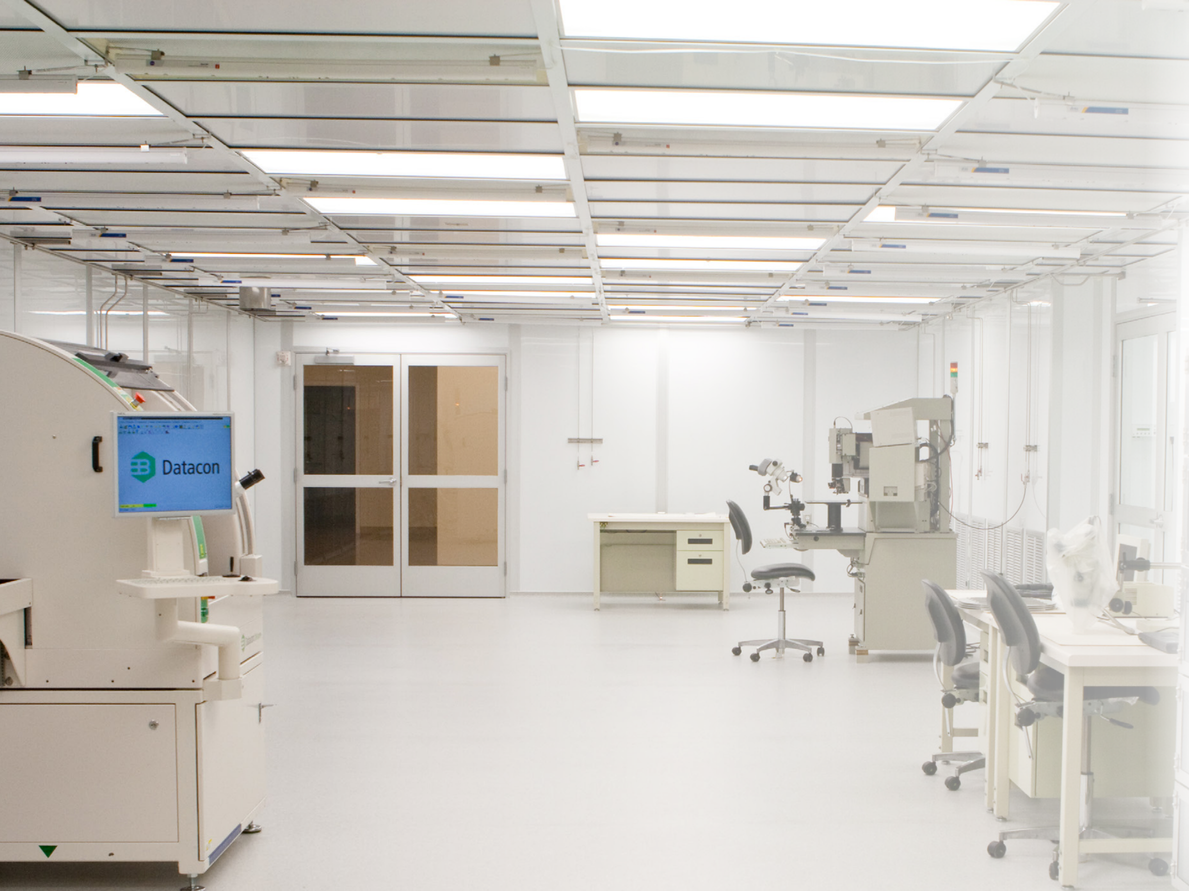
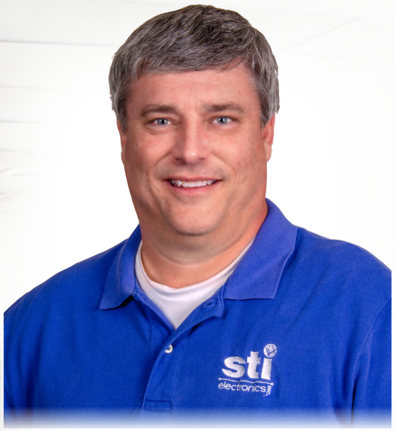
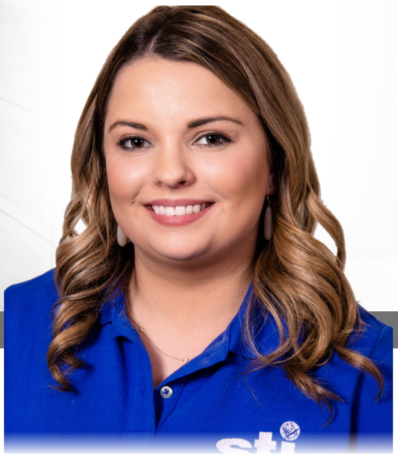




Mark McMeen
VP. Engineering Services/Manufacturing
mmcmeen@stiusa.com



Caaroline Spencer
Analytical Lab Manager
cspencer@stiusa.com

Why is my ROSE / OMEGAMETER Tester not a good tool for determining cleanliness with Today's Fluxes vs. an Ion Chromatography test for specific ionic species in the Anion / Weak Organic Acids / Cation Families?

Written by Mark McMeen V.P. of STI
and Caroline Spencer Ph.D, Analytical Lab Mgr.
Supporting peer review: Mike Bixenman Ph.D and David Lober Kyzen Corp.

This question was asked of me this week by two clients who were detecting failures in their test area as well as in their final inspection, even though their ROSE /OMEGAMETER DATA was sub 0.1 micrograms / c. ROSE and OMEGAMETER test was developed in the early '70s and became more standardized in the early '80s to measure the NaCl equivalent of soluble ionic contamination that could be dissolved into a 75% 2-propanol and 25% deionized water solution. The issue – ROSE is useful for measuring high conductivity ionic species such as - chloride, nitrate, sulfate, and nitrites. Still it will be blind to weak organic acids such as adipic, formate, acetate, succinic and any of the dicarboxylic acid groups. Most Anions and Cations have a high enough ionic conductivity threshold to be measured in a ROSE style conductivity test cell but the more sophisticated flux systems of today are using weak organic acids / dicarboxylic acid in their chemical makeup which makes them blind or unable to measure their presence because the test criteria is a conductivity cell which requires a high level of conductivity per cm2.

What is high conductivity and what is low conductivity? The answer lies somewhere between 5 microsiemens per cm and 1000 microsiemens per cm. Let us review some of the weak conductivity acids-
Acetic acid – 318 microsiemens /cm
Adipic acid - .2 microsiemens /cm
Benzoic acid - .003 microsiemens/cm
Butyric acid – 455 microsiemens/cm
Carboxylic acid - 5 microsiemens/cm
Dichloroacetic acid – 0 microsiemens/cm
Propionic acid – 479 microsiemens/cm
Succinic acid – 35 microsiemens /cm

Chloroacetic acid – 1.4 microsiemens /cm
Ethyl acetate - .00001 microsiemens /cm
The above examples show the relatively low ionic conductivity values for these weak organic acids which is why they run blindly to the electrical conductivity measurement cell of the ROSE style test equipment.

Examples of high conductivity anions and cations –
Sodium Chloride – 67200 microsiemens / cm (note the default equivalent ionic species in a ROSE Test – (NaCl)
Ammonium chloride – 91800 microsiemens/ cm
Ammonium nitrate – 59000 microsiemens/cm
Lithium chloride – 52600 microsiemens/ cm
Potassium sulfate – 45800 microsiemens / cm
Sodium sulfide – 61200 microsiemens /cm

As you can see, if the conductivity of the ionic residue is above 10,000 microsiemens/cm the ROSE test would be able to measure a conductivity value, but as the conductivity is below 1000 microsiemens / cm, the ability to measure the low conductivity weak organic acids becomes very difficult. Also, one must remember for the ROSE to measure the conductivity of ionic residue, the ionic species must be soluble, and it must have a high enough concentration level within the 75/25 solution both volumetrically and concentration wise for it to be a measured solution volume. Again, without solubility of the ionic residue, and in enough concentration, the ROSE Test cannot measure its presence in a NaCl equivalent measurement.

EXAMPLE:
Let us review a ROSE / OMEGAMETER TEST RESULT WITH AN IC TEST RESULT:
ROSE / OMEGAMETER:
AREA OF BOARD SURFACE: 75 cm2 (dynamic test)
Result: .01 micrograms/ cm2
Pass criteria: 1.56 micrograms / cm2
RESULT: PASS by the ROSE TEST

IC RESULTS FROM THE EXACT SAME BOARD AFTER ROSE / OMEGAMETER TESTING
ANIONS:
1. CHLORIDE: 2.01 MICROGRAMS / in2 or .311 micrograms / cm2
2. BROMIDE: 1.56 MICROGRAMS/ in2 or .243 micrograms / cm2
3. PHOSPHATE: .75 MICROGRAMS/ in2 or .116 micrograms/ cm2

Weak organic acids:
1. Acetate: 21.05 micrograms/ in2 or 3.26 micrograms/ cm2
2. Formate: 7.56 micrograms/ in2 or 1.17 micrograms / cm2
3. Adipic acid: 73.15 micrograms/ in2 or 11.34 micrograms / cm2
4. Maleic acid: 5.65 micrograms/ in2 or .876 micrograms / cm2

Total WOA – 107.36 micrograms/ in2 or 16.64 micrograms / cm2

Cations:
1. Sodium: 6.63 micrograms/ in2 or 1.03 micrograms/ cm2
2. Ammonium: 11.79 micrograms/ in2 or 1.83 micrograms/ cm2
3. Potassium: 8.99 micrograms/ in2 or 1.39 micrograms / cm2

Results: THE CLEANED ASSEMBLY FAILS THE ION CHROMATOGRAPHY TESTING DUE TO HIGH LEVELS OF WEAK ORGANIC ACIDS - cleaned assemblies should have WOA levels of <25 micrograms / in2 or <161.29 micrograms/ cm2.
As one can see, the IC gives a very detailed qualitative analysis of which species of Ionics are present as well as quantitative analysis which details the amount or numerical assignment of what is there. This is why IC is a good referee for a ROSE/ OMEGAMETER test by giving you useable data both qualitatively and quantitively as to what species is present and its corresponding amount or volume. Based on real data and its ionic species one can now track down the source of the problem.

This is why for years, the Ion Chromatography (IC) test, has the ability to distinguish and measure the different ionic species present and in quantity, and thus was used as the referee test. IC testing is a useful tool and has been used to referee the ROSE, but it is not a perfect test either and has its limitations because it is normally used as a whole board extraction and not a site-specific analysis where by high ionic levels may be more deleterious to electrical performance in certain component locations. An entire board extraction may dilute the specific high concentration level of a particular component, such as a BTC (bottom terminated part) that may not have adequately outgassed due to its component package style -i.e. BTC or LGA.

This is why we are seeing a return to SIR – surface insulation resistance testing of specific component designs and packages on custom specific SIR test vehicles so one can test underneath those component packages that are most prone to improper outgassing or improper cleaning and thus can hold those ionic species which are more problematic between signal and ground pins. SIR testing is a tool that allows one to determine the electro-chemical response as it relates to surface insulation resistance at its most critical point between adjacent pins and ground to signal pin locations + /- areas. SIR testing, along with IC testing allows the design and process engineer the ability to see what is happening underneath complex components and high pin count devices and thus ensure that their material choices and manufacturing processes are capable of meeting their cleanliness levels as defined by SIR levels. What are your log ohm cleanliness levels underneath your critical components and highly dense PCB assemblies? This quick explanation is designed to help those better understand why the ROSE / OMEGAMETER is not the perfect process control tool for determining if our assemblies are clean enough but it is a gross test for those Ionics that are highly conductive and, in enough volume, and are soluble to find. The IC is a useful tool for defining what ionic species are present but not necessarily where they are located and if they are there in a large enough volume to be detrimental to the end product based on lack of location influence. The custom SIR test vehicle with specific component packages such as BTC's and LGA's are good test vehicles for determining your most challenging component packages and locations because the SIR gives site specific reference data that can be applied to designers and process engineers. The ability to see underneath specific component packages allows one to dial in their process and their material choices to ensure the overall system meets the end designer and customers expectation on warranty and field use as it relates to overall board cleanliness levels. The IC test and the SIR specific test vehicle / component package test card allows one to gather REAL test data and objective evidence to meet section 8 of J-STD-001. These are the tools and tool sets of the future that will enable us to define cleanliness as it relates to finished assemblies and their expected warranty objectives.

The future may hold the ability to use SIR test data as a process control tool whereby the SIR test data can be run and calculated in 1, 2, 4, 6 or 8 hours periods and the SIR data predict the long term correlated reliability data to the 168-hour qualification SIR test used to verify a manufacturing process and material choices. SIR testing is an actual electro-chemical test that validates site-specific material choices and manufacturing process parameters to ensure compliance. What if we could use the qualification – SIR golden graph image of 168 hours as our control and then measure and overlay a quick SIR test of 1, 2, 4, 6 or 8 hours to verify our process control that our materials and manufacturing process has not deviated from the Golden qualified image (Validation test) – then we would have created a process control tool that validates our qualification plan on cleanliness and we can then use it to verify on a lot to lot basis or month to month basis that we are in control. If this sounds interesting and you would like more information call or email Mark McMeen at 256-694-1293 or mmcmeen@stiusa.com for more details about the future of cleanliness as it relates to high density and complex component assemblies.

If you have any questions or comments please feel free to call or email

Caroline Spencer, Ph.D.

256-705-5531

cspencer@stiusa.com

or

Mark McMeen, V.P.

256-694-1293

mmcmeen@stiusa.com