Passive Components Networking Symposium
15-17 September 2017 – Brno, Czech Republic

Failure Analysis feedback From all markets

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SERMA TECHNOLOGIES

SUMMARY

1 Introduction

- SERMA Technologies

2 Serma's Figures on Failure Analysis (FA)

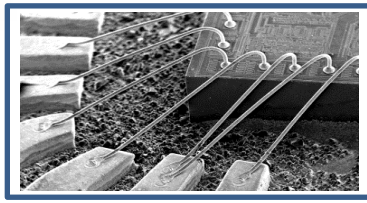
- Statistics about Passive FA
- Main defects observed on Passive Components
  - Capacitors (Ceramic, Tantalum)
  - Resistors (Thick, Thin films)

1- Introduction

SERMA Technologies
From Serma Group

Information Technology Security

Audits & Consulting



TECHNOLOGY & PROCESSES

Energy Storage Devices

Physical Expertise

Two labs:
- Pessac
- Grenoble

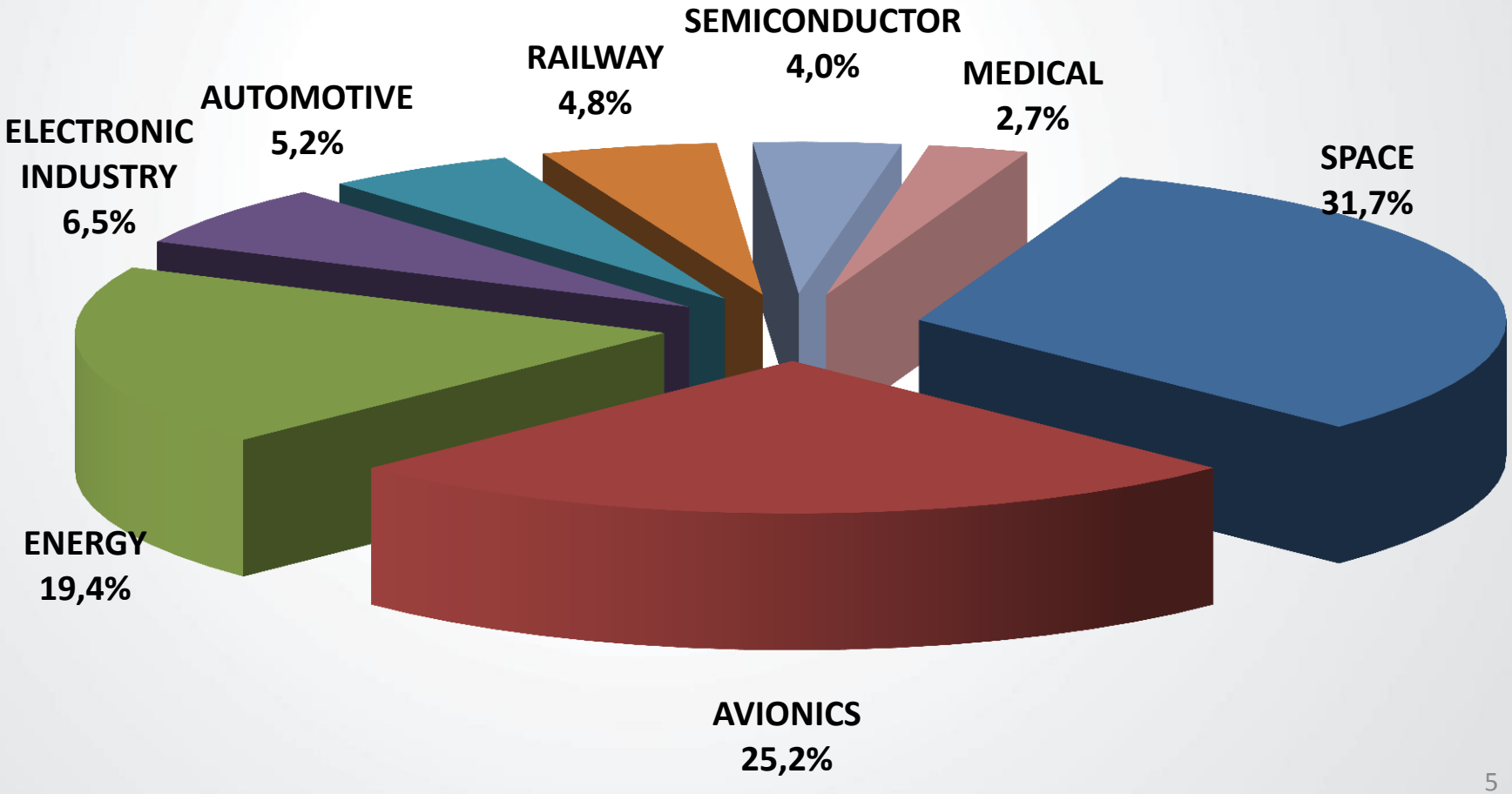
Electrical Testing

The most important independent electronic laboratory in Europe

> 6 000 analyses / year
> 20 years of experience - multi-sectoral

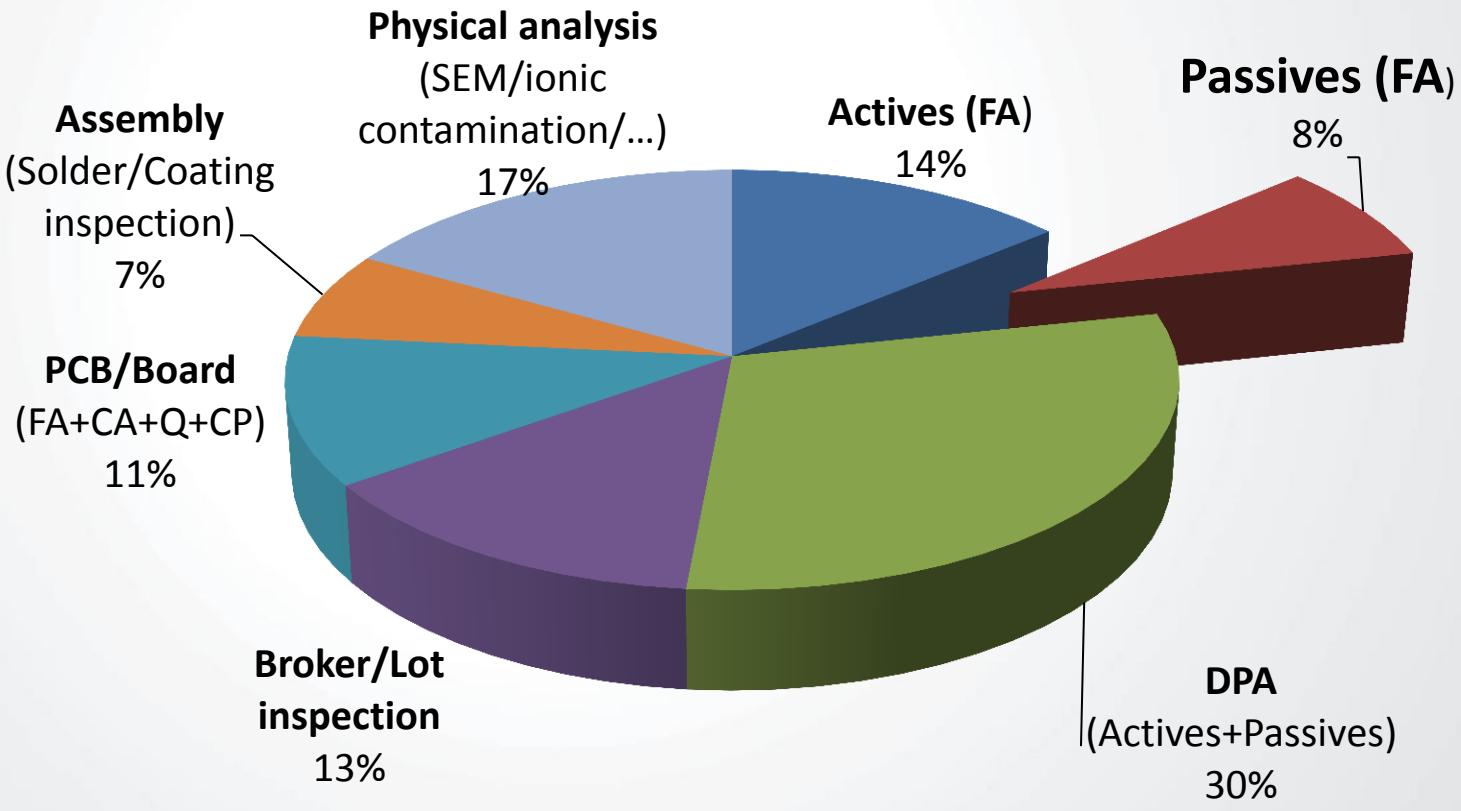
Physical Expertise

Main markets (by Turnover)



Physical Expertise
Type of analysis (by quantity)

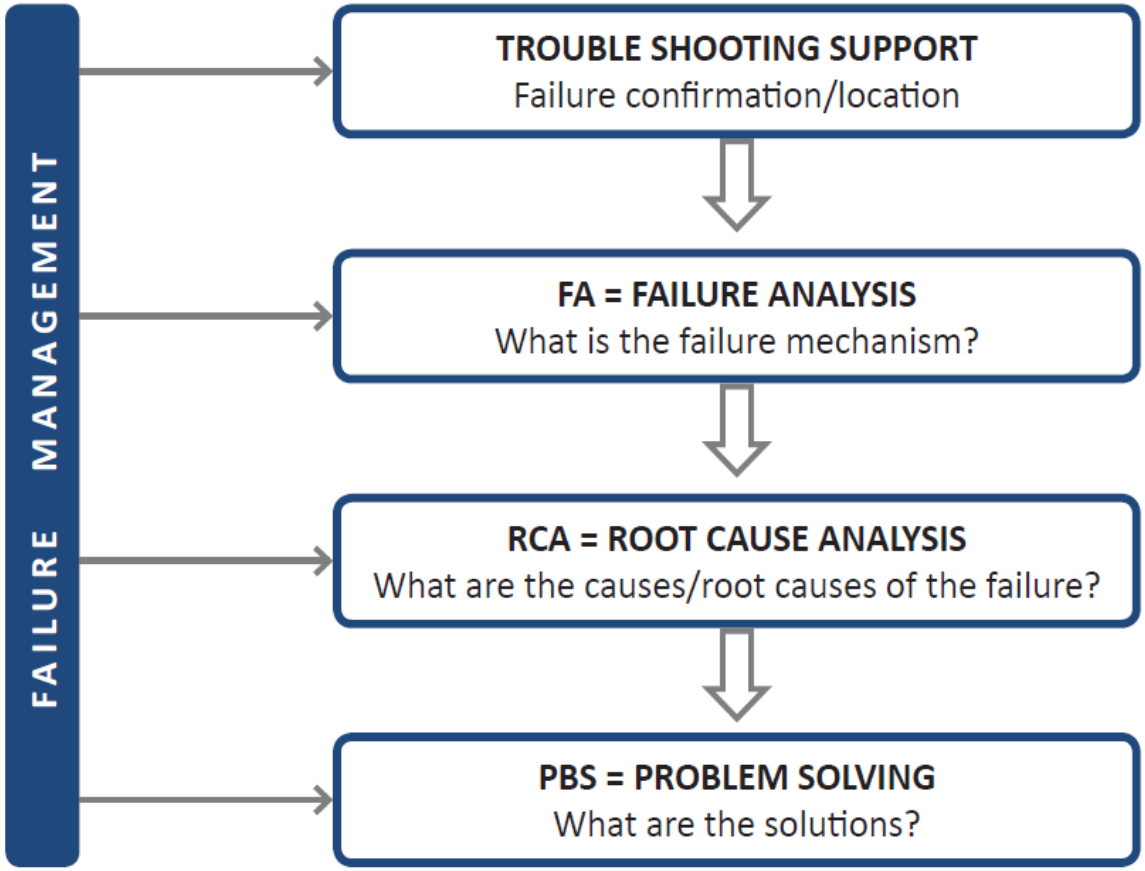
- 2011 - 2016: 23000 analyses in Serma's Lab



Failure Analysis Management

Serma is solicited for:

- Knowledge
- Material means
- Internal capability
- when an independent third party is needed



A WIDE RANGE OF TECHNIQUES

Non Destructives:

Optical microscopes

2D & 3D X-Ray

Electrical Tests

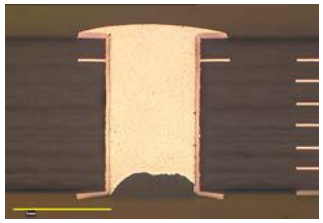
Micro-probing

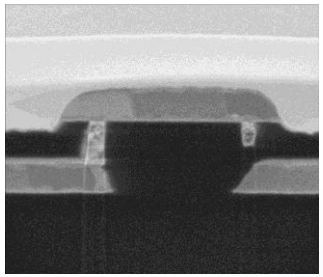
X-Ray Fluorescence

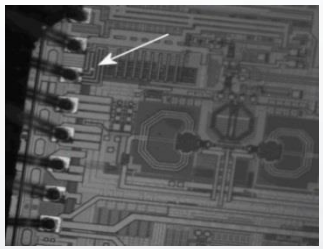
IR Thermography

Acoustic microscopy

Emission Microscopy







Destructives:

Cross section

Laser Cutter

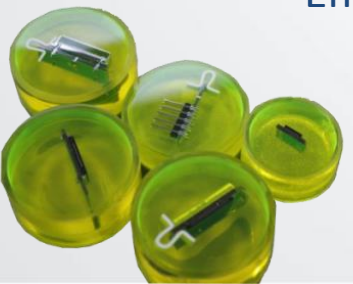
Chemical etch and plasma dry etch

SEM with EDX system

Focused ion Beam imaging

3D Slice & View

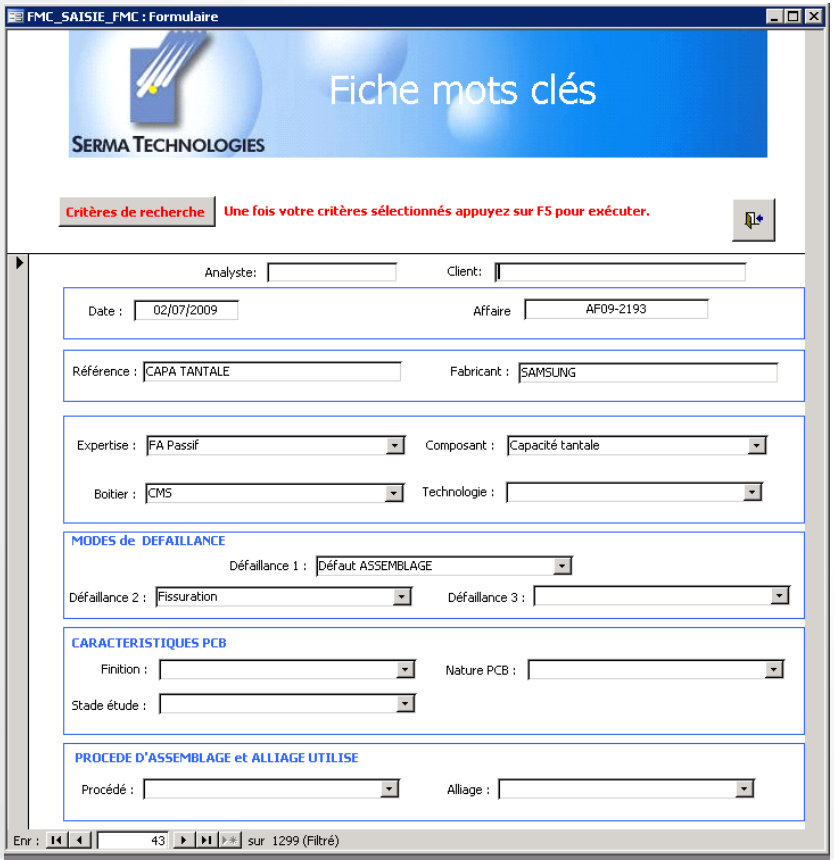
Transmission Electron Microscopy



2- Serma’s Figures on FA

EXPERIENCE CAPITALIZATION

2009: Creation of a Data base
→ Key Words after each analysis



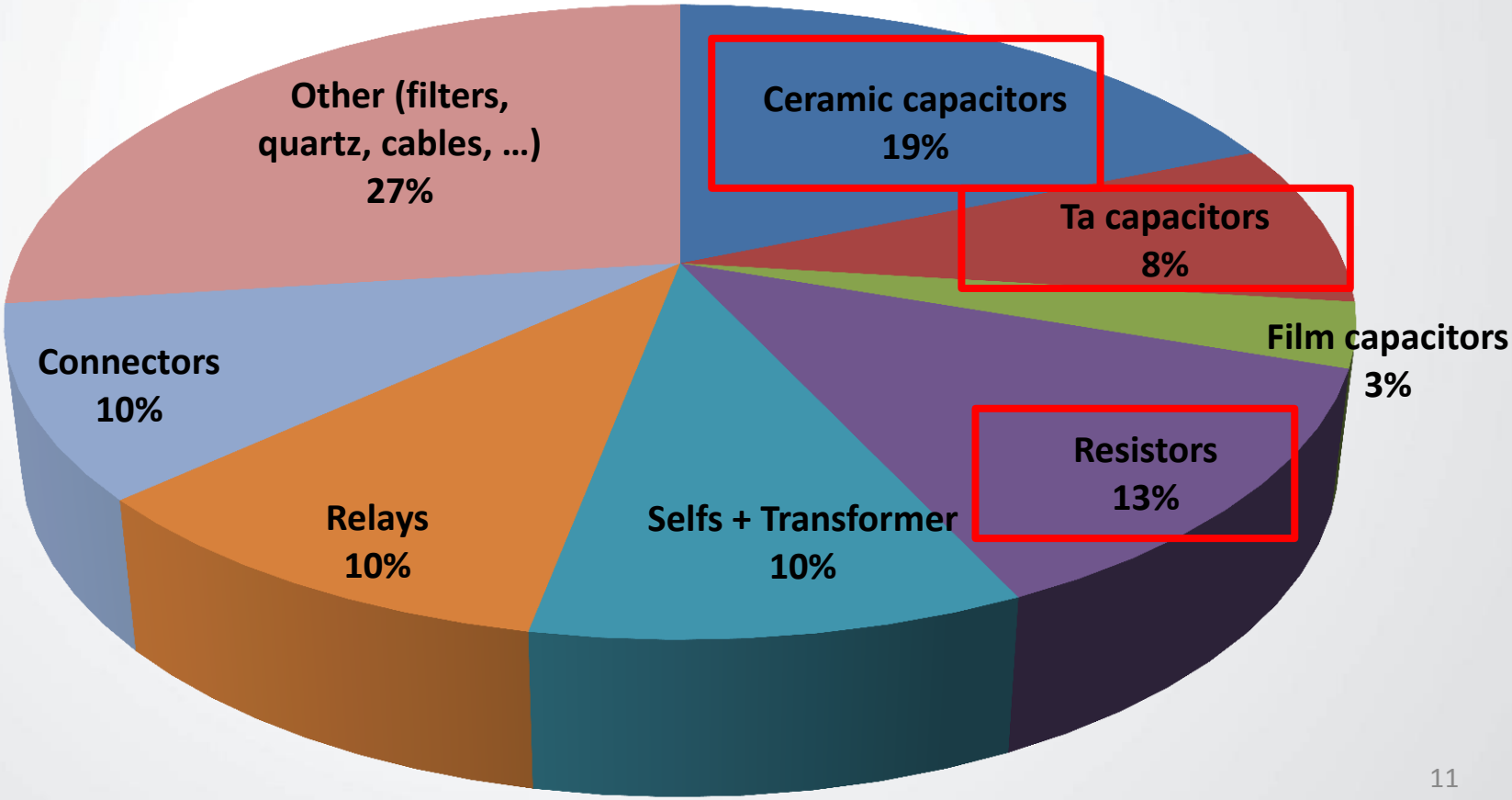
reference_fich	fabricant_fich	Expertise_fic	composant_fiche	boitier_fiche	mode_def_1_fiche	mode_def_2_fiche
TMS15A03	XXXX	FA Passif	SERTISSAGE			Aucun
	XXXX	FA Passif	Capacité céramique	CMS		Fissuration
	XXXX	FA Passif	Filtre	Axial	/Stress/Vieillissement	
	XXXX	FA Passif	Thermistance		Défaut ASSEMBLAGE	Soudure(rupture joint)
G1675588	XXXX	FA Passif	Transformateur		Défaut COMPOSANT	Fissuration
	XXXX	FA Passif	Capacité céramique	CMS		CONTRAINTE Thermomécanique
SN6278/SN5965	XXXX	FA Passif	Relais / Switch	Axial		Pb mécanique
8,25nF	XXXX	FA Passif	Autre	Radial		Aucun
SN000036/SN000007	XXXX	FA Passif	Relais / Switch	Axial	Défaut ASSEMBLAGE	Contamination
EM	XXXX	FA Passif	Capteur divers	Module Complet	Défaut COMPOSANT	Autre
	XXXX	FA Passif	Capacité film			Effet corona
	XXXX	FA Passif	Fusible	CMS	Défaut COMPOSANT	Fissuration
Capteur de courant	XXXX	FA Passif	Capteur divers	Module Complet		Autre
	XXXX	FA Passif	Relais	Module Complet	/Stress/Vieillissement	Dégradation contacts
JDC-20-J	XXXX	FA Passif		SO	Défaut COMPOSANT	Rupture fil de liaison
PT1000	XXXX	FA Passif	Capteur divers	TO/SOT	Défaut COMPOSANT	Autre
DS2E-F-DC12V	XXXX	FA Passif	Relais	DIL	/Stress/Vieillissement	Contamination
FBAC012	XXXX	FA Passif	Capacité céramique	PTH	Défaut ASSEMBLAGE	Fonte joint brasé
DS4E-S-DC24V	XXXX	FA Passif	Relais			Autre
RAL-24W-K	XXXX	FA Passif	Relais			Autre
XXX	XXXX	FA Passif	Capacité céramique	CMS		Contrainte mécanique
XXX	XXXX	FA Passif	Capacité céramique	CMS		Fissuration
	XXXX	FA Passif	Capacité film		EOS/ESD	Diélectrique
MODULE HYPER	XXXX	FA Passif				
	XXXX	FA Passif	Potentiomètre		/Stress/Vieillissement	Fissuration
	XXXX	FA Passif	Potentiomètre		Défaut ASSEMBLAGE	Fissuration
	XXXX	FA Passif	Transformateur		Défaut COMPOSANT	Autre
	XXXX	FA Passif	Résistance	Axial	Défaut COMPOSANT	Corrosion
	XXXX	FA Passif	Multiplexeur		Défaut COMPOSANT	Rupture fil de liaison
DS4E-S-DC24V	XXXX	FA Passif	Relais			Pollution (résidus)
RA4-24W-K	XXXX	FA Passif	Relais			Pollution (résidus)
QEN79	XXXX	FA Passif	Oscillateur	CMS		Fissuration
RESISTANCE	XXXX	FA Passif	Résistance	CMS	EOS/ESD	Fissuration
B82422H	XXXX	FA Passif				

FMC_SAISIE_FMC

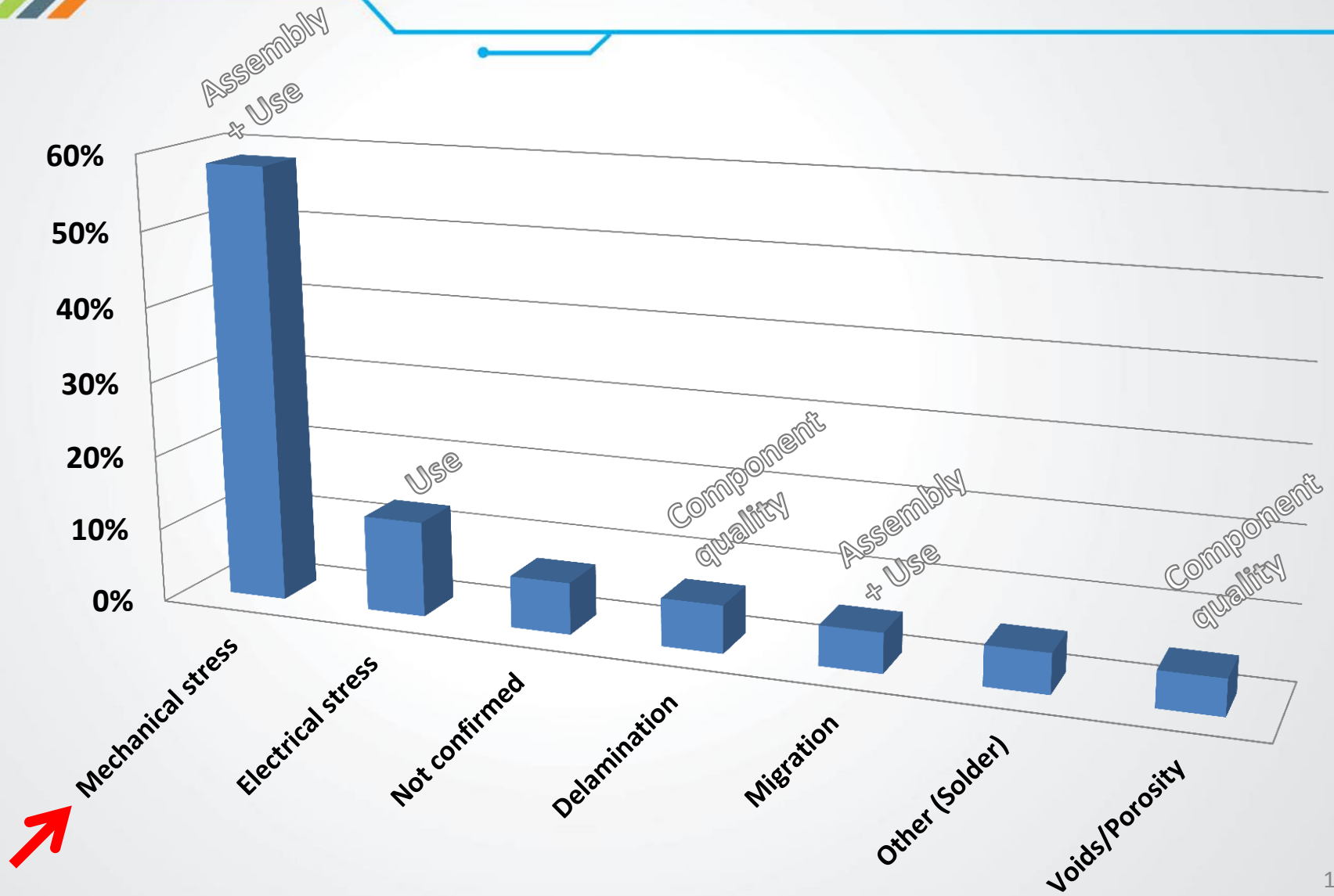
FAILURE ANALYSES

Type of component (by quantity)

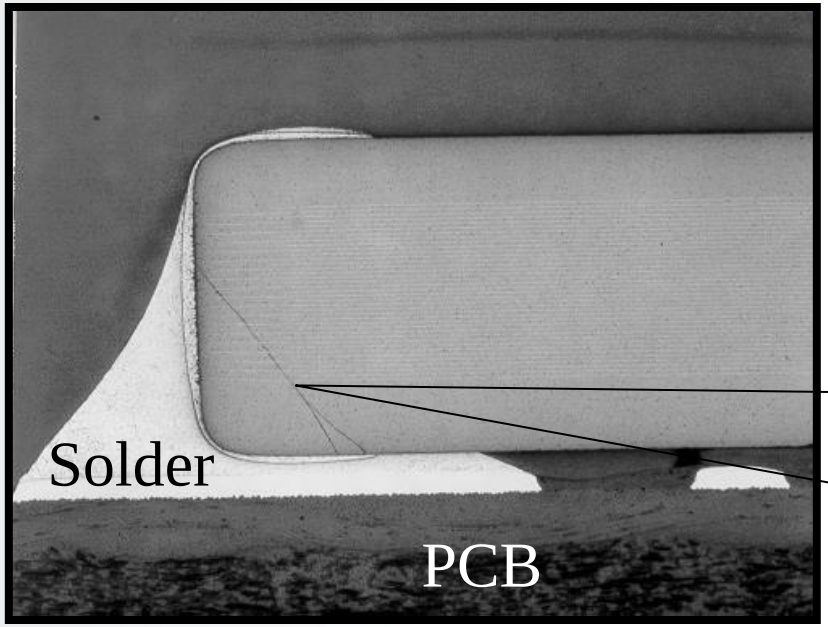
- 2011 - 2016: 1 400 failure analyses on passive components

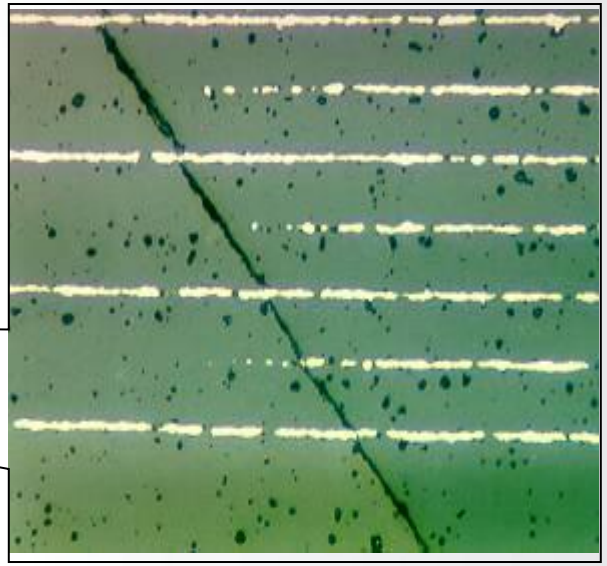


Ceramic Capacitors
Main Defects



Ceramic Capacitors
Cracks

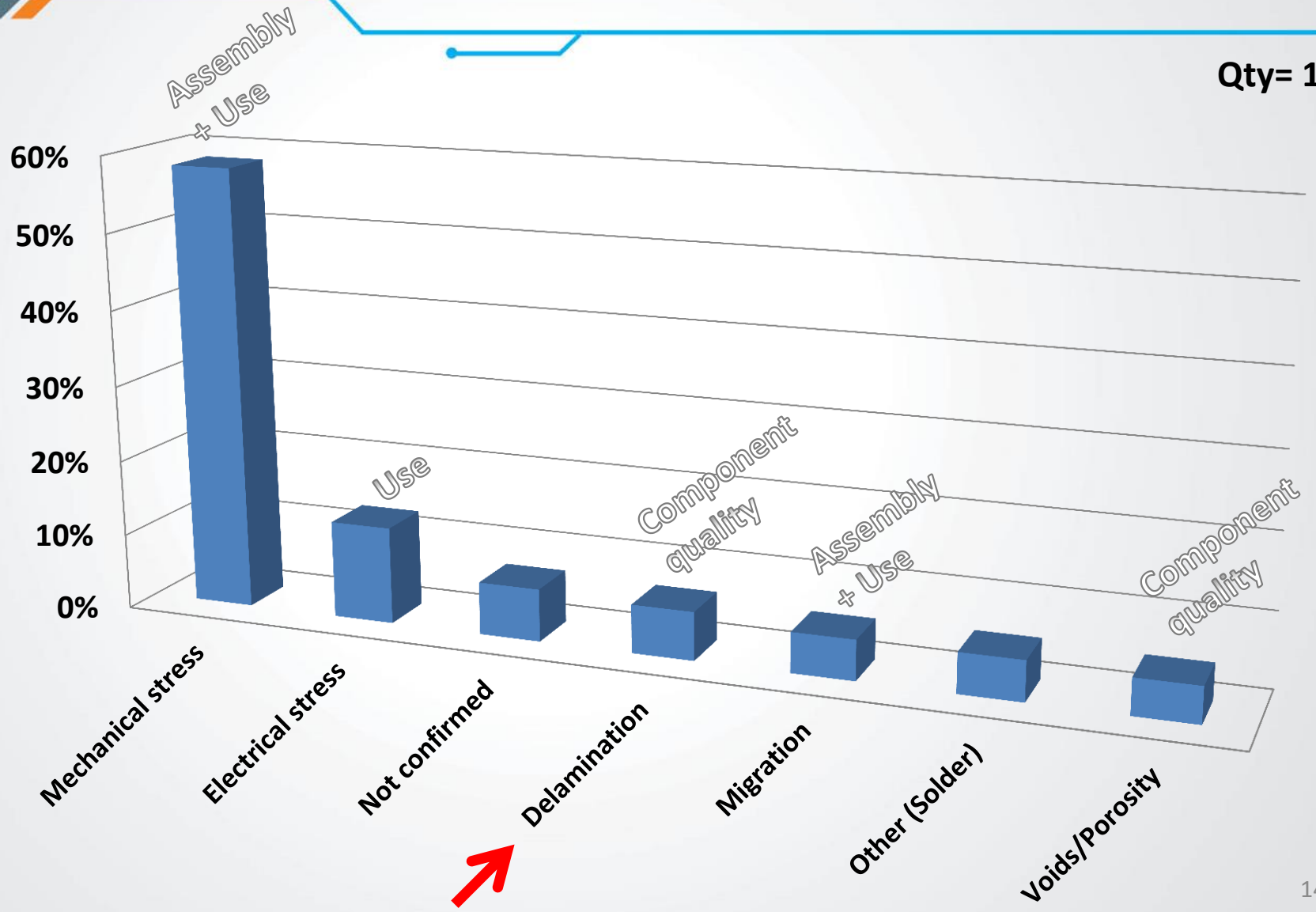




Diagonal cracks (@45°) due to Thermo and/or Mechanical stresses caused by soldering/testing/depanelization/handling…

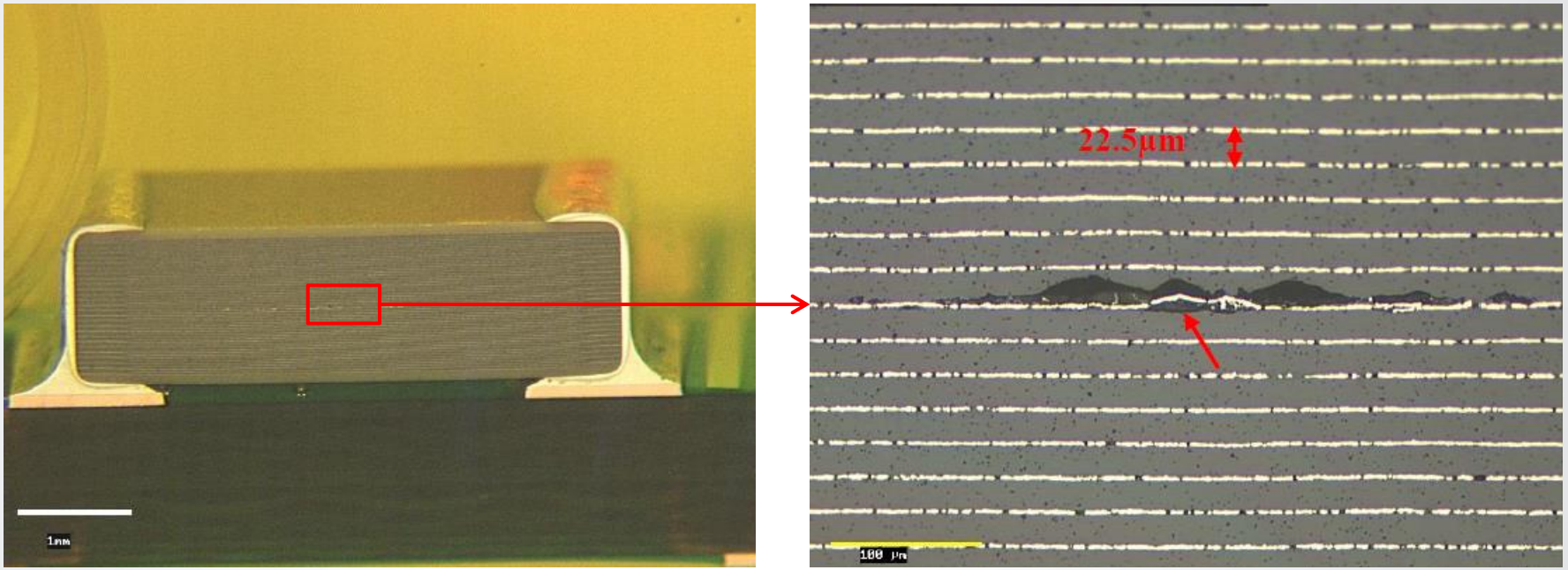
→ Short circuit occurs when dielectric between opposite electrodes is cracked

Ceramic Capacitors
Main Defects



Ceramic Capacitors

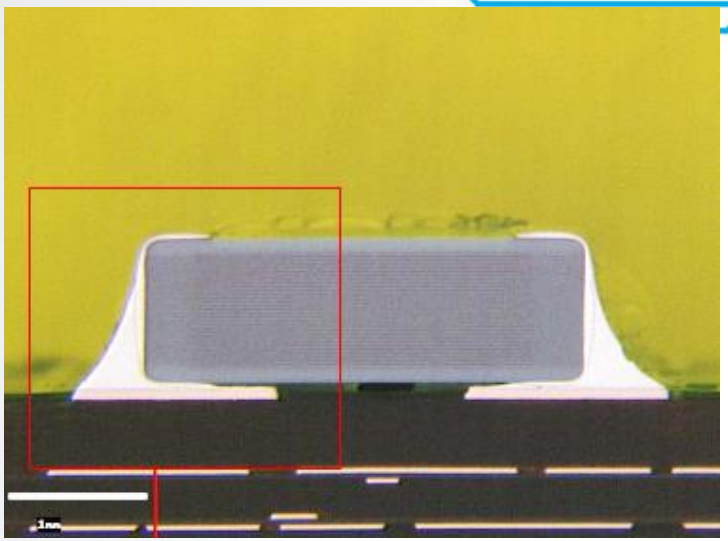
Delamination: Electrode/Ceramic



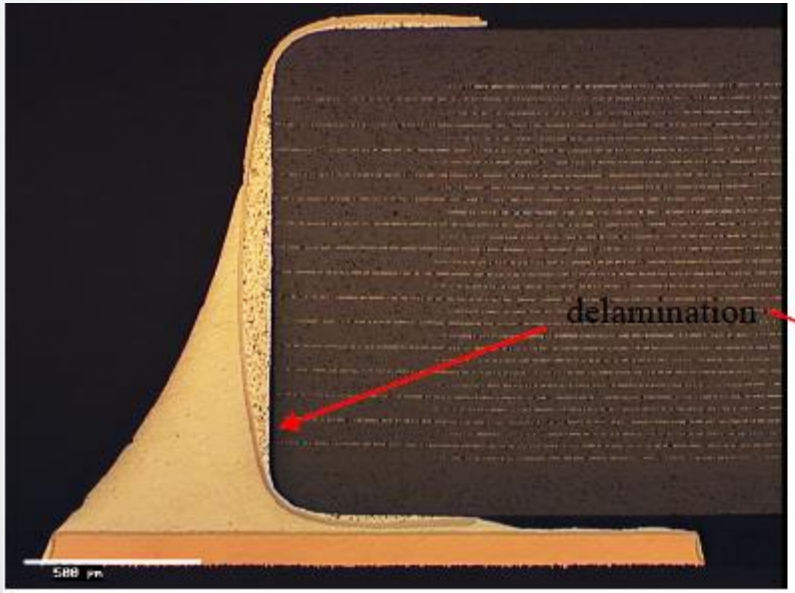
Delamination relative to the component process: Part lamination/sintering

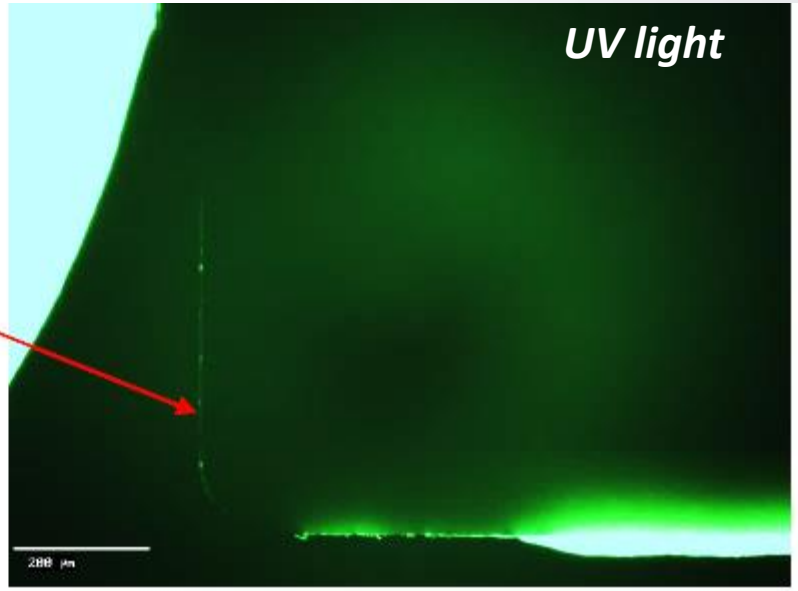
→ **Results in insulation reduction up to Short circuit**

Ceramic Capacitors
Delamination Electrodes/Termination

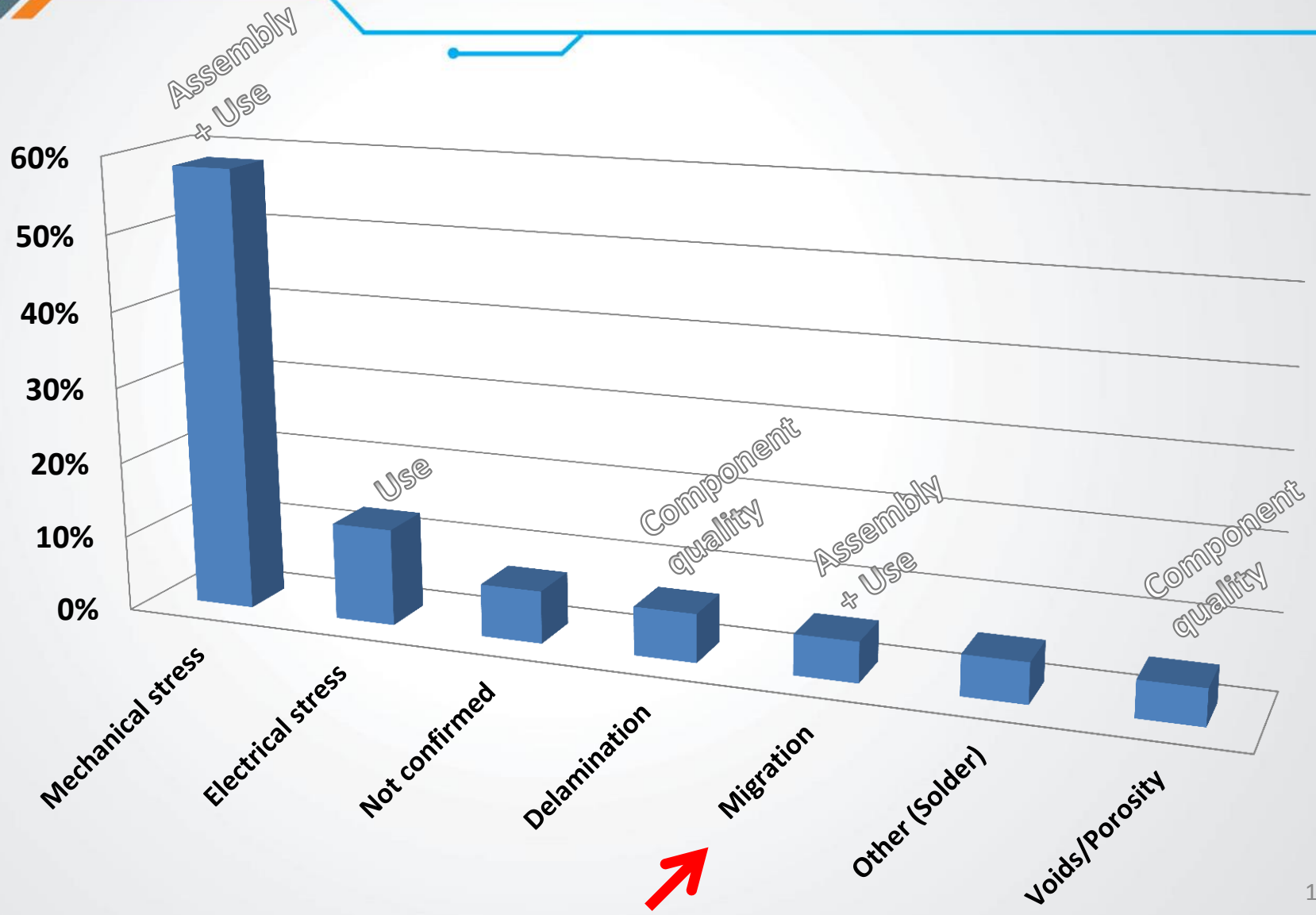


Soldering process + Component Weakness (at termination)
Revealed after ageing test
→results in loss of capacitance up to Open circuit

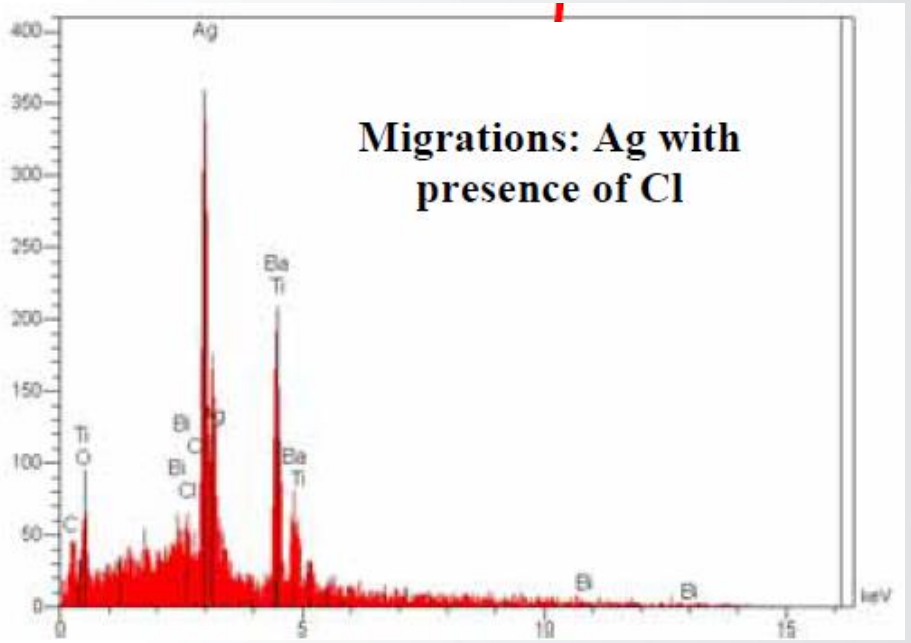




Ceramic Capacitors
Main Defects



Ceramic Capacitors
Migration

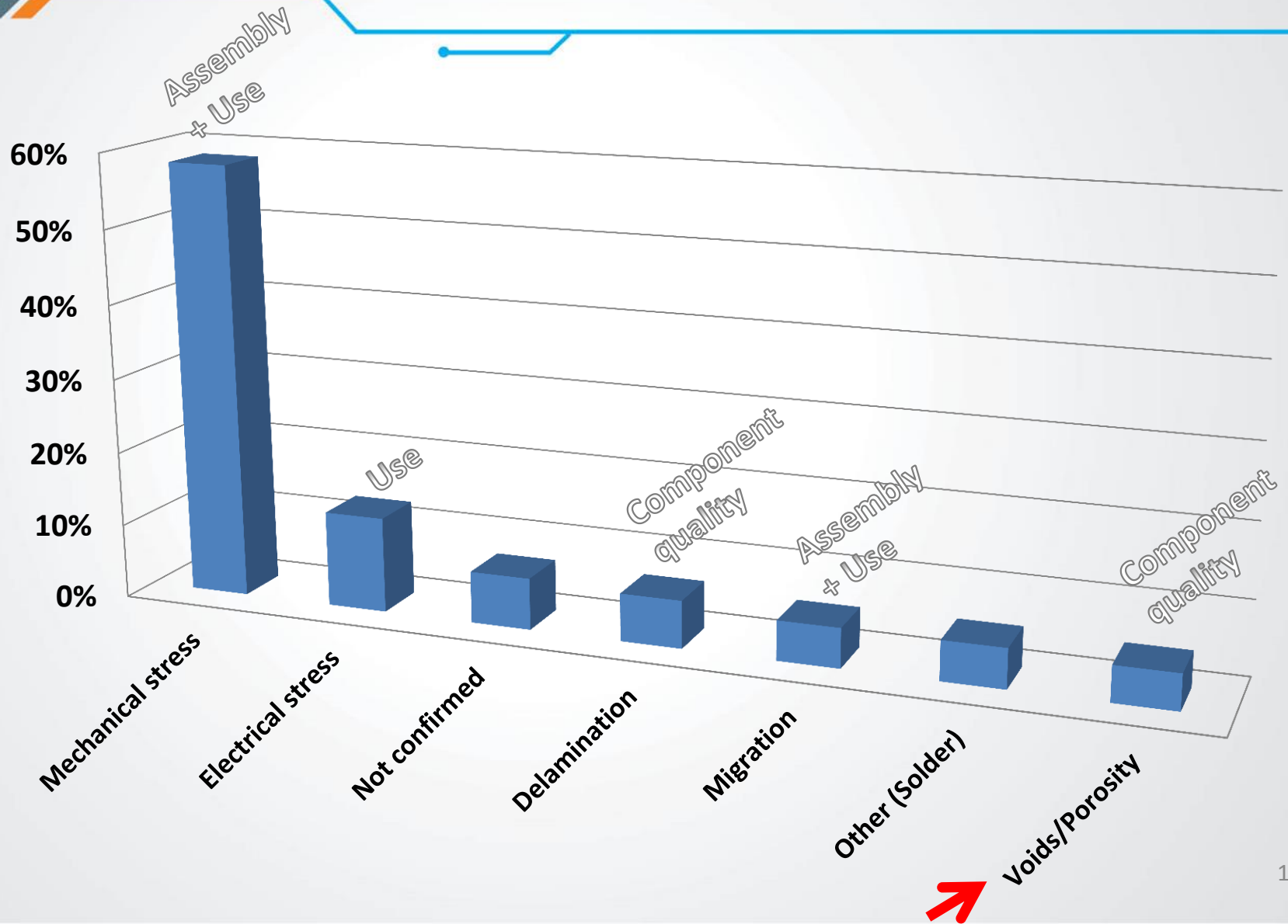


Failure occurred during Environmental tests:

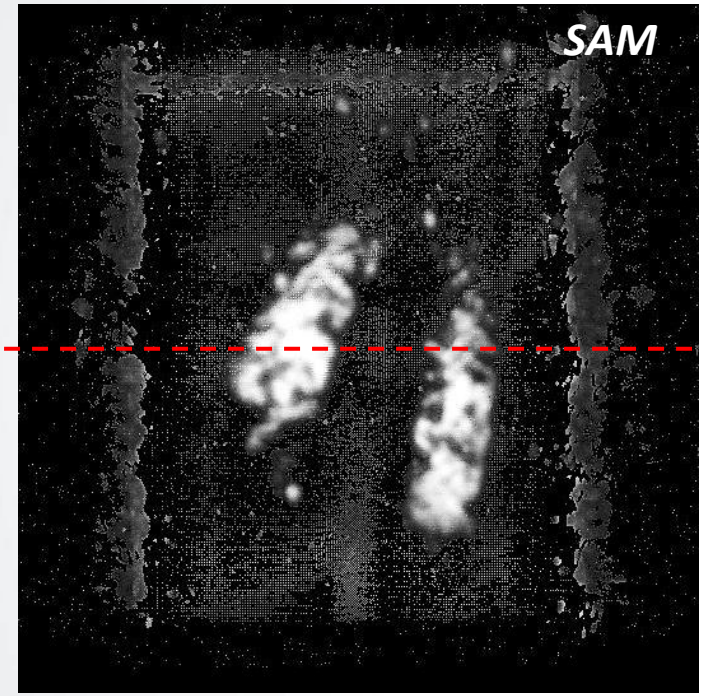
Moisture and contaminant (Cl,..) leading to Silver dendritic growth

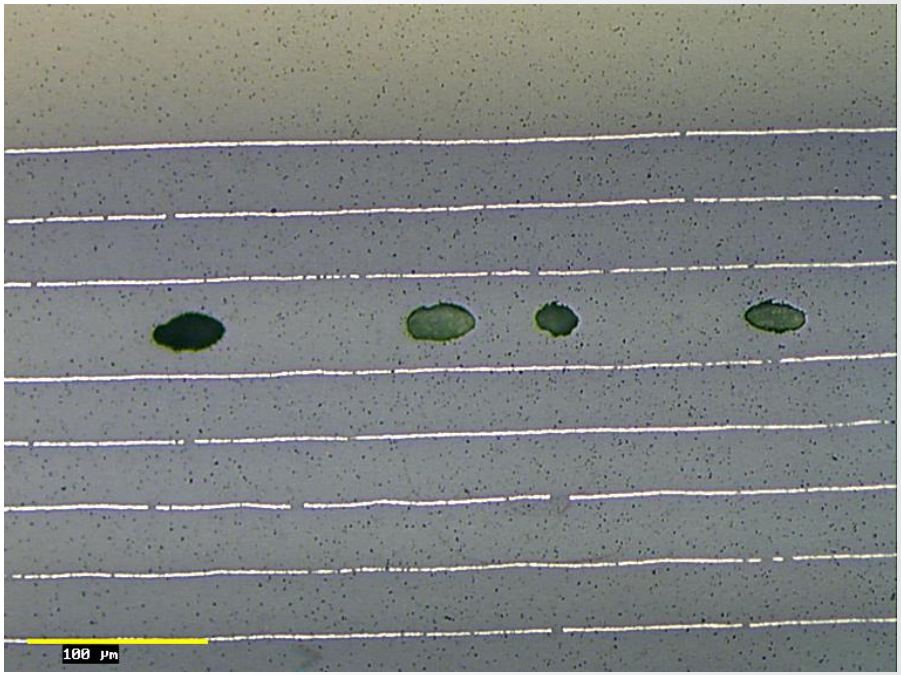
→ **Short circuit**

Ceramic Capacitors
Main Defects



Ceramic Capacitors
Porosity





- Component quality
- Ceramic preparation issue or organic/inorganic contamination

→ **Insulation reduction up to short circuit**

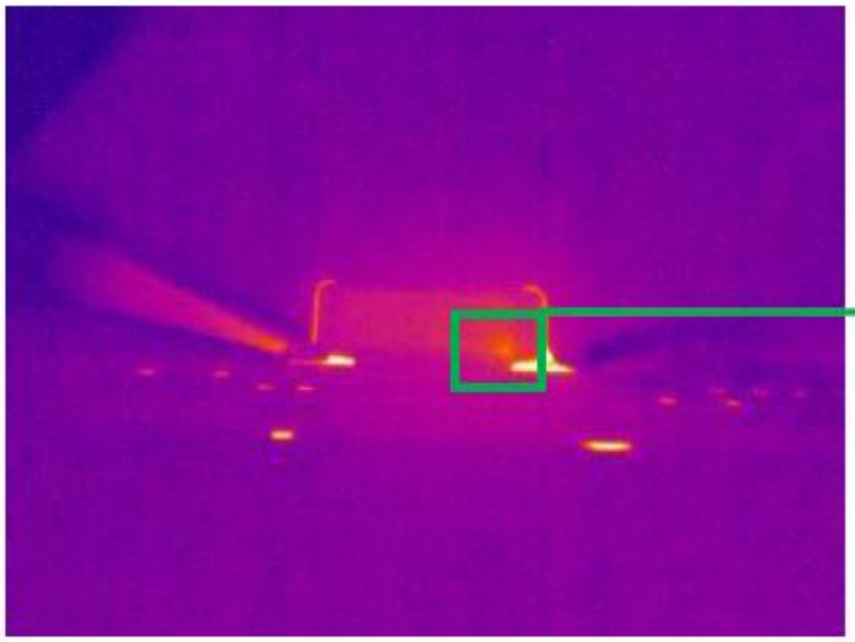
SERMA TECHNOLOGIES

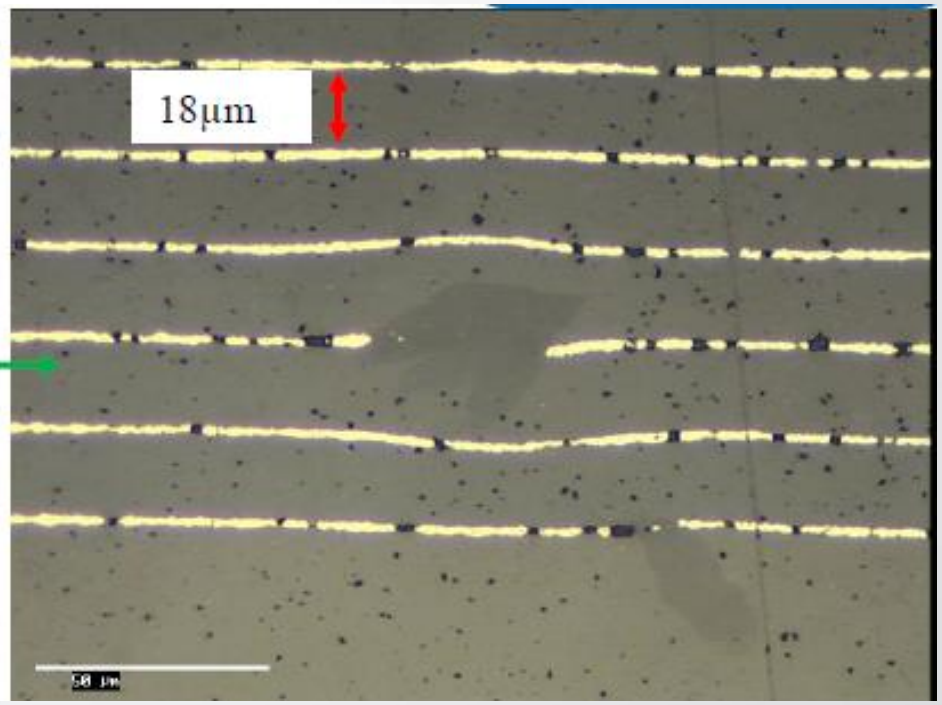
Particular Technique

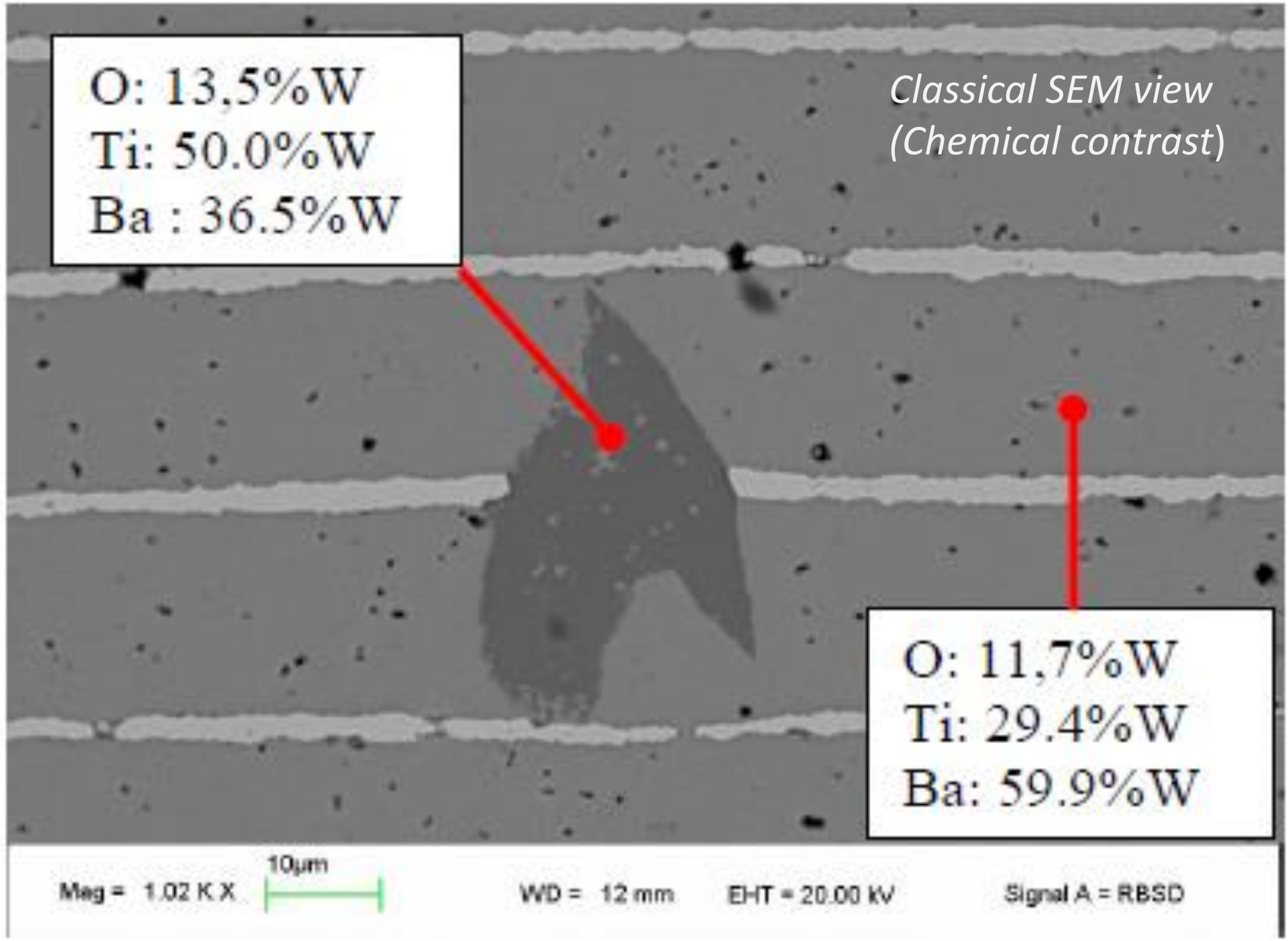
Voltage contrast coupled SEM

- Presence of a short circuit on a ceramic capacitor,
- Infra red thermography confirmed the presence of the Short
- Cross section showed the presence of specific phases

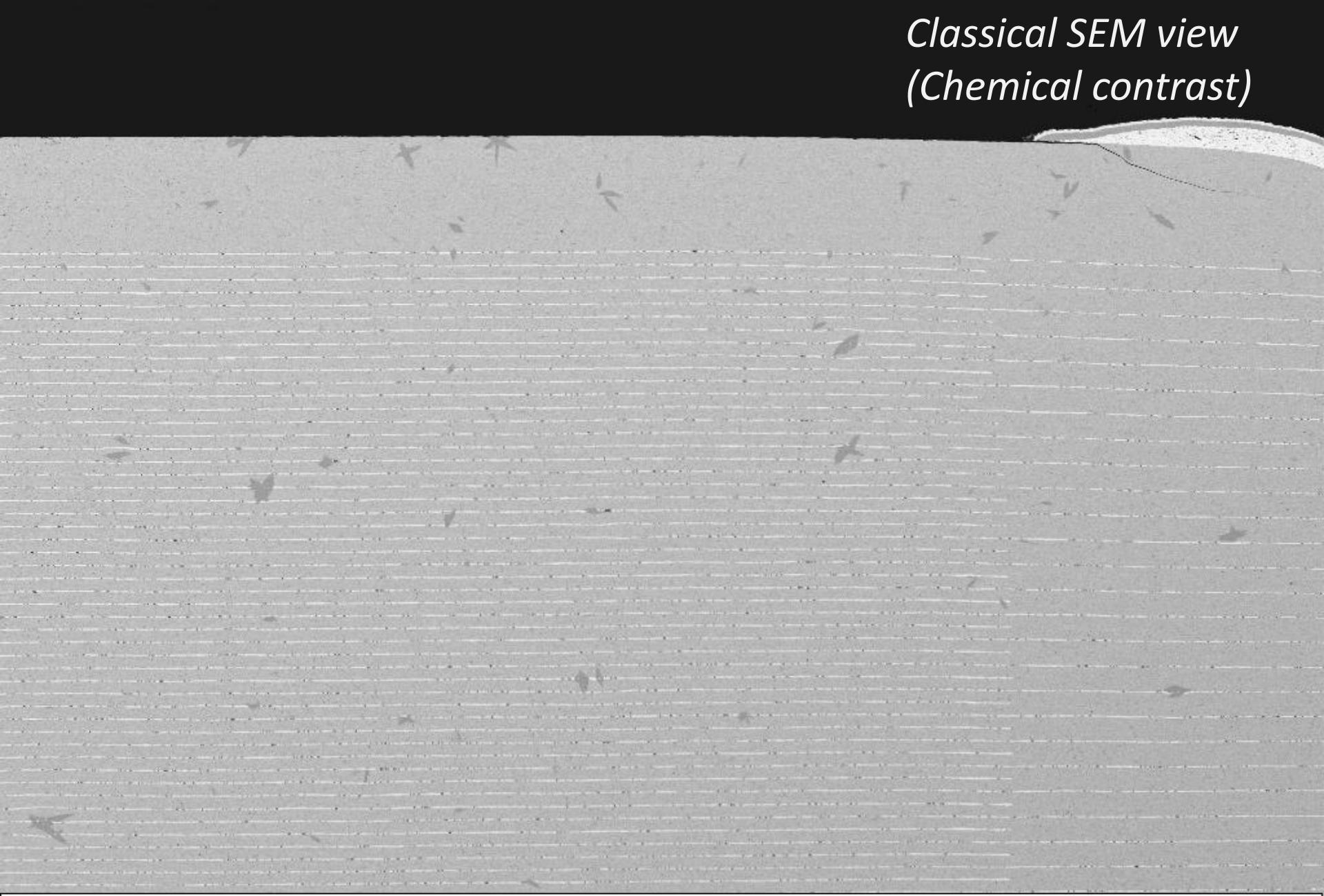
→ **Conductive or not?**

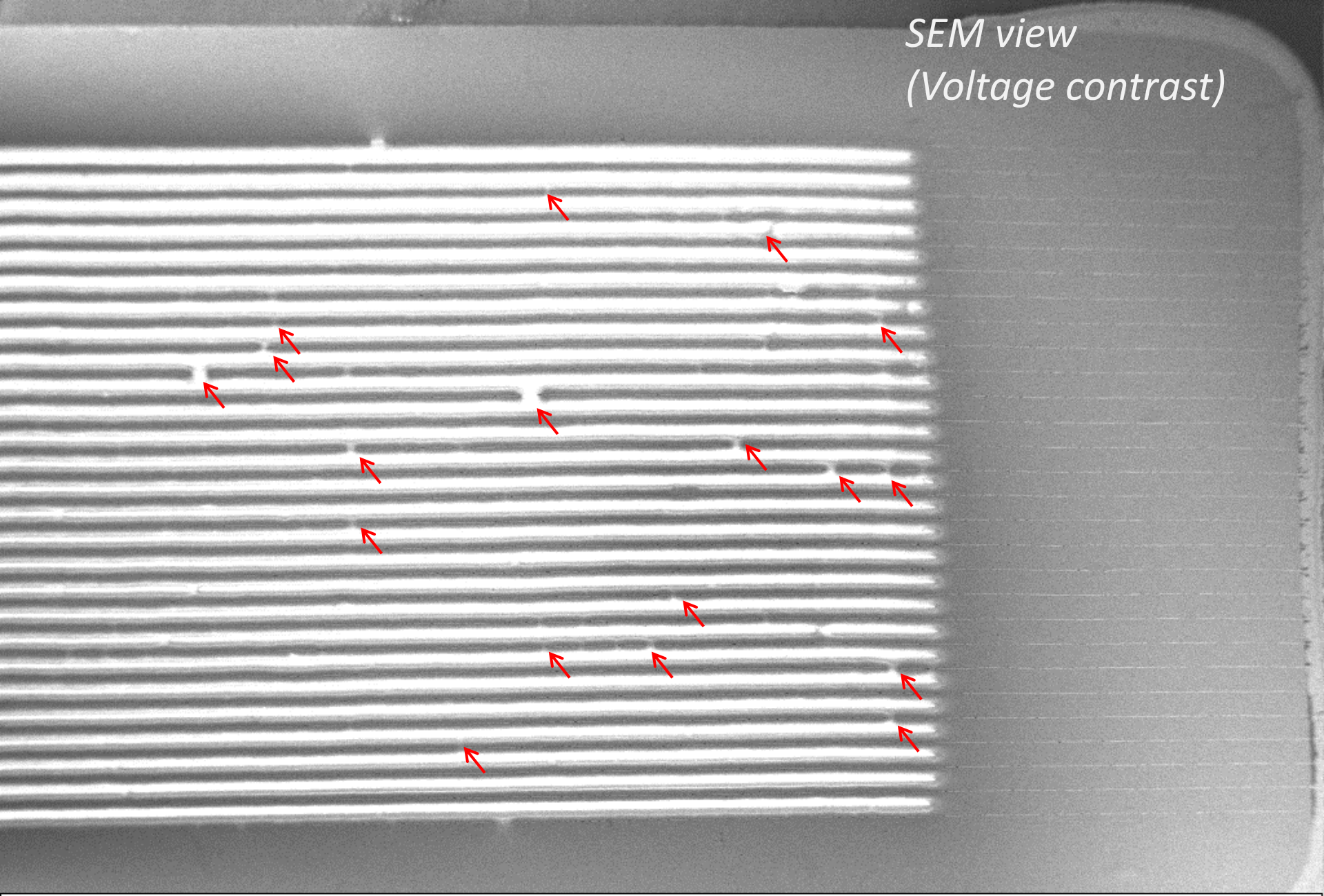


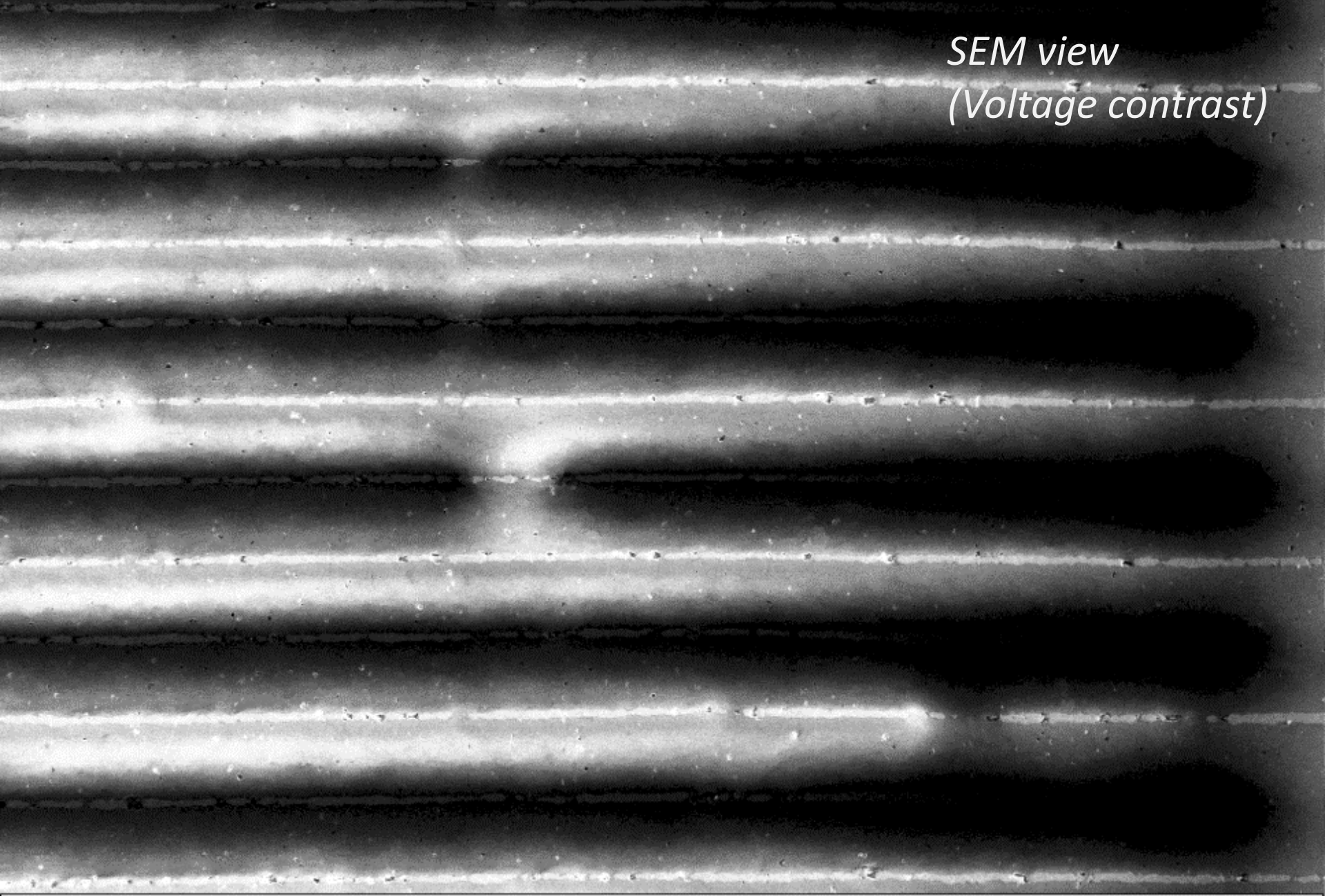



O: 13,5%W
Ti: 50.0%W
Ba : 36.5%W
Classical SEM view
(Chemical contrast)
O: 11,7%W
Ti: 29.4%W
Ba: 59.9%W
Mag = 1.02 K X
10µm
WD = 12 mm
EHT = 20.00 kV
Signal A = RBSD

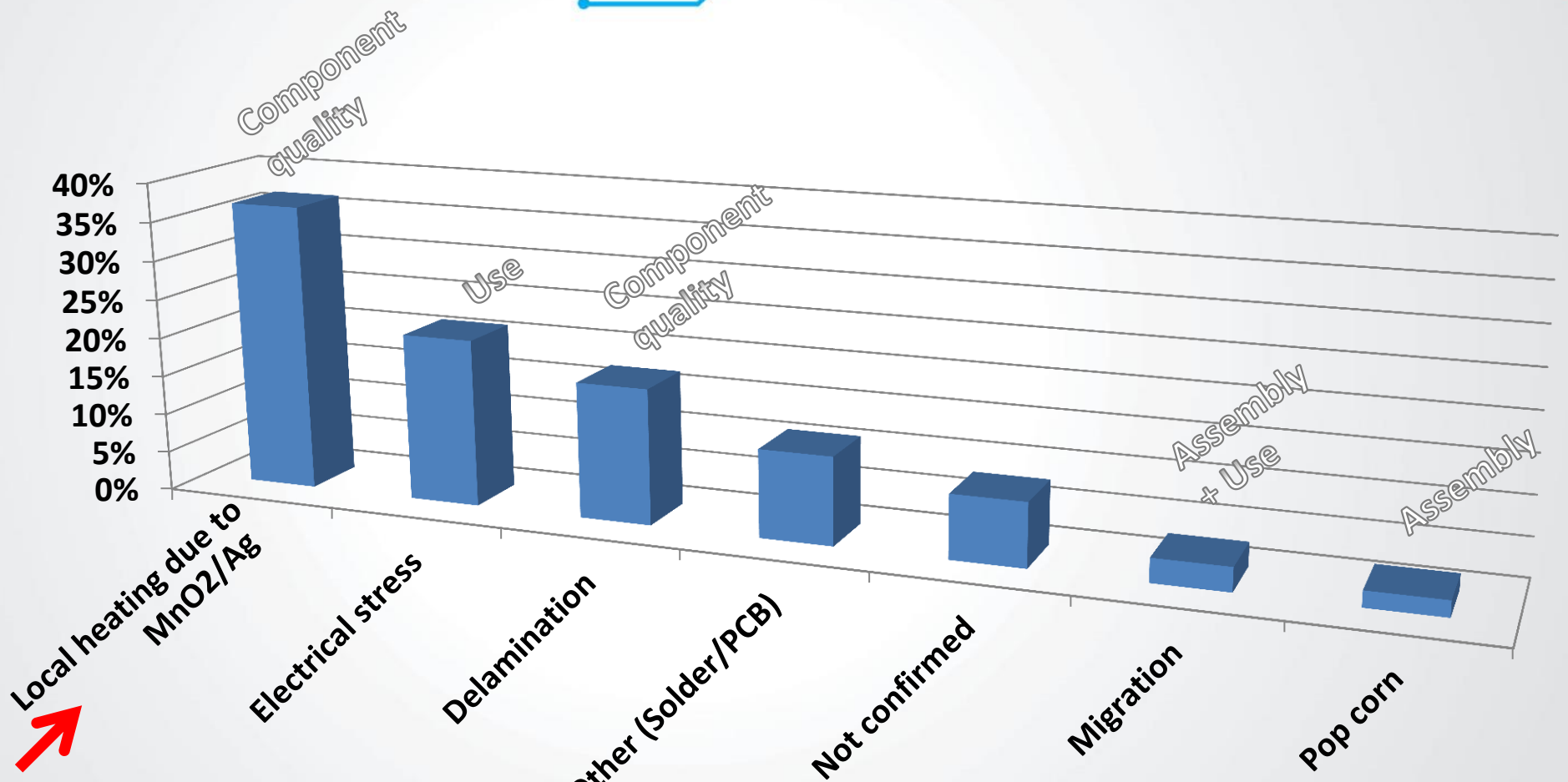
Classical SEM view
(Chemical contrast)



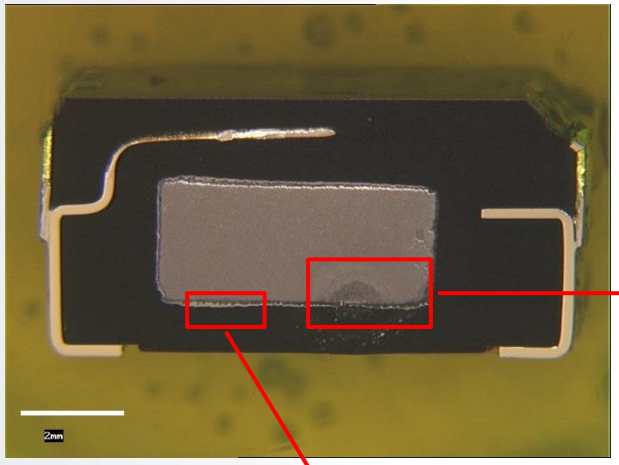

SEM view
(Voltage contrast)
Mag = 54 X
100µm
WD = 10 mm
EHT = 5.00 kV
Signal A = InLens

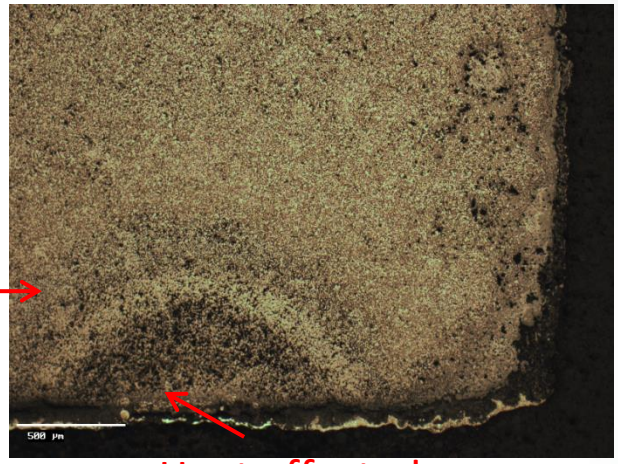

SEM view
(Voltage contrast)
20µm
Mag = 338 X
WD = 10 mm
EHT = 5.00 kV
Signal A = InLens

Tantalum Capacitors
Main Defects

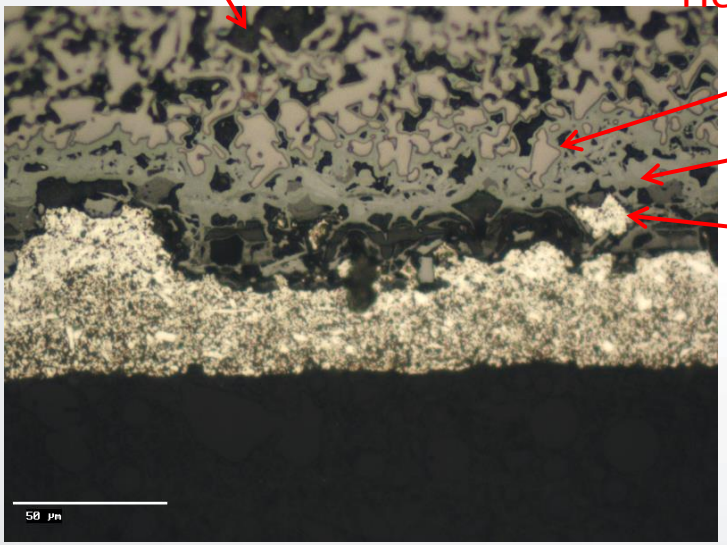


Tantalum Capacitor
MnO2 deposition





Heat affected area



Ta

MnO_2

Ag

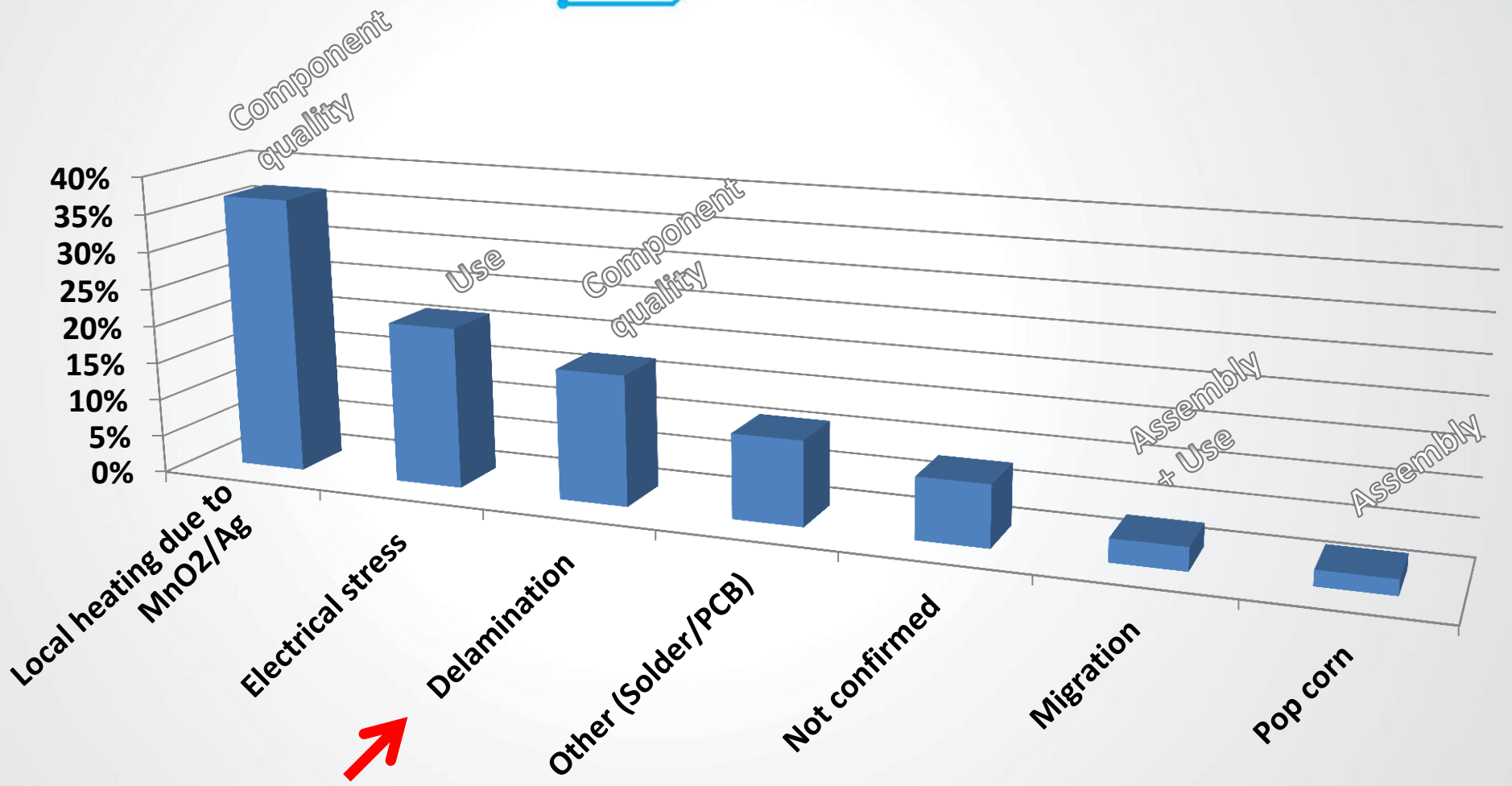
- Component quality
- MnO2 layer thin and inhomogeneous
- Ag penetration

→ **Local ESR reduced**

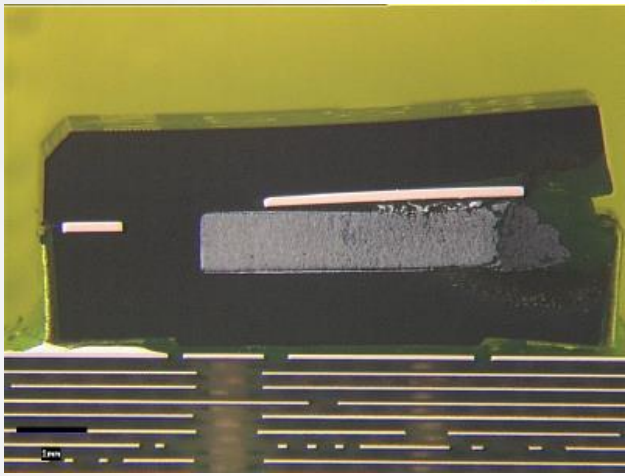
→ **Overheating**

until short circuit

Tantalum Capacitors
Main Defects

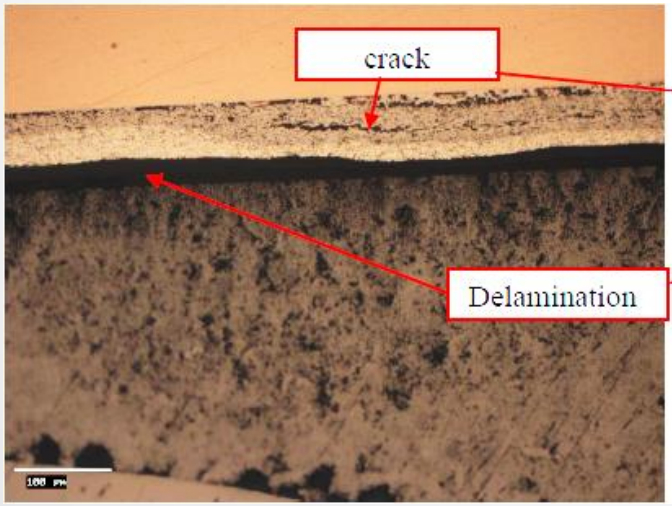


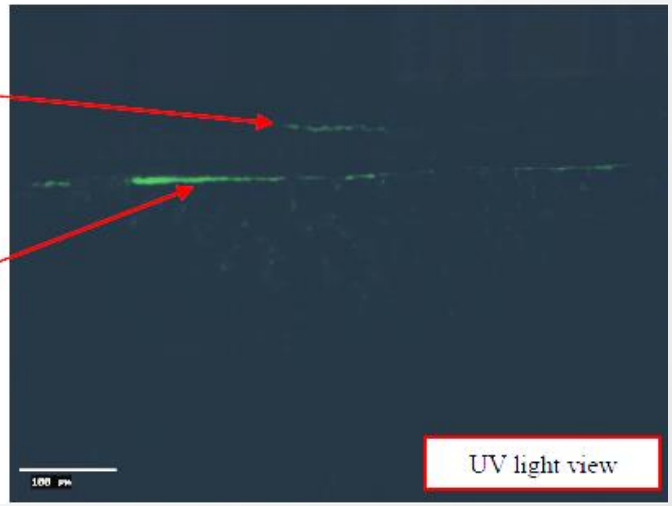
Tantalum Capacitors
Delamination



Delamination due to component quality or assembly process

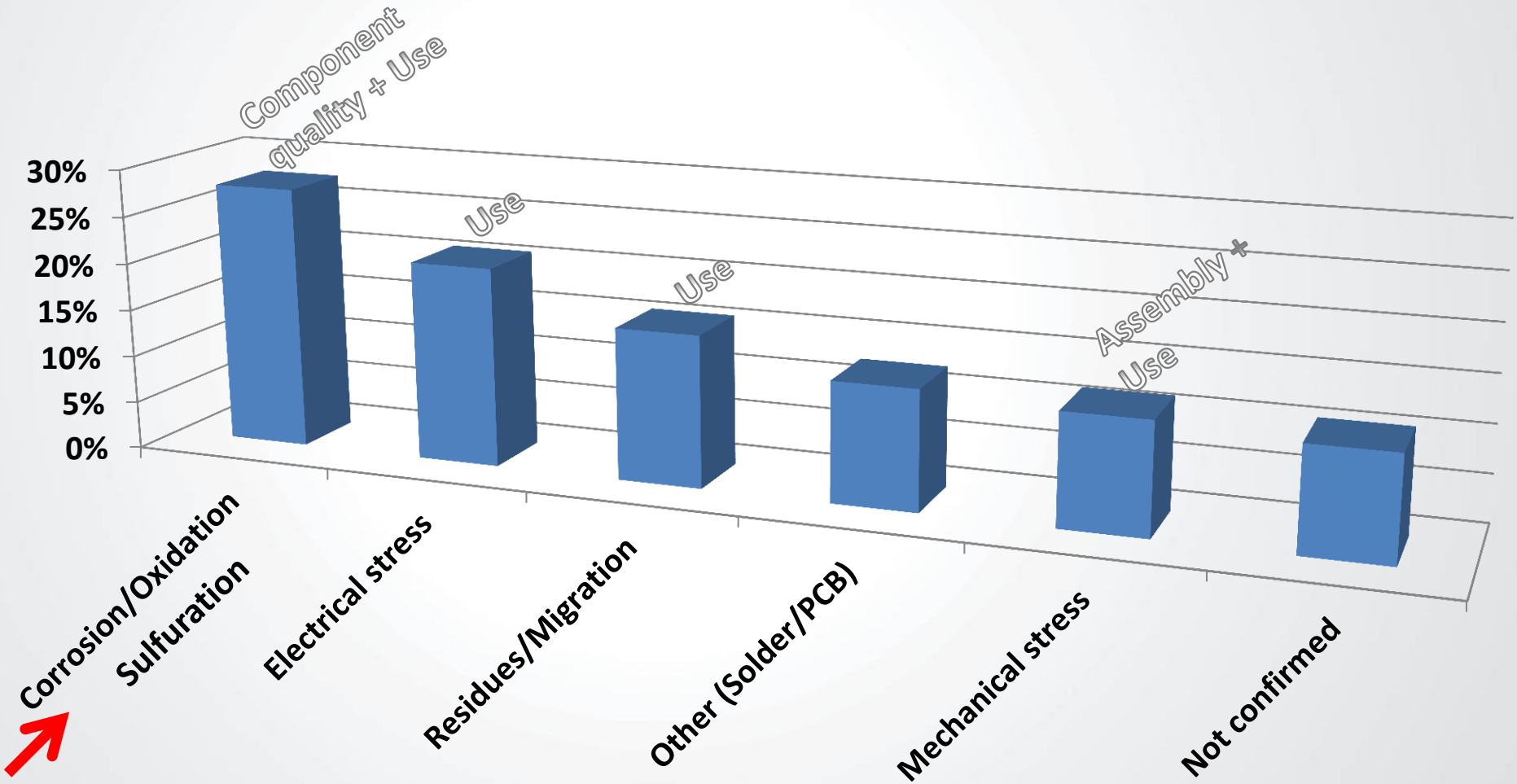
→ ESR increase up to thermal runaway



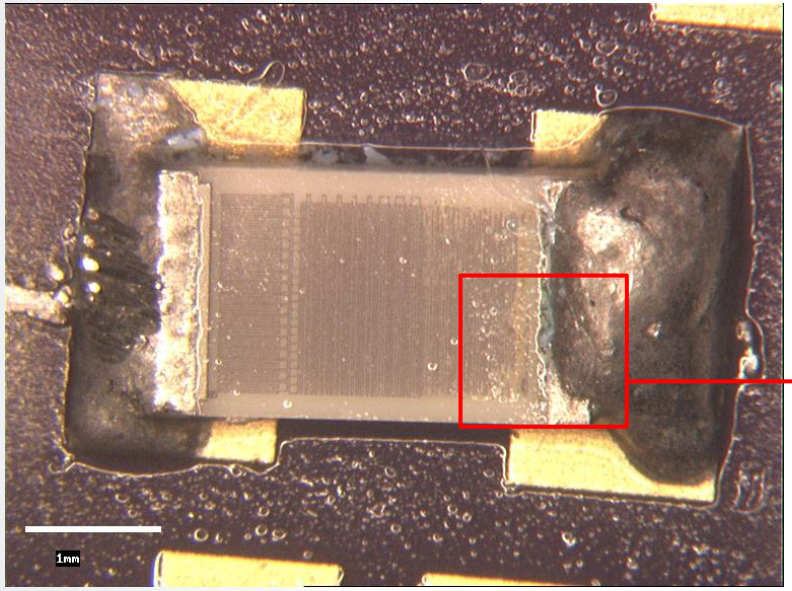


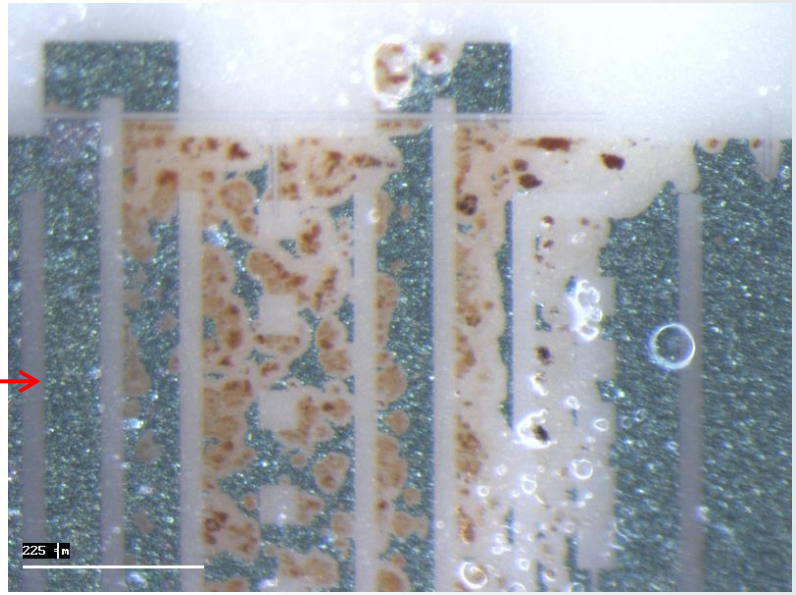
SMT Resistors (Thick+Thin film)

Main defects



SMT Resistors (Thin film)
Corrosion



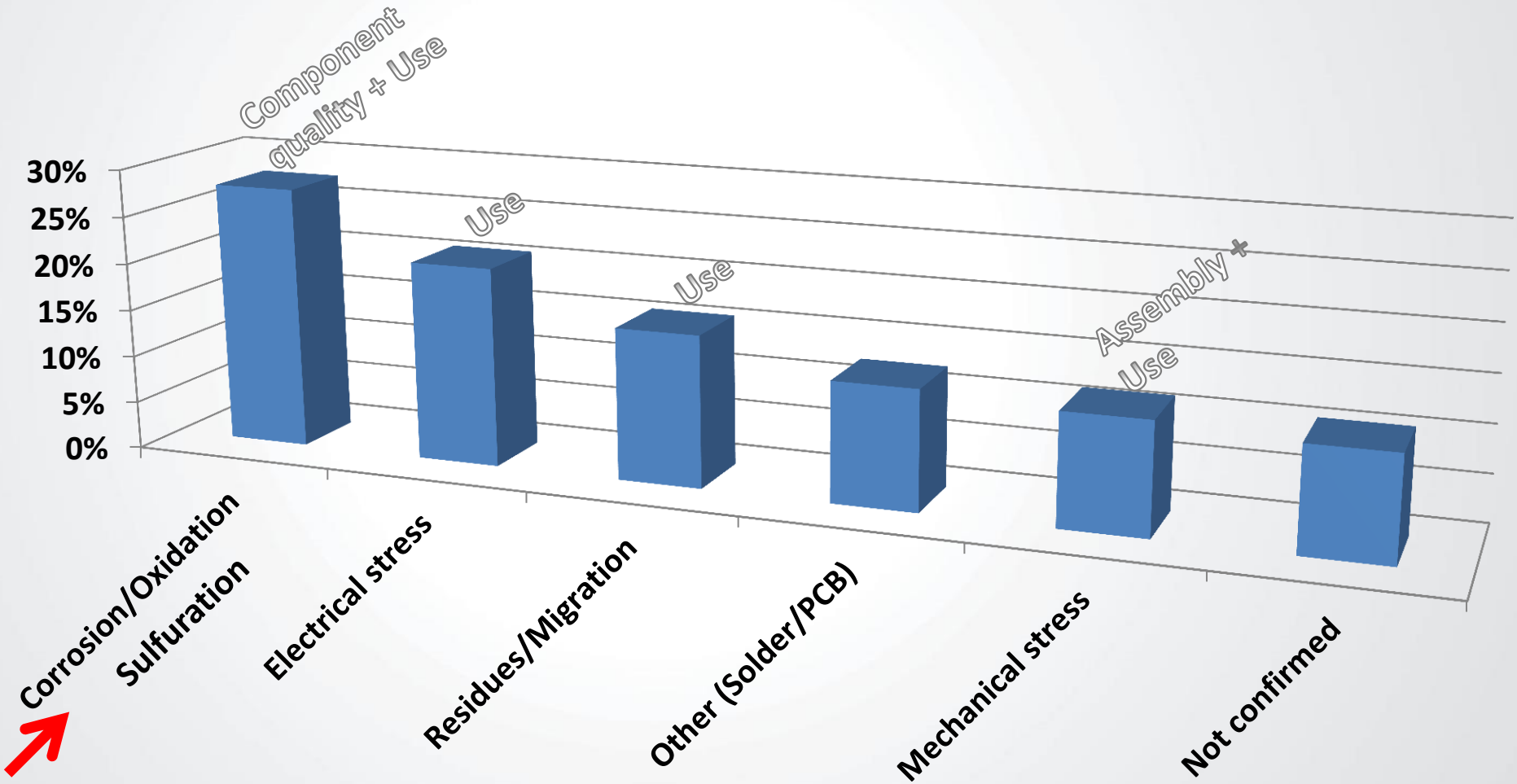


Oxidation of the resistive layer in presence of humidity

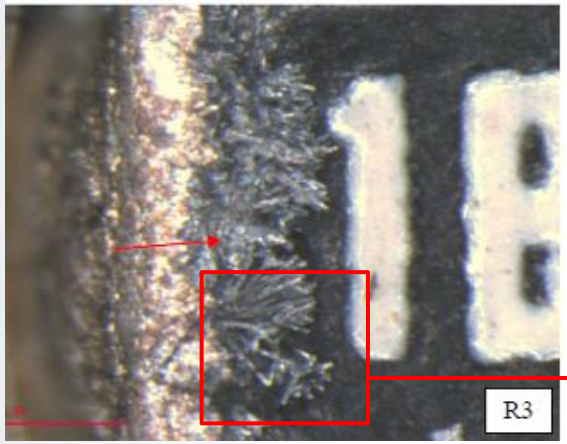
→ **Resistance increases up to open circuit**

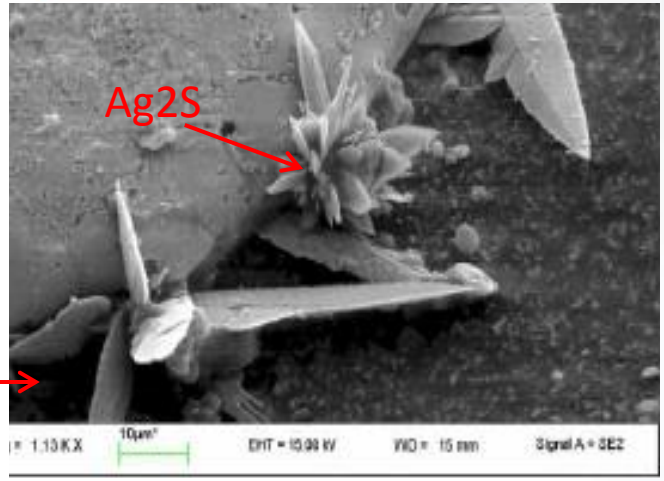
SMT Resistors (Thick+Thin film)

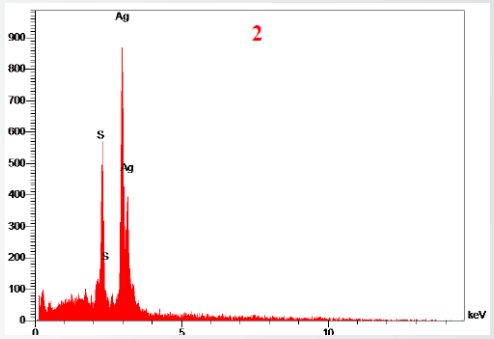
Main defects

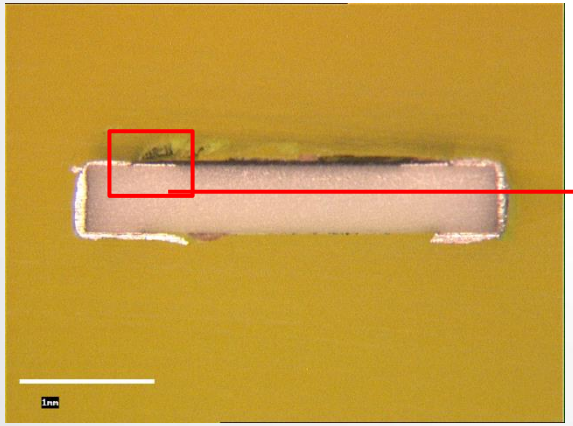


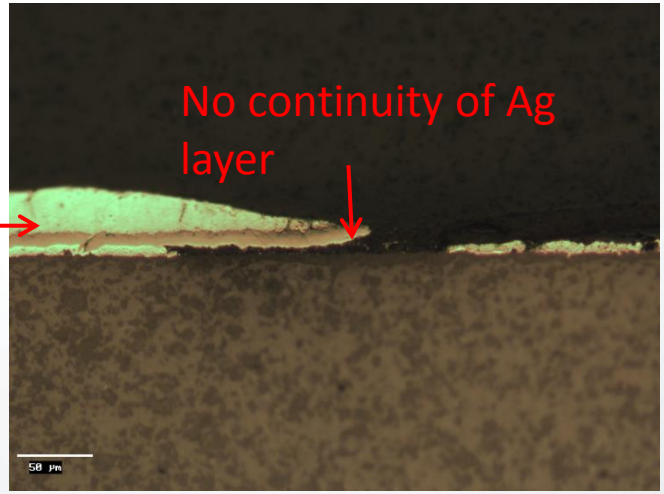
SMT Resistors (Thick film)
Corrosion (sulfuration)











Environment:
Sulfur attack of silver occurs at the interface of the glass passivation layer and the resistor termination

→ **Open circuit**

Headquarters in Pessac

Thank you

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