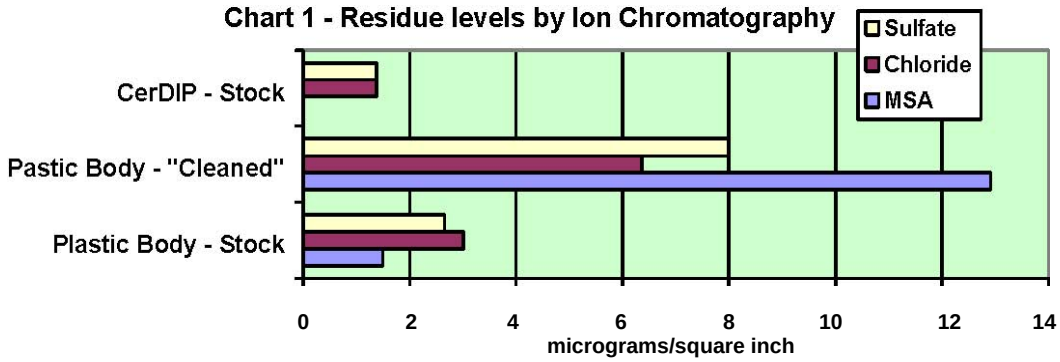
I'm Surprised You Have Any Leads Left!

Component cleanliness creates big problems

Foresite Inc.

The component in question was a very high impedance device, which could exist as a ceramic DIP (CerDIP) or as a plastic bodied surface mount device. As a high impedance device, the chip was extremely sensitive to contamination. The component manufacturer noted that the component leads had extensive corrosion on the surface following autoclave testing (121°C, 100% RH, 2 atm) or HAST testing. The corrosion on the leads interfered with functional testing in a mating socket. Unacceptably high levels of leakage currents from pin to pin were noted. In the cerDIP packages, the glass-filled epoxy seal had been chemically attacked such that the normal outward-bowed, nearly black seal appeared inward-bowed and white. For the cerDIP forms, a metallic or glassy precipitate was often found between leads. The problems occurred with alarming frequency in both U.S. and Pacific Rim manufacturing sites.

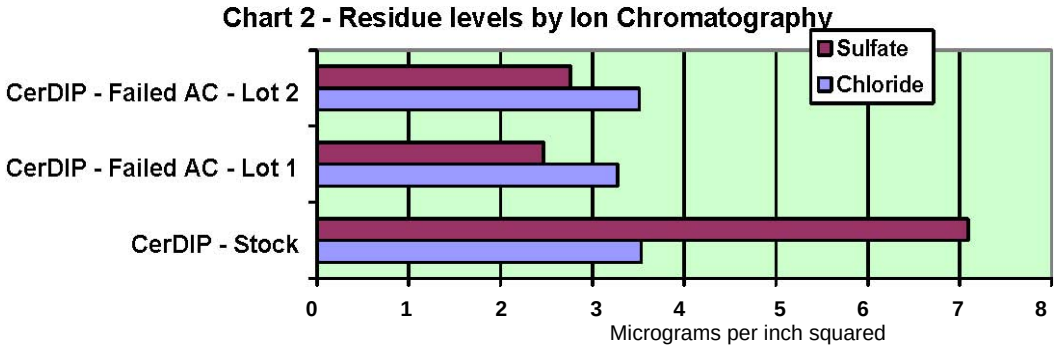
After a long series of analyses, we were able to determine two root causes for the problem. One manufacturing facility was processing the lead frames using a methane sulfonic acid (MSA) process. This is not unusual. Much of the component manufacturing industry converted to MSA from fluoroborate several years ago, because MSA was less caustic. On the down side, fluoroborate is very easy to rinse with water, while MSA requires a neutralization step, followed by hot deionized water rinsing. If not fully neutralized and rinsed, the MSA residues are extremely corrosive, and are easily transferred to surrounding surfaces in a high humidity environment (e.g. autoclave or HAST). While this facility did have a neutralizing bath and hot DI water rinsing for the plastic bodied forms, the dynamics of the cleaning were not very effective, and production pressures started to move product through the process too quickly. This same facility also produced the CerDIPs and used some concentrated acid baths, rather than flux, to prepare the leads for tinning. Chart 1 shows the residue levels found by ion chromatography on the plastic and CerDIP packages. These residues correlated with consistent failure in autoclave and HAST testing. These residues also are known to combine with moisture to form electrolytic solutions, resulting in leakage currents that are death to this device.



Why use such aggressive solutions? A pre-bake step induced a heavy oxide layer on the leads necessitating an aggressive material. A nitrogen bake would solve with the problem.

The second manufacturing site used no MSA, but used an aggressive flux. The flux was halide-free, but contained sulfuric acid. Rather than apply the flux to the lower portion of the leads, the body was immersed and put through the tinning operation. Chart 2 shows the residue levels revealed by ion chromatography on the CerDIPs for this facility. These levels also correlated to consistent failure in autoclave and HAST testing.

To give you an idea of the magnitude of the problem, we generally recommend that MSA and chloride residues be held to under 0.5 micrograms per square inch, and sulfate levels under 1.0 micrograms per square inch, for component applications. Compare these levels to those on the charts to see how far off they are.



We are still in the process of working with this customer to implement the changes and monitor the new processes. So far, we have recommended the following:

- The pre-tinning component bakes be done in nitrogen to avoid oxide buildup.
- Use a much less aggressive lead preparation flux.
- Apply the flux only to the leads with no component immersion.
- Nitrogen inert the tinning operation.
- Implement a better post-tinning cleaning process.
- Pay more attention to the MSA neutralization and rinsing processes.
- Do designed experiments to benchmark and monitor the corrosive residues.
- Assume all processes are bad, until proven otherwise.

It's a rather sobering scenario to all of you who assume your components come in your door clean, isn't it?