

TECHNICAL PAPER

Circuit Board Ionic Cleanliness Measurement: What Does It Tell Us?

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Original Publication Date: 1994



Published by IPC

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Introduction

In the early 1970's the only fluxes permissible for electronics manufacturing for military applications were types R (pure rosin only) and RMA (rosin based, mildly activated). Before any of these fluxes could be approved and established on the military "qualified products list", it was necessary to demonstrate that were non-corrosive and did not contain ionic halides in of established critical levels. All fluxes were required to pass a silver chromate paper test which sensitively indicates presence of halide ions.

Additionally, the flux was subjected a copper mirror corrosion test which is a sensitive indicator any corrosive behavior of the flux toward copper.

Because of the desirability for using stronger, more active fluxes in electronic assembly, the military agencies decided to include the category RA (fully activated rosin) on their approved flux list. RA fluxes do not, as a rule, pass the copper mirror or chromate paper tests and there was, therefore, increased concern about allowing the more highly active rosin flux into military electronics manufacture.

Although circuit assemblies are ordinarily cleaned after assembly soldering, traces of RA fluxes, left after the final cleaning, would be considered a greater risk than those of RMA or R types. It was, therefore, imperative to thoroughly clean these assemblies to provide assurance that the potentially harmful active residues had been thoroughly removed.

Cleanliness Measurement

The RA fluxes most commonly use halide salts, such as amine hydro-chlorides, as additives to enhance fluxing activity. In cleaning, these additives are removed along with the rosin residue. If, however, some of the residue is not removed in the cleaning process, some of the halide activators can remain behind, entrapped in the solid rosin residue.

Such highly ionic material can be very sensitively detected and measured if brought into a solution containing water. Using electrochemical conductometric methods, ionic

materials, which are easily detectable, can act as tracers for the presence of any RA flux residue remaining after the cleaning process.

It is well known, to physical and electrochemists, that the addition of a strongly ionized salt to deionized water will enhance its electrical conductance to a degree that is nearly proportional to the concentration of the salt {1,2}. Conductance measurement can thus be used to indicate concentration of an ionic salt extracted into a solution.

This was discussed, by T.F. Egan of Bell Laboratories, in a paper published in 1973{3}, who used this method to measure ionic plating salt residues on plated components. The method described by his was, however, unsuitable to measure the ionic content of rosin flux residues from an electronic assembly. Rosin is insoluble in pure water, therefore, any ions present in the residue would be trapped in a matrix of the solid, insoluble rosin and not brought into aqueous solution where they could be measured.

In 1972, W. Hobson and R. DeNoon, at the Naval Avionics Center, Indianapolis, IN, showed that rosin flux residues could be solubilized in a solvent mixture containing 75% isopropanol and 25% water{4}. This mixture could be used as the solvent base for the conductometric measurements. The alcohol, at that level, is able to solubilize any rosin traces and the water is needed to sustain ionization for a conductivity measurement.

Testing Methods

Several testing procedures and instruments were established to monitor the levels of residual ions extracted in alcohol/water mixtures:

- a. The original method of Egan was adapted by Hobson and DeNoon to include the use of an isopropyl alcohol/water mixture as the extracting solvent. In this method, the assembled board is flushed with a pre-determined quantity of the mixture and the resistivity of the "contaminated" solvent measured{4}.
- b. An instrument was developed in which an assembly was immersed in an agitated, fixed volume of a mixture of isopropanol/water{5}. The resistivity of the solution is monitored until there is no further indication of resistance change. The effective level of ionic contamination can then be calculated from the change in solution resistivity. This instrument, utilizing extraction into a static volume of alcohol/water mixture was named the Omega Meter.
- c. Another process was developed utilizing a continuously re-circulating system in which the solvent mixture was deionized by passing it through an ion-exchange column before recirculating it back into the extraction tank{6,7}. During the course of ionic extraction from an assembly, the conductivity of the mixture falls continuously as the sample and solution are cleaned. The integrated ionic measurement, over time, is indicative of the total extracted ionic material. This process, known as the dynamic