Process Doctor

组装程序教育

No Silver Lining

Sulfate contamination causes visible silver crystalline growth.

FIGURE 1: Failing open resistor area with visible crystalline growth.

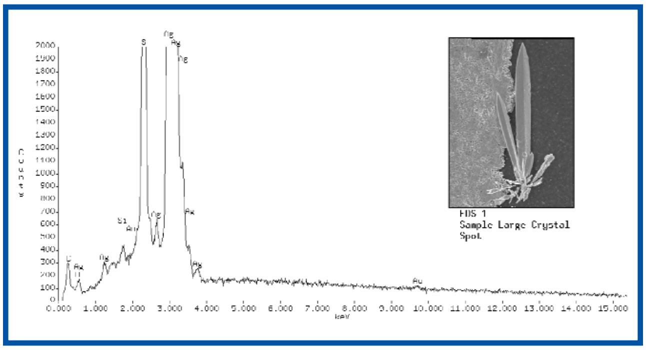

FIGURE 2: SEM/EDX analysis of crystal showing large peaks of sulfur and silver.

Currently, marked concerns exist over the increased propensity of crystalline growths such as tin whiskers. The cause of such growths is still being debated, and mitigation methods are being investigated. Besides tin whiskers, Foresite has encountered other crystalline growths causing failure mechanisms such as zinc whiskers, copper sulfate crystals and silver crystals. In our failure analysis experience of assemblies exhibiting crystalline growths, a corresponding high level of ionic contamination in areas of crystalline growth has been found. These led us to hypothesize that ionic contaminant levels are correlated to occurrences of crystalline growth. In this case study, we examine a customer's problem with silver crystalline growth.

A customer was seeing open resistor failures in the field. On the potting layer of these failing assemblies was a visible crystalline growth (**Figure 1**). This growth appeared to be occurring right at the epoxy/solder interface. The client sent failing assemblies to Foresite for analysis, with samples of the potting compound, incoming components and materials.

To analyze the makeup of the visible crystals and determine the presence, if any, of ionic contaminants, Foresite used SEM/EDX analysis and ion chromatography (IC) per IPC-TM-650 method 2.3.28. Using the C3 tester, we were able to extract localized samples from just the failing resistor areas, and board surface areas and reference samples.

Our localized findings showed a very high concentration of sulfate residues on all the failing resistor areas of the four failed assemblies submitted for analysis (**Table 1**). This level far surpasses our recommendations for reliable performance. Examining the crystalline growth area with SEM/EDX (**Figure 2**), we also found very high peaks of silver and sulfur. Conversely, in examining reference areas, the potting compound directly above the failing parts, board area and housings, sulfate levels were low and acceptable by Foresite's IC standards, and with no abnormal peaks in the SEM/EDX findings. These findings showed no external source of sulfate causing the contamination and crystalline growth.

One other area of concern was found, though. The incoming resistors were noted to be high in sulfate residues. The client revealed that the component vendor used an end-termination plating process that had the potential to entrap harmfully corrosive methane sulfonic acid (MSA). This residue was becoming entrapped at the epoxy/solder interface. Often with this level of measurable sulfate contamination, it takes a good deal of time and moisture to propagate a corrosion event at the silver layer across a part at the epoxy interface. This explains the spanning time differential between the failed units examined.

This unique silver crystal scenario closely aligned with Foresite's failure analysis findings among client projects where tin whiskers, zinc whiskers and copper sulfate crystals were found.

In each of these failure mechanisms, a corresponding amount of ionic contamination in the areas of crystalline growth was found. These findings led Foresite to believe that such crystals can be prevented if ionic cleanliness is kept in check. Because we are so concerned that incoming components and materials are RoHS compliant, perhaps we should make ionic cleanliness an equally critical concern to ensure the long-term reliability of products. ■

Table 1. IC Analysis of Failed Resistor Areas

	Ion Chromatography					
Sample Description	Cl^-	Br^-	NO_3^-	WOA	SO_4^{2-}	Na
Foresite recommended limits for bare boards	2.0	6.0	3.0	NA	3.0	3.0
Foresite recommended limits for components	1.0	6.0	3.0	NA	3.0	1.0
Foresite recommended limits for no-clean assemblies	3.0	12.0	3.0	SMT 25	3.0	3.0
Foresite recommended limits for cleaned assemblies	6.0	12.0	3.0	SMT 25	3.0	3.0
Individual Resitors						
Failed resistor unit 1	0.14	0	0	12.11	6.49	0.21
Potting Material Only						
Open resistor potting outer	0.24	0	0.11	0	0	0
Individual Parts						
Current production unpotted resistor	0.22	2.49	0	10.36	5.47	0.17

Note: All values in µg/in², unless otherwise noted.

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