Know Your Sources

When it comes to contaminants, what you do not know *can* hurt you.

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It is important to be aware of all potential sources for contamination in an assembly process. We must also understand whether cleaning equipment is doing its job and if cleaning processes are in control. A good qualification process and monitoring processes will help ensure assembly of clean, reliable products.

An electronics manufacturer was experiencing field failures on boards after switching to a new cleaning process. The previous process produced failures as well. The failures were occurring in the area of a low-standoff component. Samples sent to Foresite for localized cleanliness analysis included three good working boards and three failing boards from each wash procedure, as well as five bare boards. All failing units showed very high chloride and weak organic acid flux residues in the area of the failing low standoff component. These results indicated poor and inconsistent cleaning (**Figure 1**). We also looked at several reference areas on the finished assemblies, and the failing units showed marginally high chloride levels here as well. Obviously a serious cleanliness issue needed to be addressed. Boards were sent to Foresite for remedial cleaning, and we were able to eradicate residues that were the culprits in the field failures (**Figure 2**), pointing more conclusively to a weakness in this customer's cleaning process.

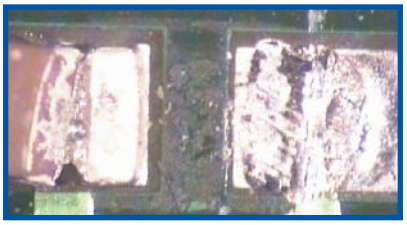

FIGURE 1: Hazy, uncleaned flux residue underneath a resistor.

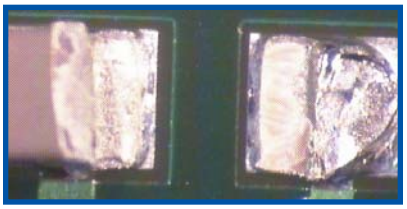

FIGURE 2: Resistor area remedially cleaned at Foresite.

To find the problem, Foresite dispatched one of its process consultants to the location producing the failing units. After examining the processes and equipment used to clean these assemblies, it was found that the equipment gave no alarms to warn if a zone was inoperative. We found a number of issues that were critical to cleaning effectiveness, including low water levels, clogged nozzles and inoperative cleaning zones. Water levels were low enough that the machine was unable to pump water during the rinse cycle, and the operators had no indication that this was occurring. Also, this customer did not follow the solder paste manufacturer's guidelines for wash temperature, and did not monitor water quality or use a saponifier. The lack of a rinse process contributed to the problem, as contaminated wash water was deposited on the cleaner curtains as boards passed through, and contaminants from this water could continue to redeposit as the cleaner operated.

We examined potential sources of these harmful residues. Ion chromatography analysis showed that the primary source came from the fabrication process. Our evaluation of incoming bare boards found very high chloride levels. These residues introduced during fabrication permitted board level parasitic leakage, which caused failures. We found several other potentially harmful residue sources. Finger cots and ESD gloves used by personnel were high in chloride. Handling circuit boards with materials high in residue content, especially when wet, opens the door to transfer ionic species. Our consultant also examined the reflow oven. Most zones were functioning properly, but the cooling zone had a prolonged vapor accumulation of solder flux residues. This accumulation can cause sporadic introduction onto boards as they pass through the chamber. Other elements in this process such

Table 1. Ion chromatography analysis can help determine the source of failures.

	Ion Chromatography						C3 Tester	
Sample Description	Cl^-	Br^-	SO_4^{2-}	WOA	NO_3^-	PO_4^{2-}	**Results**	**Time(sec)**
Foresite recommended limits for bare boards	2.0	6.0	3.0	N/A	3.0	3.0	Clean	>60
Foresite recommended limits for components	1.0	6.0	3.0	N/A	3.0	3.0		
Foresite recommended limits for no-clean assemblies	3.0	12.0	3.0	150.0	3.0	3.0		
Foresite recommended limits for cleaned assemblies	6.0	12.0	3.0	25.0	3.0	3.0		
New wash failure area	6.98	3.05	0	59.11	0.47	5.27	**Dirty**	**31**
New wash good area	6.08	3.97	0	40.21	0.28	4.27	**Dirty**	**47**
Old wash good area	4.99	4.35	0	48.95	0	0	**Dirty**	**37**
Old wash failure area	7.21	8.11	0	77.14	0	0	**Dirty**	**26**
Foresite remedially cleaned assembly	1.1	1.23	0	7.24	0	0	**Clean**	**180**

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

as the housings, PVC gloves, water, stencils and incoming components were found to be clean.

Our recommendations involved first taking the cleaning equipment out of commission until full qualification data could be obtained, all observed problems repaired and a system developed to monitor equipment effectiveness and provide appropriate alarms when zones were inoperative. Once the equipment could be qualified, we suggested following the flux manufacturer's guidelines for wash temperature, and to use a good saponifier to effectively get underneath low standoff components and drive off ionic residues. Second, we recommended that the assembler to work with the fabricator to obtain ionically clean bare boards. Finally, we recommended that the client begin using a localized cleanliness monitoring protocol on its production floor to track cleaning effectiveness around the sensitive low-standoff components that were prone to residue entrapment. Thus, a cleaning weakness can be caught before a reliability issue occurs (**Table 1**).

This case shows that not having monitoring capabilities and a qualified and controlled assembly and cleaning process can lead to major reliability problems. These problems may not be apparent immediately, but happen slowly over time and are not discovered until quality issues arise. ■