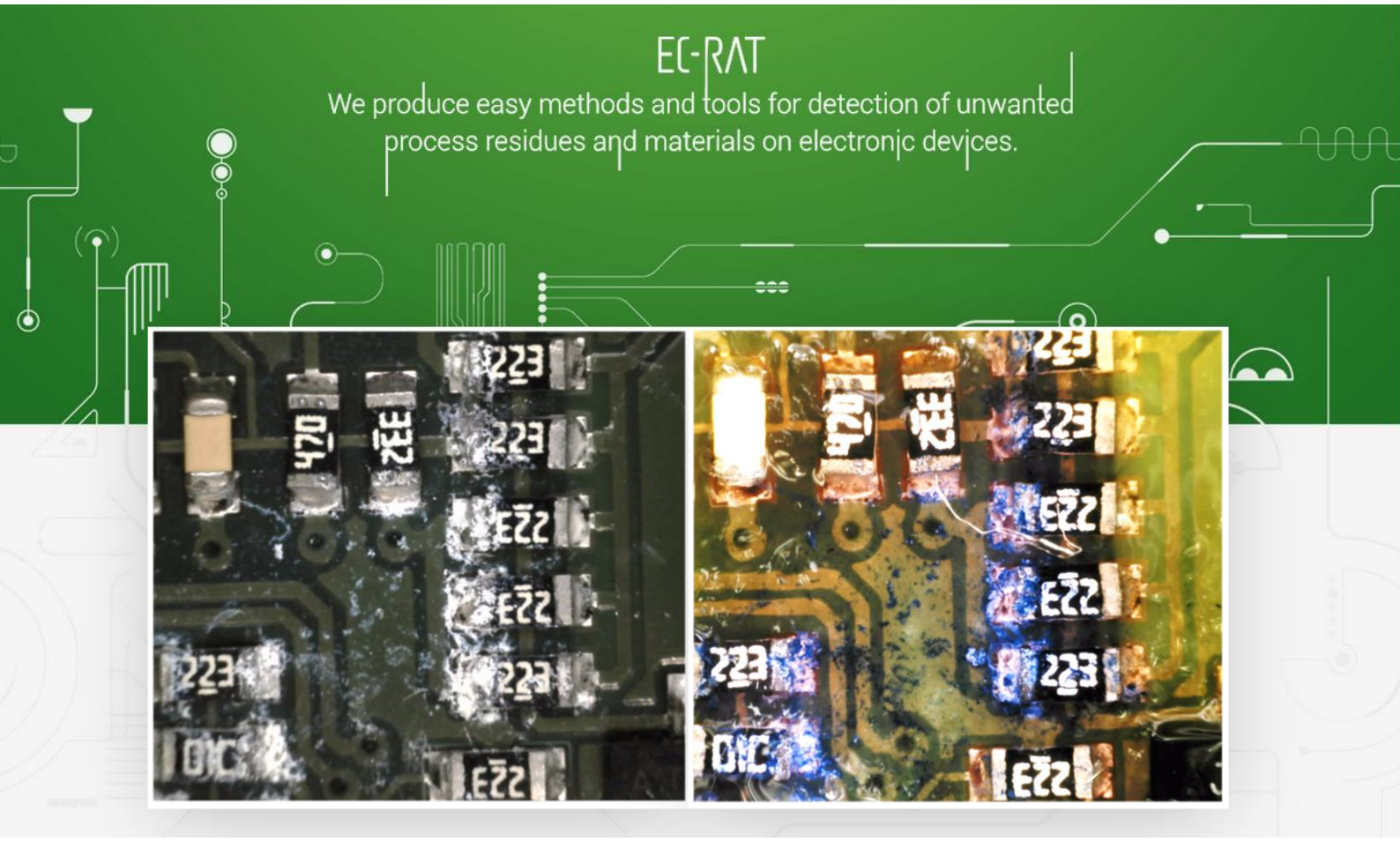
Tin RAT

APPLICATION AND ANALYSIS MANUAL



www.ec-rat.com

Glossary:

Corrosion product	Tin ions/hydroxides
Flux residues	Compounds remaining after soldering process
IC	Integrated circuit
PCBA	Printed circuit board assembly
SMC	Surface mount component

Part I: What is Tin RAT and where to use it?

Background

Intermittent malfunctioning of an electronic device, occurring at the event of high humidity or condensation is a common type of failure in electronics. It is often categorized as a no-fault-found since the water layer on the surface evaporates before failure analysis. It is more challenging to identify this type of failure as evidence of condensation and tiny amounts of tin (Sn) corrosion products is hard to detect. Moreover, visual inspection of PCBA using optical microscopy not always provide unambiguous conclusion, as the appearance of tin hydroxide precipitation is similar to the appearance of the flux residues after exposure to high humidity at elevated temperatures.

Why detection of tin corrosion on the PCBA is important?

In general, presence of tin corrosion products such as tin ions/hydroxides is an indication that electronic assembly has been exposed to harsh conditions i.e. high humidity or condensation. Harsh climatic condition can be present in user environment or created during testing of a device. The detection of corrosion traces induced in user environment (field returns) is important for failure analysis, while detection of corrosion induced by accelerated testing provides vital information about corrosion prone areas i.e. circuitry where high leakage currents, corrosion and thus failure is most likely to occur. Overall, analysis of corrosion profile of the PCBA after exposure to particular test condition reveals the places where synergetic effect of humidity, contamination, and voltage would result in corrosion (equivalent to parasitic leakage currents).

What is Tin RAT?

Tin-(corrosion) RAT is a gel test method, which aims to visualize tin (Sn) corrosion on the PCBAs and at the levels seldom detectable by conventional test methods.

Where to use Tin RAT?

Following are typical applications:

- Device robustness testing i.e. as combined with accelerated humidity/temperature testing
- Failure analysis of field returns
- Complementary technique for SIR testing

Part II: Application examples

Typical examples of tin corrosion on the PCBAs are following: corrosion between solder pads under surface mount components, between the legs of ICs and through-hole components etc., especially prone are the areas and components with excessive amounts of flux residues.

Example 1: Figure 1 (a) shows the corrosion between the tin plated terminals of chip capacitor. The Tin RAT gel in this case reveals the pattern of tin ions/hydroxides spread over the surface of chip capacitor, as indicated by blue coloration. Under humid conditions and at elevated temperatures, the reflow flux residues can be released from the film-former thereby conductive water layer formed under the component will result in increased leakage currents and corrosion between the solder pads. Such example is shown in Figure 1 (b).

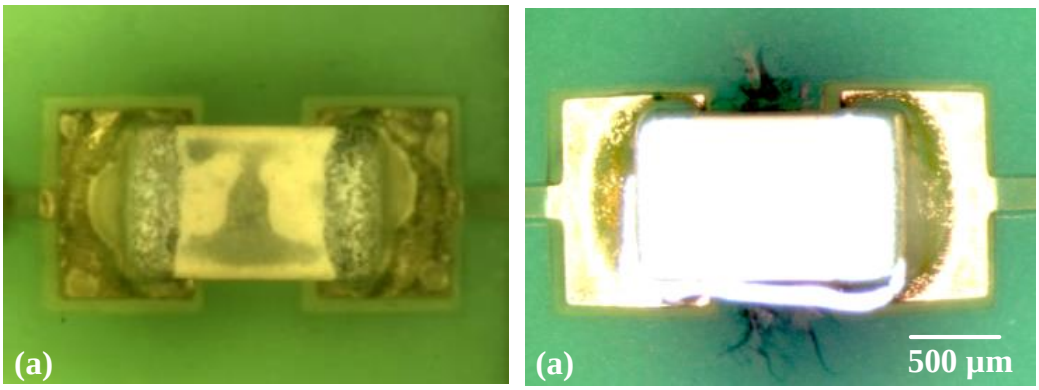


Figure 1: (a) Corrosion on the SMCs (*after exposure to high humidity*), and (b) corrosion under the SMC (*after exposure to humid conditions, corrosion is induced by reflow flux residues*)

Example 2: Increase in leakage currents and corrosion between the IC legs due to flux residue and humidity is another commonly seen failure. An example of tin corrosion of the reflow soldered IC is shown in the figure below.

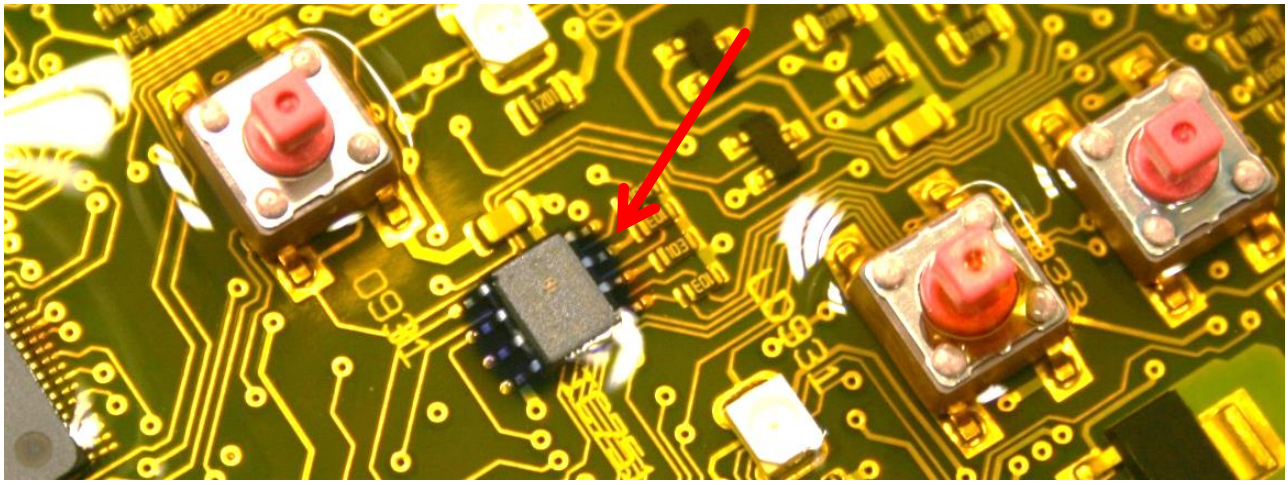


Figure 2: Reflow flux residue induced corrosion

Example 3: Presence of hygroscopic dust particles on the PCBA, and deliquescence at low RH levels can be accounted for some of the electronic failures seen the in the field. Such example of corrosion on the PCBA induced by the dust particles is shown in Figure 3.

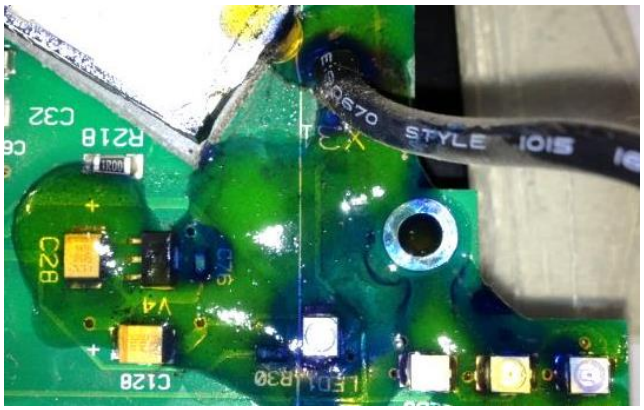
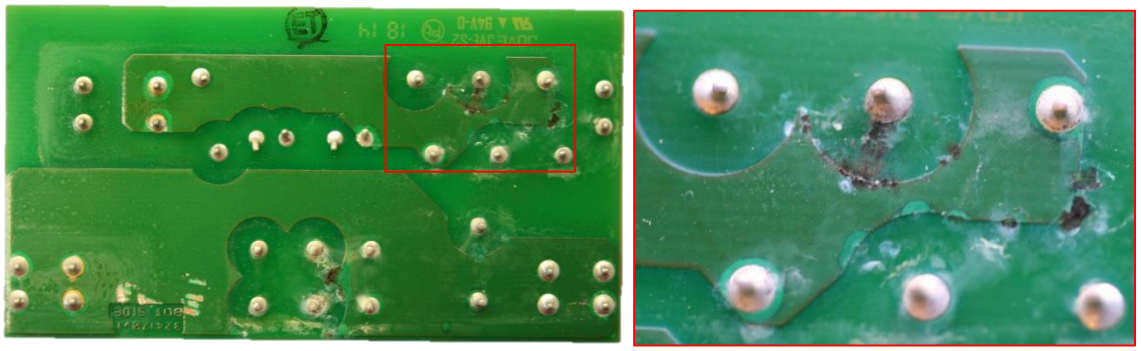


Figure 3: Corrosion induced by hygroscopic dust particles in the user environment

Example 4: Figure below illustrates an example of corrosion failure which occurred in the field. Visual observations prior to application of the gel have clearly indicated the appearance of tin corrosion products (black deposits), also suggested possible presence of tin hydroxides (white deposits). Usually the white cloud seen on the PCBA need not be tin products, but can also be due to flux residue after humidity exposure. In current example, application of the gel confirms that the white residues are the tin hydroxides, formed under AC electric field.

(a)



(b)

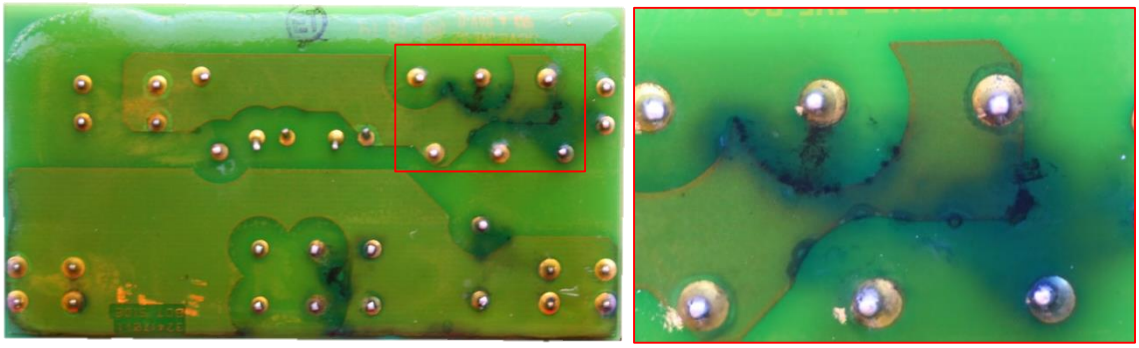


Figure 4: Tin corrosion under AC voltage (*PCBA from the filed return*): (a) before and (b) after application of the gel

Part III: Preparation procedure

Step 1: Heating of the gel

Heating of the gel can be done either using a MICROWAVE or HOT WATER BATH. The gel needs to be fully melted before application as this will ensure clear dispensing. *Microwaving is the recommended easy and fast method*.

MICROWAVING: It is recommended to microwave/heat in steps instead of continuously. IT IS IMPORTANT TO REMOVE THE CAP BEFORE HEATING. In between the heating steps e.g. 30 seconds, you may need to agitate mixing of the gel by shaking the bottle. USE THE GLOVES, bottle gets hot. Use the gel when it reaches homogeneous consistence. If you are re-melting a used gel within short time, less heating time is needed.

HOT WATER BATH: Immerse the bottle until its neck in a hot water bath at 90-95 °C. Use intermittent shaking until the gel is fully melted.

Step 2: Application of gel onto a PCBA

Dispensing of the gel to the PCBA can be done either using the SPRAY NOZZLE or the PIPETTE. SPRAY NOZZLE is recommended for overall application on a PCBA, while use PIPETTE if only a localized area e.g. particular component, ICs, connector pins etc. needs to be tested. Application of the gel over a large area using the SPRAY NOZZLE minimizes the risk of spreading corrosion residues (i.e. tin hydroxides which sometimes are poorly adhered to the PCBA surface).Optimum layer thickness of gel after application is about 0.5 – 1mm.

SPRAY NOZZLES and PIPETTES are meant for one time use. If you would like to re-use for left over gel, please remember to clean it with DI water immediately after use.

Step 3: Analysis of gel on a PCBA

The reaction with corrosion product starts within minutes after application of the gel. The change of initial color of the gel yellow to blue/indigo indicates presence of tin corrosion products (i.e. tin ions/hydroxides). Increase in intensity of the color represents extent of corrosion. Typical timing when the gel is recommended to be read is 5-10 minutes after application of the gel at 80 °C. The reaction process is temperature dependent, thus the variation in time can be expected with variation in the temperature of the gel applied on the boards.

PRECAUTION: The prolonged contact of the gel (*beta version*) with the metals on the PCBA itself may cause corrosion. Thus interpretation of the results after more than 30 minutes may be misleading, as one may observe the *in situ* corrosion reactions on the PCBA due to the gel. Therefore when gel is used to identify *ex situ* corrosion products, it has to be read not later than 15 minutes after application of the gel. The correct interpretation of the results after prolonged contact of the gel with the PCBA is only possible by the comparison with the reference samples without temperature-humidity-bias stress.

PART IV: Product liability

EC-RAT ApS assumes no liability for:

- any misuse of EC-RAT products
- any use not in accordance with the instructions in the manual
- any wrongful interpretation of the results by the user

EC-RAT ApS recommends that the Tin Rat test should be regarded as a destructive test. Therefore, EC-RAT ApS assumes no liability for:

- Changes in functionality of PCBAs that have been exposed to Tin Rat
- Lack of functionality of PCBAs that have been exposed to Tin Rat

EC-RAT ApS cannot be held responsible for any harm or loss experienced by the user/buyer physically, mentally or economically – during or after – the use of Tin Rat.

The Tin RAT kit is only intended to be a screening test and should not be used as – or regarded as – a replacement for tests according to relevant international standards.

THIS PRODUCT IS COVERED BY PATENT NO.: PATENT NO.: WO 2011048001, 2011