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

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EC-RAT Aps

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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. <u>www.celcorr.com</u>



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







Outlook

05

How you can benefit / time for questions



The problem EXCESSIVE FLUX RESIDUES, HUMIDITY AND CORROSION



Corrosion due to humidity and flux residue

Local humidity effects on a PCBA





Activator in the flux ACID TYPE, CONTAMINATION LEVEL AND RELATIVE HUMIDITY

111111111 SIR, R (Ohm) SIR, R (Ohm) 10T 10T 6.77G 👎 6.77G 677M 677M 1T 1T 67.7M 100G 67.7M 100G 6.77M 10G - 6.77M 10G







TIN DENDRITE 200 µm



Flux residue effect on functionality DRIFT FROM SPECIFIED VALUES





Equivalent circuit for resistor



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

Equivalent circuit for capacitor

Verdingovas V. et al., 2016. Analysis of surface insulation resistance related failures in electronics by circuit simulation. Circuit World.



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



EC-RAT products are covered by the patent: WO 2011048001, 2011





Residues RAT LOCAL DETECTION OF FLUX RESIDUE



Failure of re-setting switch





Jellesen, M.S. et al., 2010. Corrosion failure due to flux residues in an electronic add-on device. *Engineering Failure Analysis*, 17(6), pp.1263–1272.

Excessive residue after hand soldering



Residues RAT ASSESSMENT OF TEST RESULTS

THROUGH HOLE MOUNTED PINS

Row of SM components

AMOUNT OF ADIPIC ACID / (µg/cm²)













0-5

5-20

>20

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.



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 after 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











PCB after 48hrs, at 60°C, 99%RH

Jellesen, M.S. et al., 2012. Detection of acid release from reflow solder flux residues using localized test methods. In *Eurocorr* 2012.







Failure due to flux residue





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



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





Benchmarking of fluxes CORRELATION BETWEEN SIR AND CORROSION





Verdingovas V. et al., 2016. Colorimetric visualization of tin corrosion: A method for early stage corrosion detection on printed circuit boards. J. Electron. Testing

Electronic Corrosion - Reliability Assessment Testing www



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.



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:

50'C

20'C



IR profile of PCBA in operation mode









Device level testing REVEALING CORROSION PRONE AREAS AND COMPONENTS





After climatic testing without bias applied

After climatic testing with bias voltage applied



Corrosion influencing factors BIAS VOLTAGE, TEMPERATURE, COMPONENT LAYOUT





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



Failure analysis of field returns (2) HUMIDITY INGRESS DUE TO CORROSION OF DIE CAST ALUMINUM CASING





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

DRH_{start} 75% RH **CRH**end 52% RH 1.00E+06 NaC a DRH_{end} kHz, 79% RH Ľ N CRH_{sta} 59% RH 1.00E+05 Increasing RH Decreasing RH 1.00E+04 50 30 60 70 80 90 100 RH (%) 1.00E+07 Increasing RH Decreasing RH DRH_{start} 55% RH 1.00E+06 44% RI G kHz, DRH_{end} CRH_{end} 63% RH Ξ 50% RH N 1.00E+05 **** Dust 1 00F+0 60 70 ٩N 30 50 80 RH (%)

L. D'Angelo et al., 2017. On the effects of atmospheric particles contamination and humidity on tin corrosion. *IEEE Trans. on Dev. and Mat. Reliab.*





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.

EC-RAT products are covered by the patent: WO 2011048001, 2011



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