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ZESTRON High Precision Cleaning News

Back to Basics – Why Clean?

Let's be honest, if the OEM's and CEM's of the electronics industry did not have to clean their assemblies, they wouldn't. Nobody wants to invest the additional capital or commit operational funds and manpower unless it is absolutely necessary. So, why has cleaning become such an important part of many electronics production lines?

Effectively removing contamination is one step toward guaranteeing the long-term reliability of mission critical circuit assemblies. While circuit boards in ordinary consumer products are not intended to last, high reliability applications in the military, aerospace, communication, medical and automotive industries demand a guaranteed, long-term product life.

There are several types and sources of contamination which must be removed from circuit assemblies. Possible impurities can be a result of:

- bare board manufacturing processes
- component manufacturing processes
- assembly processes

Contamination is often present on the incoming bare boards and components. These include plastic, metal and fiberglass particulate residues from drilling and machining as well as salts from plating and etching operations.
Furthermore, the process that ensures the long-term solderability of bare boards produces contamination that can compromise assembly performance. A commonly used method used to ensure the extended shelf life of a bare board is hot-air solder leveling (HASL).

In this process, the potential primary sources of contamination are the ionic and polyglycol content of the applied flux and the impurities (i.e. oil, rust, etc.) in the hot air blown onto the circuit boards. The fluxes are very aggressive and can greatly increase the ionic contamination level of the board. The polyglycols in the flux are particularly troublesome as they can penetrate improperly cured coatings and leach out.

When components are manufactured, contamination can result from metallization baths, rinse water, de-flashing chemicals, mold release agents and flux residues. Finally, during assembly leftover solder paste, reflow condensates, outgassing, manual welding and handling residues can create problems. In particular, solder pastes occasionally produce small solder balls which can cause serious circuit reliability problems.

In the assembly process, it is recommended to check any new lot of bare boards and components for both, ionic and non-ionic contamination levels, generated by dust, oils, etc. This regular procedure could lead to fewer surprises after assembly.

Additionally, if not rinsed properly, the very cleaning agent designed to remove any soils generated during the assembly process can generate contamination itself. Even the water used in washing or rinsing processes can leave residual impurities on boards if not effectively dionized. So, how does contamination affect the reliability of circuit assemblies?

Circuit assemblies are cleaned to remove those contaminants that could be corrosive to joints and components and ultimately result in circuit failure.

These failures can have several root causes:

- electrochemical migration and dendritic growth
- electrical leakage currents

None of these phenomena are good for the reliability of the assembly as they will eventually cause it to fail. Circuit assemblies must operate and continue to function with exposure to a full range of environmental conditions. Contaminants left on boards can compromise the circuit assembly by directly short circuiting components and absorbing moisture from the atmosphere, thereby reducing resistance between component leads and promoting electrochemical migration and dendritic growth across connections. In simple terms, the combination of humidity and contamination can result in conductive electrolytes. Add stress voltage and electrochemical migration and dendritic growth can occur.

Continued on page 2.

CONTENTS:

Continued from page 1 - Back To Basics - Why Clean?

Additionally, the sensitivity to contaminants is increased where high impedance circuitry is used. Thus, while a tiny electric leak across a low resistance component may have a negligible effect on a circuit's performance, the same leak could be disastrous across a high resistance component. Presently, one of the latest trends in the industry is the increasing occurrence of high frequency (HF) circuits. This circuitry requires clean surfaces in order to ensure functionality; and of course, the correct functioning of these devices largely determines the reliability of the end product.

Conventional circuits with high ohmic components are increasingly sensitive to climatic disturbances due to small current leakages interpreted as signals when reaching the same current level. High frequency circuits between 30MHz and 5 GHz are even more sensitive to climatic disturbances.

In order to ensure the integrity of the signal, two factors are necessary: High ohmic resistance and stable impedance. This means that in the PCB design, capacitive surface effects need to be taken into account. Furthermore, the environments in which these HF circuits operate is full of humidity and harmful gasses. This can result in failure due to the interaction between the flux residue and environmental contaminants if the assembly has not been properly cleaned.

With present high-end assemblies, corrosion can also induce electrochemical dendrites resulting in leakage currents, which increasingly affect the reliability and life of the boards. Surface contaminations, which can cause parasitic capacities, lead to the distortion of the signal slew rate and often result in a disturbance of the signal integrity and even failure of the product. For example, as the systems in automobiles become ever more integrated, the interactions between the different components become ever more critical for the correct functioning of the system as a whole.

The rpm sensor on a wheel in an automobile provides data not only to the ABS system but also to the engine management system. If the rpm sensor provides incorrect data, error traceability becomes difficult if not impossible.

In addition to the above, residual contaminants can cause problems when boards are conformally coated. In fact, conformal coatings may not bond properly if contaminants are present on the surface. Under the appropriate relative humidity conditions, any water soluble contaminant trapped under the coating will promote the passage of water vapor through the coating and the contaminant will dissolve.

The resulting expansion in volume will cause blistering and the coating to detach from the surface. Electrochemical migration, dendrite growth and electrical leakage currents are, of course, dangerous as well. In summary, for any manufacturer producing mission critical assemblies whose product performance envelope dictates a long product life, cleaning is a step that cannot be missed as reliability requires cleaning!

New ZESTRON Academy

Through tradeshows, technical presentations and seminars as well as collaboration with experts and press and, of course, our daily customer contact, ZESTRON has recognized a tremendous demand for cleaning education sought by engineers new to the industry as well as seasoned professionals. To fill this void, we established ZESTRON Academy.

This gap became very obvious at a recent cleaning workshop held at the American Competitive Institute in Philadelphia. Together with Aqueous Technologies, ZESTRON presented "Why Clean Electronic Assemblies?"

Over the course of two days, more than 50 participants attended the event, which introduced the most important key elements needed for a successful PCB cleaning process, discussed cleaning agent technologies, equipment options as well as different process control tools and methodologies.

Figure 1: ZESTRON America

ZESTRON Academy is designed to meet the industry's as well as our customers' demands, close the gaps and enable the proliferation of knowledge. As the worldwide leading provider of high precision cleaning products and services and with more than 35 years of experience in high precision cleaning and over 2000 processes installed worldwide, ZESTRON has gained a tremendous amount of knowledge about cleaning agents, equipment, process control, surface analytics and trouble-shooting techniques.

And, with global teams of engineers and research scientists, we always remain one step ahead of the latest industry developments and can help you find solutions to your organization's most intricate cleaning challenges. To share our knowledge and insights through a variety of resources, ZESTRON Academy offers:

- hands-on technical workshops at ZESTRON Technical Centers or customer sites
- topical webinars with ZESTRON @cademy
- collaborative multiplier workshops
- access to an extensive technical library including published research papers and articles
- and more

To learn more about ZESTRON @academy's cleaning series taught by our expert process engineers and for the latest workshop schedule, please call (703) 393-9880 or contact us at infoUSA@zestron.com.

Case Study

Validating the Effectiveness of Your Cleaning Process with Ion Chromatography

How do you know if your cleaning process is working properly and you are meeting your end customer's cleanliness requirements? While the IPC standards outline several methodologies that can be used for quantitative validation, other methods provide purely qualitative results.

All of these include but are not limited to Visual Inspection, Ionic Contamination, Surface Insulation Resistance, Contact Angle Measurement as well as the ZESTRON® Flux Test and ZESTRON® Resin Test.

Figure 1: Test assembly

One of the most widely used test methods in the electronics manufacturing industry is ion chromatography. As opposed to ionic contamination, which can only measure the total amount of ionic contamination present on the substrate, this validation system (performed according to *IPC TM-650 2.3.28*) has the ability to identify as well as quantify specific ionic species that are present on a board's surface and/or components. The Ion Chromatography test measures Fluoride (Fl-), Chloride (Cl-), Bromide (Br-), Nitrate (NO3-), Nitrite (NO2-), Phosphate (PO4-), Sulfate (SO42-), and Weak Organic Acids (WOAs). Results are reported in µg/in^2.

In this particular case study, one of the worldwide leading suppliers of automatic tank gauging and fuel management systems contacted ZESTRON to have the cleanliness of three test boards analyzed via ion chromatography. It is interesting to note that this specific customer is one of the few companies in the industry to design, manufacture and service its own products. As the reliability of the systems they build is critical, perfectly clean assemblies are one way to minimize risk. The boards' specifications are summarized in table 1.

Board Type	Quantity	Dimension	Paste	Flux	Handling
Test	3	5" diameter	No-clean Lead-free	No-clean Lead-free	ESD Bags

Table 1: Assembly specifications

How does Ion Chromatography work?

The contamination on each board is extracted at 80°C/176°F for 1 hour in a 75% IPA – 25% DI-water solution. Each board is placed in a Kapak® bag containing a certain volume of extract solution. The volume of the extract solution as well as the bag size is based on the board dimensions.

The Kapak® bags are heat sealed and placed into a hot water bath which is maintained at 80°C/176°F. After 60 minutes, the bags are removed from the water bath and shaken vigorously for ten seconds to mix the contents. The solutions are allowed to cool to ambient temperature before removing the substrate samples.

Subsequently, the extract solutions are transferred to ionic-free plastic containers for injection into the Ion Chromatography unit.

Ionic Species	Maximum Contamination Levels	Sample # 1	Sample # 2	Sample # 3
Anion Species always tested for				
Fluoride (F^-)	3	ND	ND	ND
Acetate ($C_2H_3O^-_2$)	3	ND	ND	ND
Formate (CHO^-_2)	3	ND	ND	ND
Chloride (Cl^-)	4	ND	ND	ND
Nitrite (NO_2^-)	3	ND	ND	ND
Bromide (Br^-)	10	3.94	3.29	3.85
Nitrate (NO_3^-)	3	ND	ND	ND
Phosphate (PO_4^{3-})	3	ND	ND	ND
Sulfate (SO_4^{2-})	3	ND	ND	ND
WOA (Weak Organic Acids)	25	ND	ND	ND
Cation Species always tested for				
Lithium (Li^+)	3	ND	ND	0
Sodium (Na^+)	3	2.26	2.67	2.32
Ammonium (NH_4^+)	3	0.15	0.16	0.17
Potassium (K^+)	3	1.68	2.20	1.76
Magnesium (Mg^{2+})	1	ND	ND	ND
Calcium (Ca^{2+})	1	ND	ND	ND

Table 2: Test results

Sample Analysis

At ZESTRON, the sample extract and blank samples are analyzed for specific ion content using a Dionex ICS-1100 Ion Chromatograph with an AS22 column for anion and weak organic acids analysis and a CS12A column for cation analysis. Three- to five-level calibrations for anions and cations are run prior to sample testing. For the analysis of anions and weak organic acids, samples of 25µl are injected into a sample loop of a sodium carbonite and bicarbonate mixture eluent with self-regenerating suppression. The cation analysis is performed using 25µl samples injected into a sample loop of a methane sulfonic acid eluent with self-regenerating suppression.

The results are determined using the following equation:

$$Analyte\left(\frac{\mu g}{in^2}\right)=\frac{[Concentration\ in\ Extract\ (ppm)]*[Volume\ of\ Extract(ml)]}{[Sample\ Surface\ Area(in^2)]}$$

How are the results reported?

Table 2 shows the Ion Chromatography results for the specific customer samples tested. The values are expressed in µg of ions per in^2 of sample surface area. ND means that no contamination was detected.

What do the results mean?

Based on the extensive experience gained with cleanliness level analyses over the past 35 years, ZESTRON has been able to develop the maximum contamination levels for each ion species. However, sometimes end customers have gathered empirical data and will specify their own pass/fail limits

Conclusion

In this particular case, no pass/fail limits were defined by the customer. *The sample boards passed the Ion Chromatography test as the ion species values measured were below the maximum allowable contamination limits as recommended by ZESTRON and are therefore deemed safe with minimal risk of in-field service failure.* The effectiveness of the cleaning process with regard to ionic contamination has been validated.

Contact us today for a detailed Ion Chromatography quote at infoUSA@zestron.com

ZESTRON Responds to Market Demands in South Asia

With the opening of its 4th Technical Center in Kulim, Malaysia, in 2009, ZESTRON marked its entry into the South Asian electronics manufacturing industry.

Modeled after the three existing Technical and Analytical Centers in the US, Europe and China and equipped with the latest spray-in-air (inline and batch) and ultrasonic cleaning machines from leading manufacturers, ZESTRON's Kulim facility and its highly qualified staff of process and application technology engineers have been serving South Asia with the same capabilities.

In the past few years, this area of the world has experienced a tremendous amount of growth, particulary in the electronics manufacturing industry. To meet global customer demands and better serve this market, ZESTRON has taken appropriate steps to align its South Asian operations with its U.S. based business.

"As a large number of our US customers manufacture in both parts of the world and oftentimes experience similar bottlenecks and obstacles, it only makes sense to provide them with an operational structure that meets their needs," says Dr. Harald Wack, president of ZESTRON. "A solid support structure consisting of several engineering teams that are globally linked and also available on the ground, provides synergy as well as transparency and ultimately ensures customer success."

ZESTRON has taken several steps to facilitate this change. First, the company has expanded its South Asian support team by hiring Mr. Nathan Tan, Regional Sales Manager and Ms. Harwin Kaur, Application Engineer.

After spending several weeks of initial adaptation in Malaysia, Nathan and Harwin attended extensive technical and engineering training at the ZESTRON America Technical Center in Manassas, Virginia. Furthermore, ZESTRON hired Ms. Sheyreen Khaw to fulfill local administrative and marketing functions.

Second, Dr. Harald Wack promoted Michael McCutchen to be the Managing Director for North America and South Asia at a recent company function.

After successfully serving ZESTRON for more than 3 years as National Sales Manager and Sales & Marketing Manager, Michael is now responsible for continued business development as well as current customer care in North America and South Asia.

Michael brings more than twenty years of professional experience to ZESTRON, which includes technical sales, chemical research, and U.S. Naval Aviation electrical systems troubleshooting and repair.

Figure 1: Technical Center - ZESTRON South Asia

He holds a Master's degree in Organic Chemistry from the Johns Hopkins University, Baltimore, MD, where he specialized in the design and stereo selective synthesis of completely novel complex molecules. He graduated with honors at both, the graduate and undergraduate level, and is the recipient of numerous academic awards including "Outstanding Senior in Chemistry and Physics."

"Despite a slow economic recovery, ZESTRON has had an excellent year," said Dr. Harald Wack, President, ZESTRON worldwide. "Much of this success has been due to Michael's dedication and customer oriented approach. His willingness to do whatever it takes to get the job done and solve any customer's cleaning problems in collaboration with our Application Technology Department, has been exceptional. With Michael in this new position, we look forward to another and even more successful year for ZESTRON in the North American and South Asian market."

ZESTRON
High Precision Cleaning

ZESTRON provides superior support and know-how for precision cleaning applications and services in the electronics manufacturing industry.

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