CLEANING BEFORE CONFORMAL COATING

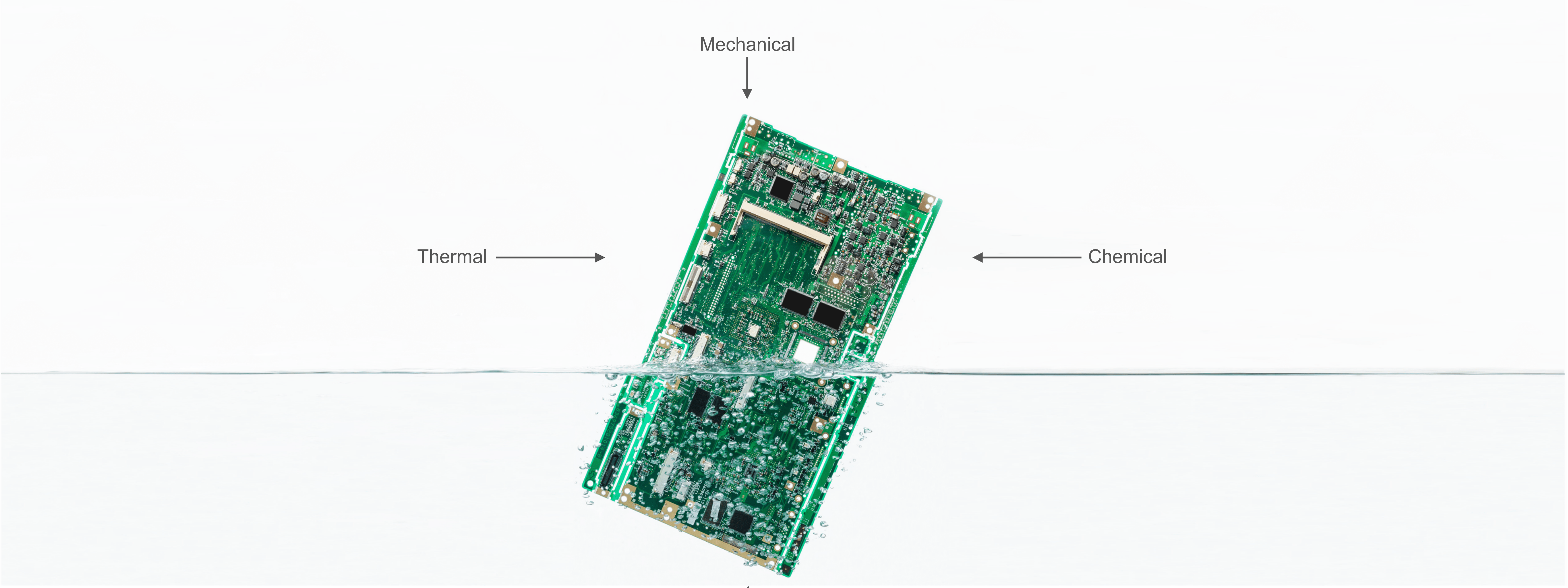
Naveen Ravindran, M.S.Ch.E.,

Application Technology Engineer

If you cannot hear me clearly, please notify me via the chat function at this time. This webinar is being recorded, slides will be emailed within 24 hours.

CONTENT

INTRODUCTION



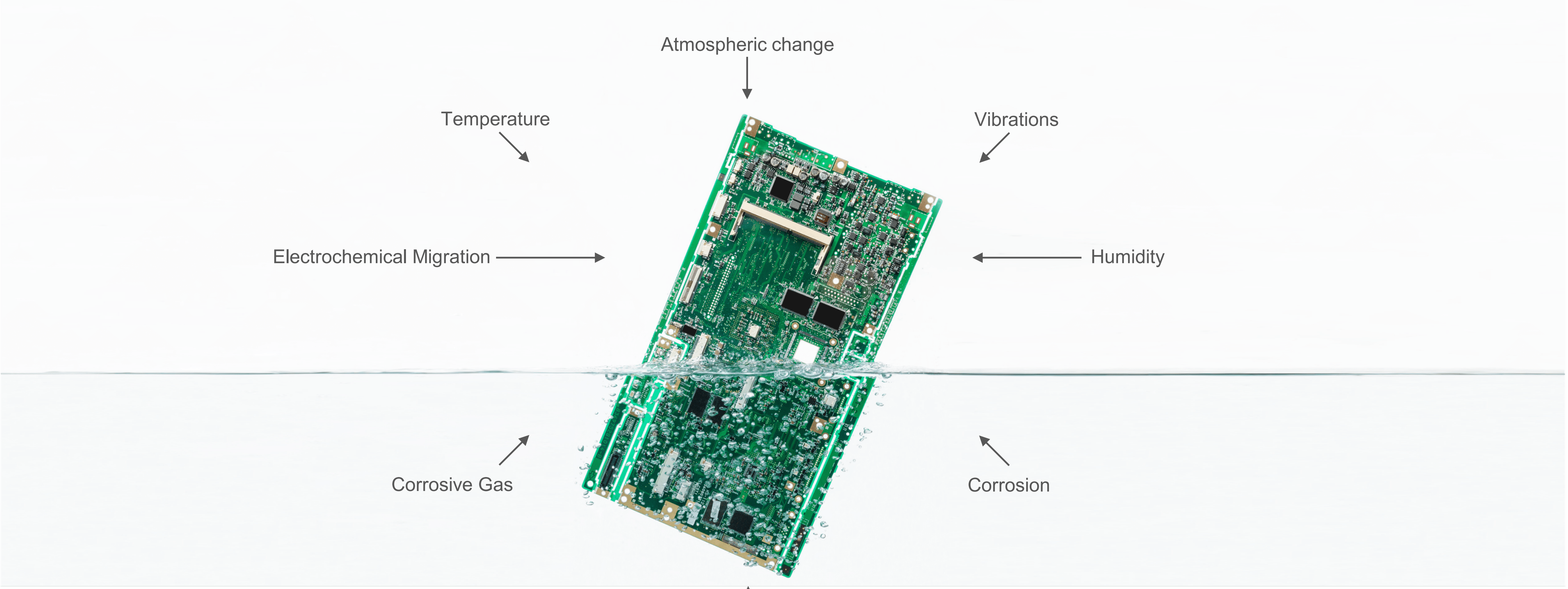
Mechanical

Thermal

Chemical

Electrical

INTRODUCTION



Atmospheric change

Temperature

Vibrations

Electrochemical Migration

Humidity

Corrosive Gas

Corrosion

Salt Spray

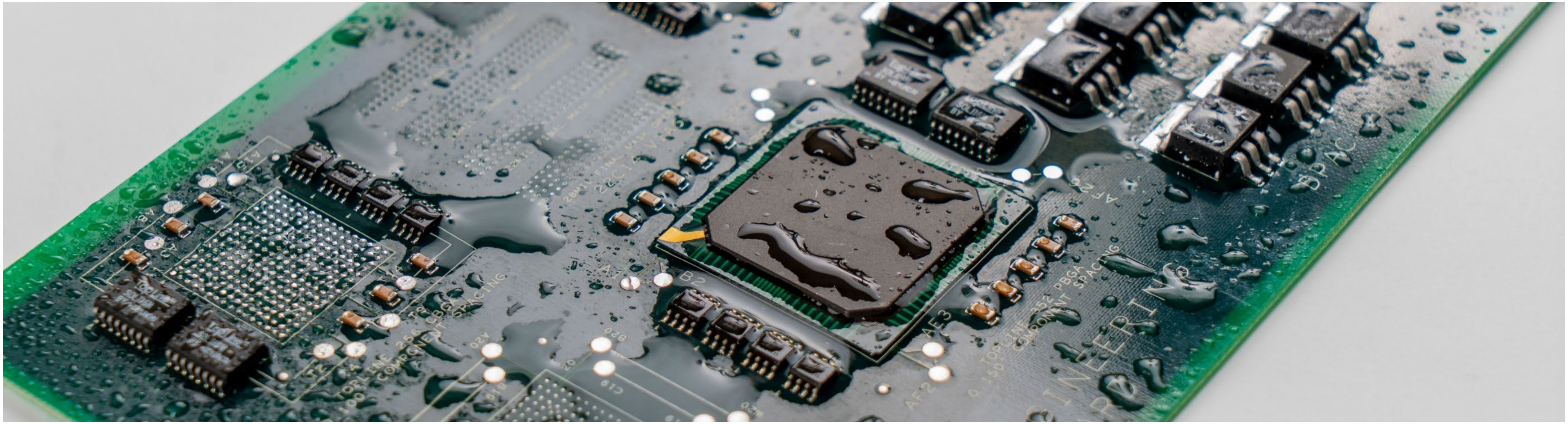
INTRODUCTION

COMPONENTS ARE GETTING MORE COMPLEX.

Old Trends	New Trends
Larger components	Miniaturized components
Low component densities	High component densities
High standoff spaces	Low standoff spaces < 1 mil
Simple component types	Complex component types

NEW TRENDS

ADVANTAGES OF COATING



Coating protects against failures due to humidity

- Electrochemical migration
- Leakage current
- Signal distortion on high-frequency circuits

POSSIBLE CONTAMINATION

Manufacturing PCBs

Residues from acid processes
Developer chemistry
Alkaline cleaner
HAL-Residues
Residues of ENiG-/ CSN-Process
Rinse water quality

Manufacturing Components

Residues from metalization baths
Rinse water quality
Deflashing chemicals
Mold release agent
Flux residues

Assembly

Solder pastes
Wave soldering
Rinse water quality
Reflow soldering
Reflow condensates
Gas emission
Hand perspiration

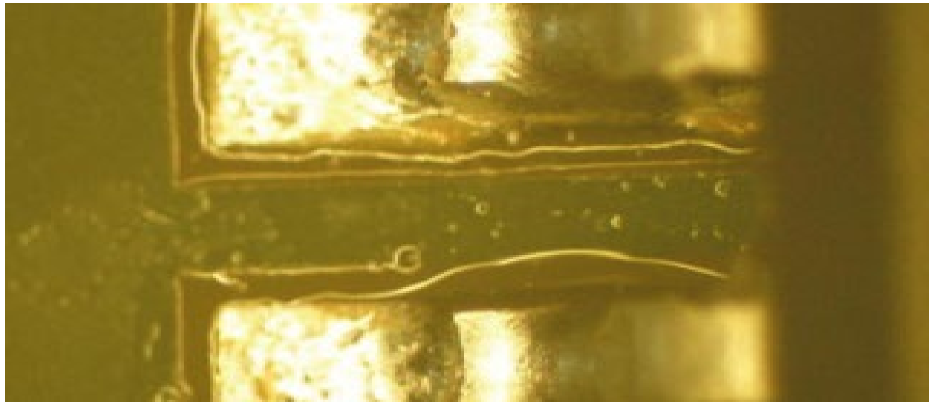
CRITICAL RESIDUES

Resin or rosin

Activator – organic or inorganic

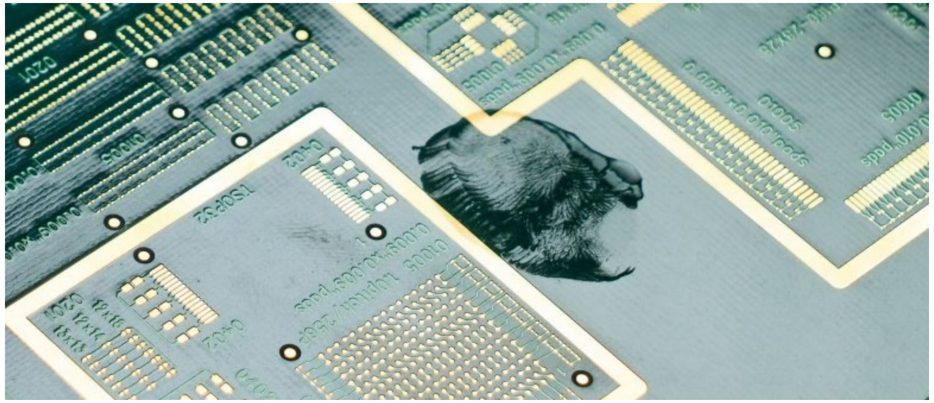
Solvent (dilution)

Thixotropic agent



Contamination due to handling

i.e. fingerprints, dust, oil, salts



CONTENT

CLIMATIC FAILURE MECHANISMS

Electrochemical Migration

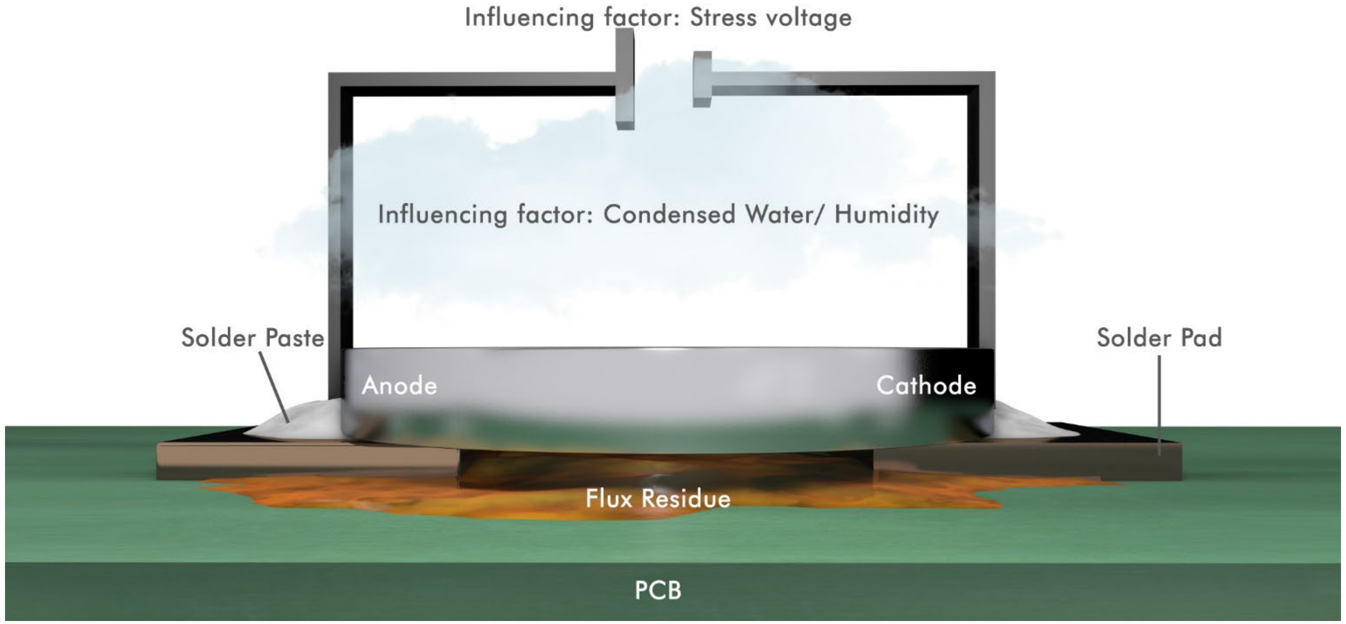
Contamination Induced Leakage Current

Signal Distortion on High Frequency Circuits

MECHANISM IS ACCELERATED BY CONTAMINATION

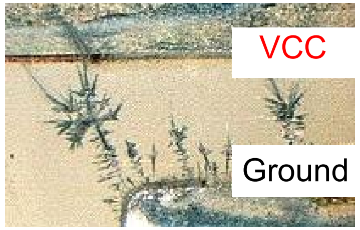
(concentration of electrolyte)

Electrochemical Migration - Mechanism
- Water dissociates under voltage (OH- formation)
- Local increase of pH value (alkalinity)
- Shift from passive area to corrosion area
- Dissolution of metal at the anode
- Ion migration to the cathode due to potential difference
- Precipitation of metallic dendrites at the cathode
- Dendrite grows from cathode to anode



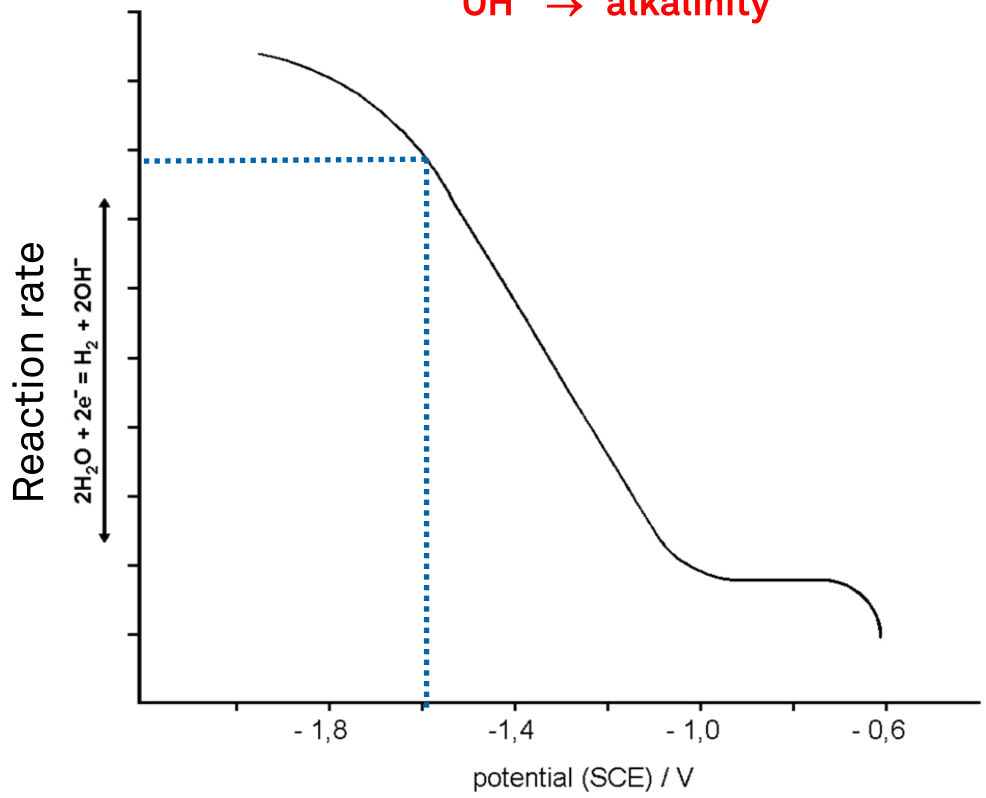
Moisture/Humidity + Ionic Contamination(salts, flux activators) = **Conductive Electrolytes**

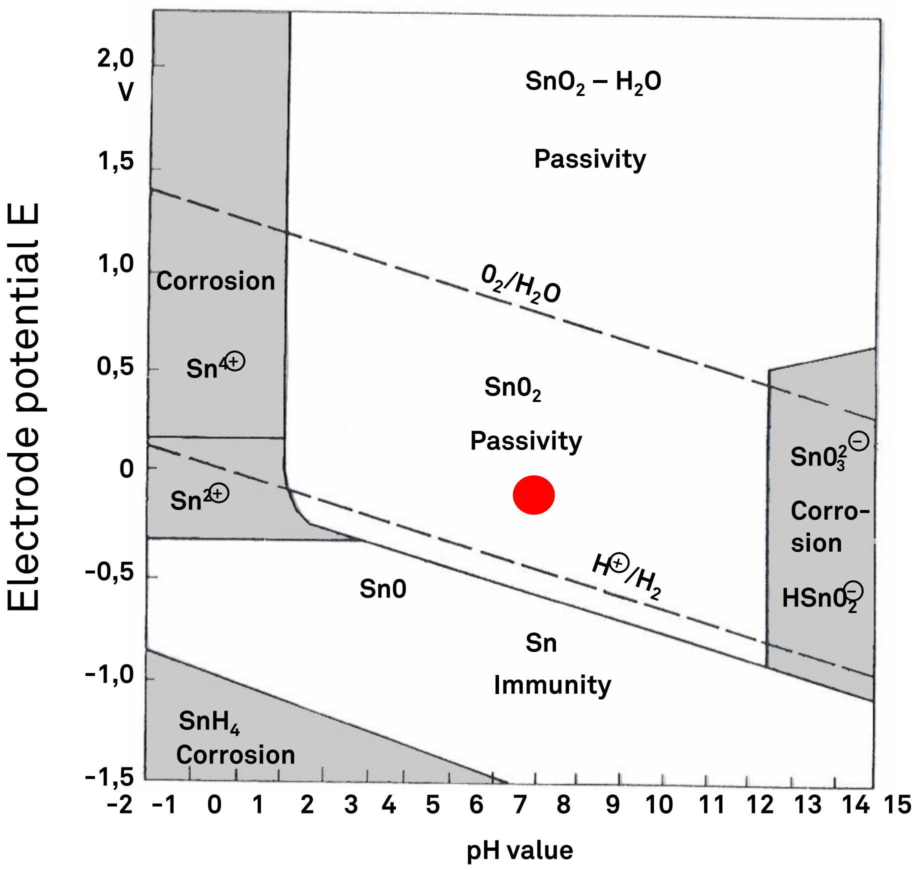
Conductive Electrolytes + Stress Voltage = **Electrochemical Migration**



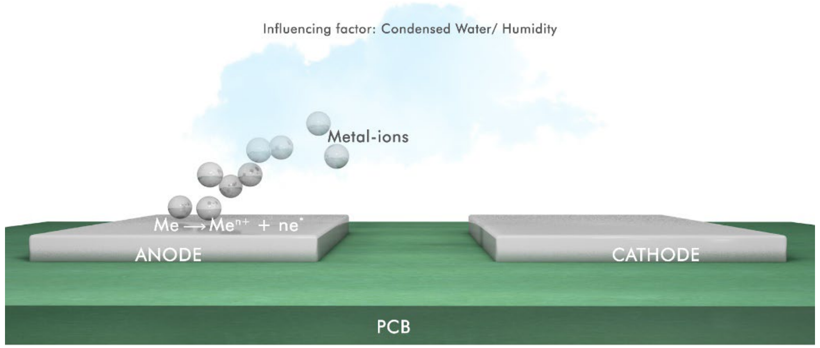
DISSOCIATION OF WATER AND TIN CORROSION

OH$^-$ → alkalinity

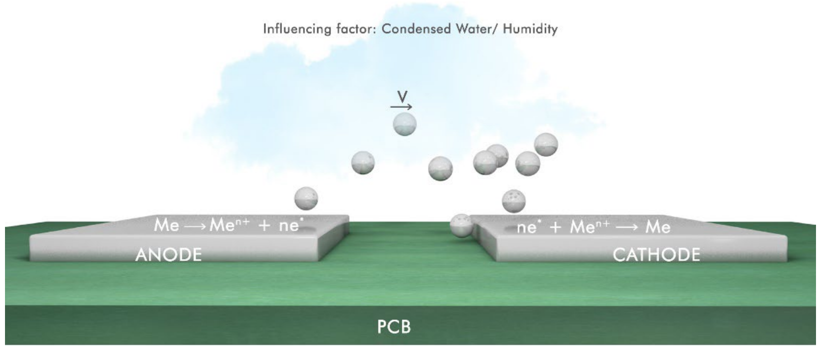




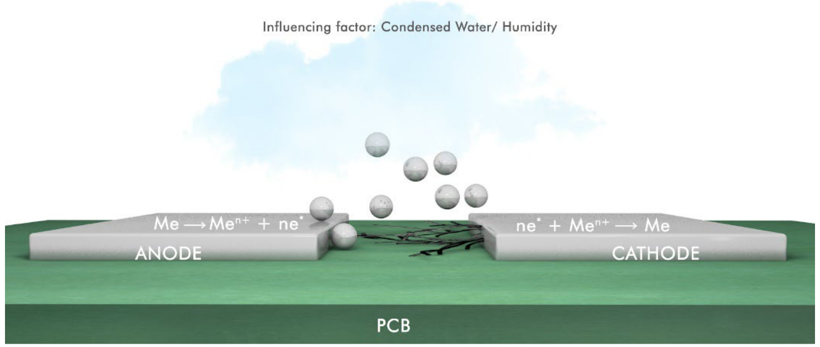
MECHANISM OF DENDRITE GROWTH



DISSOLVING



ION MIGRATION



DEPOSITION

CLIMATIC FAILURE MECHANISMS

Electrochemical Migration

Contamination induced leakage current

Signal Distortion on High Frequency Circuits

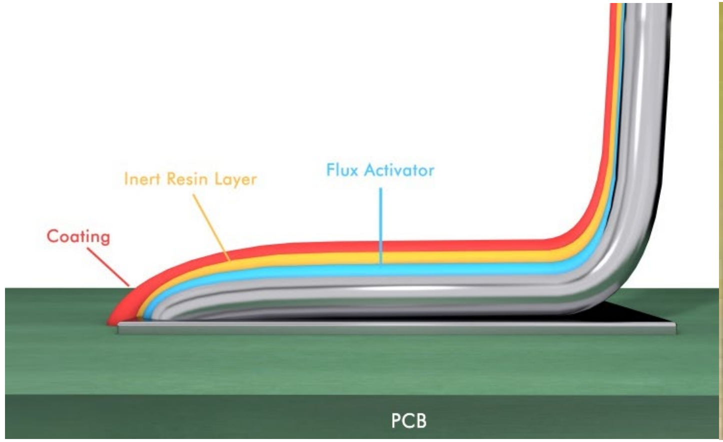
DANGER OF LEAKAGE CURRENT

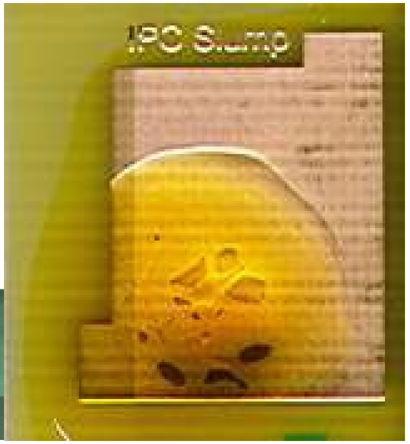
IMPORTANT

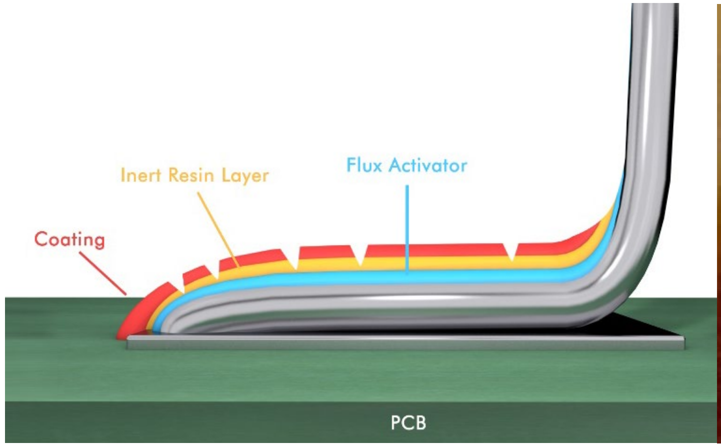
No humidity necessary, only change of temperature

ACTIVATORS

Are affecting leakage current and climatic reliability







CLIMATIC FAILURE MECHANISMS

Electrochemical Migration

Contamination induced leakage current

Signal Distortion on High Frequency Circuits

INFLUENCE OF GEOMETRY and FLUX

UNWANTED CAPACITANCE IN HIGH FREQUENCY CIRCUITS

Close proximity of electrodes causes “Parasitic Capacitance”

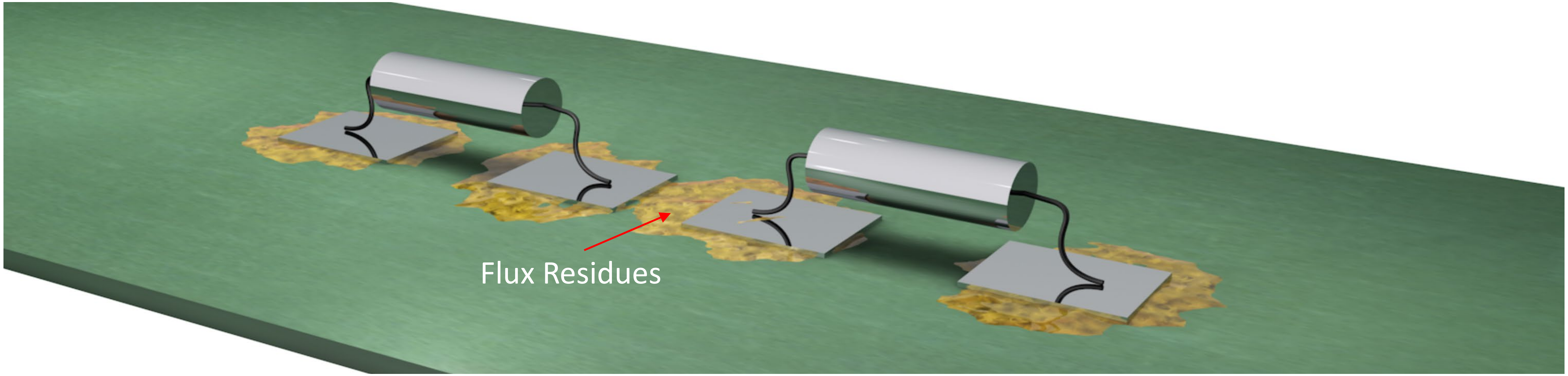
- – build up of electrical energy due to electric fields generated between electrodes at different voltages

Affects performance of HF devices – limits bandwidth and operating frequency

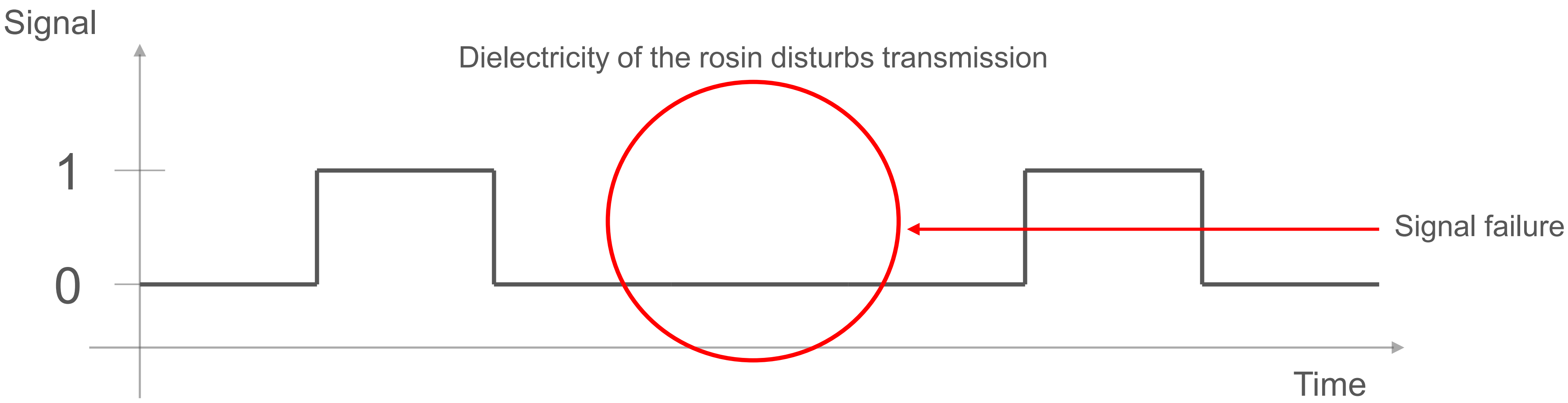
Usually dealt with at design stage or by using RF shields

CAUTION!!

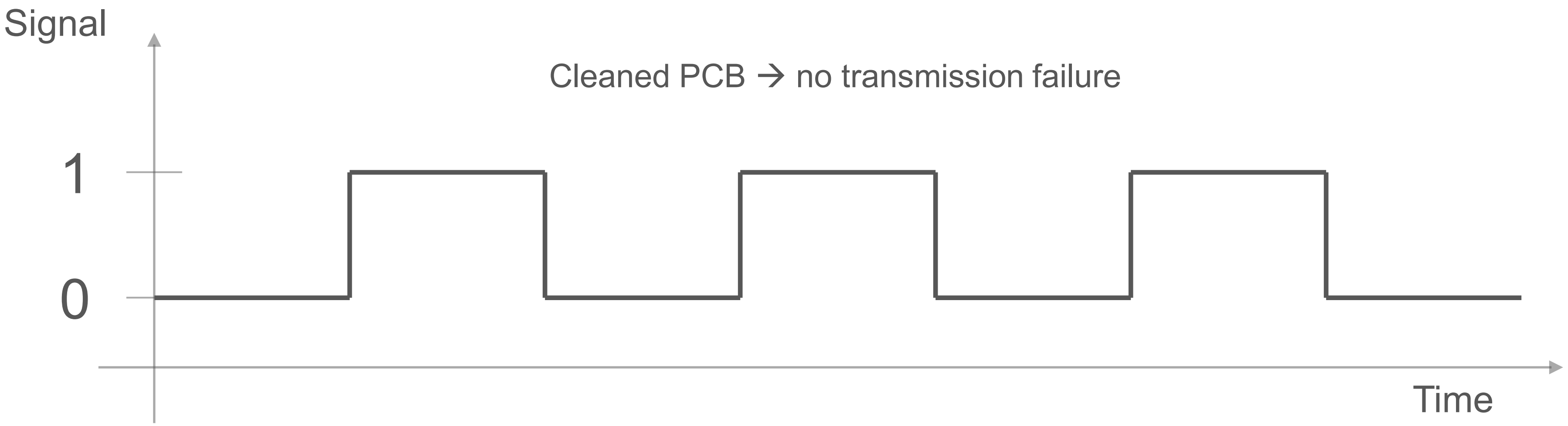
Rosin in Flux → acts as dielectric → increases local capacitance



SIGNAL FAILURES IN HF CONNECTIONS

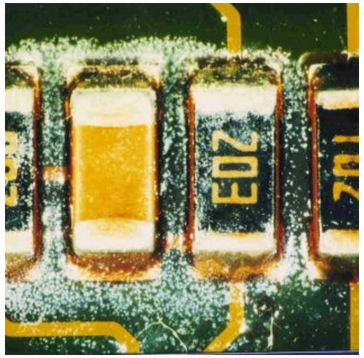

Dielectricity of the rosin disturbs transmission

Signal failure

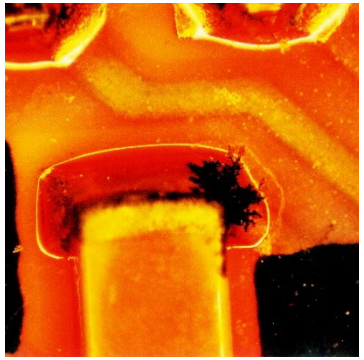

Cleaned PCB → no transmission failure

CONTENT

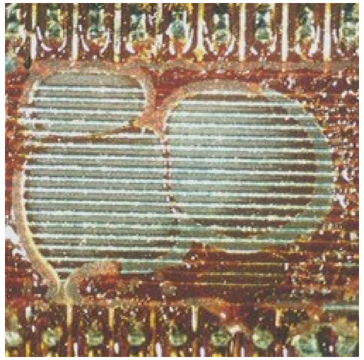
COATING FAILURES



Blister Type Failure

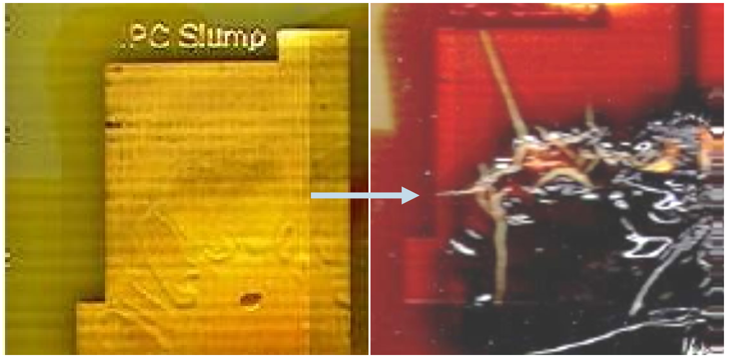


Electrochemical Migration Underneath Protective Coating



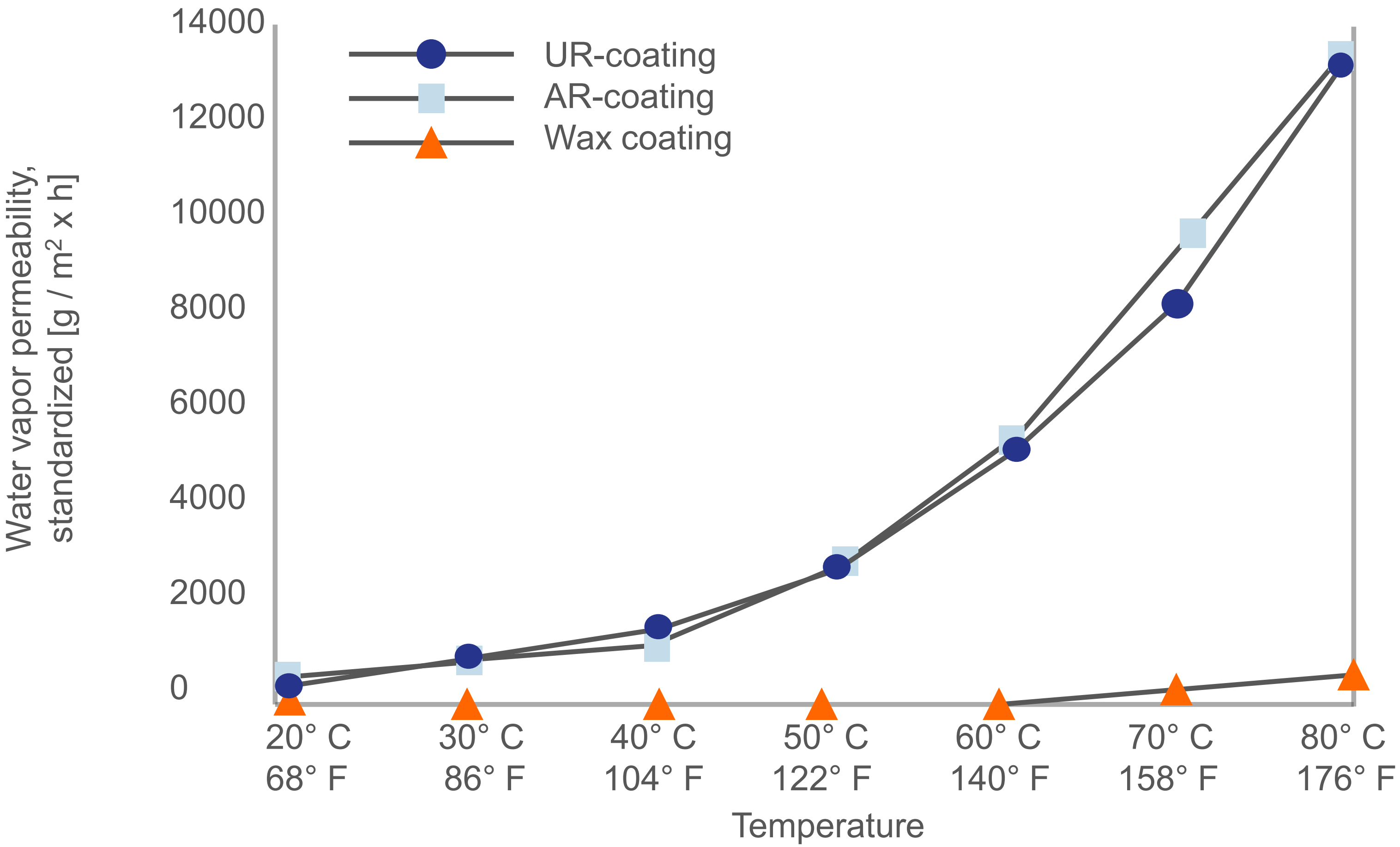
Wetting Failures Undercomponents

Pore Formation and Delamination

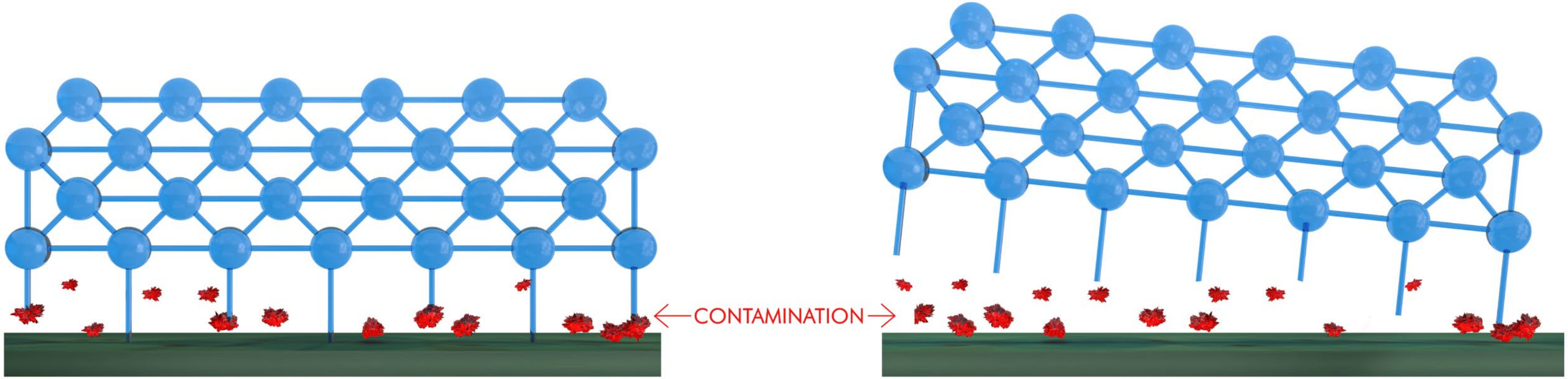


Cracks due to temperature change and reaction of coating with resin

WATER VAPOR PERMEABILITY



INFLUENCES ON UNCLEANED SUBSTRATES

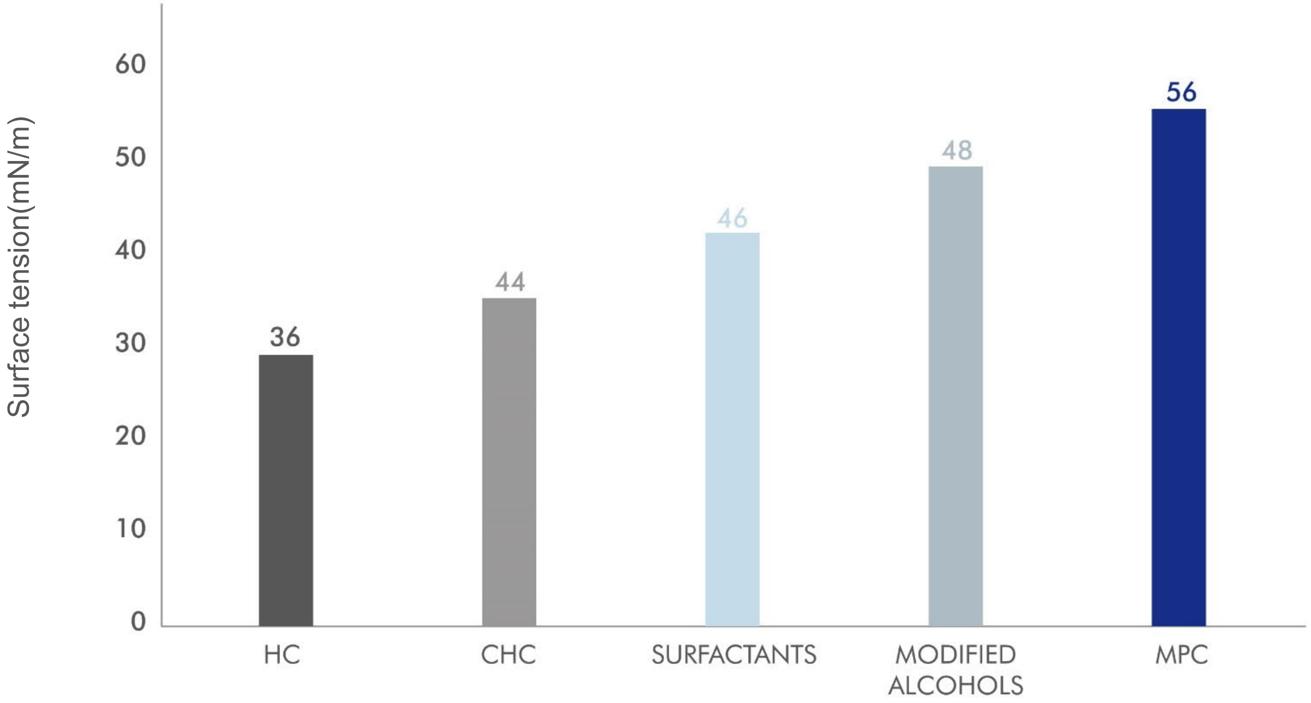


Contamination reduces adhesive forces and leads to delamination

RESIDUES CONSEQUENCES

Resin based residues as part of the flux	Subsequent delamination when exposed to climatic changes Cracks in coatings Failures in HF connections
Flux activators	Hygroscopic – danger of failure Corrosion on connections Leakage currents
Organic tin-salts (reaction product from flux and solder paste)	Insufficient adhesion and creeping underneath coatings
Sulfur and ammonium compounds (can be contained in fluxes)	Insufficient adhesion and creeping underneath coatings
Chemical facilitators for component release	Impacts wetting properties Delamination possible
Oligomeric parts of substrates and solder mask interaction	Contamination film Similar effect as with chemical facilitators

SURFACE ENERGY AND CLEANING



HIGHER SURFACE ENERGY = BETTER COATING ADHESION

CLEANING BEFORE CONFORMAL COATING

Coating is applied to increase climatic reliability

Coating alone is inadequate because of vapor permeability

- Could be worse than cleaning without coating

Contamination under coating is hygroscopic

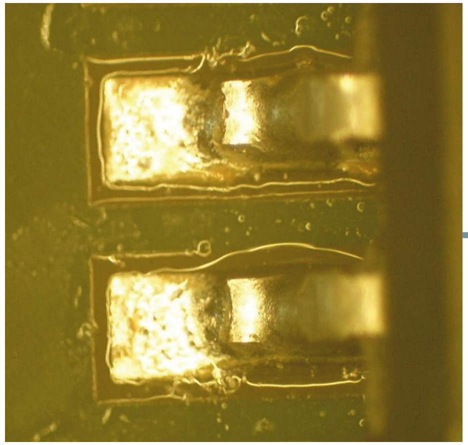
Limited adhesion on uncleaned PCB

RELIABLE COATINGS REQUIRE CLEANING

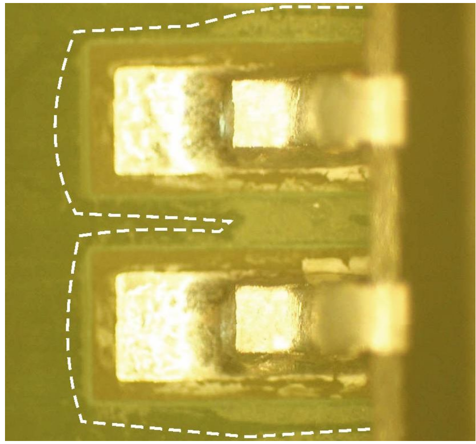
- CONFIRMED BY COATING SUPPLIERS

CONTENT

STAGES OF FLUX REMOVAL

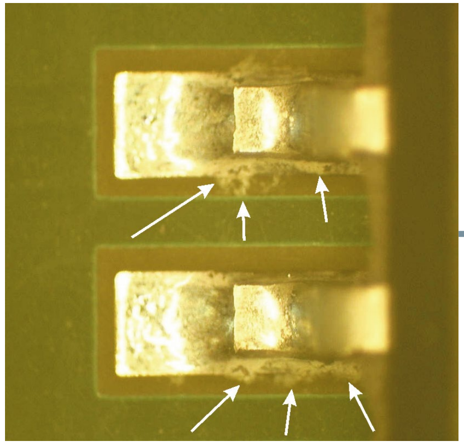


Partially removed residues



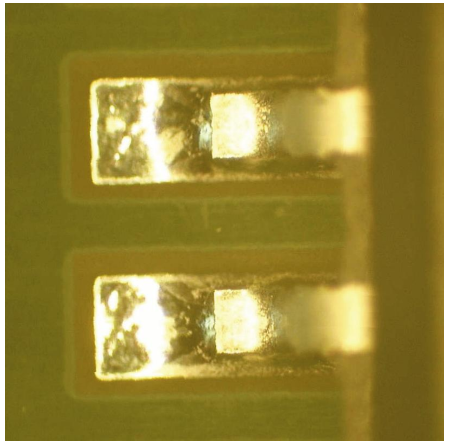
Partially attacked residues

CRITICAL!!



Almost removed residues

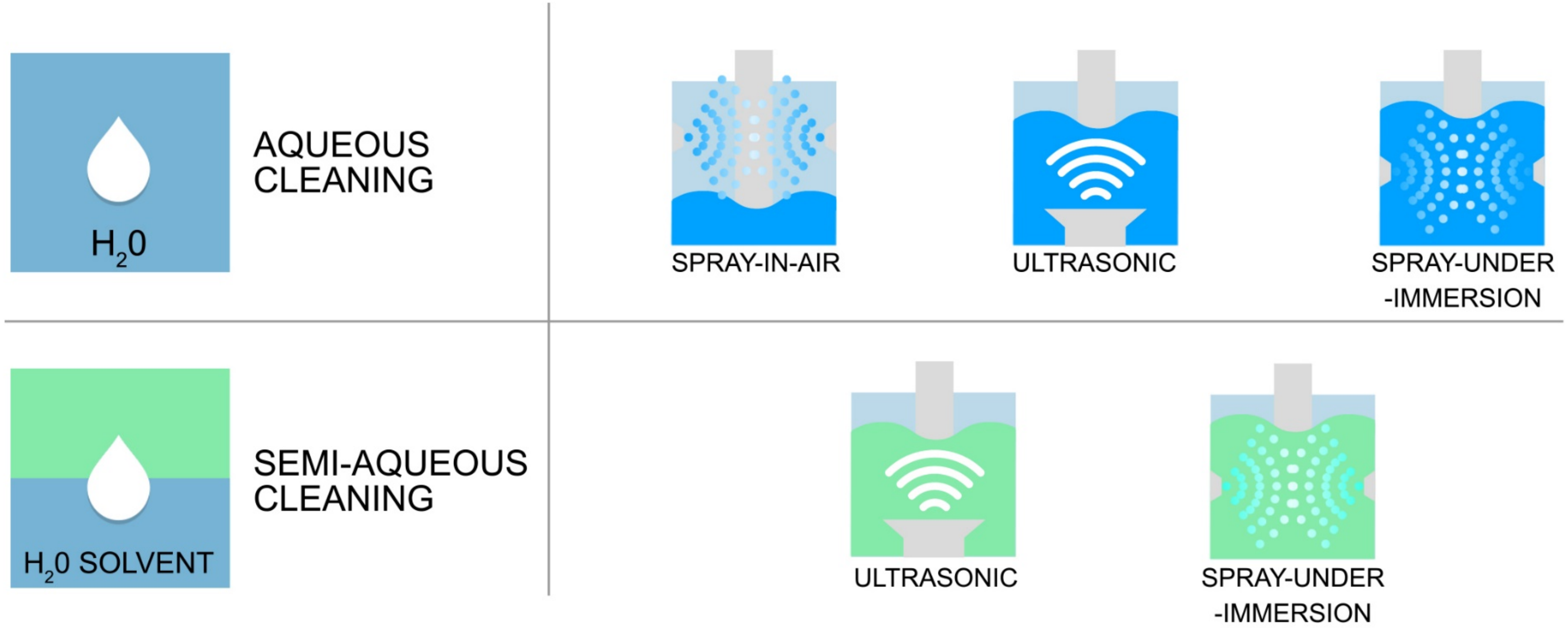
LESS CRITICAL!!



Flux Residues completely removed

TARGET!!

CLEANING BEFORE CONFORMAL COATING



H_20

AQUEOUS CLEANING

SPRAY-IN-AIR

ULTRASONIC

SPRAY-UNDER-IMMERSION

H_20 SOLVENT

SEMI-AQUEOUS CLEANING

ULTRASONIC

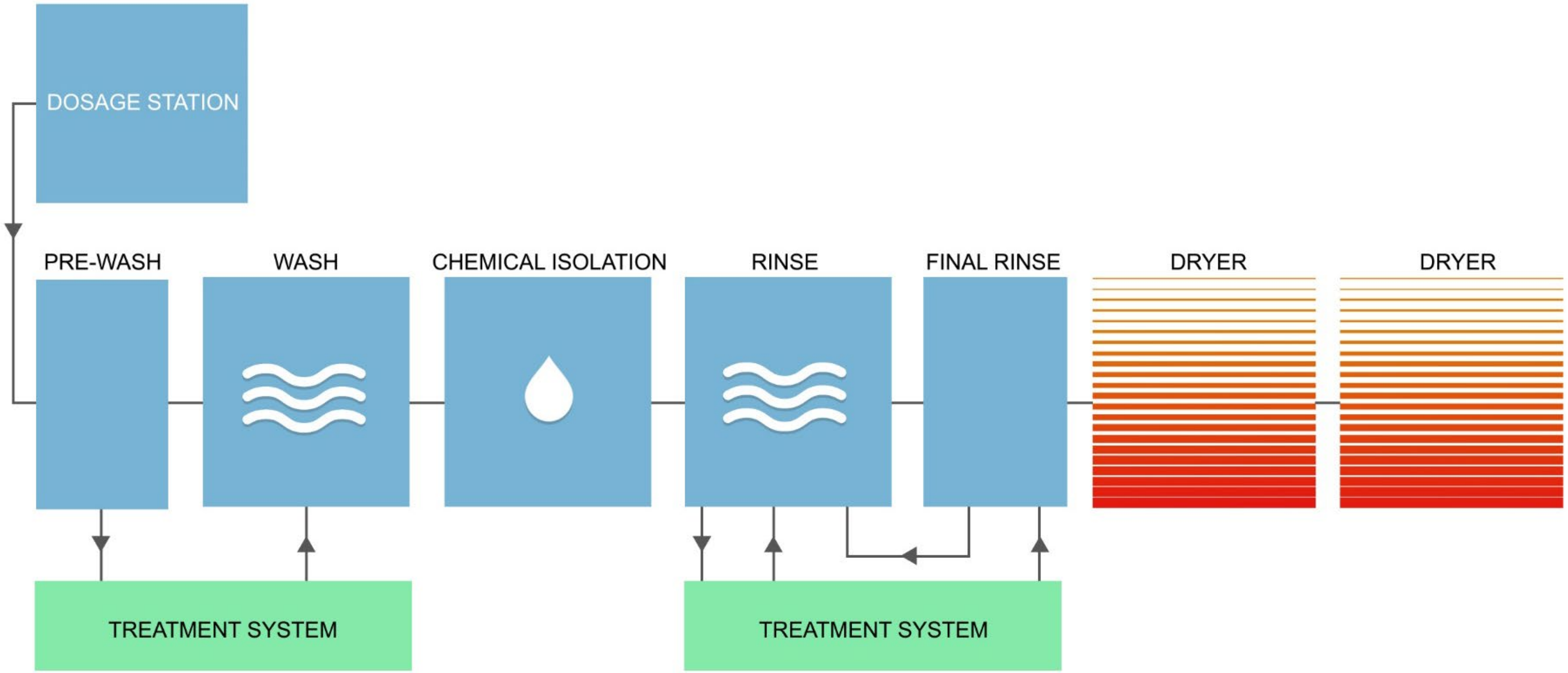
SPRAY-UNDER-IMMERSION

WATER SPRAY-IN-AIR HIGH PRESSURE INLINE PROCESS

Process Characteristics

Medium to high throughput

Spray pressure 50 – 120 PSI



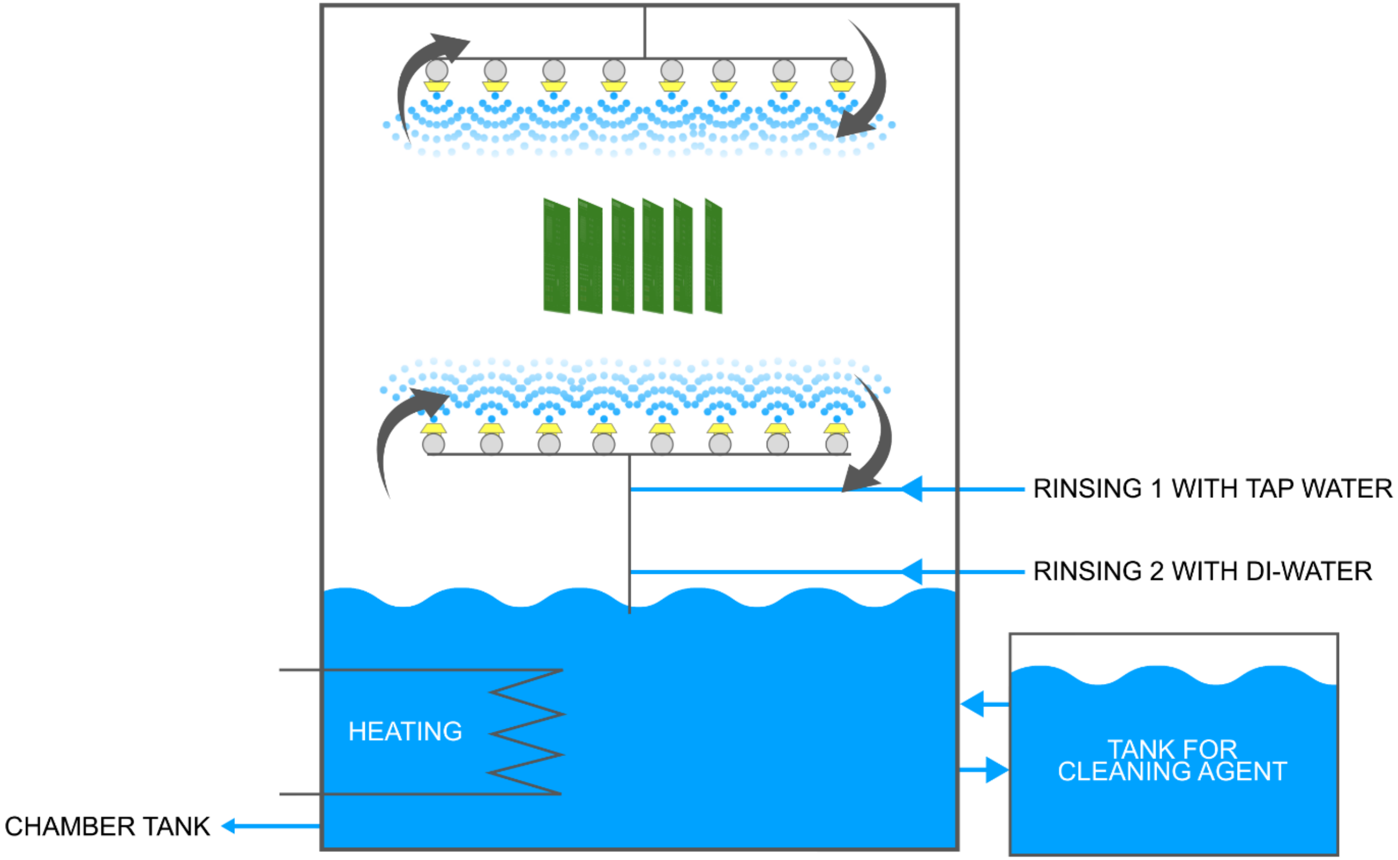
WATER SPRAY-IN-AIR BATCH PROCESS

Process Characteristics

For low to medium throughput

Spray pressure < 20-70 PSI

Small footprint



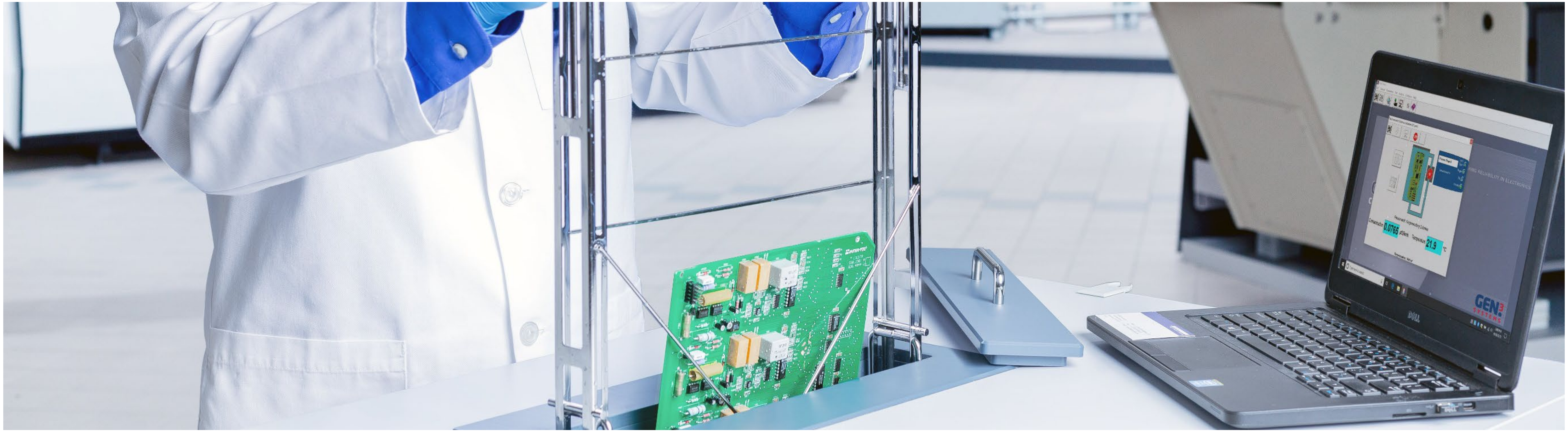
CONTENT

REQUIREMENTS FOR COATING

Evaluation of cleanliness (prior to coating)

Test	Required Value	
Ionic Contamination	< 0.4 µg/cm²	✓
Surface tension	> 40 mN/m	✓
ZESTRON® Flux Test	Residue-free	✓
ZESTRON® Resin Test	Residue-free	✓

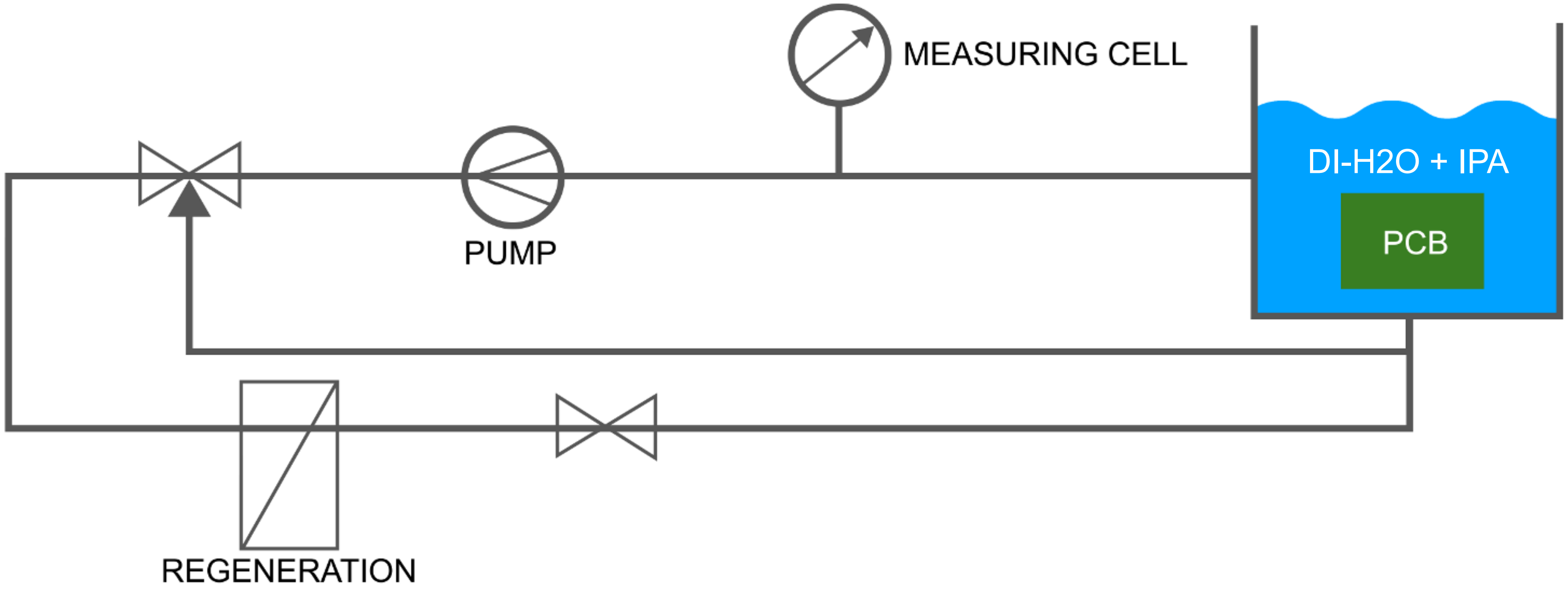
TEST METHOD IONIC CONTAMINATION



Measurement using an ionic contamination tester

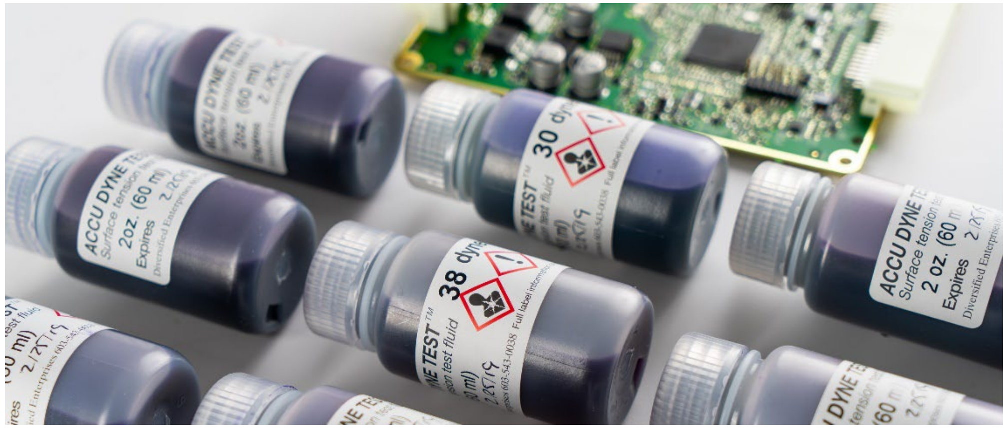
TEST METHOD IONIC CONTAMINATION

Process Schematic

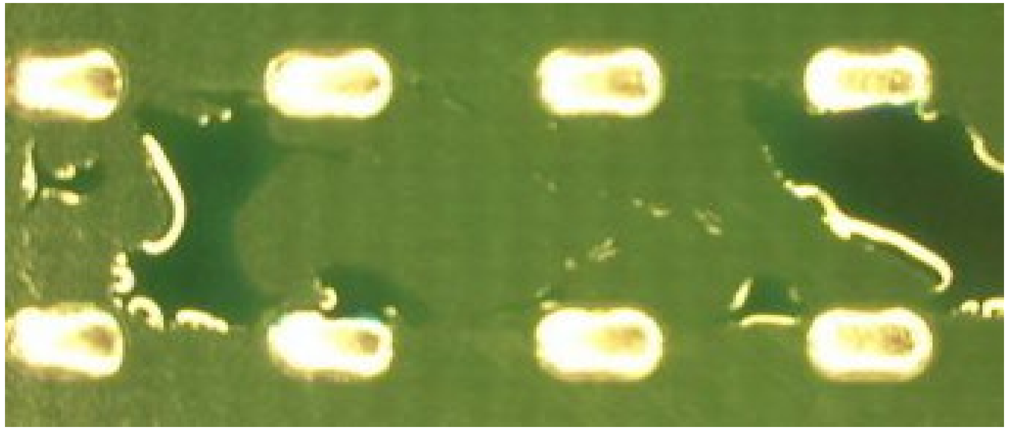


WETTABILITY & SURFACE CLEANLINESS

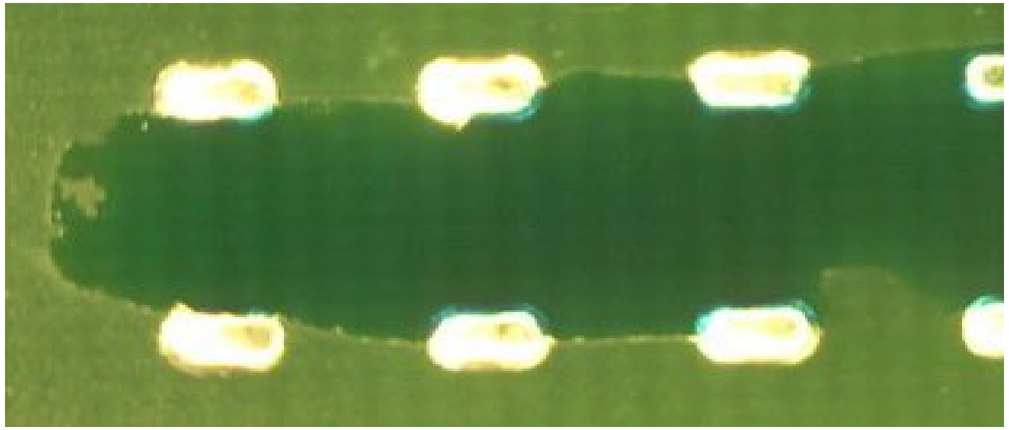
Testing method – ink test



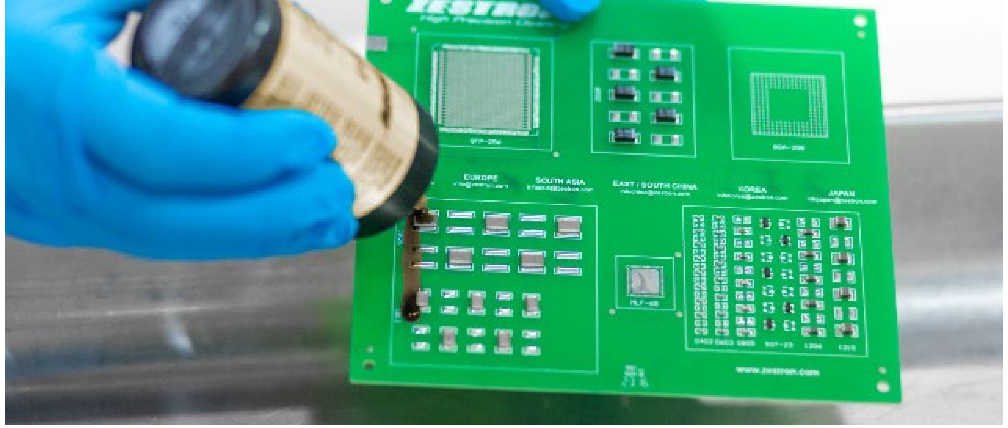
Bad wetting = unclean surface



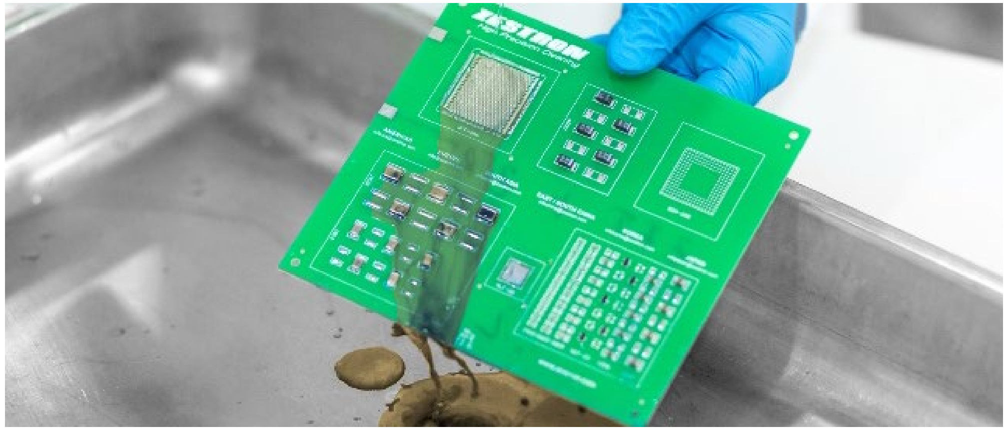
Good wetting = clean surface



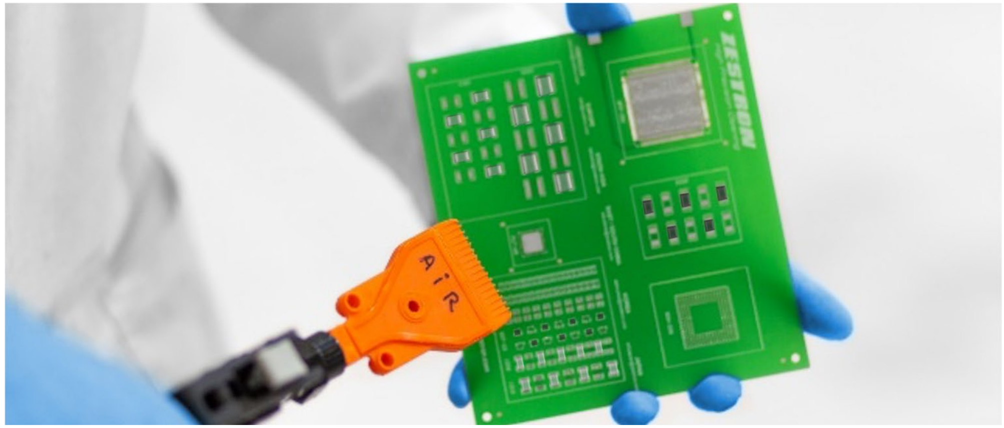
ACTIVATOR ANALYSIS



Application



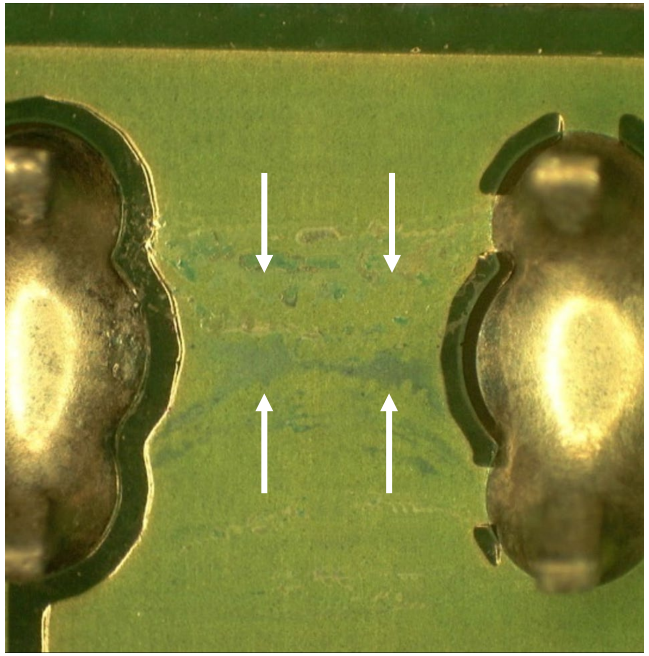
Rinsing

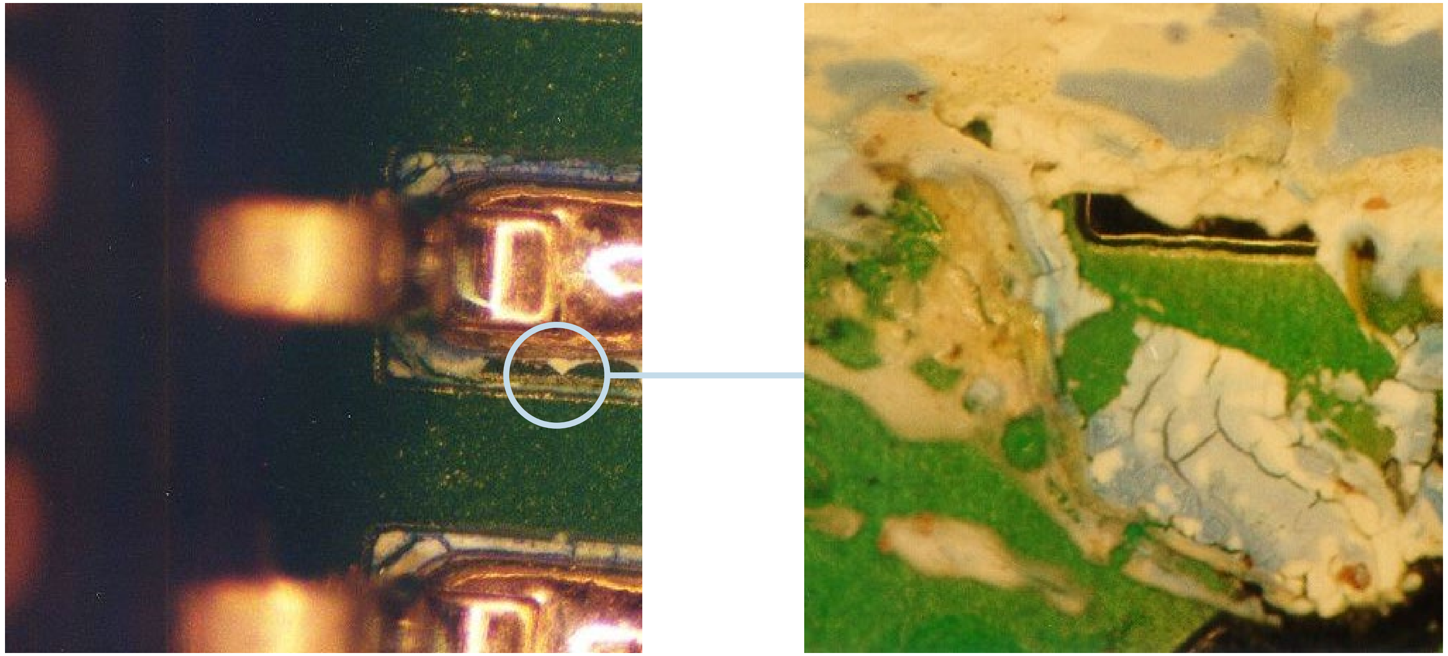


Drying

SAMPLE RESULTS AFTER FLUX TEST

No encapsulation of activators in the resin





RESIN RESIDUES DO NOT CHANGE COLOR

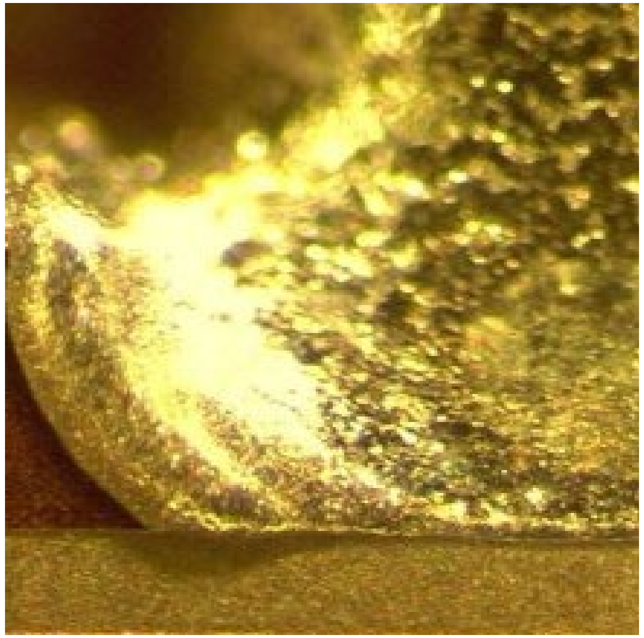
RESIN ANALYSIS

Confirmation of synthetic and natural resins

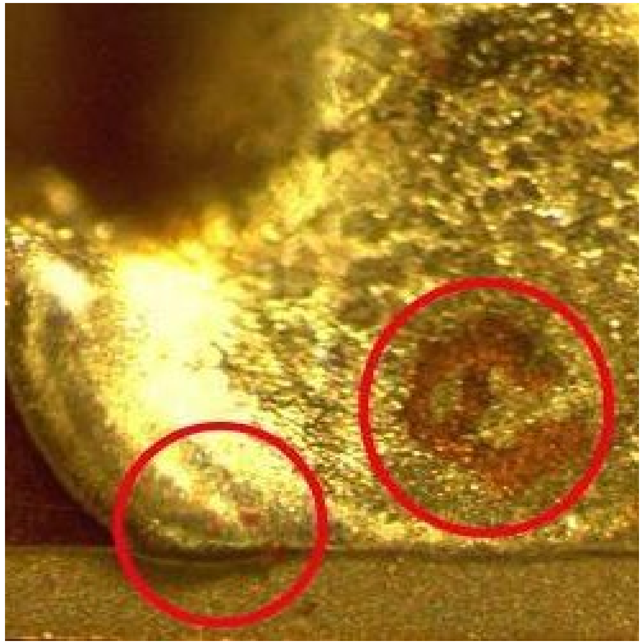
Shows local dispersion

Based on color reaction

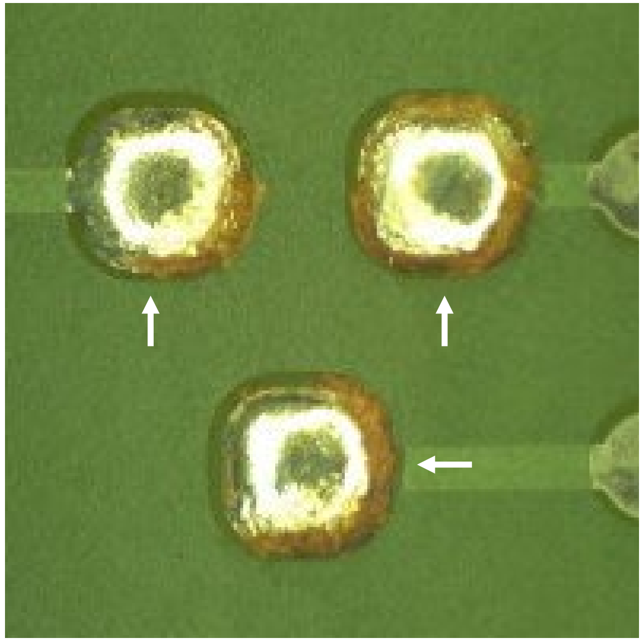
SAMPLES OF RESULTS AFTER RESIN TEST



Before



After



Resin residues turn Amber

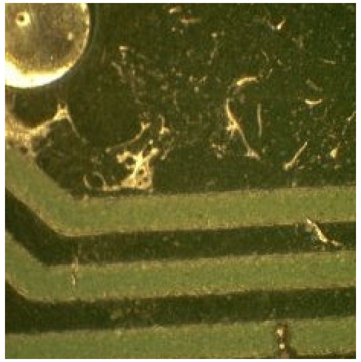
TEST METHOD – TIN TEST

Evidence of stannous components

Based on color reaction

Tin Test Negative

Tin Test Positive



COATING CONFIRMATION

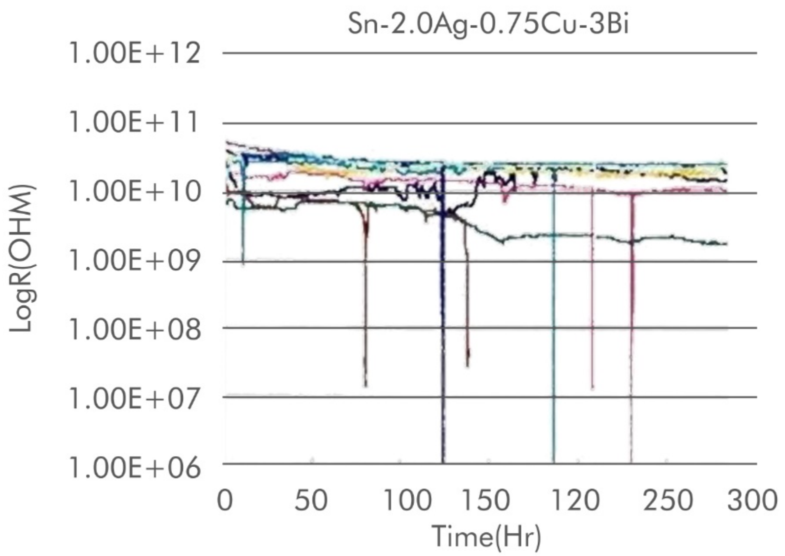
Test	
Climatic Reliability	✓
Coating Reliability Test	✓

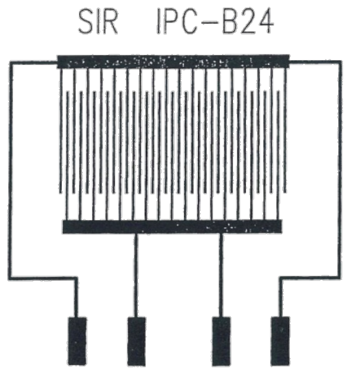
CLIMATIC RELIABILITY

Ag-containing solder pastes have a tendency to form temporary dendrites

Electrochemical Migration Test TM-650 2.6.14.1

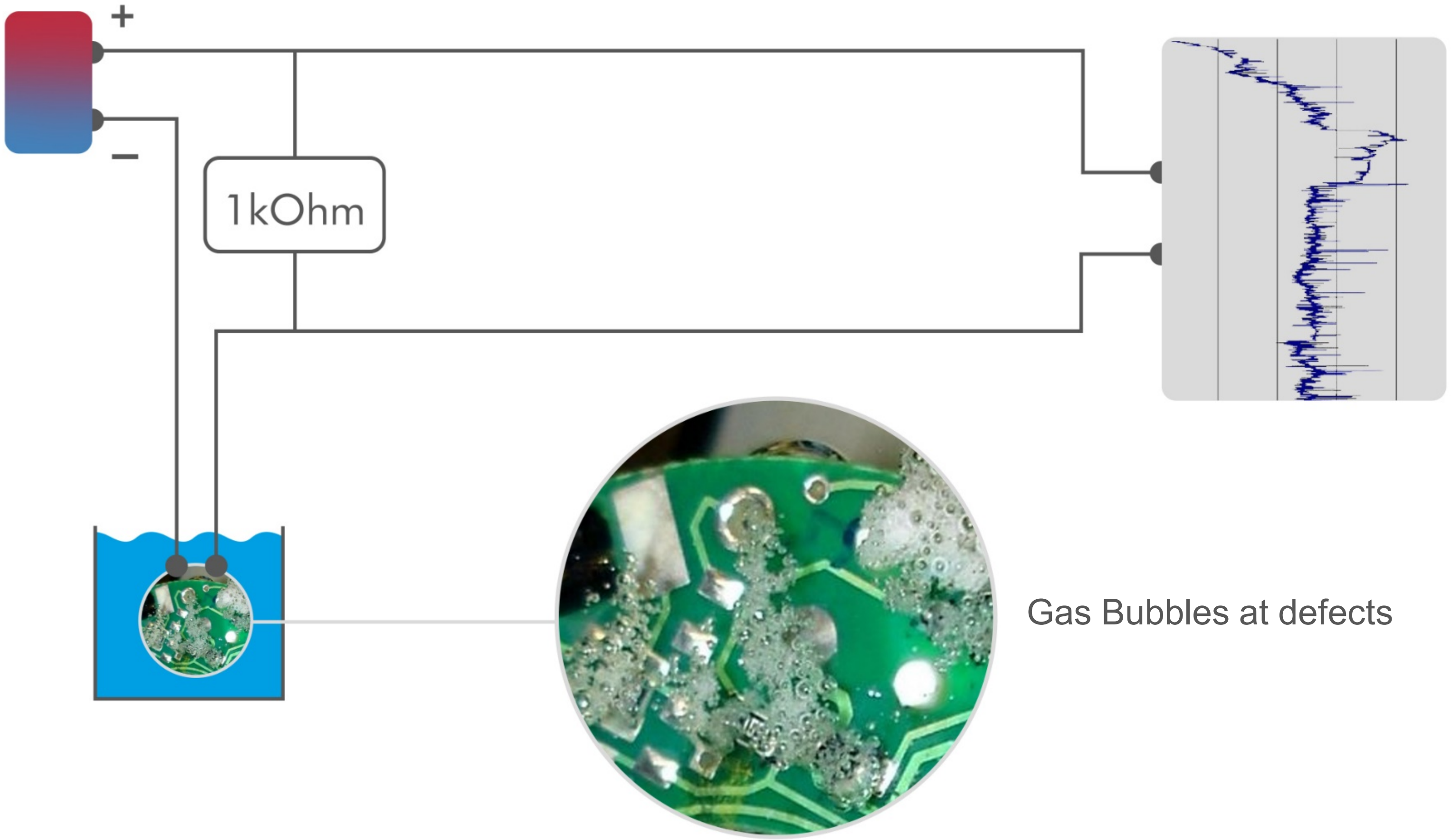
Surface Insulation Resistance Test TM-650 2.6.3.7





COATING ANALYSIS

Coating Reliability Test (CoRe Test)



Gas Bubbles at defects

ADVANTAGES OF THE COATING RELIABILITY TEST

Weak point analysis (Coating Reliability Test)	Life expectancy test (for example IEC 68-2 Standard)
+ During development	- After development (type approval)
+ Fast (max. 10 hrs)	- Time consuming (approx 6 months)
+ Low costs	- High costs
+ Identification of all weak points	- Failures could remain undiscovered
- Pseudo failure rate	+ No pseudo failure rate

CONCLUSION

Coating necessary to protect against moisture / condensation

Residues affect the coating integrity

Simple test methods for quick analysis available

Cleaning increases reliability of coating

Various cleaning processes are available

QUESTIONS?

NEXT WEBINAR: DI-WATER VS. CHEMISTRY | 4.27.2021 11^{AM} EDT