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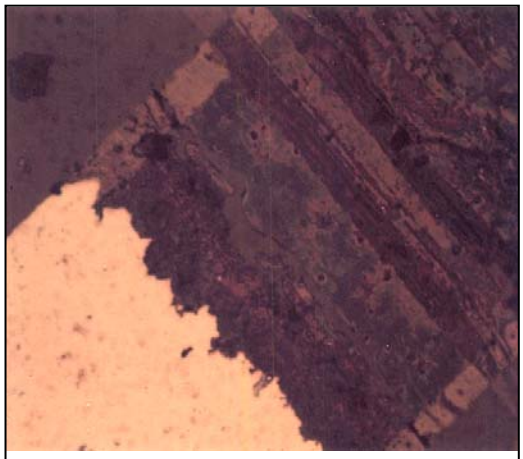
Swabbing It Clean?

How clean are the cleaning materials that contact your product?

Foresite Inc.

An instrument manufacturer noticed corrosion on the metal interconnects at the edges of its Liquid Crystal Displays (LCD's) after environmental testing. They wanted to know where the corrosive residues were coming from – were they coming from inside the LCD or from outside the LCD?



Picture: Magnified view of corroded metal interconnect

Analysis

Several assemblies, components and processing materials were analyzed using Ion Chromatography per IPC-TM-650, method 2.3.28 to determine the root cause of the corrosion.

Data Discussion

The samples from the interior of the LCD (Table 1) appeared to be reasonably ionically clean. Therefore, we concluded the residues were originating outside the LCD. The exterior of the 'un-cleaned and untested LCD' samples showed low levels of chloride and sulfate. However, the 'failed LCD' samples and the 'cleaned but not yet tested LCD' samples showed high levels of chloride and sulfate, as did the 'cotton swab' and the 'Isopropyl Alcohol (IPA) dispenser.' Consequently, we concluded the cleaning process was introducing the corrosive residues.

Sample Description (Levels represent the mean of samples tested)	Chloride Levels ($\mu g/in^2$)	Sulfate Levels ($\mu g/in^2$)
Interior of LCD		
Internal liquid from failed LCD	0.57	1.02
Fluid side of LCD top	0.32	0.76
Fluid side of LCD bottom	0.23	0.67
Exterior of LCD		
Un-cleaned and untested LCD	0.78	0.62
Failed LCD	20.42	9.81
Cleaned but not tested LCD	13.22	9.62
Cotton swab	5.74	10.95
Isopropyl Alcohol (IPA) dispenser	17.84	31.99
Zebra strip from failed LCD	4.07	3.19
New, unused, zebra strip	1.10	2.23

TABLE 1: Summarized Ion Chromatography results

Root Cause

The LCD's were cleaned prior to installation of a Zebra connection strip using a cotton swab, which was dipped in IPA. The cotton from these non-clean room quality cotton swabs contained chlorides and sulfates, which entered the cotton from tap water used during the cotton swab manufacturing process. These contaminates were then absorbed into the IPA. Capillary action pulled the IPA into the corner joint of the two glass plates, where it dried on top of the metal interconnects – leaving residues. Under electrical power these invisible corrosive residues combined with moisture to form acids (such as hydrochloric and sulfuric acid) and caused corrosion and electro-migration of the metal interconnects – resulting in failure of the LCD.

Corrective Actions

The cotton swabs and alcohol dispenser were replaced with prepackaged clean room purity alcohol wipes. Furthermore, regular ionic contamination testing of assemblies, components and materials was added as a means of process control.

Conclusion

LCD manufacturing is at least as sensitive to corrosive residues as printed circuit board (PCB) manufacturing. Moreover, any product that will have electrical voltage applied to it is sensitive to corrosive residues and therefore requires careful examination of the materials that are used to clean them.