

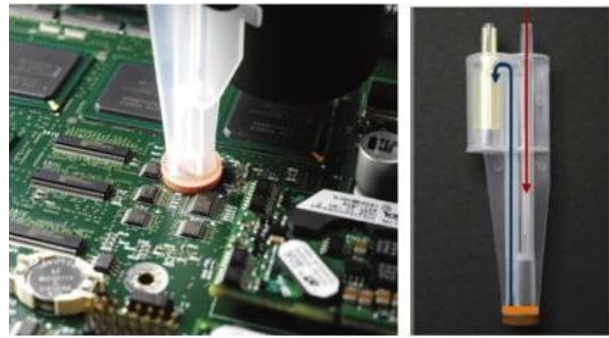


Scope

This document provides information about ionic contamination testing and its relevance in a **no-clean** soldering process. Also so-called C3 testing and ROSE (Resistivity of Solvent Extract) testing are forms of ionic contamination testing.



Ionograph for ionic contamination testing



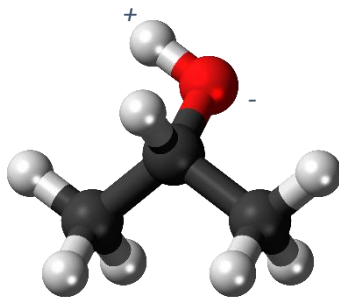
C3 test for local ionic contamination testing

History

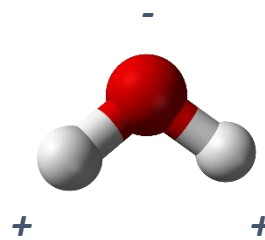
- Ionic contamination testing in the electronics industry was introduced to test the cleaning efficiency and stability of a **cleaning process**.
- Cleaning processes are usually required when **aggressive chemistry** is being used. The residues and/or reaction products of this aggressive chemistry can lead to detrimental effects like e.g. corrosion and electro(chemical) migration when they remain on the unit.
- Aggressive chemistry can be :
 - Electrolytic solutions in electrolytic processes in PCB manufacturing
 - Copper etching liquid in PCB manufacturing
 - Hot air levelling fluxes in PCB manufacturing
 - Water soluble soldering chemistry in PCB assembly
 - ...
- Residues of this kind of chemistry will strongly influence the readings/values of an ionic contamination test. If the values are out of range, usually it is an indication of a problem in the cleaning process. **The nature of the chemistry** that causes this out of range value is known (aggressive chemistry) and hence indicates a high risk on **reliability problems**.
- Ionic contamination testing is a useful tool for checking the process efficiency and stability of a cleaning process in an application where aggressive chemistry is being used. In this case it can give valuable information about chemical reliability of the residues.

Working principle

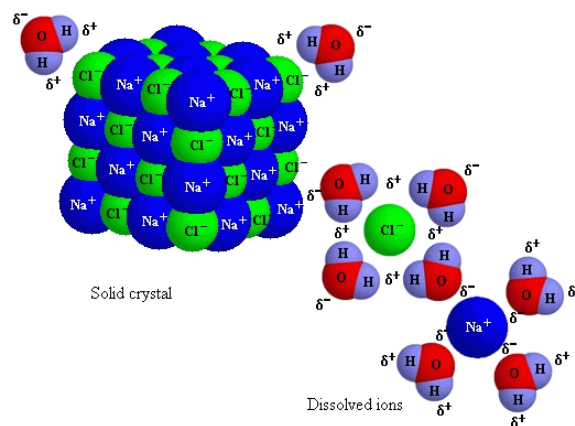
- An extraction medium is being used to clean off and dissolve residues from the unit. Usually, a mixture of IPA and DI-water (often 75/25 vol %) is being used. C3 testing uses steam of DI-water.
 - IPA is known as a substance with low polarity. It has the ability to dissolve substances with similar polarity like e.g. most oils and resins.
 - DI-water (Demi water) is known as a substance with high polarity. It has the ability to dissolve substances with similar polarity with a high probability to dissociate them into ions. Ions are charged particles that support an electrical current which means that they will reduce the resistivity of the solution. This property is used for measurement in ionic contamination testing.
 - Steam of DI- water has very high solvent power due to its temperature. It can open up the structure of the surface so also subsurface substances can dissolve. It can also crack stable reaction products with the risk of creating other reaction products.



IPA : $(CH_3)_2CHOH$: low polarity

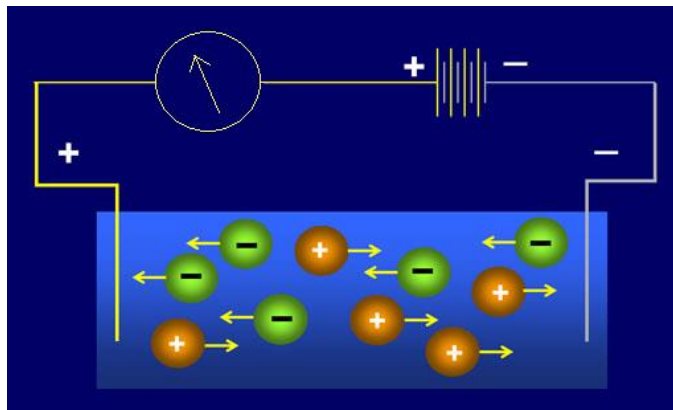


Water: H_2O : high polarity



Example of dissociation in water: $NaCl$ dissociates in water into ions

- After dissolving the residues into the extraction medium, its resistivity is being measured by applying a DC voltage to it.
 - The amount of ions in the solution will determine the measured resistivity of the solution.
 - The ionic contamination value is then calculated from the measured resistivity and the surface from the unit.
 - The ionic contamination value is usually expressed in $\mu\text{g NaCl}/\text{cm}^2$ or in^2 . NaCl is being used as a reference, it does not mean that NaCl is actually present.



Measuring resistivity of the extraction medium

- Remarks

This method only measures substances that can be dissolved in the extraction medium into ions.

The ions are not present on the unit as such, they are being formed when dissolving into the extraction medium.

This method does not provide any information about the nature of the substances that ionize in the extraction medium. To assess a possible reliability risk of these substances, more in depth testing is needed to identify the nature of these substances.

How well the residues are exposed to the extraction medium influences how well they are being dissolved: residues underneath components, residues in shadow areas,...



The relevance of ionic contamination testing in a no-clean soldering process

- **No- clean soldering chemistry** is designed to remain on the electronic unit after soldering.

When designed well, no-clean soldering chemistry has residues that are:

- Non hygroscopic
 - Non conductive
 - Non corrosive
 - Non metal etching
- To a certain extent, residues of no-clean chemistry can be dissolved by extraction media used in ionic contamination testing and they can be measured.

Due to the fact that these ions are not present on the board as such, but only in extraction medium, and the fact that the ionic contamination test does not provide any information about the nature of the ions, **it does not give any information about the chemical reliability of the residues** and hence is not a useful tool for assessing chemical reliability of no-clean soldering chemistry.

Furthermore, **many other sources beside no-clean soldering chemistry can give ionic contamination in a no-clean soldering process :**

- Components
- PCB-boards
- Handling
- Contamination from production machines and carriers used in the process
- ...

To test the chemical reliability of the residues in a no-clean soldering process, more specific and dedicated test are being needed.

- Ionic contamination testing however can be used as **a useful process control tool** in a no-clean soldering process.

In an established no-clean soldering process, the value of ionic contamination measured on a specific unit can be used as a reference value, when samples of this unit are being taken from the process for ionic contamination testing on a regular base.

If the value of the sample deviates, it indicates that something has changed in the process.

The possible causes of this change however are multiple and more in depth investigation will be needed to determine the real cause. Useful techniques can be:

- SEM element analysis
- FTIR-spectrum analysis
- Ion Chromatography



Testing chemical reliability of soldering chemistry

- Many different kinds of tests and standards exist to assess the **chemical reliability of soldering chemistry**:
 - Some are area related : European (EN), Japanese (JIS) German (DIN) standard,...
 - Others are branch related: Telecom standard (Bellcore), Military standard (Mil Spec),...
 - Others are company specific : Siemens, Schneider, HP,...
 - Most electronic manufacturers still refer to IPC: an American standardization organization
- The purpose of a chemical reliability test for soldering chemistry is to evaluate the effect of the residues and reaction products of this soldering chemistry on the functionality of an electronic circuit.

Most popular tests are:

- Surface Insulation Resistance test (SIR)
- Electrochemical migration test (ECM)

These tests use a defined test pattern that is being processed with the soldering chemistry. This pattern is powered with a defined voltage and submitted to high moisture and high humidity for a defined period time. In this period of time, the evolution of the Surface Insulation Resistance is being measured. Depending on the test, the values have to fulfill certain requirements. There is also a visual inspection for the formation of dendrites (electro chemical migration).

- As **so many different parameters come together on an electronic unit beside soldering chemistry**, there is a tendency not only to test the chemical reliability of the soldering chemistry on a test pattern, but to **test the chemical reliability of the finished unit itself**. The electronic unit that has been through all the process steps and has been produced with the actual materials is submitted to accelerated conditions that simulate as good as possible the conditions that the unit will be submitted to in the field.

Conclusion

- Ionic contamination testing is not a useful tool for assessing chemical reliability in a no-clean soldering process.
- Ionic contamination testing can be a useful process control tool in a no-clean soldering process.
- Specifically designed tests exist for assessing chemical reliability in a no-clean soldering process.