Does Cleaning the PCB Before Conformal Coating Add Value?

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Abstract
Cleanliness level of PCBs is becoming more and more critical given component miniaturization, component density, and manufacturing practices that include no-clean solder flux. The reliability of high risk circuitry (Class 3-Class 1) assemblies requires clean assemblies with field protection using a conformal coating; including poly-para-xylene vapor deposited films.

Residues from the manufacturing process limit the level of adhesion of conformal coating on a PCB. Conventional liquid coatings are limited in their uniformity under, around, and across the component, given the application method. The adhesion on hard to reach areas –one can argue- is not a major concern with liquid coatings, but an argument can be made for leadless components where the power and ground are in close proximity. Poly-para-xylene coating is truly a conformal coating that has the potential to penetrate crevices, bottom side of components, board surfaces, component surfaces and cavities present on the component.

The purpose of this paper is to research the value of cleaning under Bottom Terminated Components before Conformal Coating. A QFN surface insulation resistance test vehicle, with sensors placed under the component termination will be used for this research. The designed experiment will study both cleaning and non-cleaning before poly-para-xylene coating. The response variables will be measured: 1.) Visual Inspection of Post Soldering Residues, 2.) Site Specific Ion Chromatography and 3.) Surface Insulation Resistance using the IPC TM650 2.6.3.7 test method.

Introduction
Printed circuit assembly cleanliness has grown increasingly critical in recent years due to evolving component miniaturization, greater part densities, and manufacturing processes centered on no-clean solder fluxes.The newest circuit assemblies are characterized by devices with high lead counts, reduced lead spacing and high aspect ratios. Leadless and bottom terminated components have reduced standoff gaps for the device being soldered. As standoff gaps reduced, flux residue accumulatesandfills the underside of the component. Lead-free soldering involves higher temperatures and chemicals that further promote adhesion of contaminants, resulting in flux residues that can persist despite rigorous cleaning.Flux residue trapped under the component has environmental and corrosion risks in the form of leakage currents, which can result into intermittent and permanent failures.

Post solder assembly cleaning can improve reliability by removing residues, which can ionize with moisture. Ionic residues in the presence of moisture can create an electrolytic solution that can solubilize metal oxides. When the assembly is biased, the metal oxides within the electrolytic solution are attracted to the cathode and plate dendrites back toward the anode. With time, the part will eventually short circuit, causing either intermittent or permanent device failure.

An additional layer of protection is needed to coat the assemblies to prevent environmental contaminants in contact with the conductors on a PCB. Some of the conventional coatings, such as acrylics, silicones, urethanes and epoxies, are limited in their ability to penetrate uniformly beneath, around and across miniature components. Vapor deposited coatings, such as poly-para xylene are conformal on planar surfaces as well as round edges, in micro-crevices and beneath closely spaced devices. Vapor applied coatings do a better job of penetrating small gaps and crevices coating the component underside.

A question that commonly comes up is whether there is value in removing post soldering residues prior to coating the printed circuit assembly. Two common schools of thought are considered as to the value of post solder cleaning. The first is adhesion. Post soldering residues have been found to cause adhesion issues. Some areas of the board coated with a conformal coating over flux residues appear to adhere well while other areas do not adhere well. The second consideration is moisture ingression into the coating itself. When moisture has the potential to penetrate into the coating, ionic residues present under the coating can cause leakage currents to form. There have been multiple cases of dendritic growth reported on conformal coated devices that failed in the field.

The purpose of this research paper is to evaluate a high reliability no-clean solder paste for its reliability under bottom terminated QFN components in function with the assembly process conditions. A non-standard test board using QFN components with sensors placed under the component was used for this study. A set of test boards in the DOE will be coated with poly-para xylene coating on non-cleaned, partially cleaned and totally cleaned assemblies. An additional set of test boards in the DOE will not be coated on non-cleaned, partially cleaned and totally cleaned assemblies. The boards will be inspected for adhesion, residues levels under the component termination, site specific Ion Chromatography and Surface Insulation Resistance.

Poly-Para Xylene Coating

Poly-para-xylene is a high dielectric, chemically resistant encapsulating film based on a powdered raw material known as a chemical dimer. It is selectively applied in a batch process, is free of cure forces, and adds very little dimension to a substrate. The raw material is heated and sublimated under vacuum to form a monomer gas, and this vapor is introduced to a room-temperature vacuum chamber containing the substrates to be coated, where it is deposited on all exposed surfaces as a thin, transparent and pin hole-free polymer film. No catalysts or solvents are required in this process.

Vacuum deposited poly-para xylene coating differs from conventional resin coatings in that there is no liquid phase, and the physical properties common to liquid coatings - such as viscosity, meniscus, and a tendency to pool and draw away from corners - are not seen. The coating film does not exhibit liquid properties, does not create cure stresses and will not bridge between components.

Since the poly-para-xylene coating is formed directly from a gas, it conforms closely to substrates, building concurrently, with equal thickness and no pooling whether on flat surfaces, around edges, in deep crevices or beneath very closely spaced devices. This coating achieves good conformal coating protection at greatly reduced physical mass compared to liquid coatings. Typical coating thickness is 0.75 mils (0.00075 in.), while protective liquid coatings generally cure in the thickness range of 0.005 to 0.010 in. With a liquid coating, it may be necessary to cover flat surfaces with at least 0.005 in. cured thickness in order to achieve the minimum thickness of 0.001 in. around corners and edges. As a result, liquid coatings may pool and add unwanted physical mass.

The thermal coefficient of expansion for a relatively thick liquid coating may differ from the underlying substrate, resulting in mechanical stress during cure and subsequent temperature cycling. In contrast, very thin poly-para-xylene film gives effective protection without the threat of physical stress. Coating thickness on a surface can be precisely controlled by the volume of raw material used, and by the dwell time of the deposition cycle.

Cleaning PCB Assemblies before Coating with Poly-Para-Xylene Coating

Circuit manufacturers are responsible to minimize the potential for contamination during the production of assemblies that are to be coated with para-poly-xylene coating, and to conduct routine cleaning of their completed assemblies to ensure pristine surfaces, free of fingerprints and ready for coating.

The range of potential contaminants is wide, depending to some extent on the various materials that may be present, including metals, plastics, glass and ceramics. They may include rosin flux, low-residue paste, water soluble and no-clean fluxes, organic acid flux, adhesive residues, and various ionic contaminants. Production steps may bake some contaminants on assembly surfaces, further complication cleaning.

Poly-para-xylene film relies on contamination-free processes throughout the production sequence. Every step, from post-production cleaning, coating pre-treatment, priming, cleanliness testing, adhesion promotion, oven baking and, finally - vacuum coating deposition - must be closely controlled to ensure that assemblies are fully cleaned and remain free of contaminants that could compromise long-term coating results.

Even trace amounts of a surface contaminant on objects that are to be coated can degrade the film-to-substrate bond, resulting in delamination and compromised coating integrity. Additionally, contaminants trapped beneath the polymer film can eventually promote corrosion of conductive elements, and electronic malfunction. Common potential contaminants include residual chemicals, mold release compounds, oils, fingerprints, dust or other contaminants on surfaces as well in crevices and openings.

Masked, cleaned and surface promoted substrates must be handled carefully to avoid recontamination before coating. Workers use clean room gloves and handling methods to avoid contact with components during the coating process.

Substrate cleanliness can be confirmed by immersing parts in an instrumented final rinse tank for ionic residue measurement. Ionic contamination test systems utilize the dynamic extraction method to measure resistivity change when a substrate is submerged in the ultra-pure test solution. The degree of change in resistivity indicates the level of contamination, which is often the result of residues from fabrication and board assembly processes.

Experimental
A test board with QFN 48 single row and QFN 156LD 12mm x12mm double row components with sensors placed under the bottom termination were used for this research study.

Test Board layout:

- QFN 48
    - U1 and U2
        - NSMD
        - No Venting
        - Routed for IC Site Specific Analysis
    - U3 and U4
        - NSMD
        - Solder Mask Windows Vented
        - Routed for IC Site Specific Analysis

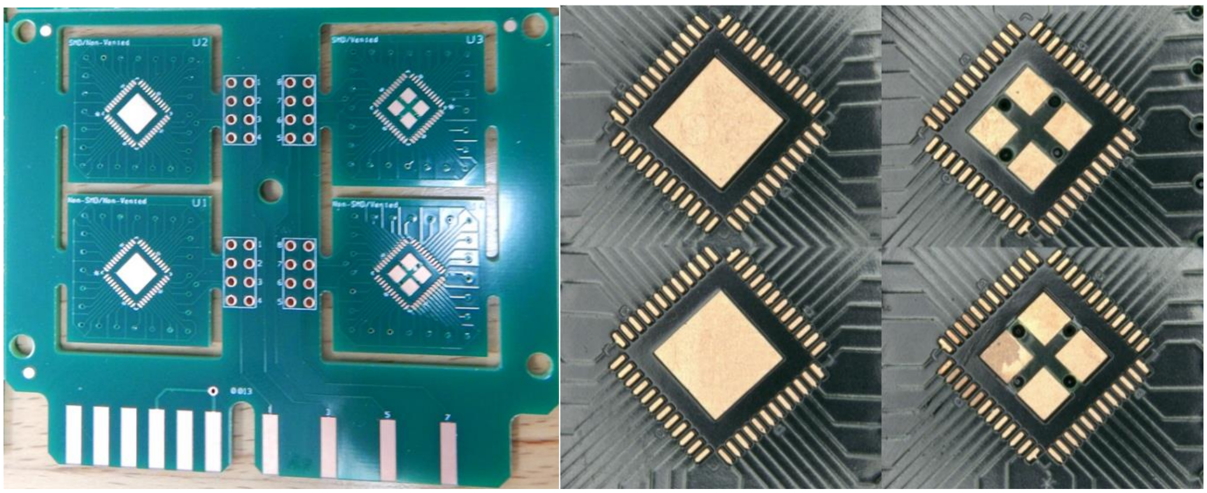

Figure 1: QFN48 Test Board Layout

- QFN 156LD
    - U1 – NSMD pins – SMD Center Lug
    - U2 – NoSM pins – SMD Center Lug
    - U3 – NSMD pins – Solder Mask Defined Windows Vented
    - U4 – NoSM pins –Solder Mask Defined Windows Vented

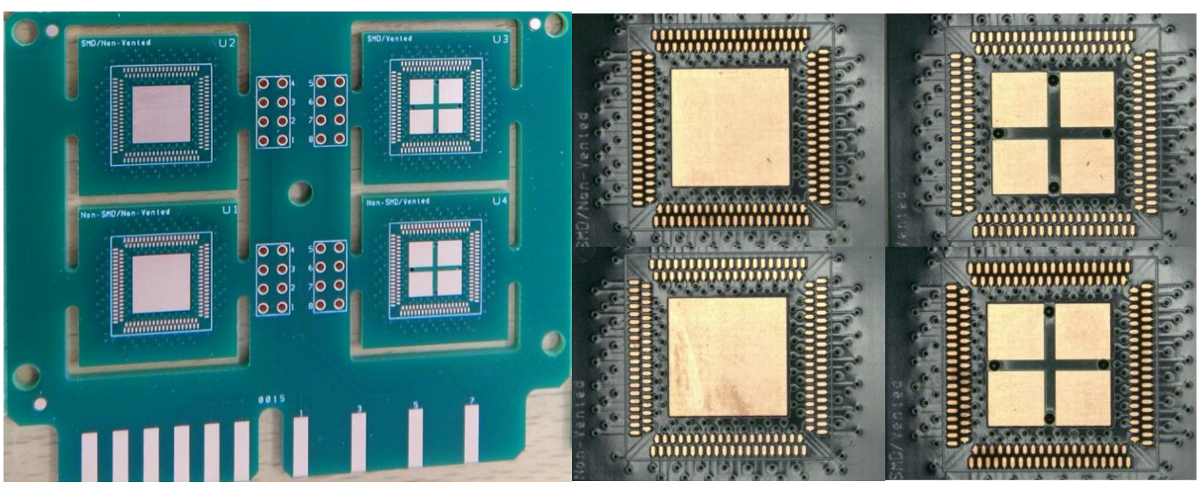

Figure 2: QFN 156LD Board Layout

- Boards Fully Populated
- Low Residue No-Clean Solder Paste
- Cleaning

- No Cleaning
- Partial Cleaning
- Total Cleaning

- DOE Matrix

Table 1: DOE Matrix

StdOrd	Test Board	Surface Finish	Solder Paste	Reflow	Para-Poly xylene Coat	Sensor Looped around Ground	Cleaning	Test Plan
1	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	No Cleaning	Visual Dry/Pry
2	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Partial Clean	Visual Dry/Pry
3	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Total Cleaning	Visual Dry/Pry
4	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	No Cleaning	IC -Site Specific
5	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Partial Clean	IC -Site Specific
6	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Total Cleaning	IC -Site Specific
7	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	No Cleaning	SIR
8	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Partial Clean	SIR
9	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Total Cleaning	SIR
10	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	No Cleaning	Visual Dry/Pry
11	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Partial Clean	Visual Dry/Pry
12	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Total Cleaning	Visual Dry/Pry
13	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	No Cleaning	IC -Site Specific
14	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Partial Clean	IC -Site Specific
15	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Total Cleaning	IC -Site Specific
16	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	No Cleaning	SIR
17	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Partial Clean	SIR
18	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Total Cleaning	SIR

Data Findings – Visual

Once the boards were assembled, the boards were imaged for visual residues looking from the side of the components.

Table 2: Visual Images of the Not Cleaned, Partially Cleaned and Totally Cleaned Test Boards

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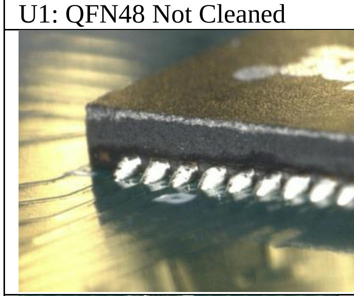		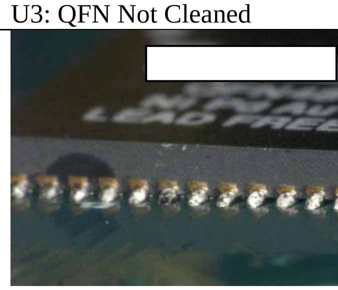	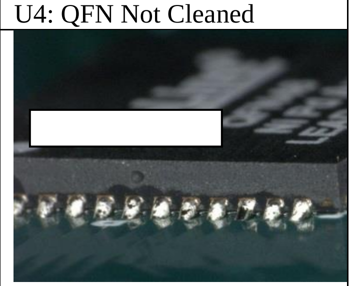
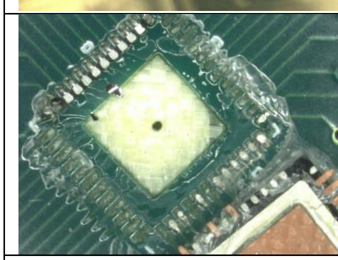	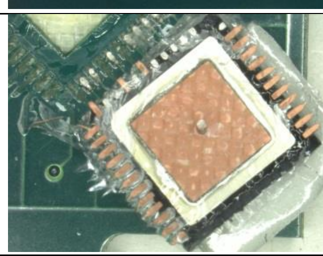	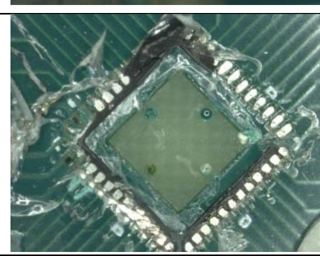	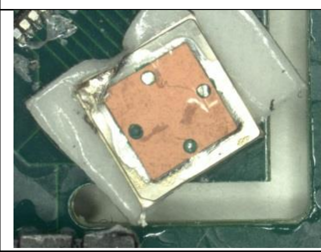
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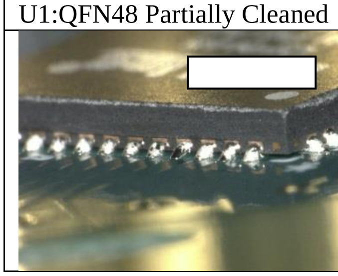			

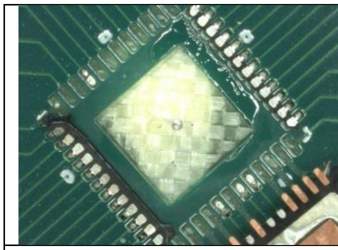	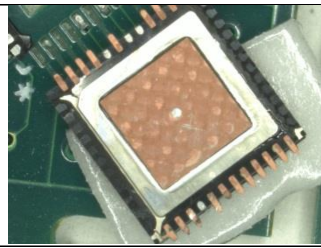	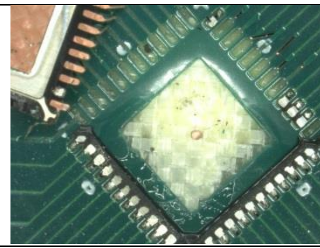	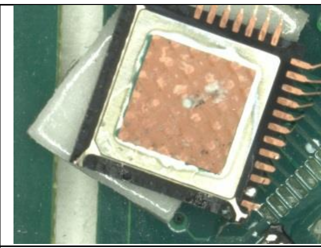
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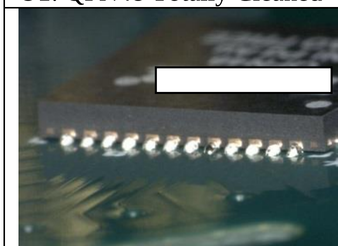	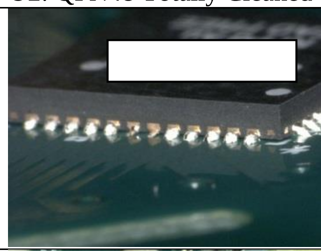	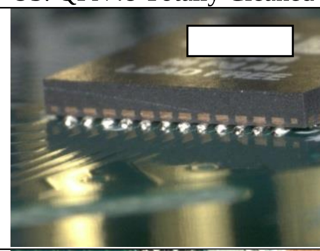	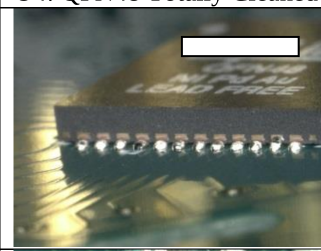
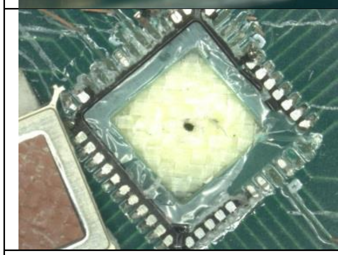	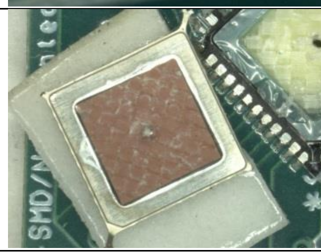	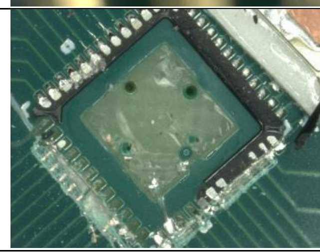	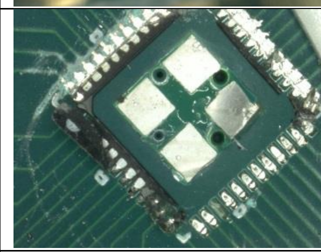
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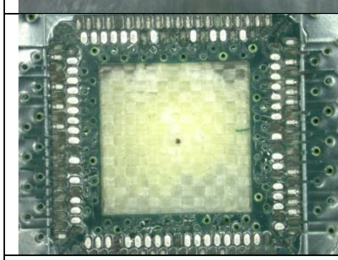	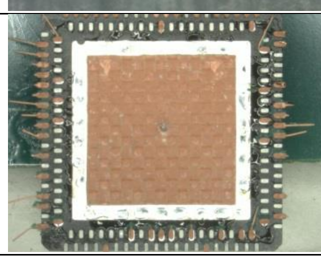		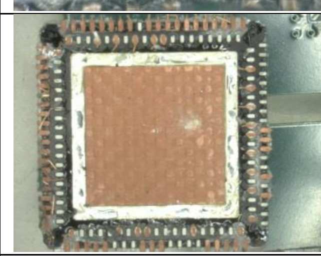
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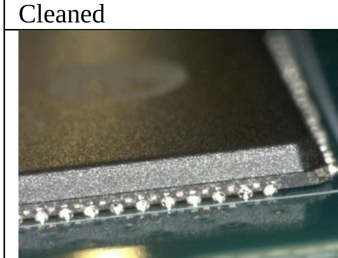	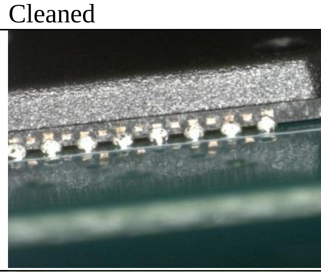	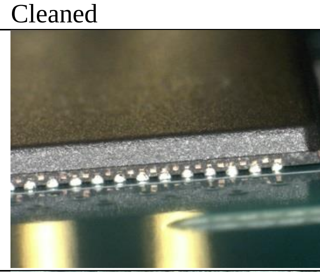	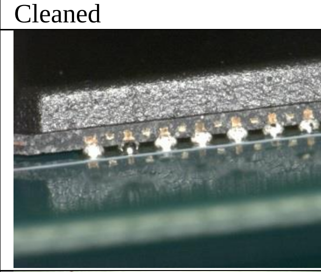
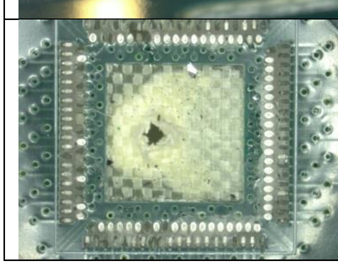	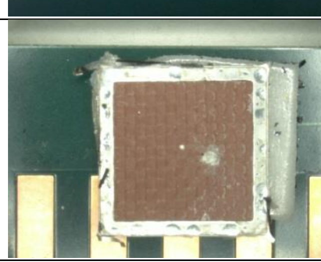	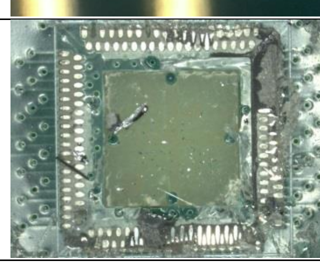	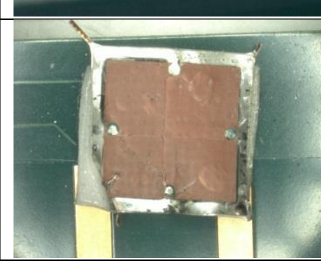

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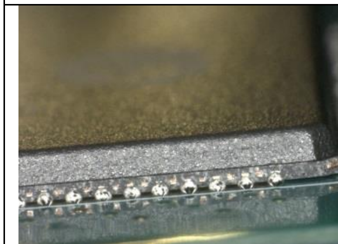
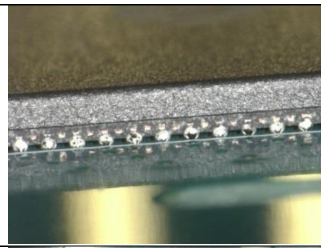
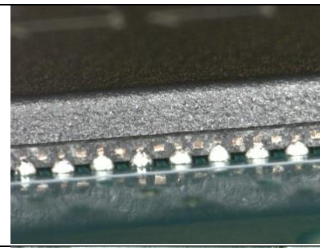
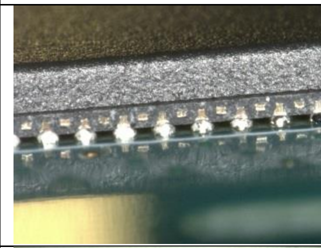
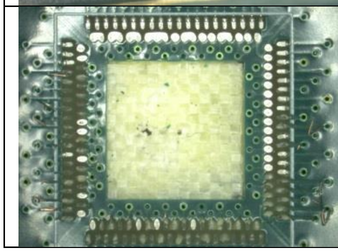
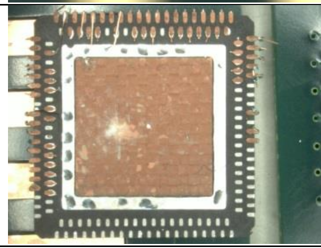
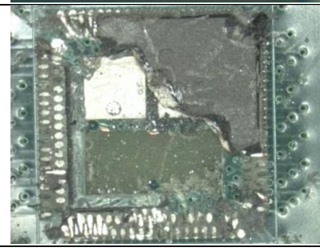
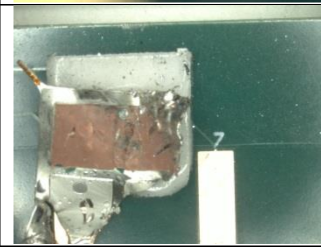
			
			

Data Findings – Ion Chromatography (IC)

The test board was designed to remove each component for site-specific testing of active ions at the component site. One of the limitations with current Ion Chromatography (IC) testing is accurate detection of active ions trapped under the body of the component. When running IC over the entire board, the residue can be averaged down. By routing the area of the board where the component is placed, there is the potential to obtain a more accurate measure of the ions that are present. Figure 3 illustrates the concept. Each component is routed, which allows for the component to be snapped off for IC testing. The thinking is that this provides a more accurate representation of ions present that could propagate leakage in the presence of moisture and bias.

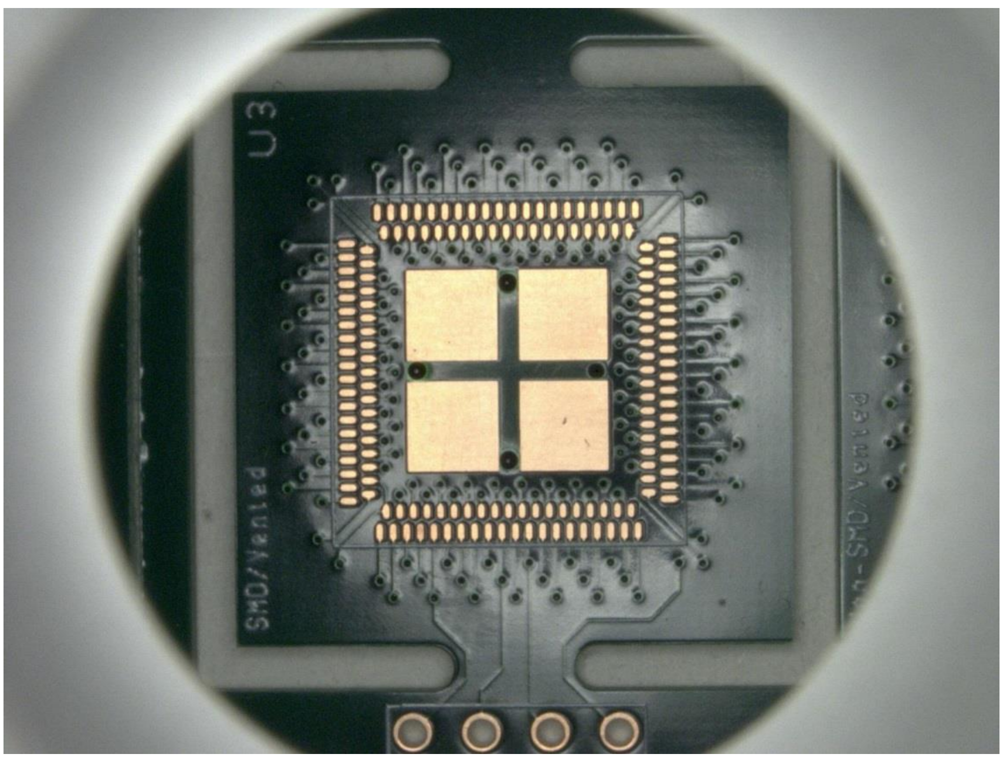


Figure 3: Example of a Snap off Coupon for IC Analysis

The IC data findings are listed in Table 3.

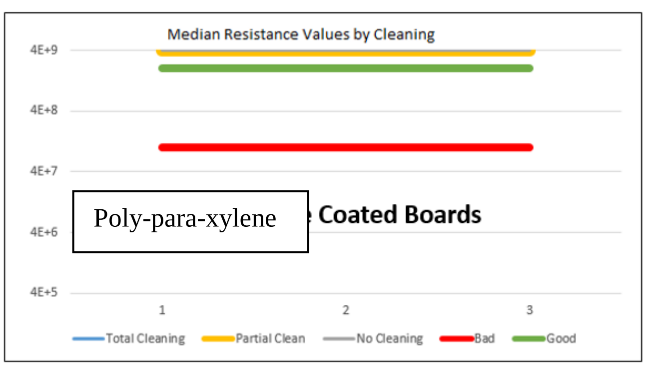
Table 3: IC Data Findings from Specific Components Not Cleaned, Partially Cleaned and Totally Cleaned

Anions	QFN 48: BOARD 1 NO CLEANING	QFN 156LD: BOARD 1A NO CLEANING	QFN 48: BOARD 2 PARTIAL CLEANING	QFN 156LD: BOARD 2A PARTIAL CLEANING	QFN 48: BOARD 3 TOTALLY CLEAN	QFN 156LD: BOARD 3A TOTALLY CLEAN
Fluoride						
Chloride	97.04	9.26	50.84	6.76	35.75	5.06
Nitrite	9.82	1.22				
Sulfate	13.99	5.85	8.73	1.66	5.21	0.94
Bromide	412.58	153.84	114.57	40.00	84.71	16.61
Nitrate						
Phosphate						
Weak Organic Acids						
Acetate	157.83	8.13	207.14	18.28	78.27	
Formate	190.23	6.95	153.52	13.79		
MSA	74.40	9.39	33.27		110.21	13.31
Adipic Acid						
Succinic						99.08
Maleic Acid						
Cations						
Lithium						
Sodium	228.49	21.83	175.50	18.17	123.76	21.00
Ammonium						
Potassium	23.35	3.57	24.46	2.52	18.35	2.19
Magnesium						
Calcium						

Data Findings – SIR

Test conditions

- 90% RH
- 40°C
- 5V
- Time
  - 168 Hours
  - 200 Hours
- Components
  - QFN 48 Single Row
  - QFN 156LD Dual Row
- Cleaning
  - No Cleaning
  - Partial Cleaning
  - Total Cleaning
- Solder Paste
  - Lead-Free No-Clean
- Coated
  - No
  - Yes with Poly-para-xylene
- Solder Mask Windows with Thermal Vias (Vents)
  - No
  - Yes



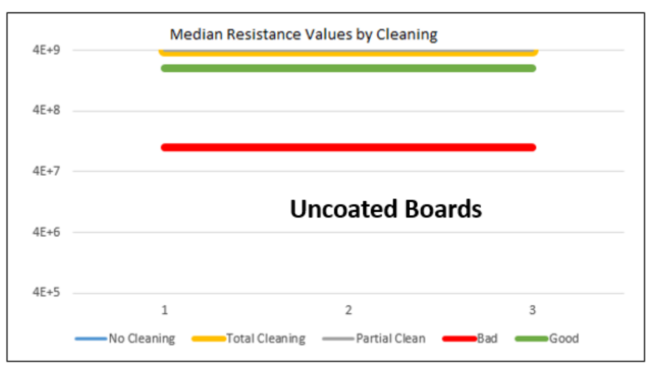


Figure 4: Medium SIR Findings on Coated and Uncoated Boards

Resistance values were measured using a multiplexed continuity meter. Though it is normally used to perform cable tests, it is capable of measuring resistance values up to 4 G-Ohm (4E9) on well over 200 electrical networks in a matter of seconds. This piece of equipment resided adjacent to the environmental chamber and was programmed to measure the resistance across sensor pairs without taking the hardware out of the chamber. Ribbon cables, connected to test samples were run through a bulkhead in the side of the chamber, presenting electrical access to all samples. These ribbon cables were plugged into the meter to perform measurements. The chamber was, therefore, not opened during the test period, and samples were not disturbed once the test had begun. The test data collected corresponds to the resistance values of each pair of nets on each board over the course of the test. Measurements were performed just prior to imposing environmental conditions in order to get a baseline view of the resistances. Measurements were again taken after 168 hours (1-week) and 200 hours of environmental exposure. Any deviation from baseline measurements can be attributed to the influence of the environmental conditions.

Table 4: SIR Data on Non-Coated Test Boards

StdOrder	Part Type	Solder Paste	Reflow	Poly-para xylene Coated?	Cleaning	Test Plan	BP From	BP To	Baseline	168hr	200hr
1	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J7-8(1)	J7-K(2)	4.00E+09	4.00E+09	4.00E+09
1	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J7-10(3)	J7-M(4)	4.00E+09	4.00E+09	4.00E+09
1	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J7-12(5)	J7-P(6)	4.00E+09	4.00E+09	4.00E+09
1	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J7-14(7)	J7-S(8)	4.00E+09	4.00E+09	4.00E+09
2	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J4-8(1)	J4-K(2)	4.00E+09	4.00E+09	4.00E+09
2	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J4-10(3)	J4-M(4)	4.00E+09	4.00E+09	4.00E+09
2	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J4-12(5)	J4-P(6)	4.00E+09	4.00E+09	4.00E+09
2	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J4-14(7)	J4-S(8)	4.00E+09	4.00E+09	4.00E+09
3	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J1-8(1)	J1-K(2)	4.00E+09	4.00E+09	4.00E+09
3	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J1-10(3)	J1-M(4)	4.00E+09	4.00E+09	4.00E+09
3	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J1-12(5)	J1-P(6)	4.00E+09	4.00E+09	4.00E+09
3	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J1-14(7)	J1-S(8)	4.00E+09	4.00E+09	4.00E+09
4	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J7-8(1)	J7-K(2)	4.00E+09	4.00E+09	4.00E+09
4	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J7-10(3)	J7-M(4)	4.00E+09	4.00E+09	4.00E+09
4	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J7-12(5)	J7-P(6)	4.00E+09	4.00E+09	4.00E+09
4	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J7-14(7)	J7-S(8)	4.00E+09	4.00E+09	4.00E+09
5	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J4-8(1)	J4-K(2)	4.00E+09	4.00E+09	4.00E+09
5	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J4-10(3)	J4-M(4)	4.00E+09	4.00E+09	4.00E+09
5	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J4-12(5)	J4-P(6)	4.00E+09	4.00E+09	4.00E+09
5	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J4-14(7)	J4-S(8)	4.00E+09	4.00E+09	4.00E+09
6	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J1-8(1)	J1-K(2)	4.00E+09	4.00E+09	4.00E+09
6	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J1-10(3)	J1-M(4)	4.00E+09	4.00E+09	4.00E+09
6	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J1-12(5)	J1-P(6)	4.00E+09	4.00E+09	4.00E+09
6	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J1-14(7)	J1-S(8)	4.00E+09	4.00E+09	4.00E+09
1a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J8-8(1)	J8-K(2)	4.00E+09	5.01E+05	5.01E+05
1a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J8-10(3)	J8-M(4)	4.00E+09	4.00E+09	4.00E+09
1a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J8-12(5)	J8-P(6)	4.00E+09	4.00E+09	4.00E+09
1a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J8-14(7)	J8-S(8)	4.00E+09	4.00E+09	4.00E+09
2a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J5-8(1)	J5-K(2)	4.00E+09	4.00E+09	4.00E+09
2a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J5-10(3)	J5-M(4)	4.00E+09	4.00E+09	4.00E+09
2a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J5-14(7)	J5-S(8)	4.00E+09	4.00E+09	4.00E+09
3a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J2-8(1)	J2-K(2)	4.00E+09	4.00E+09	4.00E+09
3a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J2-12(5)	J2-P(6)	4.00E+09	4.00E+09	4.00E+09
3a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J2-14(7)	J2-S(8)	4.00E+09	4.00E+09	4.00E+09
4a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J8-10(3)	J8-M(4)	4.00E+09	1.08E+09	4.00E+09
4a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J8-12(5)	J8-P(6)	4.00E+09	4.00E+09	4.00E+09
4a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	No Cleaning	SIR	J8-14(7)	J8-S(8)	4.00E+09	4.00E+09	4.00E+09
5a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J5-8(1)	J5-K(2)	4.00E+09	4.00E+09	4.00E+09
5a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J5-12(5)	J5-P(6)	4.00E+09	4.00E+09	4.00E+09
5a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Partial Clean	SIR	J5-14(7)	J5-S(8)	4.00E+09	4.00E+09	4.00E+09
6a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J2-8(1)	J2-K(2)	4.00E+09	4.00E+09	4.00E+09
6a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J2-10(3)	J2-M(4)	4.00E+09	4.00E+09	4.00E+09
6a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	No	Total Cleaning	SIR	J2-14(7)	J2-S(8)	4.00E+09	4.00E+09	4.00E+09

Table 5: SIR Data on Poly-para-xylene Coated Boards

StdOrder	Part Type	Solder Paste	Reflow	Poly-para-xylene Coated	Cleaning	Test Plan	BP From	BP To	Baseline	168hr	200hr
7	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J7-8(1)	J7-K(2)	4.00E+09	4.00E+09	4.00E+09
7	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J7-10(3)	J7-M(4)	4.00E+09	4.00E+09	4.00E+09
7	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J7-12(5)	J7-P(6)	4.00E+09	4.00E+09	4.00E+09
7	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J7-14(7)	J7-S(8)	4.00E+09	4.00E+09	4.00E+09
8	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J7-8(1)	J7-K(2)	4.00E+09	4.00E+09	4.00E+09
8	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J7-10(3)	J7-M(4)	4.00E+09	4.00E+09	4.00E+09
8	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J7-12(5)	J7-P(6)	4.00E+09	4.00E+09	4.00E+09
8	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J7-14(7)	J7-S(8)	4.00E+09	4.00E+09	4.00E+09
9	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J1-8(1)	J1-K(2)	4.00E+09	4.00E+09	4.00E+09
9	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J1-10(3)	J1-M(4)	4.00E+09	4.00E+09	4.00E+09
9	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J1-12(5)	J1-P(6)	4.00E+09	4.00E+09	4.00E+09
9	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J1-14(7)	J1-S(8)	4.00E+09	4.00E+09	4.00E+09
10	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J1-8(1)	J1-K(2)	4.00E+09	4.00E+09	4.00E+09
10	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J1-10(3)	J1-M(4)	4.00E+09	4.00E+09	4.00E+09
10	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J1-12(5)	J1-P(6)	4.00E+09	4.00E+09	4.00E+09
10	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J1-14(7)	J1-S(8)	4.00E+09	4.00E+09	4.00E+09
11	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J4-8(1)	J4-K(2)	4.00E+09	4.00E+09	4.00E+09
11	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J4-10(3)	J4-M(4)	4.00E+09	4.00E+09	4.00E+09
11	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J4-12(5)	J4-P(6)	4.00E+09	4.00E+09	4.00E+09
11	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J4-14(7)	J4-S(8)	4.00E+09	4.00E+09	4.00E+09
12	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J4-8(1)	J4-K(2)	4.00E+09	4.00E+09	4.00E+09
12	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J4-10(3)	J4-M(4)	4.00E+09	4.00E+09	4.00E+09
12	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J4-12(5)	J4-P(6)	4.00E+09	4.00E+09	4.00E+09
12	Single Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J4-14(7)	J4-S(8)	4.00E+09	4.00E+09	4.00E+09
10a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J2-10(3)	J2-M(4)	4.00E+09	4.00E+09	4.00E+09
10a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J2-14(7)	J2-S(8)	4.00E+09	4.00E+09	4.00E+09
11a	Dual Row QFN	LF No-Clean SP2	Ramp-to-Spike	Yes	Partial Clean	SIR	J5-10(3)	J5-M(4)	4.00E+09	4.00E+09	4.00E+09
11a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J5-14(7)	J5-S(8)	4.00E+09	4.00E+09	4.00E+09
12a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J5-10(3)	J5-M(4)	4.00E+09	4.00E+09	4.00E+09
12a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J5-14(7)	J5-S(8)	4.00E+09	4.00E+09	4.00E+09
7a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J8-10(3)	J8-M(4)	4.00E+09	2.77E+08	5.00E+05
7a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	No Cleaning	SIR	J8-14(7)	J8-S(8)	4.00E+09	4.00E+09	4.00E+09
8a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J8-10(3)	J8-M(4)	4.00E+09	4.00E+09	4.00E+09
8a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Partial Clean	SIR	J8-14(7)	J8-S(8)	4.00E+09	4.00E+09	4.00E+09
9a	Dual Row QFN	LF No-Clean SP2	Ramp-to-Spike	Yes	Total Cleaning	SIR	J2-10(3)	J2-M(4)	4.00E+09	9.93E+07	1.73E+08
9a	Dual Row QFN	LF No-Clean SP1	Ramp-to-Spike	Yes	Total Cleaning	SIR	J2-14(7)	J2-S(8)	4.00E+09	4.00E+09	4.00E+09

Summary from the Data Findings

The activity of flux residues on the surface and under component terminations is an important factor in controlling the reliability of an electronic assembly. Cleaning the assembly post soldering followed by conformal coating offers crevice penetration of the coating under component terminations as well as a barrier against humidity, pressure, temperature and other environmental effects.

Para-poly xylene coatings are vapor deposited allowing the coating to penetrate crevices. One of the issues with bottom terminated components is distance from the board to the bottom of the component. As standoff gaps reduce, flux residues accumulate and fill under the body of the component. Flux activators can be entrapped. Any active residues may bridge conductors. If the coating reduces moisture or prevents ingression, the coating provides an extra layer of protection against dendritic growth.

Flux residues left on the assembly and next to component gaps can hinder adhesion (Figure 5). When this occurs there can be a pathway for moisture to penetrate areas where adhesion can be compromised. When large levels of active flux are left under the component body, there is the potential for current leakage followed by dendritic growth. Areas where there is a heavy level of flux residue make it difficult to infer that coating without cleaning is safe.

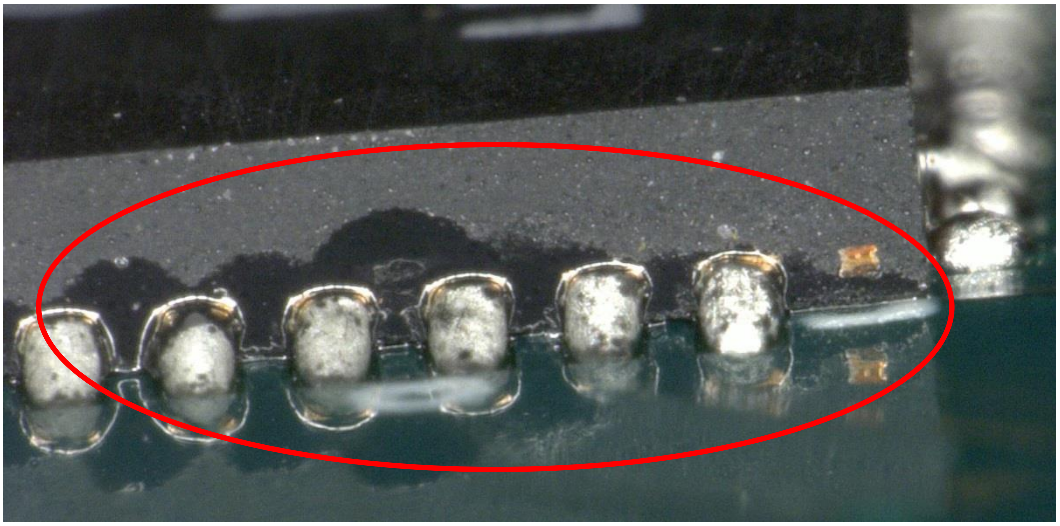


Figure 5: Heavy levels of flux residue may compromise coating adhesion

Site specific Ion Chromatography provides a more accurate testing methodology on problematic components. The single row QFN 48 had high levels of halide, sulfate, weak organic acids, and sodium and potassiumions. When the standoff gap is extremely low, the flux residue is wet and pliable. Activators do not have an outgassing channel. This level of ions could be beyond safe levels and can be problematic, even when the part has been conformally coated.

The ionic levels under the dual row QFN were lower than the single row QFN. The standoff gap on the dual row QFN were 2-3 mils higher than the single row QFN. Higher standoff gaps open up outgassing channels. Properly outgassed the activity of the flux left under the body of the component is less problematic. Instead of underfilling and leaving active trapped residue, the residue remaining encapsulates active ions. The conformal coating can properly adhere to the component side walls. These factors lower risk of moisture while reducing leakage failures from moisture ingression.

The SIR data isolated a few component failures on both uncoated and conformally coated packages. Figure 6 failure was detected on the perimeter pins of the QFN Dual Row on a non-coated and unvented component. The part was not cleaned. Figure 7 illustrates a warning next to the Ground Lug on the QFN Dual Row vented component that was not cleaned. Figure 8 illustrates a hard failure at the Dual Row unvented center lug on uncleaned Poly-para-xylenecoated board. Figure 9 illustrates a failure at the Dual Row unvented center lug on cleaned Poly-para-xylenecoated board. The cleaned board failure most likely came from flux that was not fully cleaned post soldering. The failures were all detected on the Dual Row QFNs and not the Single Row QFNs. The single row had lower standoffs, higher flux levels and higher ionics, yet no SIR failures were detected which was not what was expected.

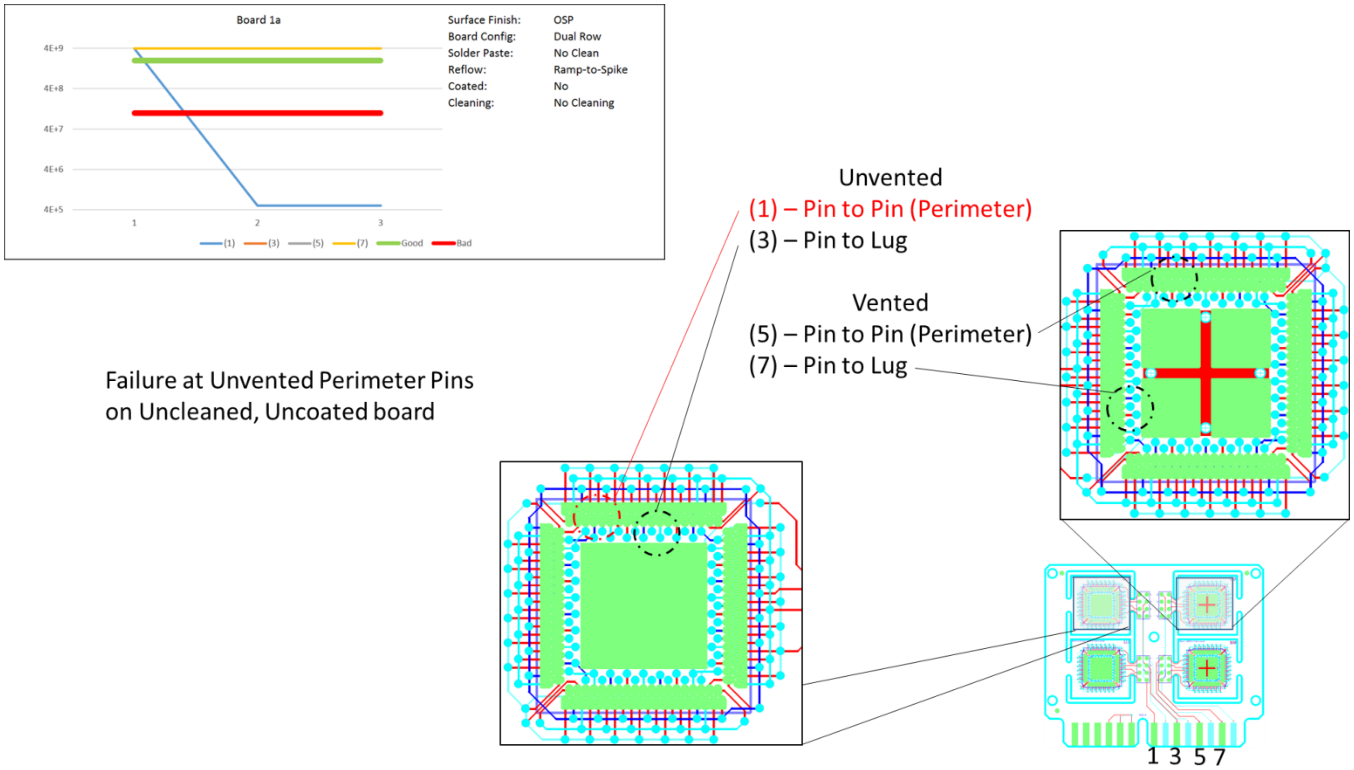


Figure 6: Dual Row Failure on Perimeter Pins on a Non Coated and Non Cleaned Component

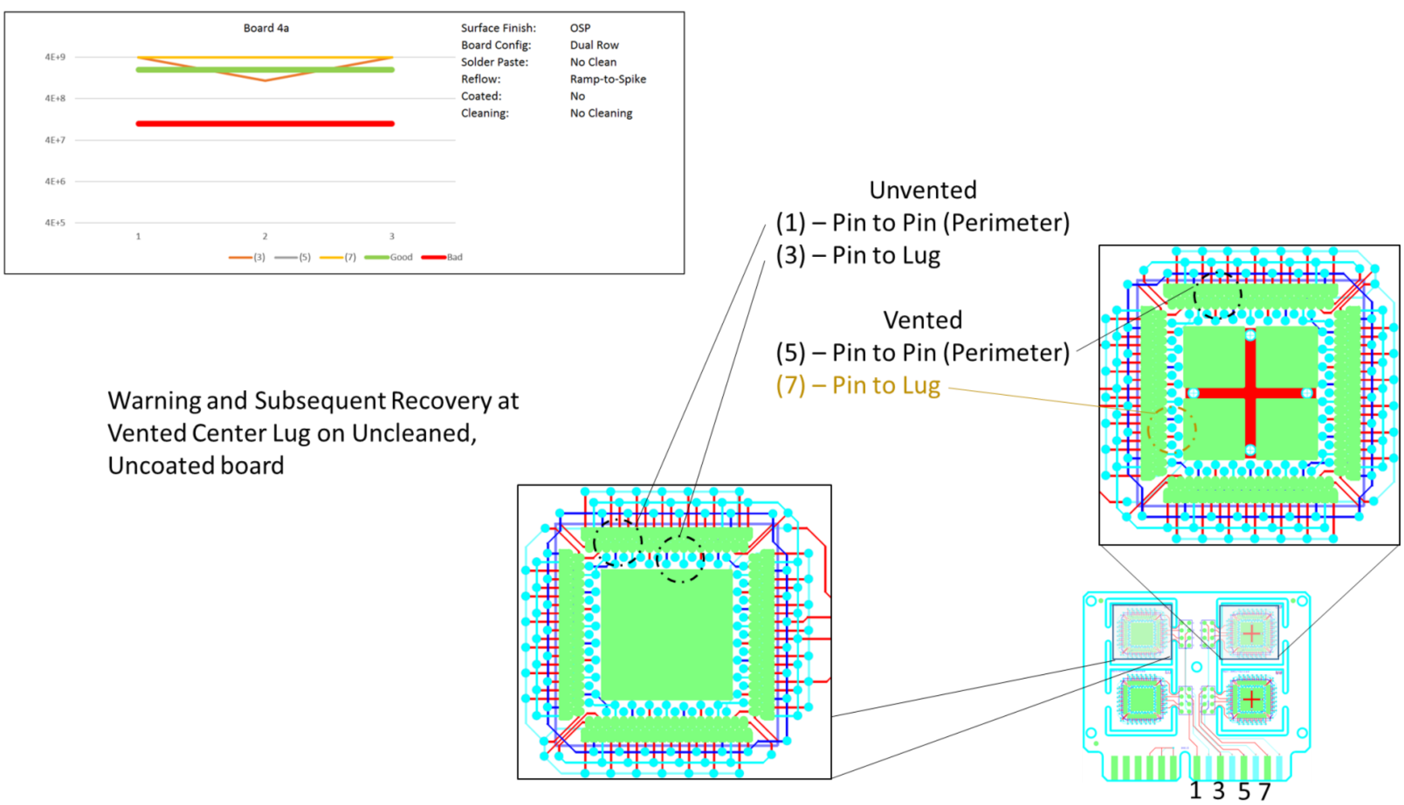


Figure 7: Dual Row Warning next to the Vented Ground Lug on an Uncoated and Not Cleaned QFN

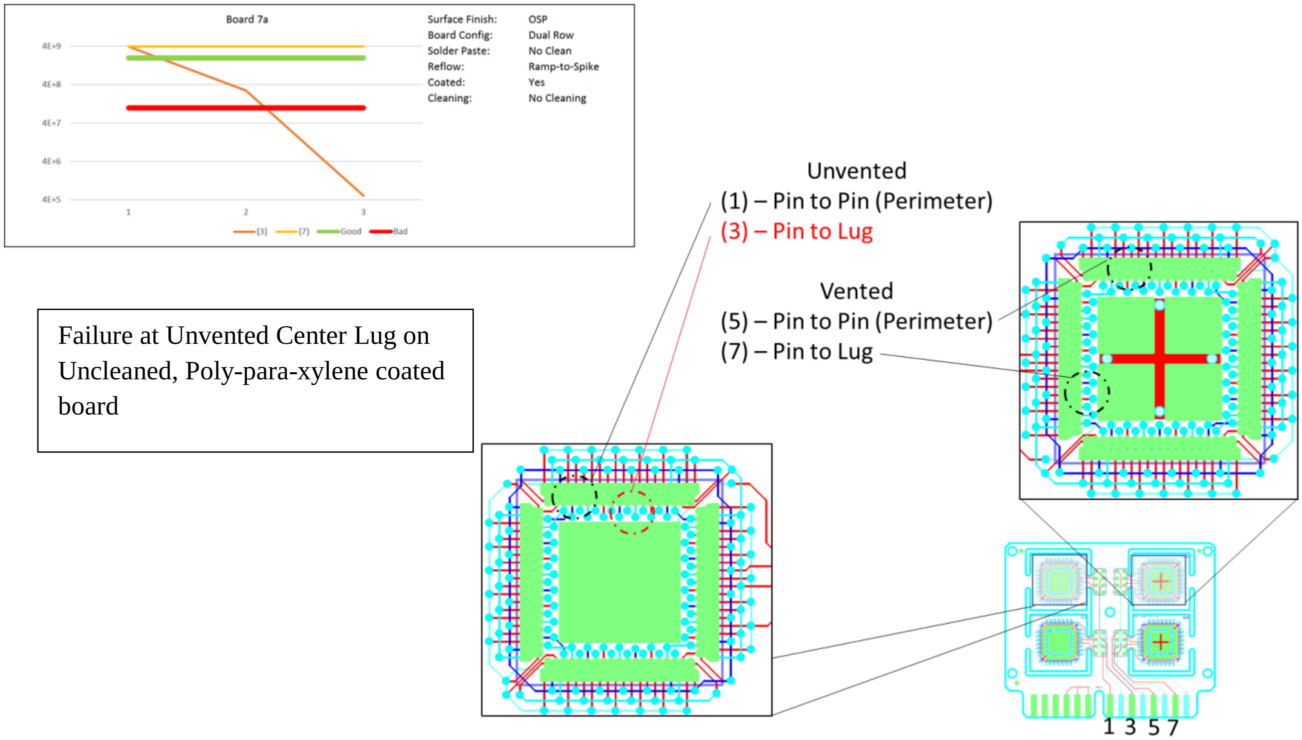


Figure 8: Dual Row Hard Failure at the Unvented Center Lug on Uncleaned, Poly-para-xyleneCoated Board

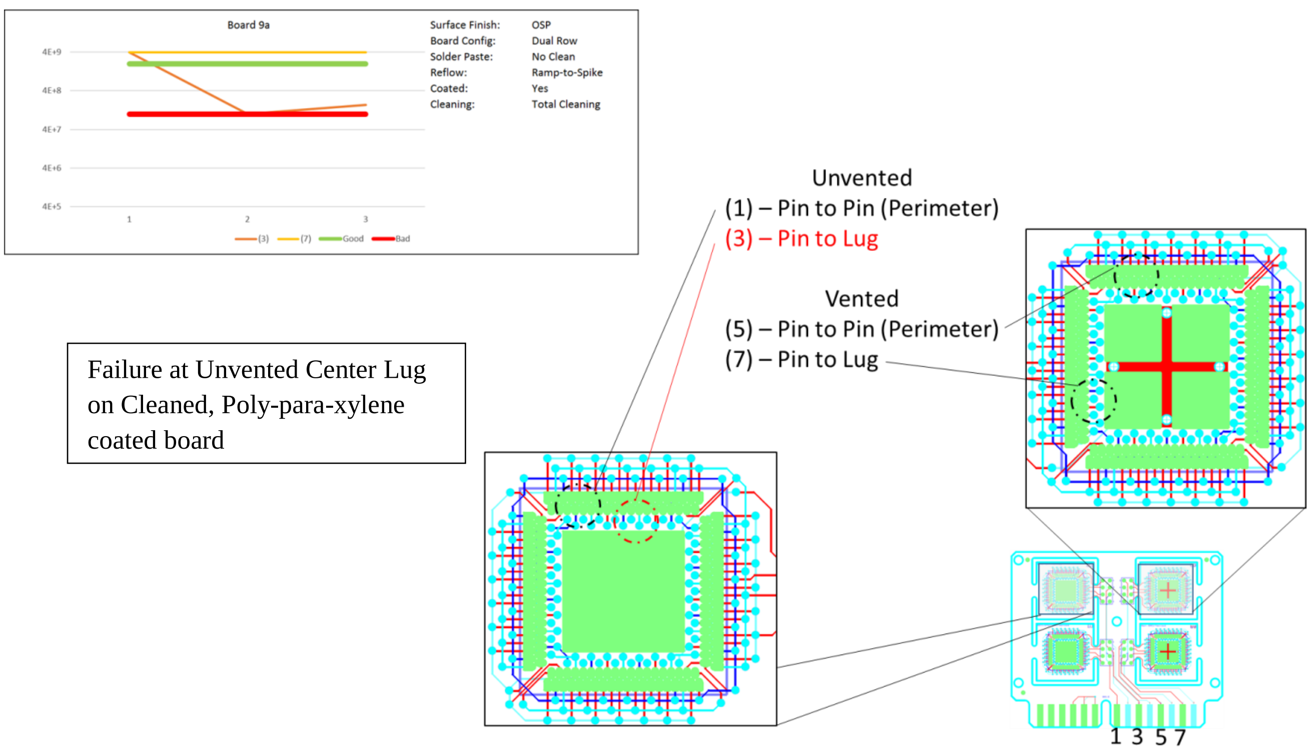


Figure 9: Dual Row Failure at Unvented Center Lug on Cleaned, Poly-para-xylene coated board

Conclusions

A series of designed experiments were performed in an effort to determine if cleaning before conformal coating was needed. The test boards were soldered with a benign high reliability no-clean solder paste. The test boards have sensors placed under the bottom termination and next to the component leads. When a test board is powered up in the presence of moisture, current leakage can be measured. Poly-para-xylene conformal coating is a vapor deposited monomer designed to protect circuitry from harsh environments. If residue is present and active under a component that was coated with poly-para-xylene coating, moisture is needed to mobilize ionic residues.

Cleaning the assembly before coating the board with a conformal coating has several benefits. Flux residue can reduce adhesion of the coating to components, plastics and laminates. Flux trapped under a bottom terminated component, such as a QFN, can still be wet and pliable. If the residue has trapped moisture, coating an unclean assembly can entrap an active contaminant that could be problematic. An additional complication can be present when cleaning the assembly. If residue trapped under a component is not fully cleaned, moisture could be trapped within the remaining flux residue. This condition could also propagate current leakage on a conformally coated assembly.

This research study identified adhesion issues when an assembly was not cleaned before coating. The IC data found that the levels of ionic residues trapped under the body of the component were high on boards not cleaned. When cleaning the boards, the ionic levels were reduced. The complexity when cleaning comes from the low standoff gap and the time needed to fully clean these parts. The SIR data found very few failures. When a failure occurred, it was most likely due to residue trapped under the body of the component that had a source of moisture. The failures were all detected on the Dual Row QFNs and not the Single Row QFNs. The single row had lower standoffs, higher flux levels and higher ionics, yet no SIR failures were detected which was not what was expected.

Even though a conformal coating such as para-poly-xylene protects the assembly from moisture ingression, the data findings in this study lead us to the conclusion that cleaning and drying the assembly of all moisture is still best practice. With that being said, it is critical to develop the process conditions needed to fully clean the assembly before coating.

General References

1. Bixenman, M., McMeen, M. and Tynes, J. (2016). BTC/QFN Test Board Design Considerations and Method for Qualifying Soldering Materials and Cleaning Processes. SMTAI. Rosemont, IL.

2. Bixenman, M., et. al (2016). Electrochemical Methods to Measure the Corrosion Potential of Flux Residues. IPC APEX 2017. San Diego, CA.

3. Tolla, B., et.al (2016). Reactivity of No-Clean Flux Residues trapped under Bottom Terminated Components. SMTAI. Rosemont, IL.

TECHNOLOGY'S TURNING POINT

TURN ELECTRONICS MANUFACTURING INSPIRATION INTO INNOVATION

Does Cleaning the PCB before Conformal Coating add Value?

Mark McMeen and Jason Tynes – STI Electronics

Gustavo Arredondo – Paratech Coating

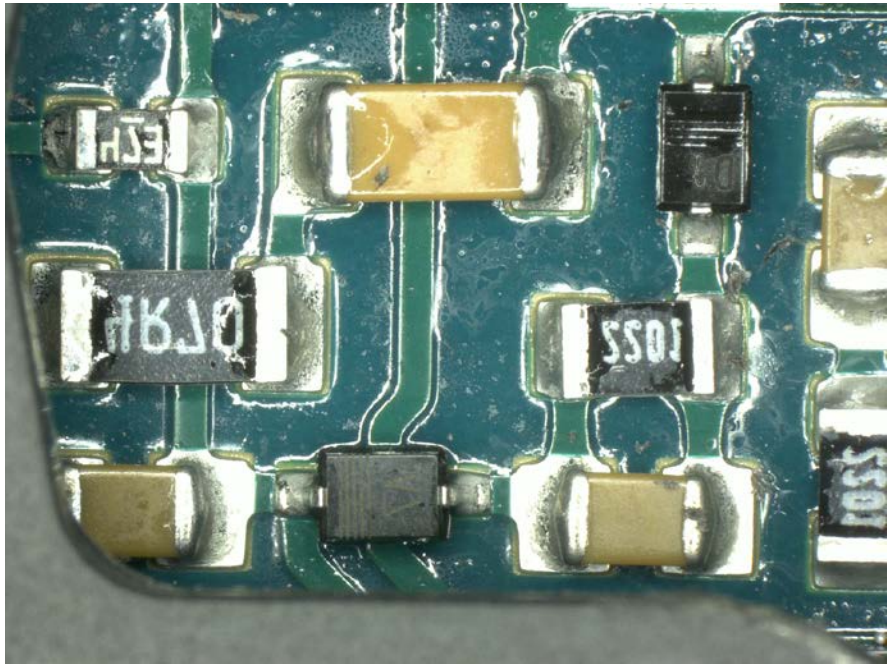
Mike Bixenman, DBA – KYZEN Corporation

Presentation Topics

- Introduction
- Purpose of the Research
- Experimental
- Data Findings
- Summary from Data Findings
- Conclusions

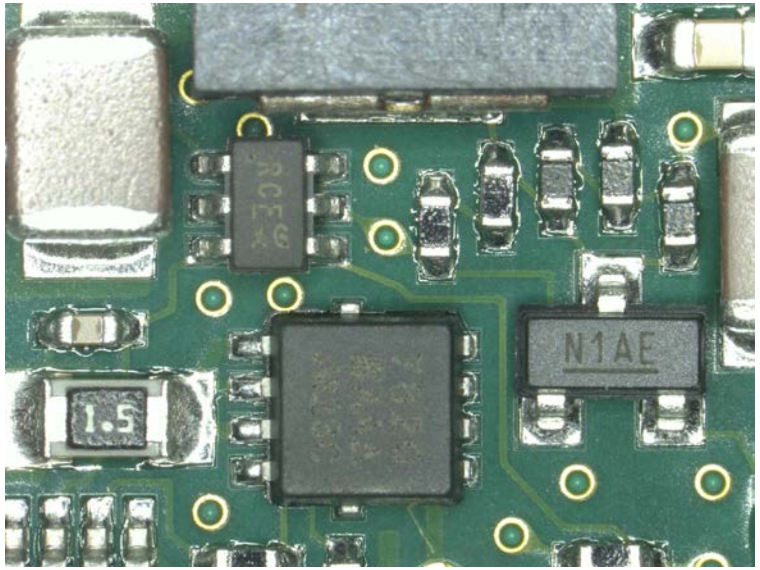
Introduction

Cleanliness Level of PCBs



- Becoming more critical
  - *Component miniaturization*
  - *Component density*
  - *Manufacturing practices*
- High reliability requires
  - *Clean assemblies*
  - *Protective films to prevent moisture and contamination from coming in contact with conductors*

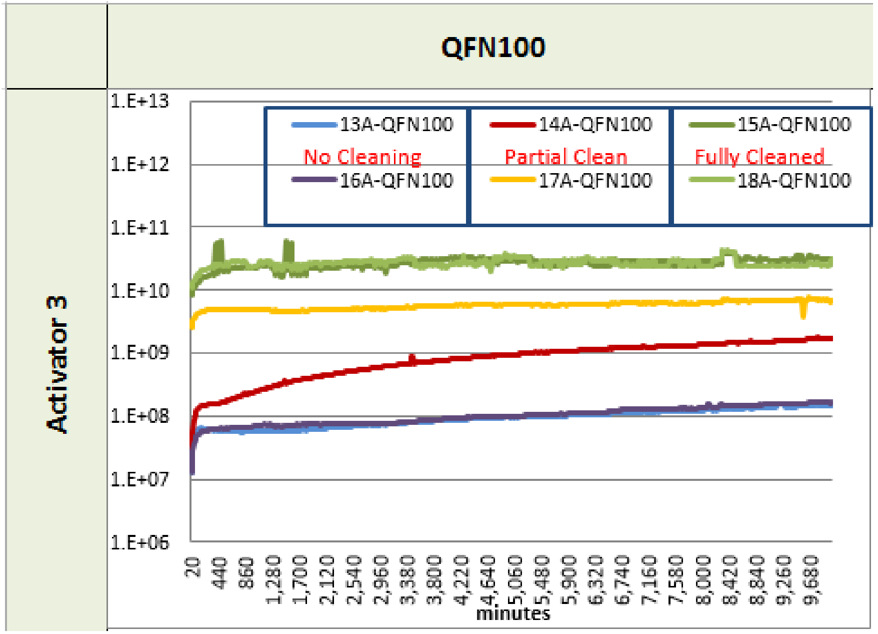
Today Electronics



- Characterized by
  - *High lead counts*
  - *Reduced lead spacing*
  - *High aspect ratios*
- Leadless and BTC components
  - *Reduce standoff gaps*
  - *Flux residue accumulates and fills underside of components*
- Lead Free soldering
  - *Promote adhesion of contaminants*
  - *Environmental and corrosion risks*

Cleaning

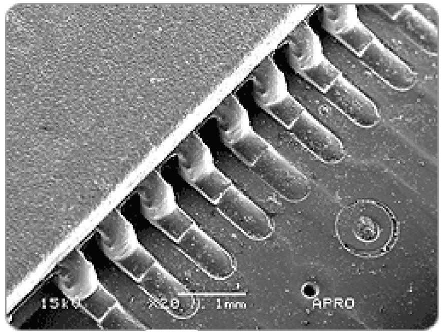
- Residues can ionize in the presence of moisture
- Potential to solubilize metal oxides
- When the assembly is biased,
  - *Leakage currents form*
  - *Intermittent failures*
  - *Can result in permanent failure*



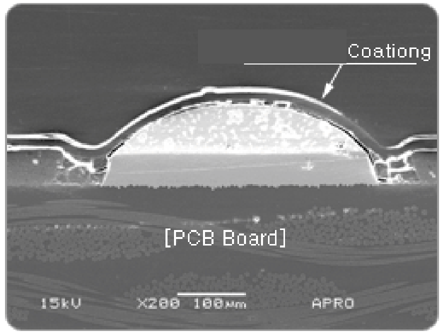
- Total cleaning
  - *Improves resistivity values systematically, regardless of the components/chemistries*
  - *Totally cleaned parts showed good results independent of the flux package*
  - *Cleaning well can solve the problems of highly active fluxes*

Conformal Coating

- Adds an additional layer of protection
  - *Prevents environmental contaminants from coming in contact with conductors*
- Is there value in removing flux residues before coating?
  - *Post soldering residues can cause adhesion issues*
  - *Moisture ingression in the coating itself*
    - Ionic residues can cause leakage currents to form
    - Dendritic growth can form under the coating



[Surface o Chip with coating]



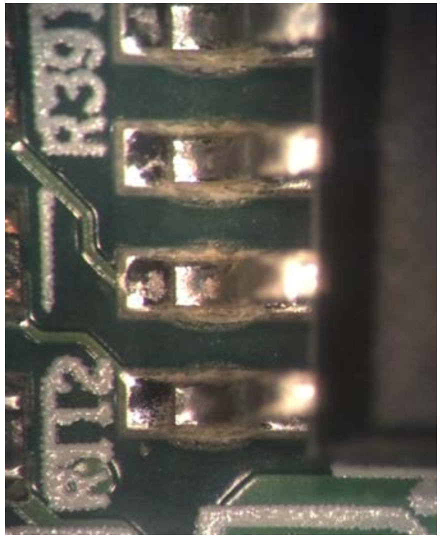
[Side o Chip leg with coating]

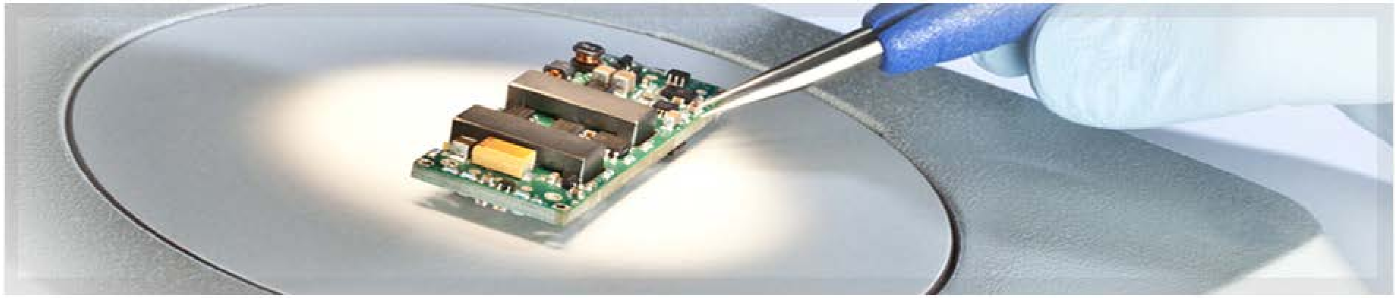
[1]

Research Purpose

Purpose of the Research

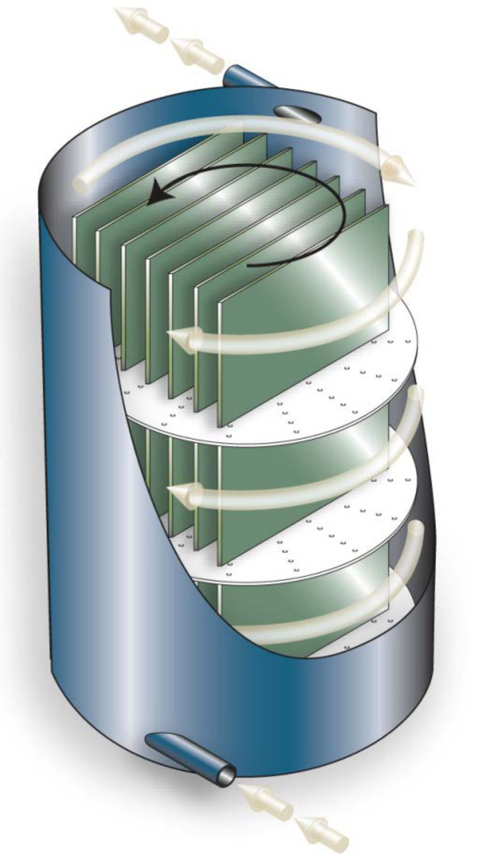
- Investigate conformal coating performance on
  - *Cleaned assemblies*
  - *Not cleaned assemblies*
- Inspect test boards for
  - *Adhesion*
  - *Visual residues*
  - *Ion residues*
  - *Surface insulation resistance*



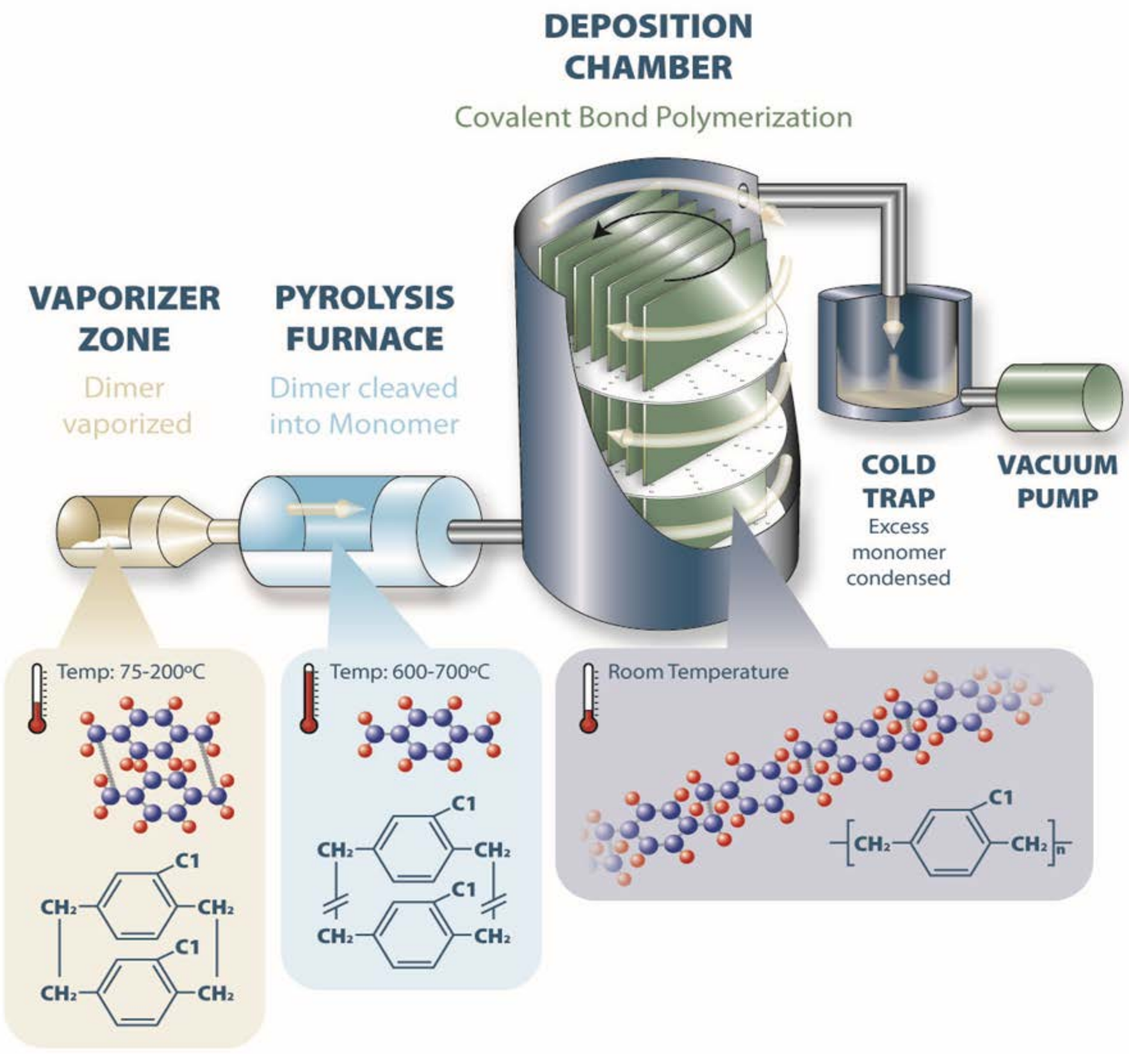


Poly-Para Xylene Coating

- Truly conformal coating
  - *Vacuum Vapor deposition*
  - *Penetrates crevices / low clearances*
  - *Conforms to the surface*
  - *Thin coating*
  - *Resistant to*
    - Blistering
    - Environmental contaminations
    - Water, chemical and other liquid contaminants



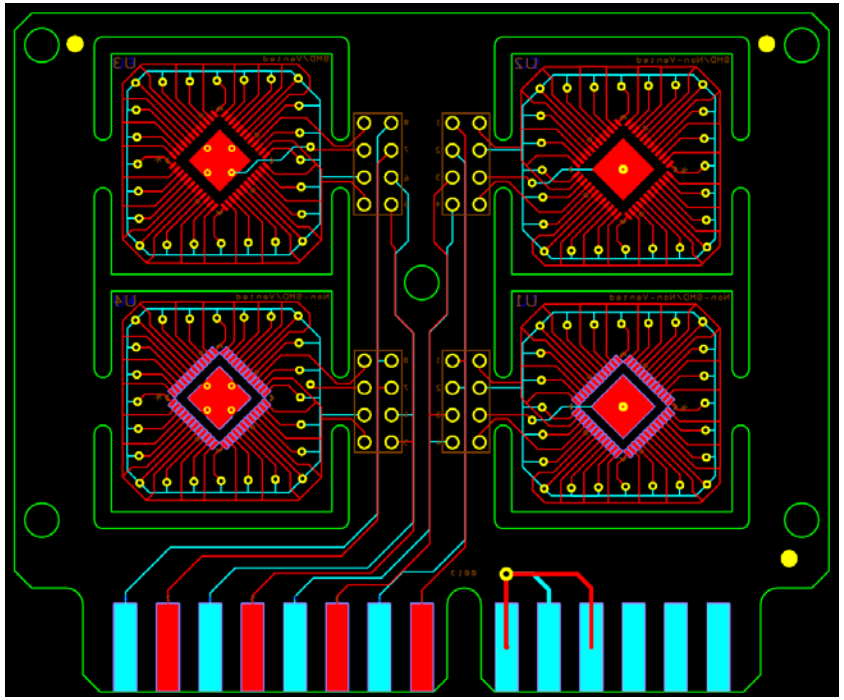
Poly-Para Xylene Coating

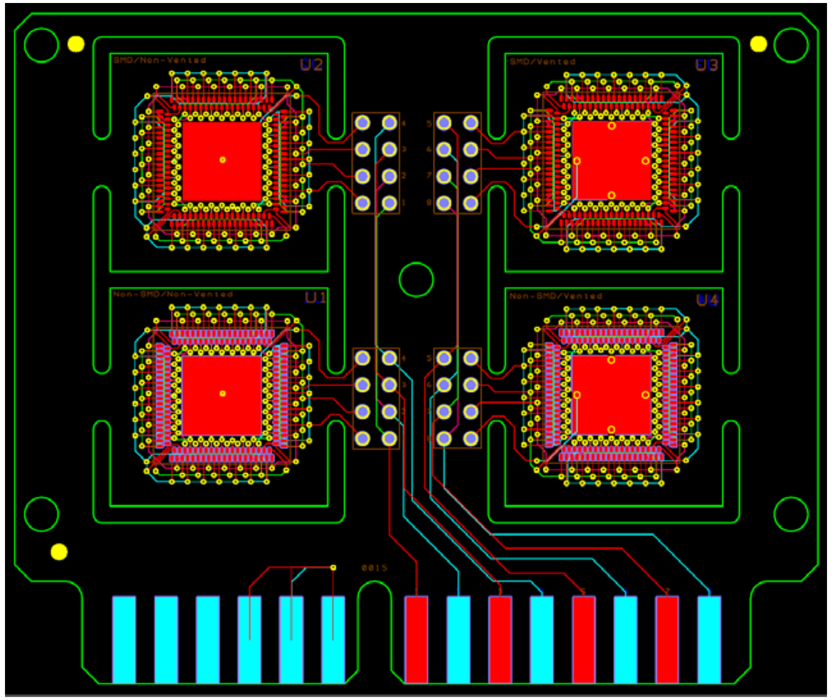


Experimental

QFN Single / Dual Row Test boards

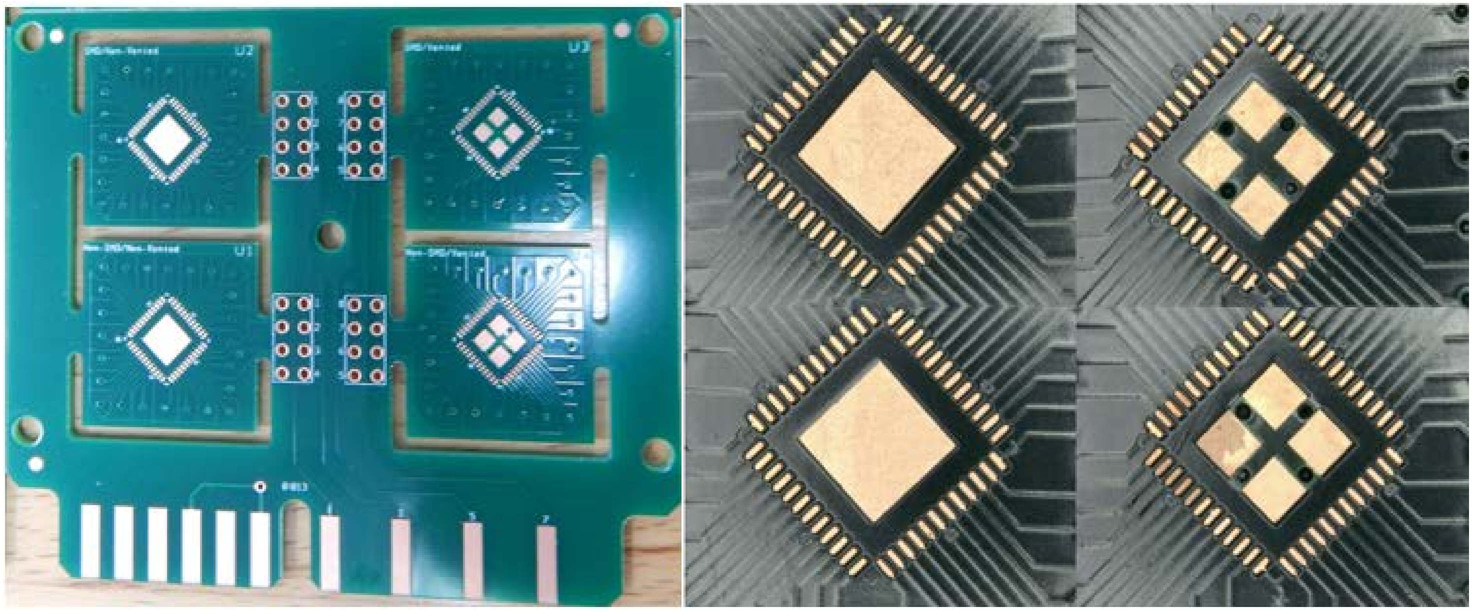
- Sensors placed at the pad and thermal lug
- Variations in board design features





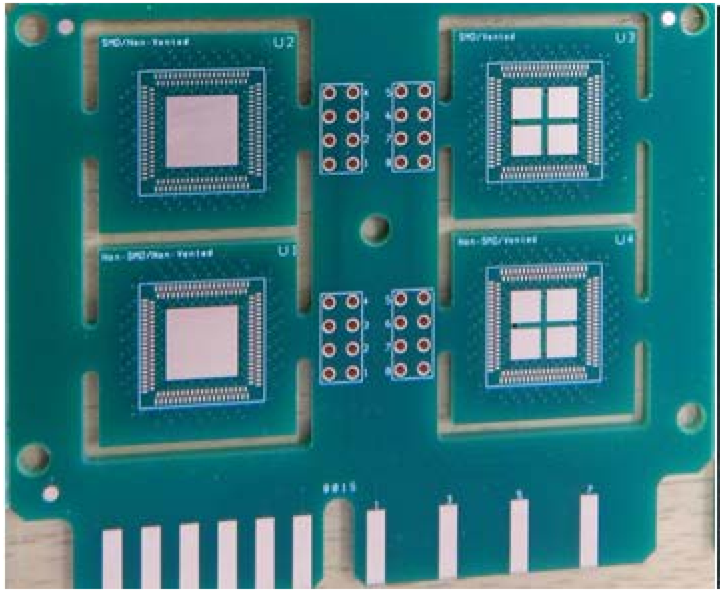
QFN 48 – Single Row Test Board

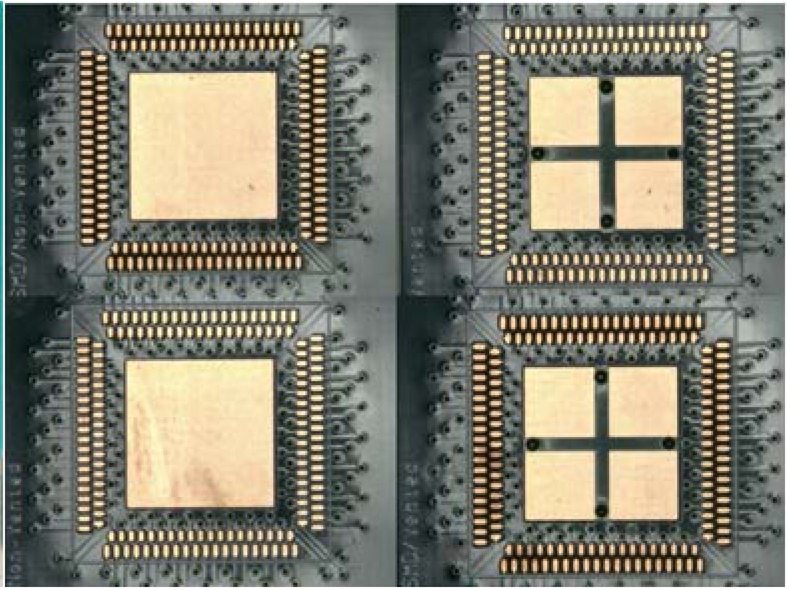
- Test Board Layout
  - *U1 and U2*
    - NSMD
    - No Venting
    - Routing for IC testing
  - *U3 and U4*
    - NSMD
    - Solder Mask Windows
    - Routed for IC testing



QFN 156LD – Dual Row Test Board

- Test Board Layout
  - *U1*
    - NSMD pins
    - SMD center lug
  - *U2*
    - NoSM pins
    - SMD center lug
  - *U3*
    - NSMD pins
    - Solder mask defined windows
  - *U4*
    - NoSM pins
    - Solder mask defined windows



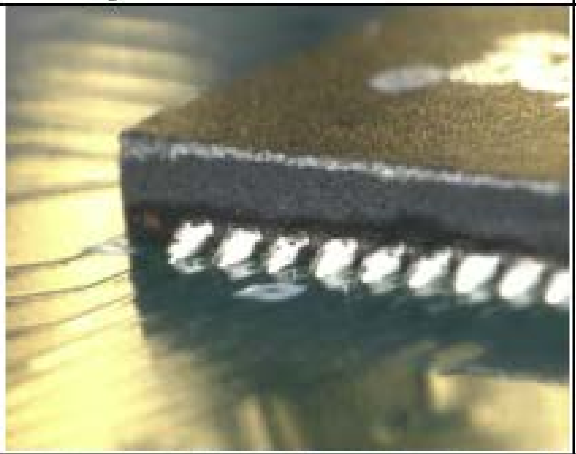
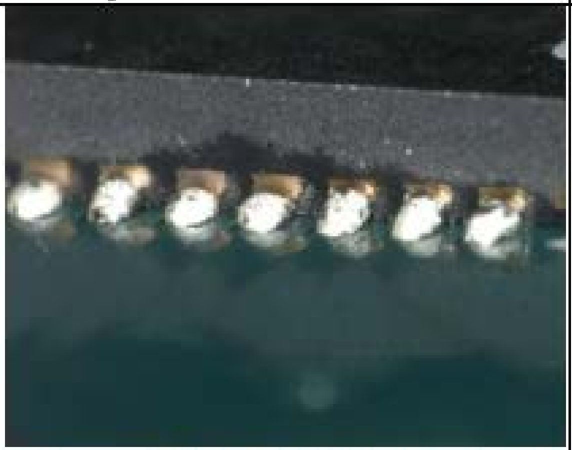
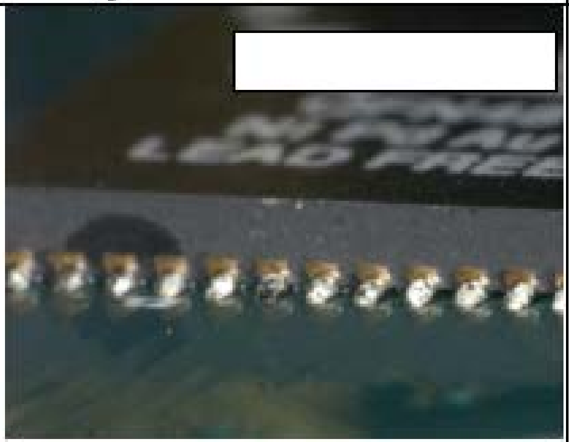
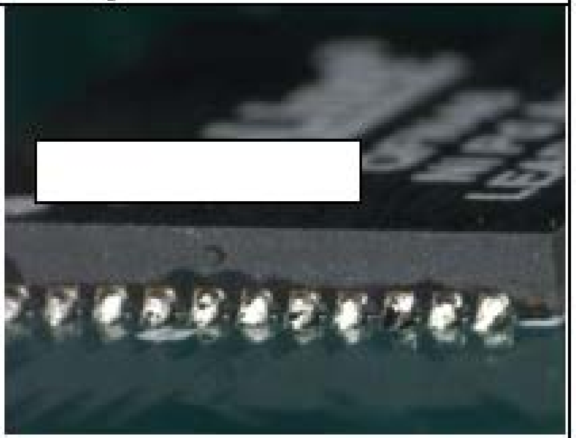
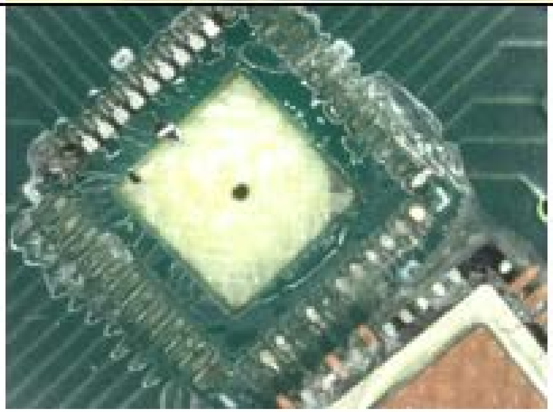
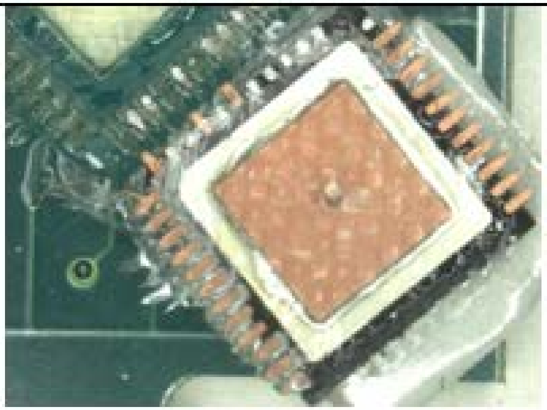
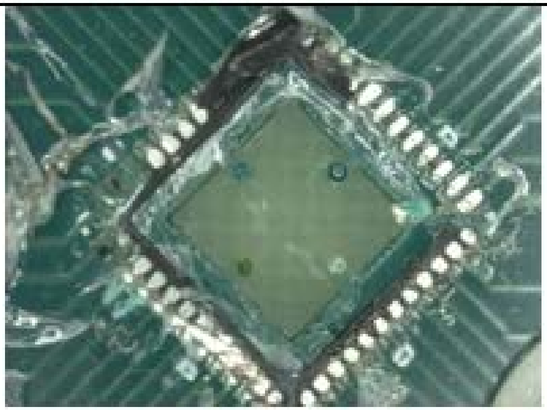
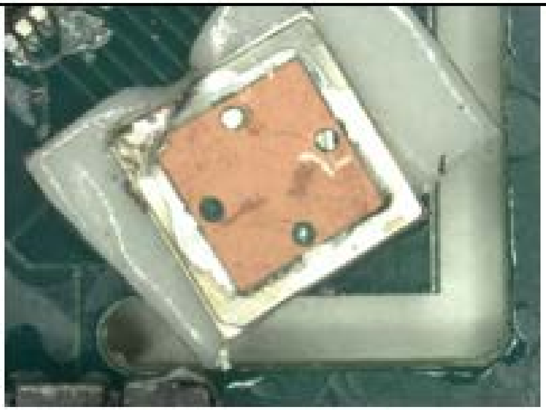


DOE Matrix

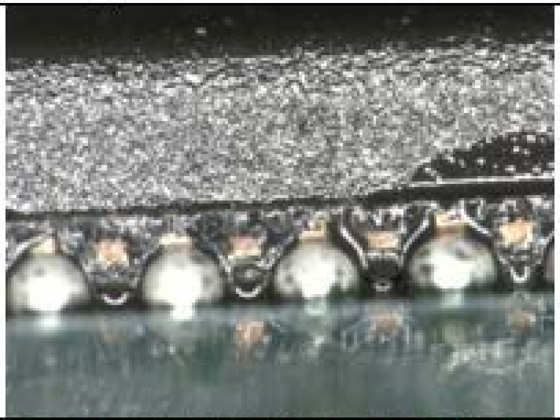
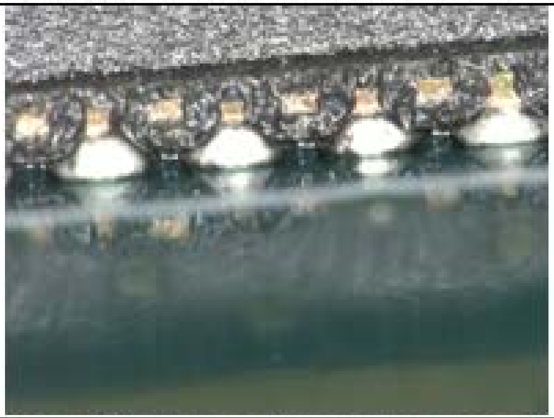
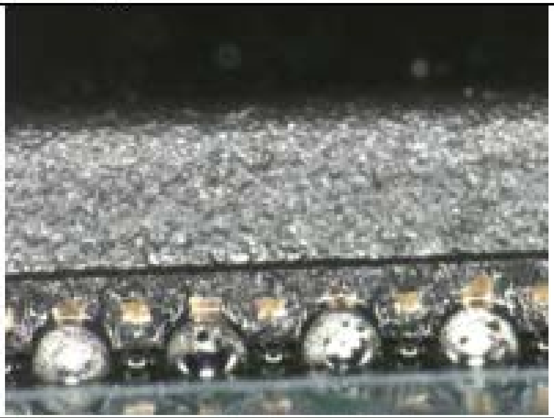
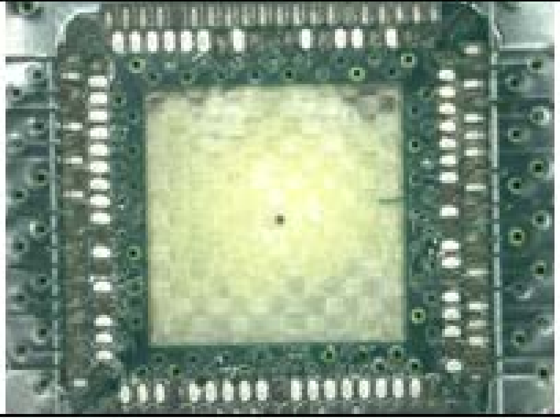
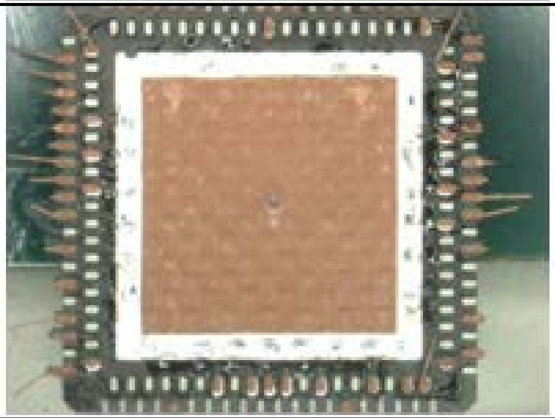
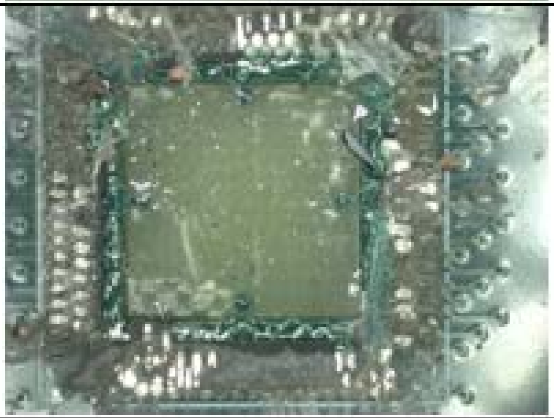
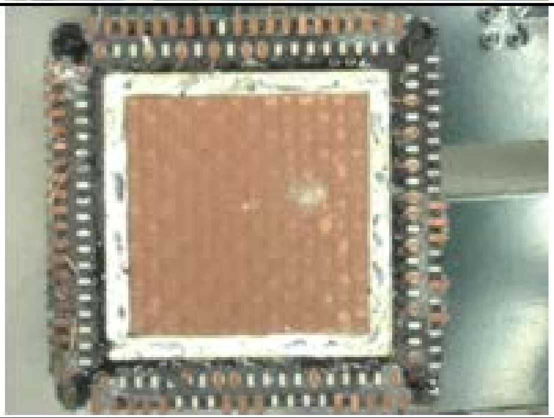
StdOrd	Test Board	Surface Finish	Solder Paste	Reflow	Para-Poly xylene Coat	Sensor Looped around Ground	Cleaning	Test Plan
1	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	No Cleaning	Visual Dry/Pry
2	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Partial Clean	Visual Dry/Pry
3	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Total Cleaning	Visual Dry/Pry
4	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	No Cleaning	IC -Site Specific
5	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Partial Clean	IC -Site Specific
6	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Total Cleaning	IC -Site Specific
7	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	No Cleaning	SIR
8	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Partial Clean	SIR
9	Single / Dual Row QFN	OSP Copper	LF No-Clean SP1	Ramp-to-Spike	Yes	Yes	Total Cleaning	SIR
10	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	No Cleaning	Visual Dry/Pry
11	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Partial Clean	Visual Dry/Pry
12	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Total Cleaning	Visual Dry/Pry
13	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	No Cleaning	IC -Site Specific
14	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Partial Clean	IC -Site Specific
15	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Total Cleaning	IC -Site Specific
16	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	No Cleaning	SIR
17	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Partial Clean	SIR
18	Single / DualRow QFN	OSP Copper	LF No-Clean SP1	Soak	No	Yes	Total Cleaning	SIR

Data Findings

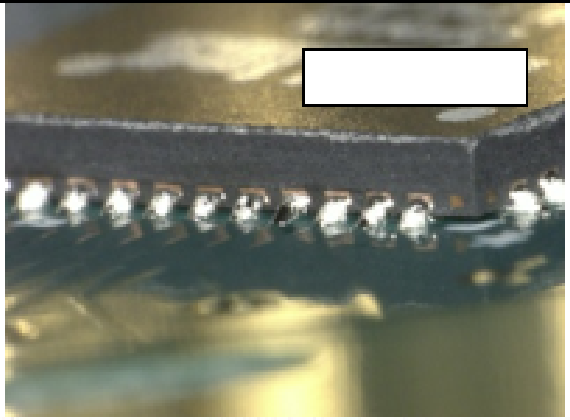
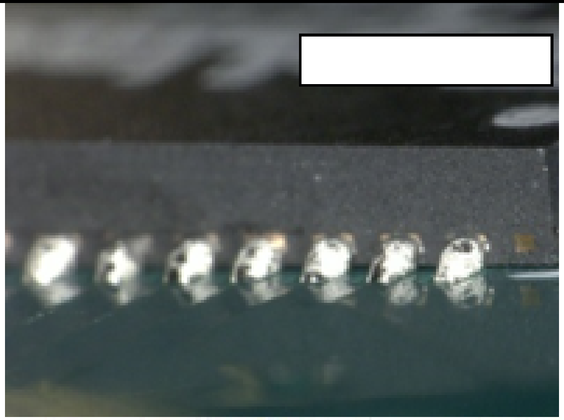
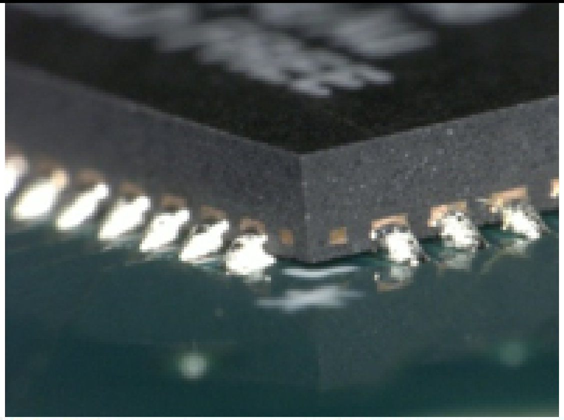
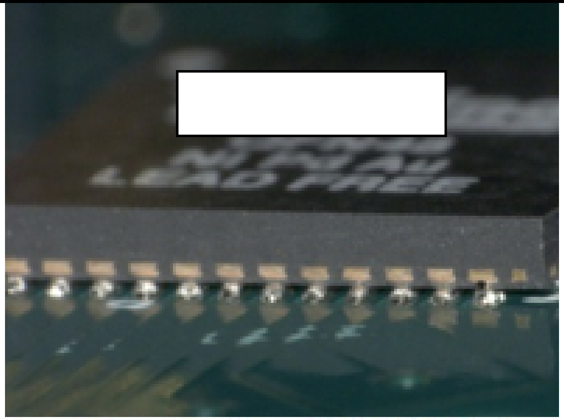
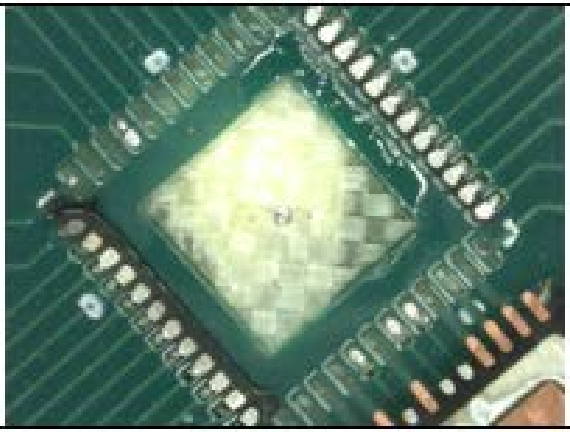
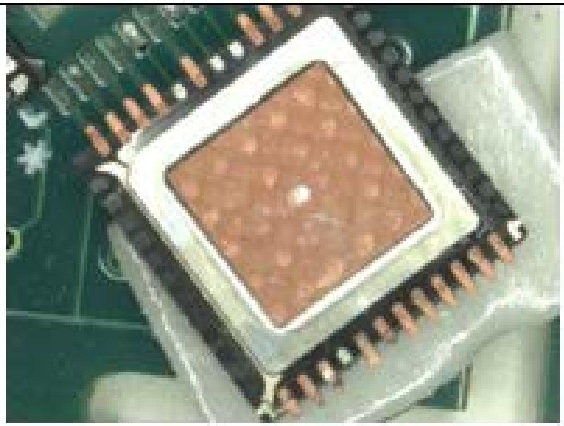
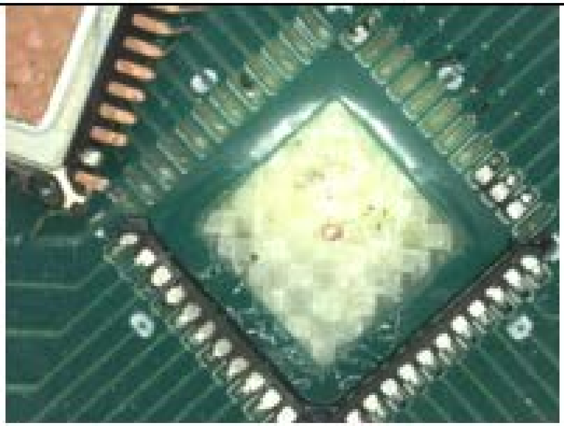
No-Cleaning - Visual

U1: QFN48 Not Cleaned	U2: QFN48 Not Cleaned	U3: QFN Not Cleaned	U4: QFN Not Cleaned
			
			

No Cleaning – Visual

U1: QFN156LD Not Cleaned	U2: QFN156D Not Cleaned	U3: QFN156D Not Cleaned	U4: QFN156D Not Cleaned
			
			

Partial Cleaning – Visual

U1:QFN48 Partially Cleaned	U2:QFN48 Partially Cleaned	U3:QFN48 Partially Cleaned	U4: QFN48 Partially Cleaned
			
			

Partial Cleaning - Visual

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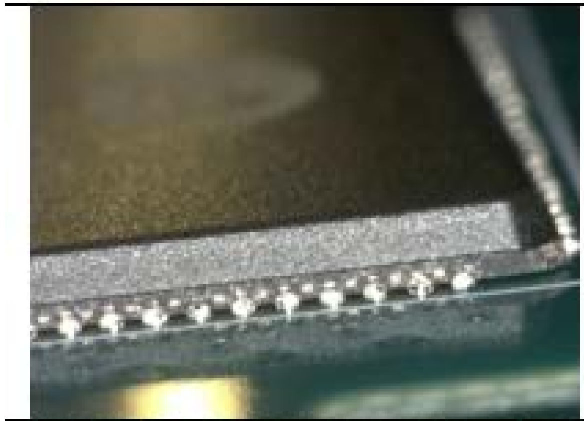	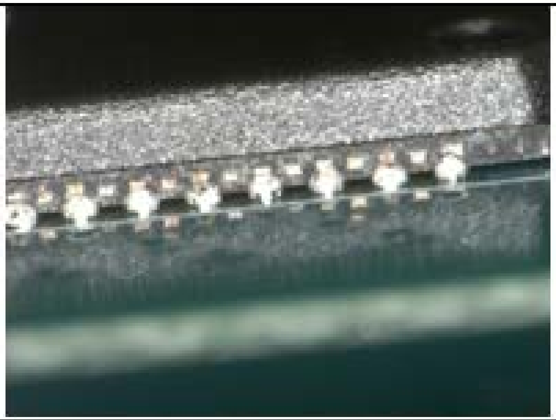	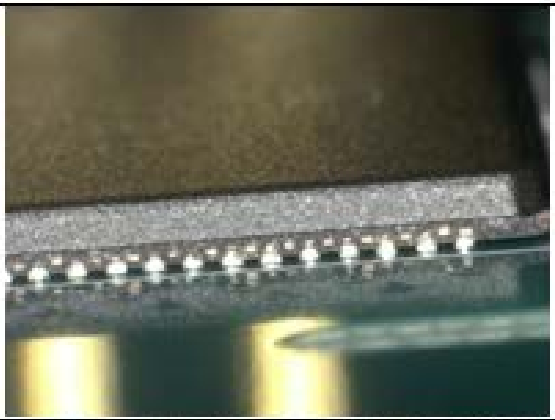	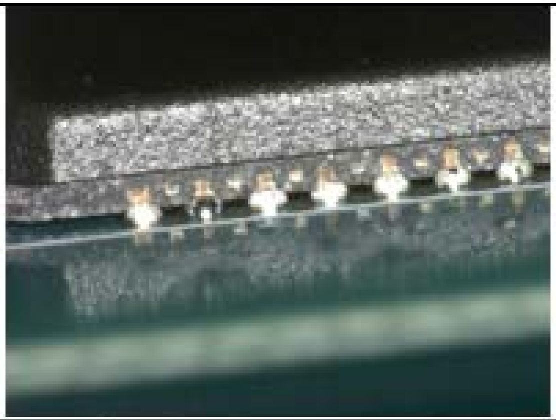
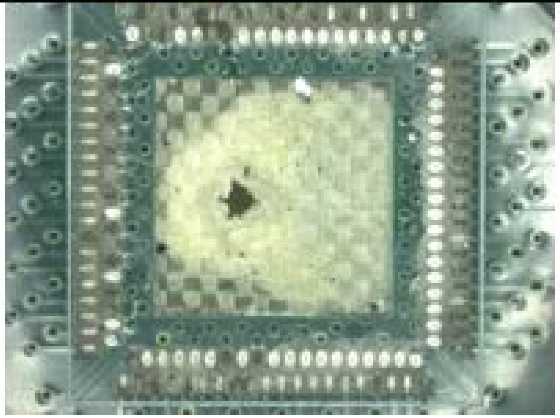	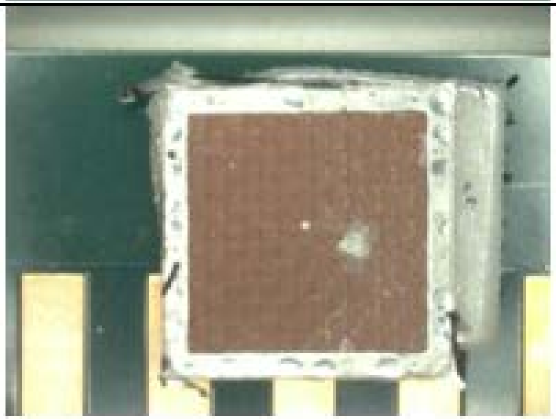	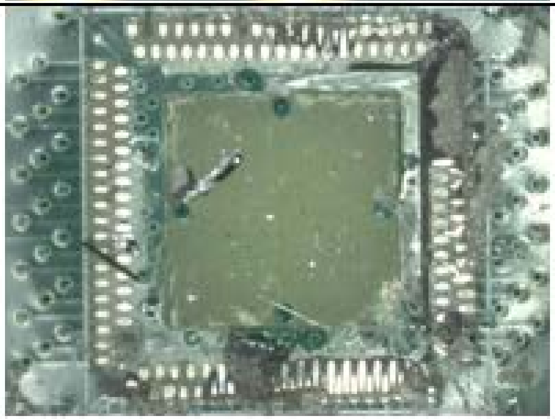	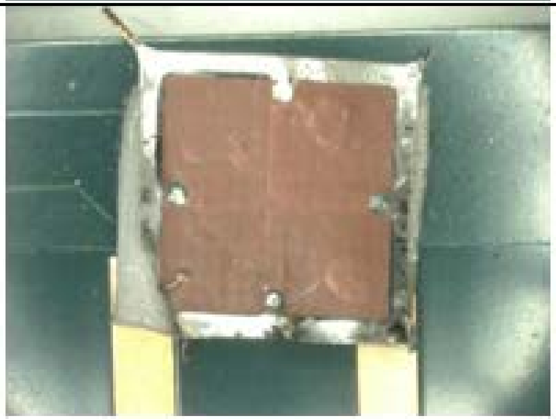

Total Cleaning – Visual

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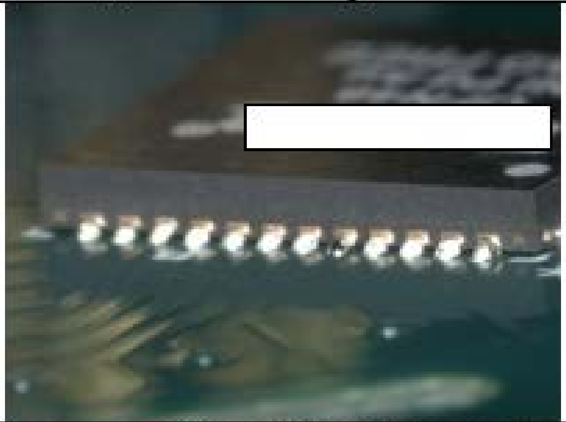
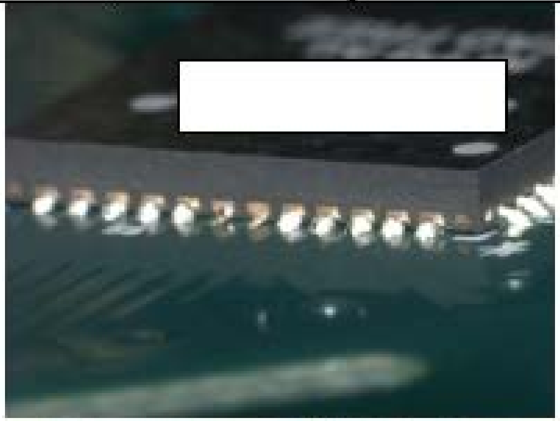
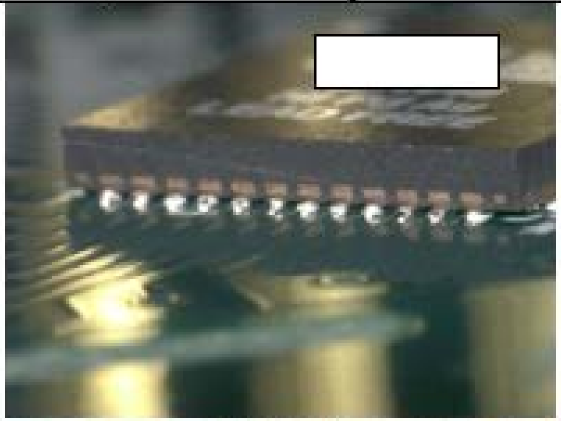
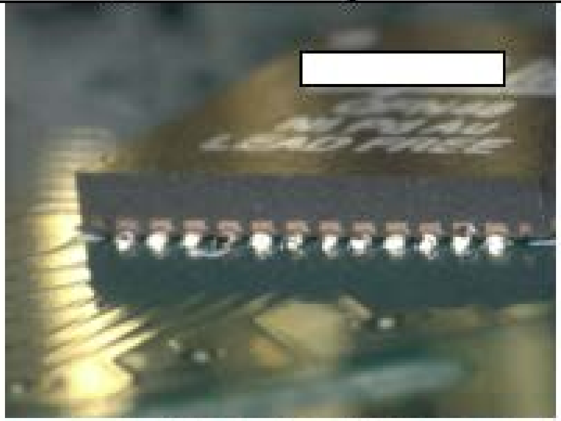
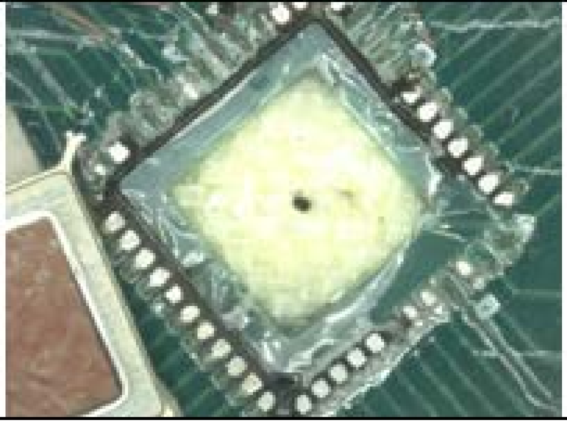
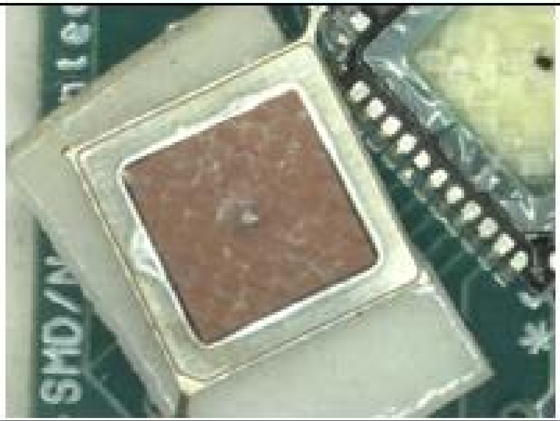
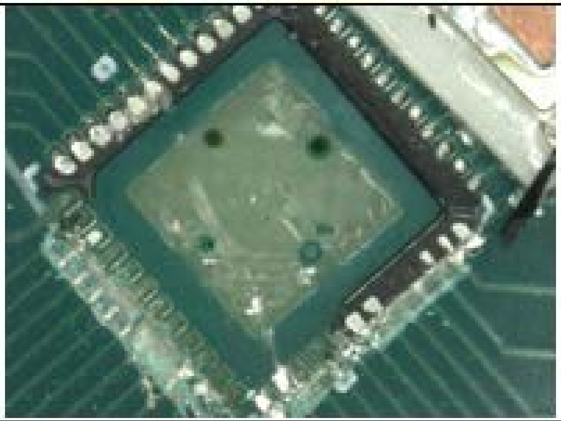
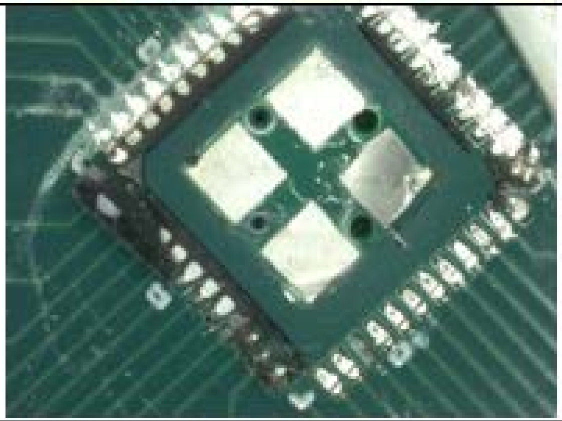
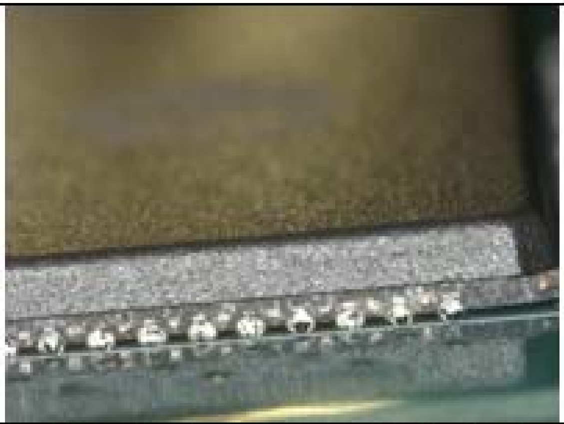
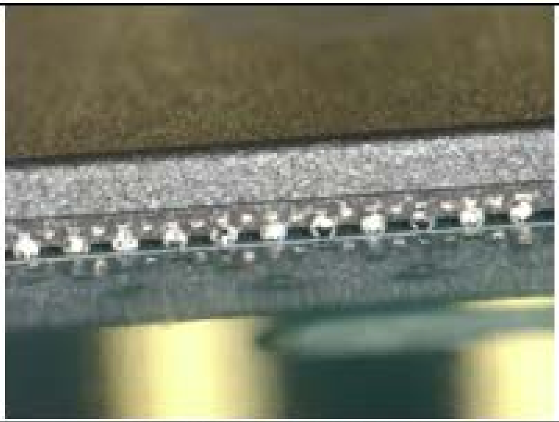
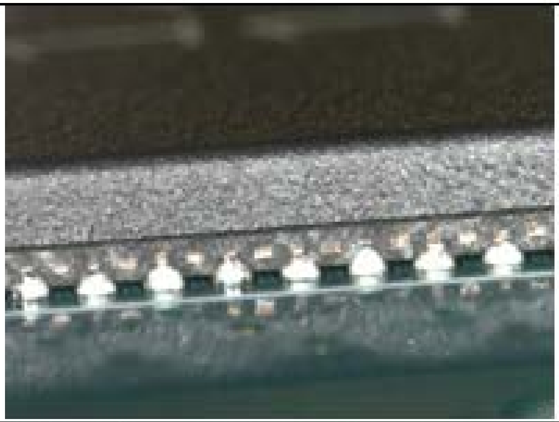
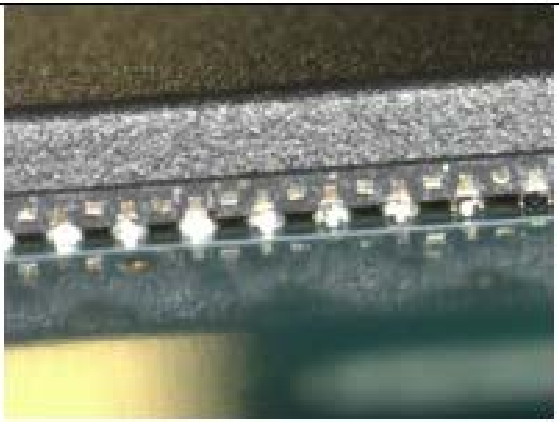
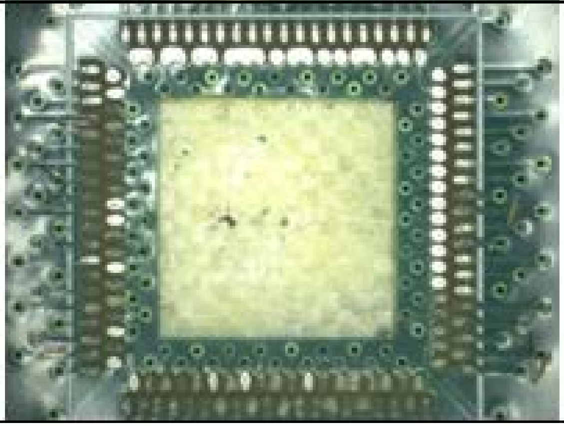
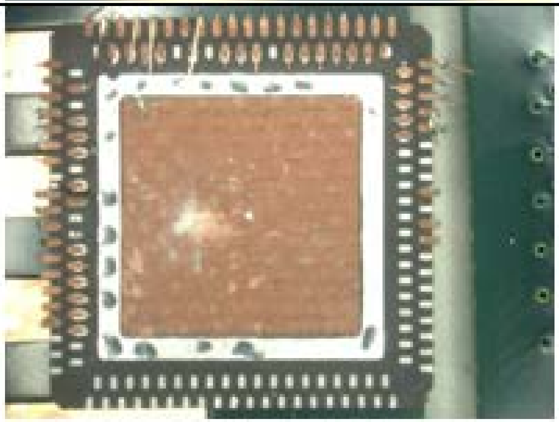
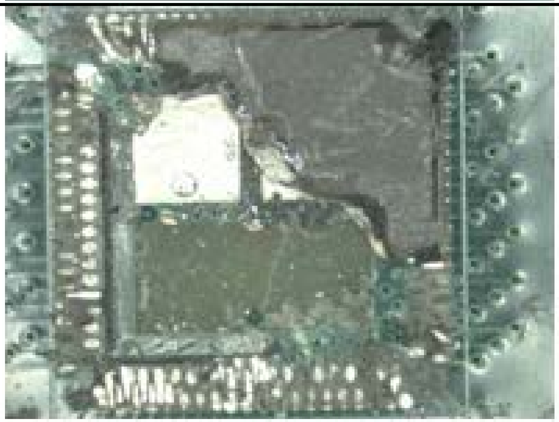
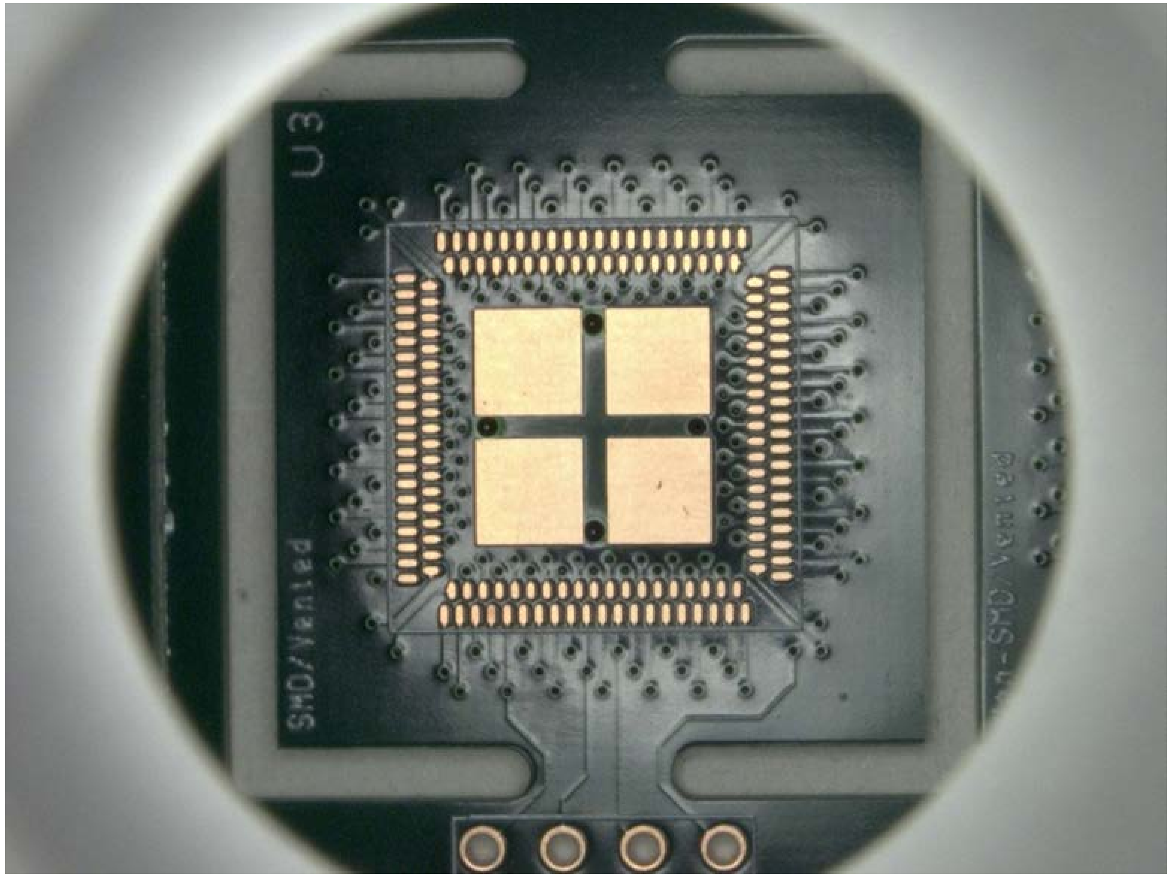
			
			

Total Cleaning – Visual

U1: QFN156LD Totally Cleaned	U2: QFN156D Totally Cleaned	U3: QFN156D Totally Cleaned	U4: QFN156D Totally Cleaned
			
			

Ion Chromatography

- Test Board design
  - *Remove each component*
  - *Site specific testing*



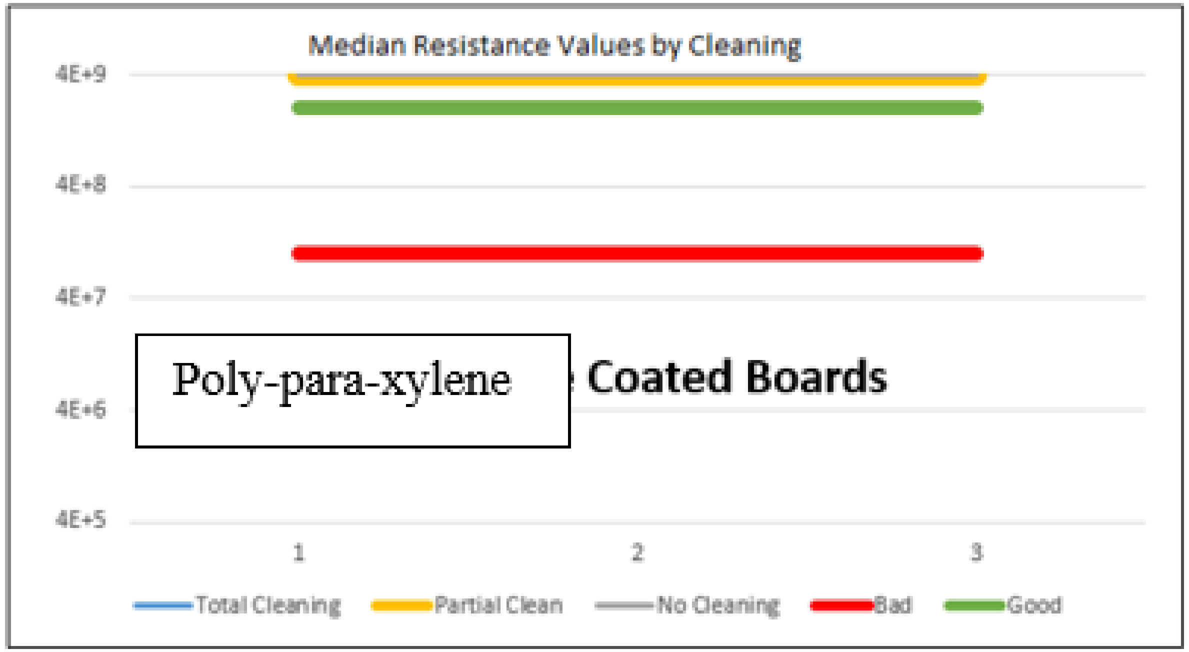
IC Data Findings

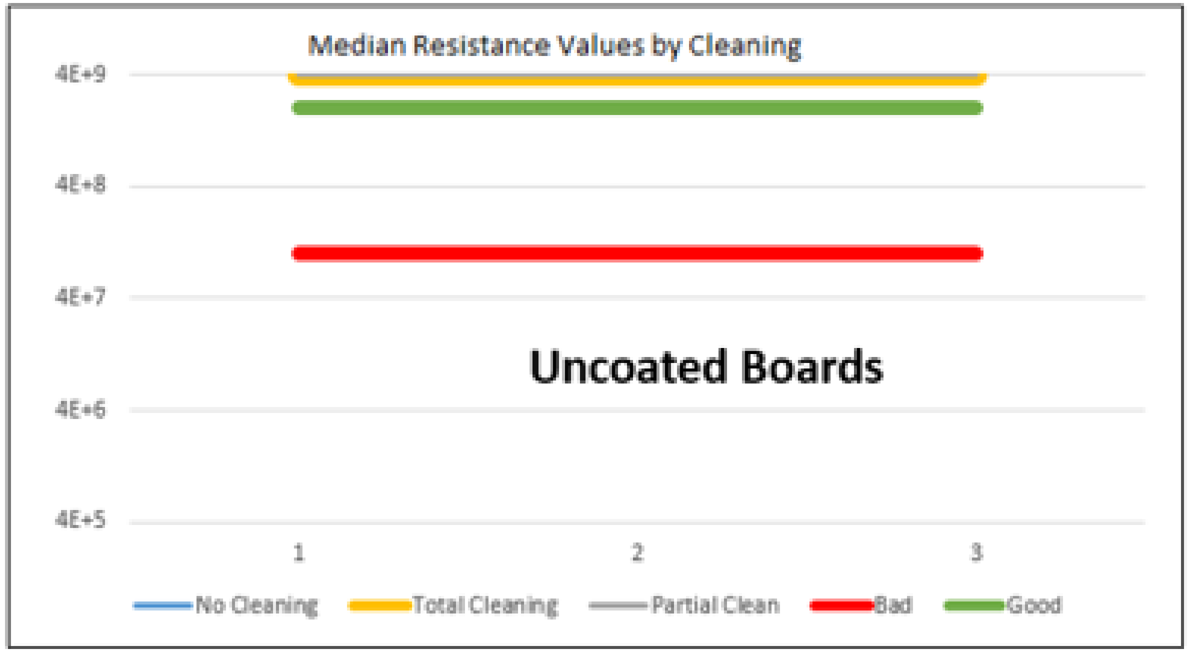
Anions	QFN 48: BOARD 1 NO CLEANING	QFN 156LD: BOARD 1A NO CLEANING	QFN 48: BOARD 2 PARTIAL CLEANING	QFN 156LD: BOARD 2A PARTIAL CLEANING	QFN 48: BOARD 3 TOTALLY CLEAN	QFN 156LD: BOARD 3A TOTALLY CLEAN
Fluoride						
Chloride	97.04	9.26	50.84	6.76	35.75	5.06
Nitrite	9.82	1.22				
Sulfate	13.99	5.85	8.73	1.66	5.21	0.94
Bromide	412.58	153.84	114.57	40.00	84.71	16.61
Nitrate						
Phosphate						
Weak Organic Acids						
Acetate	157.83	8.13	207.14	18.28	78.27	
Formate	190.23	6.95	153.52	13.79		
MSA	74.40	9.39	33.27		110.21	13.31
Adipic Acid						
Succinic						99.08
Maleic Acid						
Cations						
Lithium						
Sodium	228.49	21.83	175.50	18.17	123.76	21.00
Ammonium						
Potassium	23.35	3.57	24.46	2.52	18.35	2.19
Magnesium						
Calcium						

SIR Data Findings

- Resistance values
  - *Measured using multiplexed continuity meter*
  - *Measures resistance up to 4 G-Ohms (4E9)*
  - *Each pair of nets on each board over testing period*
    - Baseline
    - 168 hours of environmental exposure
    - 200 hours of environmental exposure
- Chamber
  - *Not opened during test period*
  - *Samples not disturbed once test began*
- Deviations
  - *Attributed to the influence of environmental conditions*

SIR Data Findings

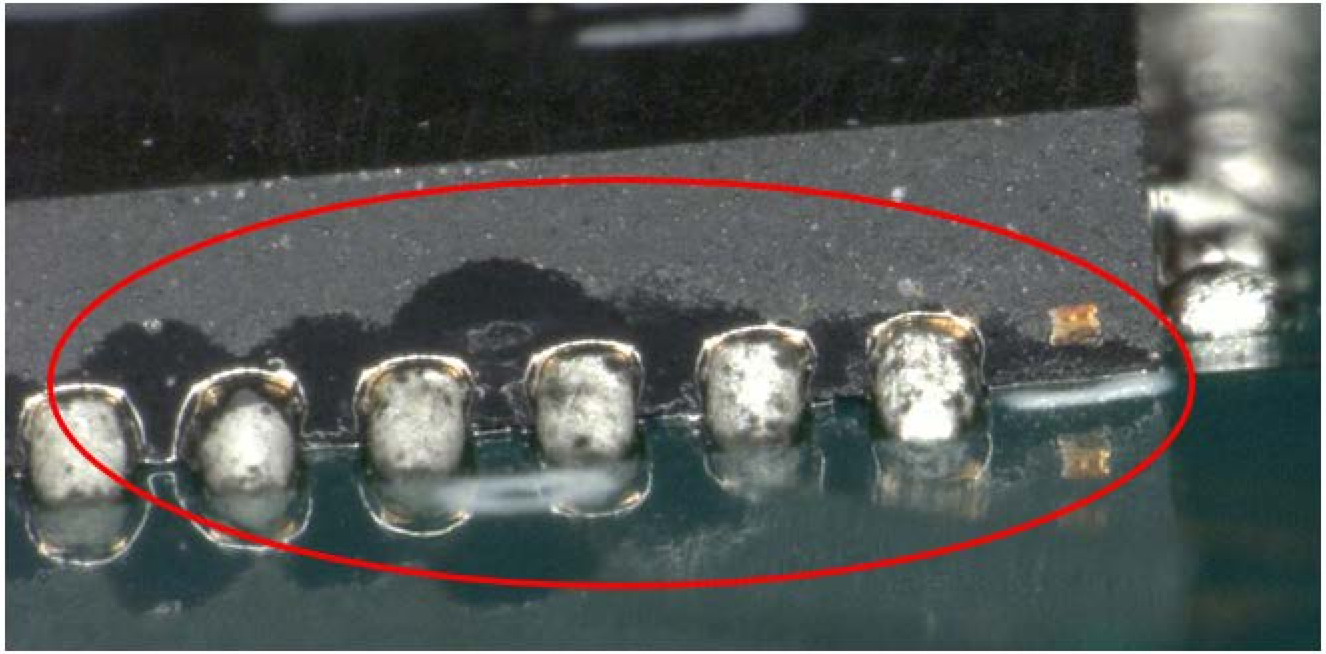




Summary from Data Findings

Flux Residue

- Can hinder adhesion
  - *Pathway for moisture*
- Leadless components
  - *Flux can fill underside*
  - *Trap moisture*
  - *Potential for leakage currents post coating*



Site Specific Ion Chromatography

- Higher precision on problematic components
- Higher levels detected compared to bulk extraction method

Anions	QFN 48: BOARD 1 NO CLEANING	QFN 156LD: BOARD 1A NO CLEANING	QFN 48: BOARD 2 PARTIAL CLEANING	QFN 156LD: BOARD 2A PARTIAL CLEANING	QFN 48: BOARD 3 TOTALLY CLEAN	QFN 156LD: BOARD 3A TOTALLY CLEAN
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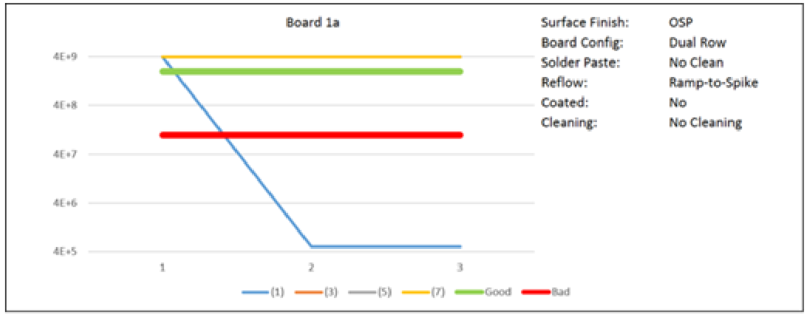
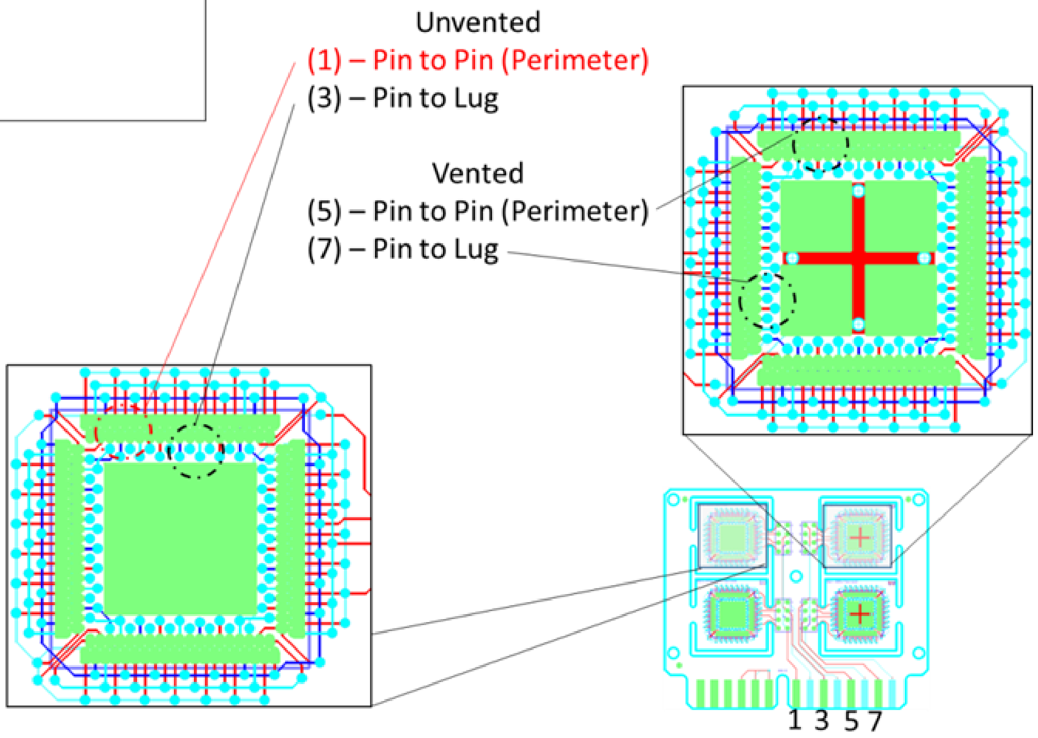
Ammonium						
Potassium	23.35	3.57	24.46	2.52	18.35	2.19
Magnesium						
Calcium						

Dual Row Failure Example

- Failure detected on Perimeter pins on a Non-Coated / Non-Cleaned Component

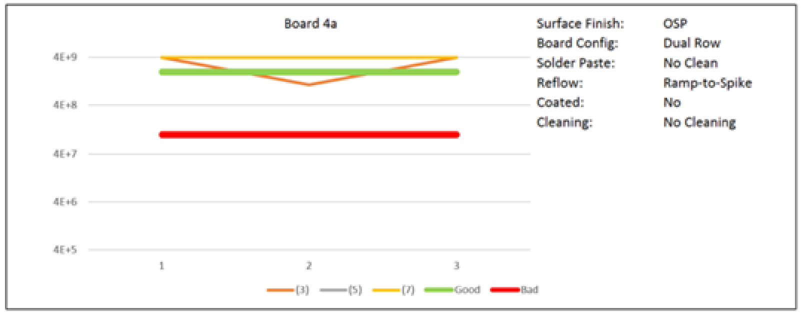


Failure at Unvented Perimeter Pins on Uncleaned, Uncoated board

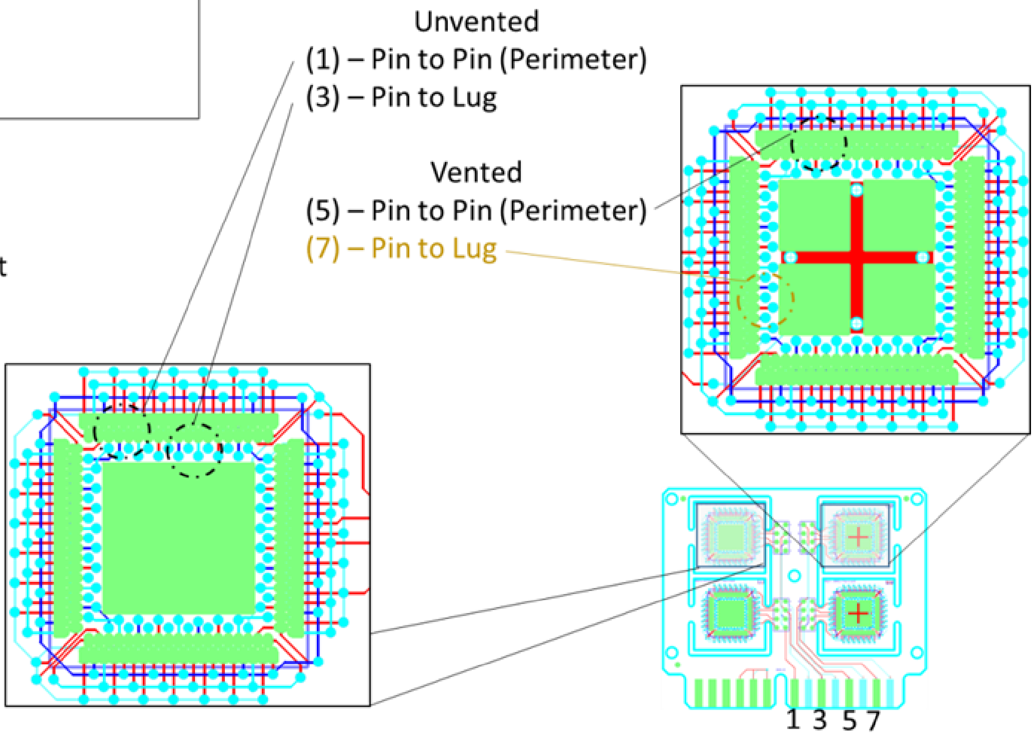


Dual Row Warning Example

- Warning next to the Vented Ground Lug on an Uncoated and Not Cleaned QFN

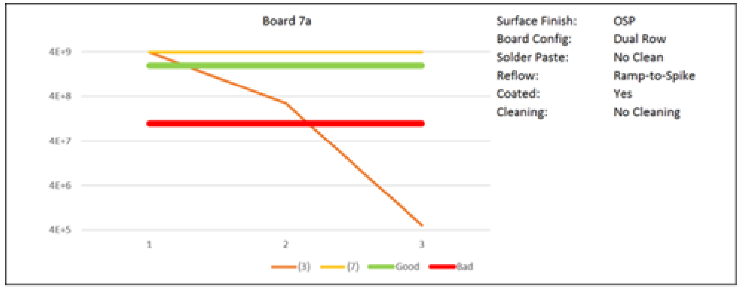


Warning and Subsequent Recovery at Vented Center Lug on Uncleaned, Uncoated board

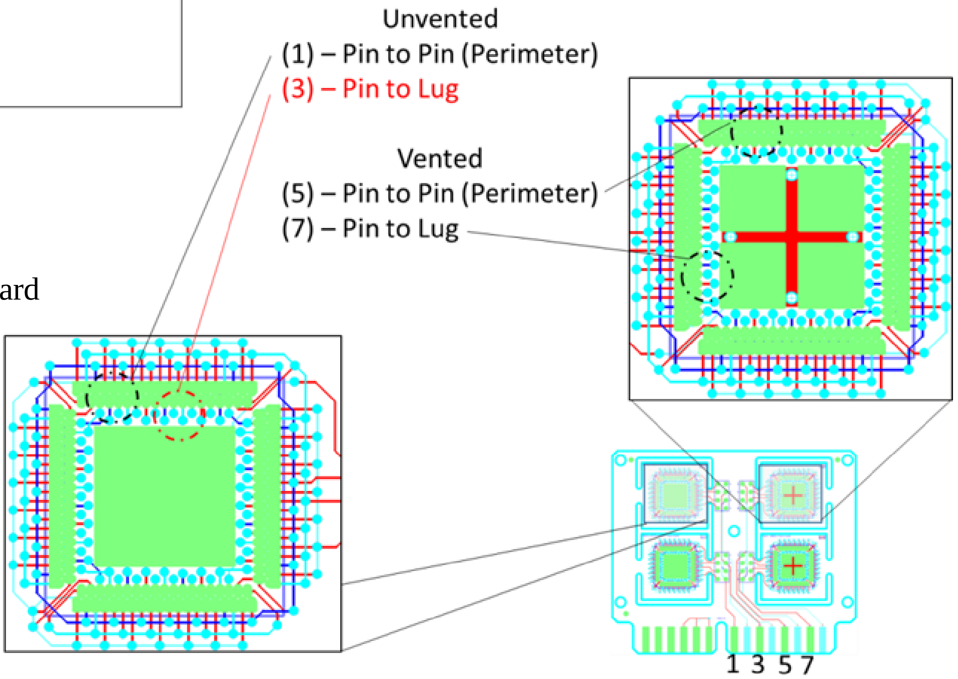


Dual Row Hard Failure Example

- Hard failure at the Unvented Center Lug on Uncleaned, Poly-Para-Xylene Coated Board

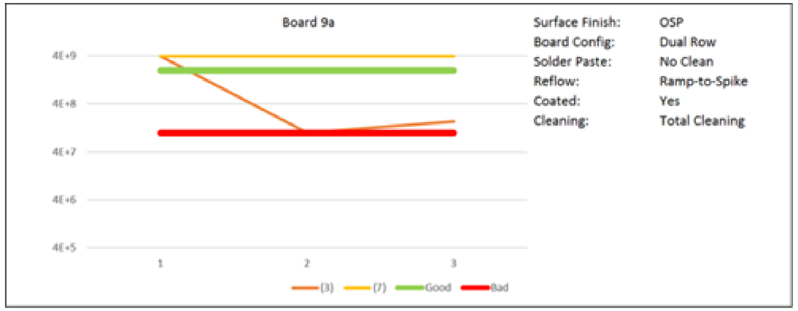


Failure at Unvented Center Lug on Uncleaned, Poly-para-xylene coated board

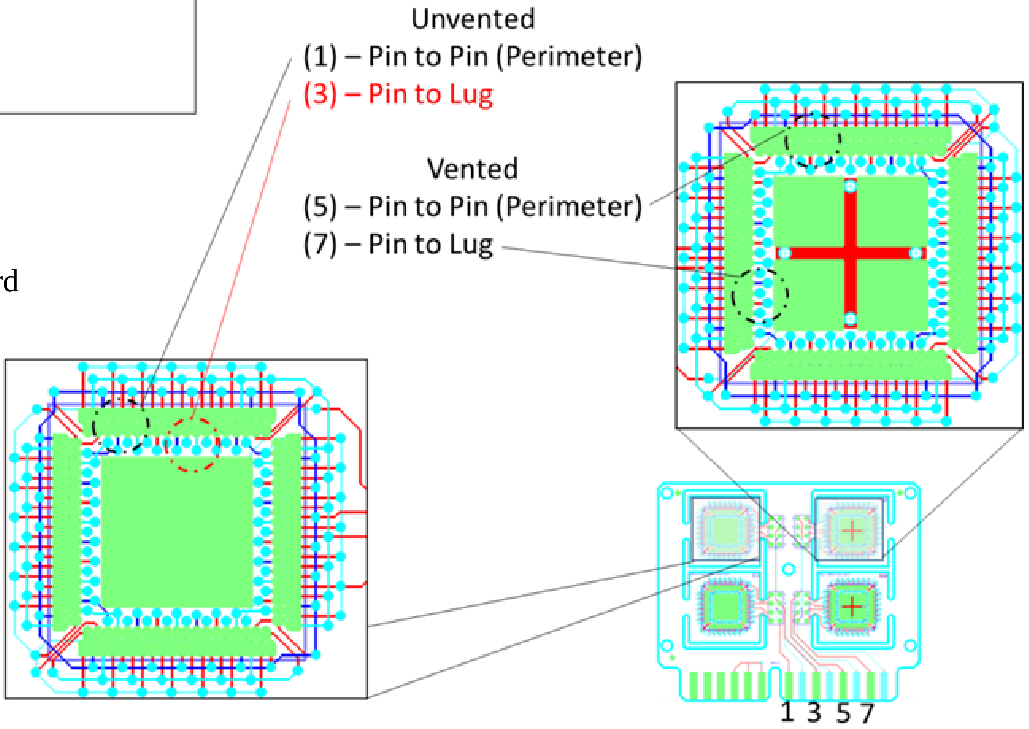


Dual Row Failure Example

- Failure at Unvented Center Lug on Cleaned, Poly-Para-Xylene coated board



Failure at Unvented Center Lug on Cleaned, Poly-para-xylene coated board



Conclusions

Designed Experiments

- Performed to determine if
  - *Cleaning before conformal coating was needed*
  - *Test boards soldered with a benign no-clean solder paste*
  - *Sensors placed under the bottom termination of components*
  - *Subset of boards*
    - Not Coated
    - Coated with Poly-para-xylene coating
  - *Cleaning*
    - No cleaning
    - Partial cleaning
    - Total cleaning

Cleaning Before Coating

- Benefits include
  - *Coating adhesion*
  - *Removal of flux trapped under components*
    - May be wet and trap moisture
    - Contaminants sealed under coating
    - If adequate moisture is present, leakage can occur under coating

Research Identified

- Adhesion could be an issue from visible residues
- Site specific IC detected high levels of problematic ions
- SIR failures
  - *Non cleaned – Non Coated boards*
  - *Uncleaned Coated board*
  - *Cleaned Coated Board*
- DOE
  - *Not conclusive*
  - *Cleaning before coating still considered best practice*

Thank you – Questions

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References

[1] www.nuri-tech.com