Ročník 2018 electroscope Číslo I

Method for qualification cleaning of electronic assemblies, validation of process changes in cleaning process

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The described experiment was designed to verify and demonstrate current situation in determining cleanliness of electronic assemblies with leadless and high dense components. We have compared the historically introduced method of ionic contamination measuring with new optical method of determining flux residues under component with very thin gap. It should be interpreted as a confirmation of just released Addendum of IPC J STD 001 standard, which definitely state, that ionic contamination measurement (ROSE method) cannot give an objective evidence of cleanliness of SMT electronic assembly and prediction of reliability.

CURRENT SITUATION

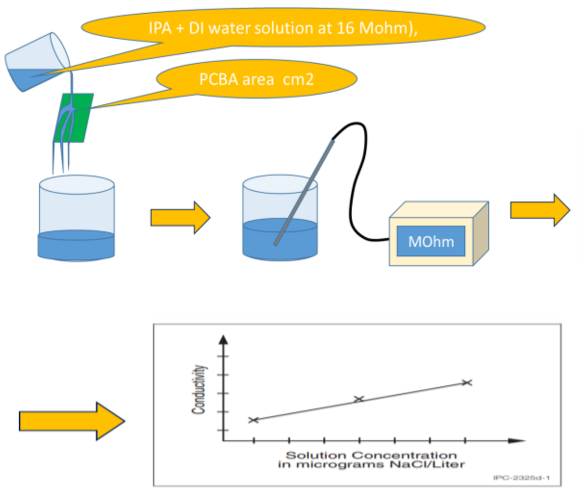
- Electronic assemblies are currently being designed for applications, which were unthinkable even some years ego. Long term or reliable functioning in harsh environment is today an often and important requirement. It is obvious, that there must be industrial procedures and standard development for this branch, which can submit an objective evidence of fullfiling these requirements, partially even before the assemblies comes to regular exploitation in the field. Knowledge and maintaining of these methods becomes to be crucial for success.
- Reliability of electronic assemblies has many segments and assemblies are submitted to many threads. Tis can be (among others) following factors:
- Intermetallic growth in solder joints
- Solder joint fatigue
- Very high and very low temperatures
- Vibrations
- Creep corrosion
- Electrochemical corrosion
- Other factors – tin pest, whisker growth

This work concentrates only on the resistance of the assembly against electrochemical corrosion and methods, how to determine objective evidence, that the designed and newly manufactured assembly fulfills all demands for reliable function in real life..

HISTORY

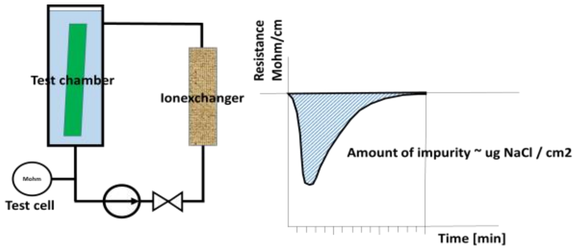
First, acute need to test robustness of electronic assemblies against electrochemical corrosion comes from 70- ties of last century, of course from US military sector (avionics). Electronic assemblies were, in these times, exclusively through-hole assembly, MIL standards accepted only pure rosin fluxes, not activated (in the past, only halide activators were used, which are today , practically banned) Entire assemblies were cleaned, because flux solutions were 15+%. Solder pastes did not exists.

Logic and pragmatic approach was to wash out free ions from the surface of assemblies (all they were cleaned!). It was easily possible with mixture of deionized water and Isopropyl alcohol, which dissolves rosin well. IPA is responsible for „ mining“ of all ionic residues and water in the solution helps to increase sensitivity of the method.
This is a principle of ROSE method, which, in its basic mode is a laboratory method and does not need any complex equipment. (see IPC TM650 2.3.25,4.4).

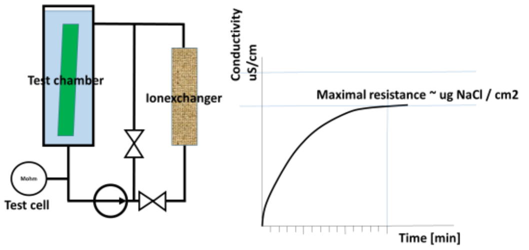


Later, there were automatic tools developed. Some of them are manufactured and used up to now. There are two main types, static and dynamic ionic residue test instruments. Beside of that, there is a plenty of manufacturers, hence several types. Everybody wants to make a best model. An overview you can find in IPC-TR-583, 1995

Dynamic contaminometer



Static contaminometer



This method was integrated into standards. Firstly military (MIL-STD-2000), later also general – IPC-J-STD001 (this is an obligatory standard in USA) and up to now, it is still there.

Already some years ago, after introducing No- clean and SMT processes, it was commonly found, that measuring of ionic contamination is probably not a best option to qualify new electronic assemblies.

Main reasons are:

- *Gaps under components become thinner up to single microns, complexity of assemblies grows.*
- *Synthetic fluxes used now are less soluble in IPA than rosin..*
- *Reading is influenced by absorption of CO2 from the atmosphere*
- *Reading is temperature dependent. None of instrument has a temperature stabilization.*
- *Reading is dependent on the flow in cuvette – each instrument has a different one – values are not transferrable between instruments.*
- *Method does not bring information on non- ionic contamination. In fact, assembly is polluted by non-ionic contamination in the instrument!*

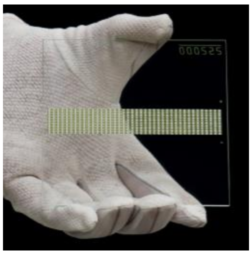
Therefore, in 2016, there was proposed an addendum to IPC – J-STD 001 document - IPC-WP-019 An Overview on Global Change in Ionic Cleanliness Requirements. It was planned that it will be integrated into J- STD 001 in summer 2017, later in autumn 2017, finally in May 2018, but, still, it was not done. Reason is simple. Even that everybody is aware that ionic contamination test is not working well for up-to-date assemblies, the obligatory standard cannot require anything for which a method of measuring would not exist. Other standards did accepted the obsolescence of ROSE already (NASA, ESA). Up to now, there is not available any ready–to use, simple and fast method, which could be used for part of measurements during assembly cleaning qualification and validation of changes in cleaning process.

PBT Works attempts already longer time to eliminate such unpleasant situation and to offer a validation method which can help to determine cleanliness of electronic assemblies.

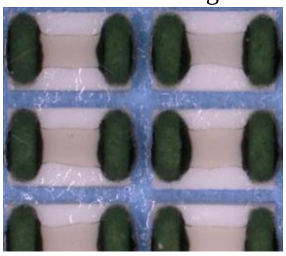
NEW METHOD

Optical measurement of flux residues amount using a precise glass ceramic test boards.

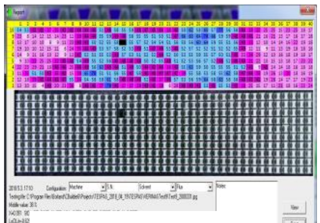
First studies and attempt to build such boards was done already in 2003. Currently, we have got a practically usable system, which can be applied during equipment development, process optimization, and validation of changes .



Glass ceramic coupon



During cleaning



AOI VERINAS

Test protocol

This method can be used also for part of qualification process for new assemblies, of course together with two main methods: SIR test acc. To IPC- 004B and ionic chromatograph testing (IPC TM-650 2.3.28)

Standard tasks, which can be done by this method:

- *Flux to cleaner matching studies (Phase 1 of cleaning process qualification acc. to IPC CH65 B)*
- *Cleaning process stability checking (full replacement of PICT (process Ionic Contamination Testing)*
- *Validation of process changes (full replacement of PICT)*
- *Machine capability studies (c_{pk})*
- *Process capability studies (c_{pk})*
- *Cleaning process optimization*
- *Cleaning and rinsing process development studies.*

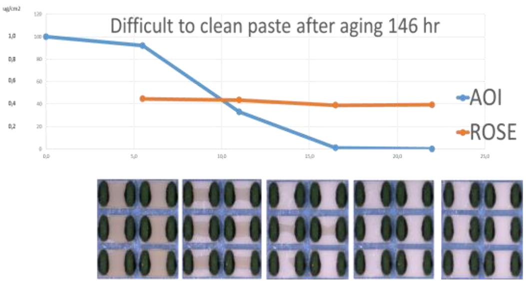
Currently, we are doing comprehensive studies using the automatic test equipment VERINAS for glass ceramic test board evaluation. One of these study is a comparison of flux residue amount under components to the reading of ionic contamination test equipment readings.

Result of these studies confirms, unfortunately, that ionic contamination measurement fails not only for qualification studies of new assemblies, but also not as Process ionic contamination test - PICT.

For illustration and better understanding we include some of many comparison characteristics which we have measured in this study.

- Amount of flux residues is measured by VERINAS AOI tester (decreasing amount of optically visible residues in the gap between chips and glass test board during cleaning process (blue line).
- On the same time, we measure also ionic contamination of the glass test board by Contaminometer (red line) .

Readings are made always after certain incremental progress in cleaning. There are also typical pictures from microscope in each stage of the process, under these graphs..



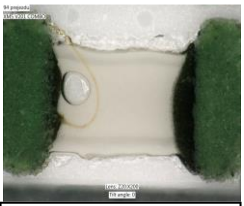
RESULTS

All measurements show very low sensitivity of ionic contamination measuring (ROSE) to the residues, which are hidden, or partially hidden under SMT components. In some cases, even the values of ROSE are higher at lower residue volumes under components.

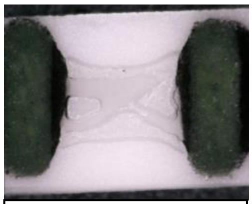
EXPLANATION OF RESULTS

Such results can be explained if we consider the exact situation of "cleaning" flux residues under components in the ion extraction instrument.

The reading of ionic contamination depends not on the volume of potentially dangerous residues, but on the contact area of that residues with ROSE measuring liquid.



Big volume, small surface
Gap clogged



Small volume, big surface
Gap open

Because, generally, flow of measuring liquid in the cuvette of ion extraction instrument is not intensive, residues, which are still completely blocking the gap under component, but are dissolved only from the edge of the gap, are not "visible" for ionic extraction. Once the gap under component is opened, some flow of liquid through this gap is established and ions can be registered again.

This behaving can be quite danger, also if using a ROSE method for process stability control (PICT) as it allows to pass potentially dangerous assemblies as safe.

CONCLUSION

New optical method of residues measuring by means of glass ceramic coupons is much precise in terms of estimate volume of residues. It is not an absolute method (we check not a PCB), but on the base of process calibration and process stability checking by these glass ceramic substrates, a reliable cleaning process for reliable assemblies can be established.

REFERENCES

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[7] Vladimír Sítko: (Contamination Cleaning & Coating Conference SMTA, Smart Group Amsterdam 2016): Cleaning process performance measurements