



Pop, Sizzle and Fry

Make sure that what appears to be dry really is dry
Foresite Inc.

In this case study, we examined the cause of laminate blistering in aqueous cleaned assemblies. The assembler in this study produced high volumes of electronic assemblies for automotive applications. The assemblies were generally FR-4 laminate, LPI solder masked, with combined through-hole and surface mount technologies. Water-soluble paste and IR reflow, and wave soldering with water-soluble flux (foam), were used with aqueous cleaning. We had worked with this manufacturing line in the past and had known it to be in control and had acceptable residue levels.

Following the aqueous cleaning (after wave solder), the assemblies were dry to the touch from the high volume blower fans at the exit of the aqueous cleaner. The assemblies were then functionally tested using automated test equipment. If no faults were detected, the assemblies went to a bake step prior to conformal coating. If a fault was determined, then the fault location was logged and the assemblies went to inspection and touch up soldering.

The touch-up soldering operation was typical. Liquid flux was applied to the suspect areas and a hot soldering iron applied to the solder joints specified. The technicians were well trained and efficient. In many cases, a delamination was found in the areas that had been hand soldered, and represented a significant blister. The operators could physically hear a “pop” and a sizzle sound in some cases. This blistering was cause for rejection by the company workmanship standards, naturally resulting in a higher scrap rate.

A series of analyses showed that the problem was residual water. In all of the areas where the blister occurred, a low-standoff high-footprint device was present. The aqueous cleaner had three high volume blowers at the exit, but low standoff, fine-pitch devices represent a significant drying challenge to the blowers. In our experience, most aqueous cleaners do not have sufficient power to completely dry an assembly. This is not an indictment of the cleaners, but an indication of the challenge involved. In most cases, the automated test equipment found electrical shorts in the areas of the low standoff devices, which was due to residual water. When these boards went to touch up soldering, the residual water in the laminate tried to vaporize all at once, resulting in a small internal explosion, creating the blisters. For the same reason, many assemblers bake the moisture out of a board prior to wave soldering to avoid measling. In this case, the only mistake the assembler made was to assume that the assemblies were dry as they exited the cleaner.

By implementing a short vacuum bake in between aqueous cleaning and functional testing, the number of shorts detected by the automated tester decreased dramatically. The number of boards that went to touch-up soldering decreased, and any still-faulty boards were dry enough to hand solder without blistering, further reducing the scrap rate.

Many assemblers do not want to incorporate a baking step into the operation because it either costs too much or reduces throughput. “Dry to the touch” is often not dry enough. Some other possible effects of residual water from the cleaning operation might be:



- Creating a short where one is not desired, as in the case above
- Sustaining a short when it masks an open circuit – residual water could mask a crack in a circuit, providing continuity for in-circuit testing, but resulting in an open circuit when the water has had a chance to evaporate
- Changes in the dielectric characteristics of the circuit during testing – affecting factors such as rise time, propagation delays, and cross talk
- A changing baseline if you are doing circuit tuning – the circuit may be tuned with water present, which would then be out of tune when the water evaporates

For processes incorporating aqueous cleaning, it is prudent to compare the end results of an assembly that had no additional drying with one that has been dried, to make sure none of the above “gotchas” occur.