Process Doctor

Terry Munson

Understanding Specific Area Cleanliness

Leave no residues behind.


FIGURE 1: Electrochemical migration.


FIGURE 2: Copper sulfate corrosion.

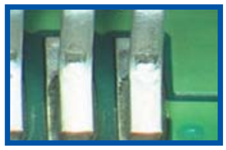
FIGURE 3: Electrical leakage.

OEM and EMS firms are encountering important issues involving circuit- and system-level performance as it relates to specific area cleanliness. Specific area cleanliness is the amount of contamination on the surface, below the component, in the board subsurface and between the traces – visible and invisible. These areas are difficult to examine individually using common industry methods, and contaminants can be diluted and overlooked by examining the board only as a whole.

Are all these residues (contamination) detrimental? No, but some can be if not completely heated. No-clean fluxes have been formulated to leave a benign insulative residue after soldering. Water-soluble fluxes are designed to be completely removed by aqueous cleaning with no residue left behind. Over the past 15 years, we have learned many things about these two processes. A VOC-free, no-clean flux (water base) can cause dendrite growth in areas where it hasn't seen enough heat to remove the entire amount of water carrier. This is due to a strong acid structure with a pH of 2.4 typically. Flux residues make up only part of the residues at each solder joint. Remember, the fabricator and component vendor left residues from their processes at these same solder joints. We must understand the differences between good protective residues and bad corrosive residues, and the critical parameters to test and monitor that identify these issues.

Are residue-related problems becoming more common? Many problems have been misdiagnosed, and new designs have a much higher level of circuit sensitivity. Many EMS firms have seen large increases in no trouble found (NTF) returns. These returns encountered an event in the field, but by the time the units were retested at the bench of the EMS the problem disappeared because the residues dried between time of failure and shipment to be tested. For a good environmental check, place the units in high humidity (35°C/65%RH) overnight, and then retest in the morning. If the units fail, the failure is residue-related. (Watch for follow-up columns on specific area cleanliness and how to address it.)

What are the field failure mechanisms caused by residues?

1. Electrochemical migration (**Figure 1**). Metallic dendrite short bridges a power to ground or lesser voltage potential point. Cause: flux residues and moisture bridging the holes or traces.

2. Electrochemical migration due to high chloride residues on a component used on a no-clean assembly.

3. Electrochemical migration caused by high chloride residues on a component used on a water-soluble flux and marginal cleaning of the assembly.

4. Electrochemical migration due to high bromide and chloride residue from bare-board HASL finishing and the wet monomer left in the void areas of a chip-bonder epoxy.

5. Electrochemical migration due to condensing moisture on a no-clean assembly with high levels of chloride and bromide HASL flux residues.

6. Copper sulfate corrosion (**Figure 2**). Exposed copper in a heavy cloud of sulfate residues, typically from outgassing in a non-vented enclosure and no coating protection.

7. Electrical leakage (**Figure 3**). Stray voltage through conductive residues in the presence of moisture or other fluid media and a conductive residue. No visible residue is seen but typically leakage can be measured.

8. Electrical leakage due to capacitor plating contamination. Cause: typically, high sulfate residues that are moisture-absorbing and conductive.

9. Electrical leakage due to heavy no-clean flux residues not completely heated and complexed to create the benign residue, but the residue becomes a moisture-absorbing conductive pathway.

10. Electrical leakage due to hand soldering with no-clean flux using extra no-clean flux from a bottle. ■

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