Process Doctor

Terry Munson

Component Cleanliness in a No-Clean World

A case study of component residues.

In the world of no-clean assembly technology, remember that what is on the components before and during assembly is also what is on the surface in the field. The primary source of contamination for no-clean assemblies is bare board residues, but, with improvements in bare board fabrication and rinsing such as hot air solder level (HASL) flux and tap water alternative processes, the residues can be greatly reduced.

Since components have become much more complex in their structure and contamination types, you should understand the residues as well. Micro ball grid arrays (microBGAs) can use water-soluble fluxes to attach the balls, but, if not properly rinsed, organic acid fluxes are left behind. As chip-scale packages (CSPs) get smaller, with 0603s, 0402s and 0201s, they can be more difficult to rinse uniformly in a large group. The residues from these processes are very ionic and corrosive if not properly removed. Current process control tools, like the ionograph or Omega Meter ROSE tools, require hundreds of these small components to get enough surface area to even be detectable; even then, the tools are not capable of separating corrosive from non-corrosive residues. We have found that using tools such as ion chromatography per the IPC 2.3.28 test method gives a very clear picture of the level and type of residues left on the components.

After examining recent findings of electromigration and electrical failures on components when processed with a no-clean assembly, we found that the incoming components can be the root cause of these failures. Ion chromatography has allowed us to separate, identify and quantify the ionic residues on the incoming parts, boards and failed assemblies.

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

The Test

In this case study, we investigated the effects of component cleanliness on a no-clean assembly single surface-mount reflow process. The bare boards, incoming components ("as received") and different sites on a high humidity test failure were analyzed for ionic concentrations. We placed 25 assemblies into a 10-day, 40°C 90 percent relative humidity (RH) environment under a biased voltage and functionally exercised each day. After three days of testing, 23 boards showed hard failures, and the last two had intermittent readings.

The bare board showed a low level of chloride, bromide and sulfate, as did the reference site on the failed board with no component technology. The low levels of ionic residues were not responsible for the electromigration failure. The reference area showed non-detectable levels of methane sulfonic acid (MSA) and sulfate residues. The failure site of a vendor A component with the corrosion showed high MSA and sulfate levels with low chloride, bromide and weak organic acid (WOA) levels, while the comparison site to the non-corroded quad flat pack (QFP) showed low MSA, chloride, bromide sulfate and WOA levels. The QFP components from different vendors showed a large difference in MSA and sulfate levels. The source of the MSA and sulfate is the plating bath solution; therefore, the cause of the high levels of MSA and sulfate is poor neutralization and rinsing plated parts.

With the clear source of MSA and sulfate ions residing on the body and leads of the incoming packages from vendor A, cleaning these components in a water wash system would have greatly reduced the possibility of electromigration failure. However, with a no-clean process, the residues are not removed after assembly and are available to react with humidity and voltage in the field.

Conclusions and Corrective Actions

The root cause of the electromigration failures during the 40°C and 90 percent RH testing under bias is the incoming contamination from vendor A on a specific lot of components. All of the assemblies were cleaned with saponified de-ionized water and steam and then retested in the high humidity environment. All 25 boards passed the 10-day humidity test after cleaning, as did the boards with cleaned components from vendor A (MSA levels <0.5 µg/in^2). With a no-clean assembly process, the component, board and assembly flux are critical variables that must be understood and controlled. ■