EASY TOOLS FOR DETECTING PRE- AND POST-FAILURE PARAMETERS FOR CORROSION ANALYSIS ON PRINTED CIRCUIT BOARD ASSEMBLIES

Vadim Verdingovas
Nordic Test Forum
Vilnius, November 30th 2016

EC-RAT
About us
EC-RAT

BACKGROUND
EC-RAT ApS is a spin-off company from the Center for Electronic Corrosion (CELCORR) research program led by the Technical University of Denmark. The company was founded by researchers with a background in materials and surface science having strong competences in corrosion and climatic reliability issues. www.celcorr.com

VISION
Implement key findings from the academic research into innovative solutions of benefit for the electronic industries.

MISSION
Generate easy to use tools that aid the electronic industries in making their products better. We aim at generating tools for making products more reliable, decrease production costs, and to detect and avoid unwanted materials or chemicals.
EC-RAT
PRODUCTS AND SUPPORT DELIVERED WORLDWIDE
02 Introduction
Importance of flux composition on corrosion

03 Residues RAT
Method for detection of active flux residue

04 Tin RAT
Method for tin corrosion profiling on a PCBA surface

05 Outlook
How you can benefit / time for questions
The problem
EXCESSIVE FLUX RESIDUES, HUMIDITY AND CORROSION

Corrosion due to humidity and flux residue
Electrochemical migration

Local humidity effects on a PCBA

Electronic Corrosion - Reliability Assessment Testing  www.ec-rat.com
Activator in the flux
ACID TYPE, CONTAMINATION LEVEL AND RELATIVE HUMIDITY

SIR, R (Ohm)

Adipic
Succinic
Palmitic

Relative humidity (%)

6.77G
677M
67.7M
6.77M
677k
6.77k
677
67.7k

Electrochemical migration

Contamination level:
- 25 µm/cm²
- 50 µm/cm²
- 75 µm/cm²
- 100 µm/cm²

Electronic Corrosion - Reliability Assessment Testing  www.ec-rat.com
Flux residue effect on functionality
DRIFT FROM SPECIFIED VALUES

Succinic acid at 50 µg/cm²
DL-malic acid at 50 µg/cm²

Reduction of SIR due to flux residue will cause a drift of component parameters from the values specified by component manufacturer.

EC-RAT solutions
EASY TEST METHODS TO DETECT FLUX RESIDUE AND TIN CORROSION ON PCBA

RESIDUES RAT
Residues RAT is a gel that identifies active flux residues in order to optimize reliability of electronics.
- Mapping levels of production residues on the PCBA
- Optimization of soldering process
- Quality control of production process

TIN RAT
Tin RAT is a gel that easily detects tin corrosion for electronics failure analysis and reliability testing.
- Device robustness testing
- Failure analysis of electronics from field returns
- Complementary technique for LAB testing
Residues RAT
Method for detection of active flux residues on PCBA
Residues RAT
LOCAL DETECTION OF FLUX RESIDUE

Excessive residue after hand soldering

Failure of re-setting switch

The examples indicate a color shade on the PCBA surfaces deliberately contaminated with adipic acid. The levels refer to the active component in the flux and can vary from flux system to flux-system.

<table>
<thead>
<tr>
<th>THROUGH HOLE MOUNTED PINS</th>
<th>ROW OF SM COMPONENTS</th>
<th>AMOUNT OF ADIPIC ACID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0-5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;20</td>
</tr>
</tbody>
</table>
Active flux residues
SELECTIVE WAVE SOLDERING + REFLOW
Active flux residues
SPREADING UNDER SELECTIVE WAVE SOLDERING PALLET
Active flux residues
DOUBLE REFLOW + SELECTIVE WAVE SOLDERING
Flux residues alter hand soldering
REWORKED VS. NON-REWORKED
Was the cleaning process effective?

SMEARING OF ACTIVE RESIDUE ON A PCB SURFACE

3 Hand soldered areas cleaned (75% isopropanol / 25% Di water)

3 Hand soldered areas without cleaning
Are the reflow residues harmful?

RELEASE OF ACID AFTER HUMIDITY AND TEMPERATURE EXPOSURE

Reference PCB with solder paste flux residue

PCB after 48hrs, at 60°C, 99%RH

Failure due to flux residue
LOCAL DETECTION OF FLUX RESIDUE

Corrosion and surface flashover due to flux residue and porosities in the solder mask

Flow pattern of solder flux on the PCBA surface suggests presence of liquid water

Electronic Corrosion - Reliability Assessment Testing  www.ec-rat.com
Benchmarking of fluxes
CORRELATION BETWEEN SIR AND CORROSION

Transferred charge (mA.s) vs Time (hours)

- DL-malic
- Glutaric
- Adipic
- Palmitic
- Succinic

Transferred charge (mA.s) vs RH (%)

- 60
- 70
- 80
- 90
- 95
- 98

**White residue: flux or corrosion product?**

**EFFECT OF HUMIDITY CONTROL INSIDE ELECTRONIC ENCLOSURE**

Appearance before application of Tin RAT. White traces seen on the PCBA can be flux residue or tin hydroxides/oxides.

Corrosion pattern after application of Tin RAT.

PCBA from device with improved enclosure design. White traces of selective soldering can be seen.

Corroded

Tin RAT

No corrosion can be seen, as a result of lower RH inside the device.
Device level testing
DELIBERATELY CONTAMINATED PCBA

Corrosion of surface mount components:

IR profile of PCBA in operation mode
Device level testing
REVEALING CORROSION PRONE AREAS AND COMPONENTS

1. After climatic testing without bias applied
2. After climatic testing with bias voltage applied

Electronic Corrosion - Reliability Assessment Testing  www.ec-rat.com
Corrosion influencing factors
BIAS VOLTAGE, TEMPERATURE, COMPONENT LAYOUT

Dissolution of tin when bias voltage is applied

Voltage map

Temperature profile of working PCBA

Electronic Corrosion - Reliability Assessment Testing  www.ec-rat.com
Corrosion failure due to high humidity
HIGH VOLTAGE AREA, SELECTIVELY SOLDERED COMPONENTS
Failure analysis of field returns (1)

HUMIDITY INGRESS DUE TO CORROSION OF DIE CAST ALUMINUM CASING

Aluminum casing with the failed PCBA

Corrosion under the gasket

Entry for moisture ingress

Appearance of the failed PCBA, arrows indicate entry points for humidity; failed gasket is on the bottom side of the PCBA

Electronic Corrosion - Reliability Assessment Testing www.ec-rat.com
After application of Tin RAT, a clear pattern of components affected by corrosion can be seen. Those components are located nearby humidity entry points which are indicated by arrows.
Hygroscopic dust particles
INCREASE THE RISK OF CORROSION

A layer of hygroscopic dust on a PCBA

Corrosion due to dust and ambient humidity

Deliquescence RH of NaCl and dust

Electronic Corrosion - Reliability Assessment Testing  www.ec-rat.com
01 About us
EC-RAT ApS
CELCORR, DTU

02 Introduction
Importance of flux composition on corrosion

03 Residues RAT
Method for detection of active flux residue

04 Tin RAT
Method for tin corrosion profiling on a PCBA surface

05 Outlook
How can you benefit / time for questions
How can you benefit?

EC-RAT SERVICES

EASY TOOLS FOR IMPROVING RELIABILITY

Residues RAT – for detection of flux residues, to control soldering process and improve corrosion reliability of PCBAs.

Tin RAT – for failure analysis, benchmarking corrosion influencing factors e.g. flux systems, ambient environment, or verifying your design changes or remedial measures.

TESTING AND CONSULTANCY

Send us your device and we do the analysis for you. We offer support in improving corrosion reliability of your electronics.

Electronic Corrosion - Reliability Assessment Testing  www.ec-rat.com
Thank You for your attention!
TIME FOR QUESTIONS