Process Doctor

Terry Munson

Can You Clean a No-Clean Assembly?

Troubled assemblies are put to the test.

Recently, a client experienced a high percentage of product returns from the field, but, on closer examination, many of the returned boards were functionally good when examined at the test bench. The number of no trouble found (NTF) returns was a significant increase over the number of returns seen by the client with previous product launches in the U.S.

The Investigation

The client used a mixed assembly process with a hand-soldered connector on the wave solder side of the assembly. A low-solids, no-clean paste, wave flux and cored solder were used on the assembly and each qualified with standard surface insulation resistance (SIR) testing. Assemblies that were built during the product validation phase also performed well during electrical stress screening (ESS) testing. Eight months into the production cycle, boards with less than 60 days of use experienced a high percentage of intermittent problems in the field. Scanning electronic microscope (SEM) and electron dispersive x-ray (EDX) analysis were inconclusive as to the root cause of the failure.

After further investigation, it was determined that none of the assembly factors had changed—the board vendor and processes, flux, paste, cored solder, thermal profiles and equipment were the same used during qualification. Visually, all assemblies showed no differences that could be identified by trained inspectors and instructors. Cleanliness testing on the production floor consistently showed low levels of sodium/chlorine equivalents (less than 6.0 $\mu g/in^2$). So, what caused the failures?

A direct comparison was made of the field returns and current production samples. The cleanliness of incoming bare boards and components (0805 resistors and connectors), which seemed to be part of each area of failure, were also examined. Ion chromatography results showed that failed assemblies and current production samples were each high in chloride and weak organic acid (WOA) values.

The high chloride came from the bare board hot-air solder leveling (HASL) fluxes and cleaning processes. The connector and resistors were ionically clean and not the source of the contamination. The boards without the hand soldering of the J1 connector showed a much lower level of WOA. The hand soldering process used extra wave solder flux for soldering the connector—these are hazy and clear residues seen between the contact leads of the hand soldered connector. The extra flux residue between leads on the connector was not heat activated and is moisture absorbing and conductive. Partially reacted flux residue and high chloride levels from the bare board fabrication process creates a product that will continue to have intermittent performance problems until enough moisture is absorbed and hard electromigration failures occur.

Now that the root cause of the NTF problems has been determined, the question is, "Can we clean a no-clean assembly?" When cleaned with water only, the assembly forms a thick, white haze between the connector leads, and a residue is also seen between leads on the board surface. Cleaning with water did not reduce the amount of residues found on the assembly.

Only a saponifier, used at a low pressure at 60°C and then rinsed with steam and deionized (DI) water, was found to be an effective cleaning method. Data shows that the board fabrication and WOA residues are greatly reduced (below recommended limits) and that functional testing of the saponified/steam-cleaned assembly showed great product performance (10 of 10 cleaned boards passed)—even after 16 hours of 40°C/90 percent RH. Assemblies that were not cleaned were also exposed to the same environmental conditions (both groups without bias, just exposure) and tested (9 of 10 not cleaned)—these boards failed due to stray voltage and leakage.

Conclusion

Heavy, partially-reacted, low solids no-clean fluxes can cause electrical performance problems—a large percentage of the NTF failures may be caused by residues—by absorbing moisture from, and creating a conductive path on, sensitive circuitry. Cleaning with a saponifier and steam, with low pressure on the entire assembly, can remove the moisture absorbing flux and even clean fabrication residues that may cause long-term reliability risks. So, yes, you can clean a no-clean assembly! ■

Terry Munson is with Foresite Inc. (residues.com); tm_foresite@residues.com. His column appears monthly.