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Commentary

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Process Residues Cause Field Performance Problems

This is a case study used to dispel the rumor that SIR (Surface Insulation Resistance) testing is a complete test to prove performance of an electrical circuit.

SIR testing is tool many have used with little or no problems, but passing SIR doesn't mean that the process is not capable of producing bad product. Dirty bare boards, components, no-clean processes, high-pressure cleaning with low stand-off components or even using selective pallets and a water based no-clean flux can all cause catastrophic problems if you don't validate and assess the residues on the assemblies and control the process. I believe that improvements in SIR testing are well overdue and will eventually make their way through an approval process only if we have clear reasons and an understanding for changing the way a process is qualified.

It has been repeatedly asked how a SIR test correlates to the performance of an assembly if you use a test coupon that is nothing like the assembly being built. The IPC test coupon B-25, B-24 or B-36 board is only bare copper on FR-4 with no soldermask (except a dot keeping the LCC standoff at 5 mil). How can the interaction of the fabricators, component vendors and soldering processes effects be completely evaluated on this type of assembly?

The industry has consistently recommended a different test assembly used to qualify a process that includes the 68 pin LCC pattern called out in IPC J-Std 001 and to have the board built at the fabricator with the soldermask and metallization used to build the assembled product requiring the test. We also believe that eventually the time, temperature and measurement voltages will improve using the new European SIR test method presented at the 2004 IPC APEX Conference.

Since I am a strong advocate for ion chromatography testing, I would like to share a case study where selective extractions and localized testing allowed us to solve a performance problem for one of our clients.

Clients typically bring problems that are field or environmental test failures, but occasionally we are presented a problem occurs before it's shipped. This case study examines a product that was in preparation for a worldwide product release.

The batteries in this new product were being drained to total depletion in less than two weeks when the box was in the 'off' position. The problem was found to be affecting 10 percent of the product in the warehouse and unfortunately, new product was arriving daily.

Initial root cause was determined to be leakage on the battery circuit at the 0805 chip capacitors (Figure 1). A screening protocol was developed to measure leakage on the battery circuit and was used to cull all assemblies with the defect.

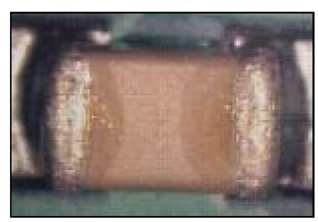

Figure 1: SOC 0805

Using a biased condition the no-clean processed assemblies were placed into a 40°C / 85%RH environment for 24 hours. This was sufficient time for the leakage to propagate. At the end of the test period, the battery circuit was measured for leakage with a Multimeter and power supply.

After an initial evaluation for cracked capacitors using cross sectional analysis and Sonotek imaging, it was determined that the problem was not due to cracking. But additional Ion Chromatography analysis on the failed samples showed consistently higher ionic residues on the surface of the capacitors when compared to the non-failing samples.

Using standard extractions, we were not able to see a difference between the no-clean processed assemblies; however, using a localized extraction approach we were able to determine a very distinct difference between the two groups.

Since we knew that there was no problem with the capacitors, we believed that the cleanliness in this critical area of the board was a problem. Further investigation with the localized extraction system in the area of the capacitor allowed for a better understanding of the pockets of contamination causing the failure.

The testing revealed a high level of sulfate residue on the capacitors of the failed assemblies and that sulfate was not present in high quantities on the units passing the screening test. Additional locations in both groups were also tested and all showed similarly acceptable results. After screening 250,000 assemblies, we identified a 7-14% failure rate for electrical leakage problems after humidity testing. All the assemblies that passed the test showed no additional problems with drained batteries.

After working with the component vendor to improve the post-plate rinsing process, a reduction in leakage failures was identified in the next 50,000 assemblies. The failure rate dropped to 0.14% and the next 100,000 assemblies showed a 0.01% failure rate. Over the course of the last year, 50,000 assemblies have been built each week with no reports of drained batteries or problems with leakage on the battery circuit.

Localized processing residues from component fabrication can be problematic, as well as flux residues that are not fully activated, cleaning processes that use high pressure with low standoff components and rework processes using extra flux or are cleaned with a brush. These issues can all be related to intermittent or large scale performance problems.

Today's tools for assessing processes and their residue impact on performance are limited to

- ESS testing (Electrical Stress Screening) where the product is thermal cycled and tested under bias and in humidity. ESS tells the most about the product.
- SIR testing to qualify a process.

Clearly, SIR has limitations. It must be used to understand materials effects, but the use of additional tools, such as Ion Chromatography and localized extractions, gives additional information not identified by other supporting analytical tools such as FTIR and SEM /EDX.

Summary

Examining the cause of the residues on the capacitors, we found that the post plating rinses after the component manufacturer's MSA (methyl sulfonic acid) barrel plating process was not neutralized or uniformly rinsed. This resulted in a percentage of dirty capacitors in each lot shipped.

These localized pockets of contamination were not high enough to affect the standard extraction test results when the whole board was analyzed. Only localized extraction (Figure 2) was able to determine localized conductive plating residue (sulfate) left on the capacitor surface.

Figure 2: Localized Extraction Equipment

Bio: Munson has extensive electronics industry experience in applying Ion Chromatography analytical techniques to a wide spectrum of manufacturing applications. His company, Foresite, is a failure analysis and process assessment facility with expertise in solder joint quality and residue effects on electronic hardware.

Terry currently chairs the IPC Rework Cleaning Task Group and has spent 16 years participating with the IPC task group activities on CFC elimination, no-clean fluxing, and aqueous cleaning.

Terry Munson
Foresite Inc. - www.residues.com - (765)457-8095
tm_foresite@residues.com

Web Page: http://www.circuitnet.com/articles/article_11278.shtml

Circuitnet - Covering the World of Electronics Manufacturing.
45 Research Drive, Haverhill, MA 01832 USA