom of the board and near the wire harness. To act as a reference, a sample was also taken from an 0805 resistor on the bottom side, but 5.2 inches away from the area of wire harness.

The results of the ion chromatography testing show a combination of contributing contaminants (Table 1).

	Chloride	Bromide	Sulfate	WOA
Bare Board Capacitor area	9.12	1.21	0.37	0.00
Bare Board Reference area	9.77	1.35	0.42	0.00

Current Prod Cap area	11.24	7.39	2.32	178.98
Current Prod Ref area	10.65	3.81	0.54	34.54

Failed Prod Cap area	10.34	6.55	2.88	193.43
Failed Prod Ref area	12.21	2.87	0.32	32.11
Capacitors from reel	0.21	0.00	1.98	0.00

(Note: Mean values from the three samples tested are displayed. All values are in ug/in2.)

Table 1

The results indicate multiple contaminants at levels that can cause electrical leakage problems. The bare board shows high chloride levels from the HASL flux and tap water cleaning system. These levels with enough moisture can cause the electrical leakage problems alone, but the very high levels of WOA (Weak Organic Acid) near the wire harness area indicate heavy flux from capillary action around the area of the selective pallet. This capacitor area is within 0.25 inch from the edge of the selective pallet area.

The combined issues of flux residues around the surface of the capacitor are high enough levels to create a leakage failure as well. But both contamination sources are assisting in moisture absorption and creating the poor performance during the powered temperature cycling testing.

Conclusion

A follow on study changes two conditions of the original failure – the results were similar.

1. When the bare boards were cleaned prior to assembly and the assembly process was left the same, units failed powered temperature cycling in 16 cycles.

2. The bare boards were not cleaned prior to the assembly process, were processed normally, including the selective process and the PCBs failed at cycle 21.

Both of these groups showed poor performance due to the amount of moisture absorbing flux below the conformal coating at recommended thicknesses. When both conditions were corrected, the assembly passed 50 cycles of testing. The conditions of cleanliness for the passing product showed chloride levels at 2.3 ug/in^2 and WOA levels of 111.32 ug/in^2 at the capacitor area. Conformal coating will delay the effect of moisture if the residues are moisture absorbing and conductive, but over time, failures will continue as moisture become available.

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