Process Doctor

Terry Munson

Does Electronics Really Have a Surface Contamination Problem?

As field returns mount, our expert's answer is 'yes.'

Is there really a surface contamination problem in the electronics industry? The question comes down every six months from some senior manager who has neither seen nor heard of problems with product performance. Nor have they seen articles in the *Wall Street Journal* about contamination causing product recalls. But, when the problems start to show in their products, these managers are curious why no new industry specifications have been created to show that these problems are being dealt with.

My response is threefold: 1) In today's legal climate, few companies discuss or admit reliability or field problems because doing so invites legal action. 2) When product performs poorly in the field, end customers suffer downtime and lost production or system performance failures. This is due to a piece of electronic hardware from a supplier or even an OEM. Every resource is made available to solve the problem. This crisis often gets solved by focusing the blame on the lack of cleaning or conformal coating in the process. Typical solutions are to renew cleaning, change flux vendors, add a coating or even change a supplier. The change seems to make things better, everyone is happy and no problem really occurred, but process improvements that were needed to tighten up the new design finally were done. That was all, or was it? 3) I now ask what appears to many as an unrelated question: What percentage of products in the field have been returned due to a problem that then was classified as No Trouble Found (NTF) or No Problem Found returns? For many companies this is a difficult percentage to assign. Many companies lack good return programs because the field technician's job is to get the product working again, and so they swap out cards until things work. It appears that sometimes these samples are returned, while often they are disposed of. I think of it as the VCR syndrome: we are not surprised the VCR stopped working one day after a year in operation, so we buy a new one instead of repairing it.

Back to NTF returns. If product in the field experienced a high-humidity event, or drew enough moisture into a critically sensitive area of the circuit under controlled humidity conditions, and this moisture created a leakage path on a capacitor or a high impedance component and the system fails, a technician is dispatched to repair the system. After pulling and replacing the card, the system works again. The trouble is solved, and the circuit card is returned to the manufacturer who built the final system, but typically not the manufacturer of the card. If the circuit card is assessed on the bench (one to two weeks after the unit was pulled from the system) and the card tests good and completely functional, and no signs of degradation are visible, the unit is classified as a NTF and set aside or put back into refurbished hardware. The circuit card now classified as a NTF could have had a system glitch due to software, or a small power shift, and that is what happened in the field.

But what if we take the circuit card and subject it to an elevated humidity environment – such as 35°C/70% RH – with no bias or temperature cycling for 16 to 24 hours? After this humidity exposure, retest the circuit performance on the bench again. If it fails, bake the board at 125°F for 4 hours, and retest the failing circuit card. Do not be surprised if it now works as well as it did before the high-humidity exposure. This type of test helps assess if a residue-related problem exists on the NTF. Not all NTFs, or for that matter returns, are residue related, but a great per-

FIGURE 1: NTF returns are rising, the result of contamination stemming from board, component and assembly chemical processes.

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centage of them are, as many of my customers learn when they start looking at these returns.

Companies that I have worked with have blamed cracked capacitors for leaky caps that drain a battery in a handheld tester. After much testing, no cracks were found in the hundreds of devices cross-sectioned or scanned. As it turned out, leaky capacitors from a plating process that were not effectively rinsed affected the entire lot of components, leaving high sulfate levels on the surface of a percentage of capacitors in a no-clean process. This will also cause the batteries to drain in a two-week period in the "off" position sitting in the final shipping box.

No-clean is not the sole culprit. Cleaning systems have the same types of problems. Another company was experiencing problems on water-washed boards, and the incoming bare board was identified as the source. A single lot of bare boards was tested for cleanliness, and it was assumed that the lot was uniform in cleanliness (we do not want to hear of variation in cleanliness in boxes of bare boards), but there were wide-ranging variations within the date code of samples. Some samples showed low chloride levels in the 2.73 µg/in^2 range, and others showed levels of 14.87 µg/in^2. It turned out that the biggest variable to cause the change in the HASL boards was the cure of the soldermask. Boards at the beginning of the shift saw good, low levels of chloride, but within two hours absorbed chloride levels rose dramatically. Because the cure oven was not recovering fast enough for the production rate, the thick, multilayer boards were not seeing the same amount of thermal energy at this belt speed.

A number of customers have experienced variation in cleanliness due to the level of cure of soldermask. Since soldermask has a large curing window, most vendors try to optimize the process to hit the midrange of the cure, but due to the cure mechanisms for liquid photoimageable masks we see variations in the Stouffer settings and intensity, and in the thermal exposure permitting the oven to recover fully. Boards with multilayer, thick ground planes need more heat than a two-sided board; however, typical production rates are the same for most similar boards.

In summary, due to new technologies, new circuit designs and sensitivity in these circuits, there is a growing problem of circuit performance and an increase in NTF field returns. Contamination problems on electronics assemblies in many cases come from board, component and assembly chemical processes. The use of conformal coating is good for product in high-humidity conditions, but only delays (by several months) the effect. As moisture passes through the coating, it reacts with residues on the board surface. We must understand the cleanliness of the localized area on these sensitive circuits to create a process control system and, eventually, new cleanliness specifications. Residue problems occur with both cleaned and no-clean assemblies, so it is not a choice of technology. Historically, the level of circuit sensitivity and the use of rosin flux gave better product performance as compared to today's design and electrical effects without a layer of rosin (varnish) protection. ■

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