(omitted) CIRCUITS, INC.
Project ENV816
April 17, 1998

Cleanliness Evaluation on EnviroGold 816 Cleaned Bare Boards

Project Overview

The purpose of this project was to evaluate the bare board cleanliness before and after cleaning on bare boards. All residues in this evaluation were characterized using Ion Chromatography per IPC-TM-650, method 2.3.28.

Process History

The bare boards used in this evaluation were fabricated with FR-4 laminate using a nickel gold over plate that uses an LPI solder mask.

The cleaned boards were processed using 2.5% EnviroGold 816 saponifier and cleaned in an in-line Marseco cleaning unit. The processing parameters for the Marseco cleaner were: 140°F wash and rinse DI water, using 25 psi wash pressures to clean bare boards. The belt speed was set at 6 ft/min.

Test Procedure

1. Each test board was placed into a clean Kapak (heat sealable polyester film) bag. A volume of isopropanol (75%) and deionized water (25%) was introduced into each bag, immersing the test sample. Each bag was heat sealed, but each bag contained a vent hole.

2. Each bag/test sample was placed into an 80°C water bath for one hour. After one hour, the bags were removed from the water bath and the test samples removed from the bags. The test samples were allowed to air dry.

3. A 3 ml sample of each extract solution was analyzed using a Dionex ion chromatography system and a sodium bicarbonate eluent.

Data Discussion – Ion Chromatography

1. The data for this evaluation is shown on the attached data page and graph. The ion chromatography data is shown as micrograms of the residue species per square inch of extracted surface ($\mu g/in^2$), unless otherwise noted. This measure should not be confused with micrograms of sodium chloride equivalent per square inch, which is the common measure for most ionic cleanliness test instruments.

2. For this project, ion chromatography detected the following anion residues: chloride (Cl), bromide (Br), and sulfate (SO_4). Each residue is discussed in greater detail below.

3. **Bromide** is generally attributable to the bromide fire retardant added to epoxy-glass laminates to give fire resistance, and which is subsequently extracted in the ion chromatography analytical procedure. Bromide can also sometimes come from solder masks, marking inks, or from fluxes which have a bromide activator material. Bromide, when from the fire retardant, is not a material considered to degrade long term reliability of electronic assemblies. If bromide is from a flux residue, then the bromide can be corrosive as other halides can be. The level of bromide can vary depending on the porosity of the laminate and/or mask. The degree of over/under cure of the laminate or mask, or the number of exposures to reflow temperatures.

4. The level of bromide is nominal for an FR-4 Gold-plated board and poses minimal risk of electromigration and electrical leakage problems.

5. **Chloride** is one of the more detrimental materials found on printed circuit assemblies. Chlorides can come from a variety of sources, but is most often attributable to flux residues. Chlorides will generally initiate and propagate electrochemical failure mechanisms, such as metal migration and electrolytic corrosion, when combined with water vapor and an electrical potential. The amount of chloride that can be tolerated on an assembly depends on the flux chemistry being used. Assemblies processed with high-solids rosin fluxes (RA, RMA) can tolerate higher levels of chloride due to the encapsulating nature of the rosin. Water soluble fluxes and no-clean fluxes are generally based on resins or very low levels of rosin, and so do not have this encapsulating protection. Therefore, they require lower levels of flux on final assemblies.

6. The amount of allowable chloride on a bare board is difficult to assess. If the boards will go into an assembly process that incorporates cleaning, then a higher level of chloride can be tolerated. If the bare board is intended for a no-clean assembly process, then a lower chloride level is required. For bare boards, we recommend maximum chloride levels of less 2.0 micrograms per square inch for tin-lead coated, solder-masked sample intended for a no-clean process, and 2.0 – 3.0 micrograms per square inch for a board intended for an assembly process with cleaning. These recommended maximums do not presently appear in any nationally accepted specifications or standards, but are based on our failure analysis efforts with numerous customers.

7. We recommend maximum chloride levels of:
   - 4.5 micrograms per square inch for final assemblies processed with rosen fluxes
   - 2.5 micrograms per square inch for final assemblies processed with low solids (no-clean) fluxes
   - 4.5 - 5.0 micrograms per square inch for final assemblies processed with water soluble fluxes
   - <2.0 micrograms per square inch for a bare board (tin-lead coated).

   These recommended maximums do not presently appear in any nationally accepted specifications or standards, but are based on our failure analysis efforts with numerous customers.

1. The level of chloride is high for the as-received bare boards, and this level poses a great risk on built assemblies for electrical leakage and corrosion problems.

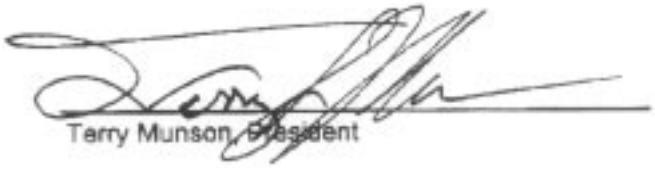
2. The EnviroGold 816 cleaned assemblies show very low levels of chloride. These levels of chloride pose minimal risk of electrical leakage and corrosion problems.

3. The level of sulfate seen on each as-received board and each cleaned board are nominally low and pose a minimal risk of electromigration and electrical leakage.

Conclusion

1. The level of chloride reduction is substantial for the cleaning of bare boards with the EnviroGold 816 in the Marseco unit.

Reported By:



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Contact: OMITTED
Date: April 17, 1998
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Cleanliness Evaluation on #816 Cleaned Boards

Anion Data

All values are in µg/in^2, unless otherwise noted — Ion Chromatography

CSL ID	Sample Description	Chloride	Bromide	Sulfate
	Grouped by Board			
1	Board 1 - As Received	7.57	1.97	0.48
2	Board 1 - As Received	7.08	1.51	0.37
3	Board 1 - As Received	6.32	1.56	0.59
	Mean	**6.99**	**1.68**	**0.48**
4	Board 2 - EnviroGold 816	0.90	1.07	0.18
5	Board 2 - EnviroGold 816	0.75	0.85	0.11
6	Board 2 - EnviroGold 816	0.63	0.81	0.12
	Mean	**0.76**	**0.91**	**0.14**