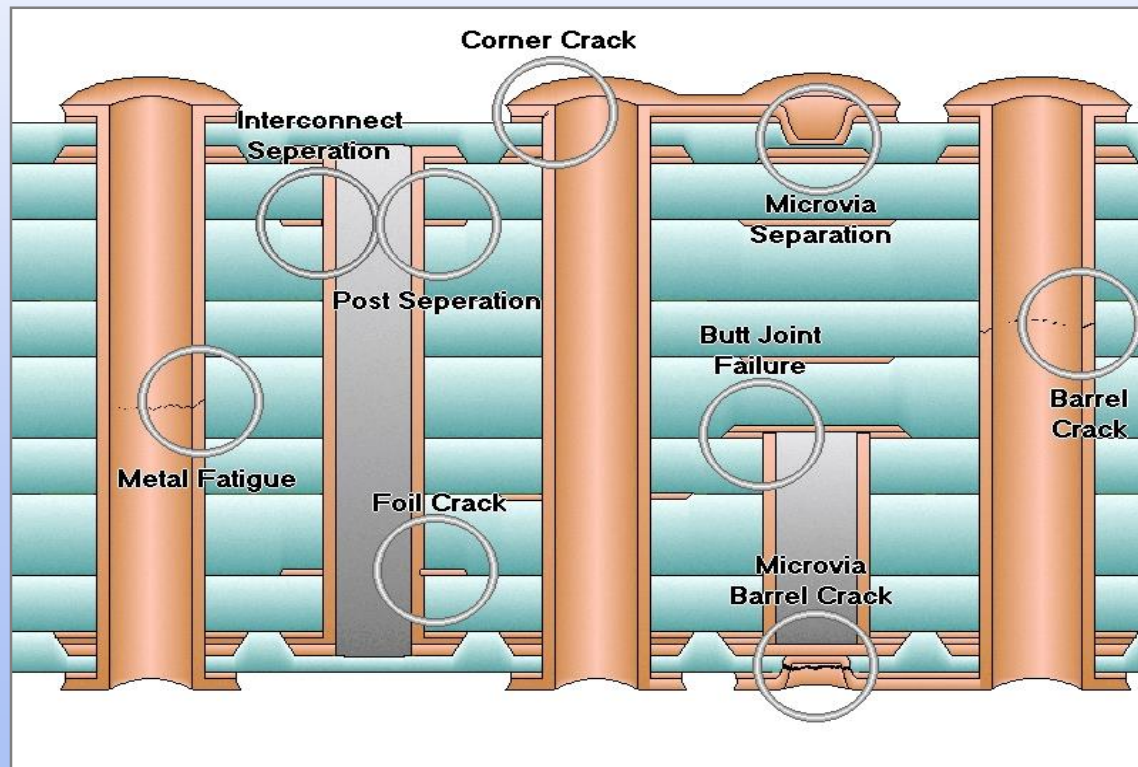
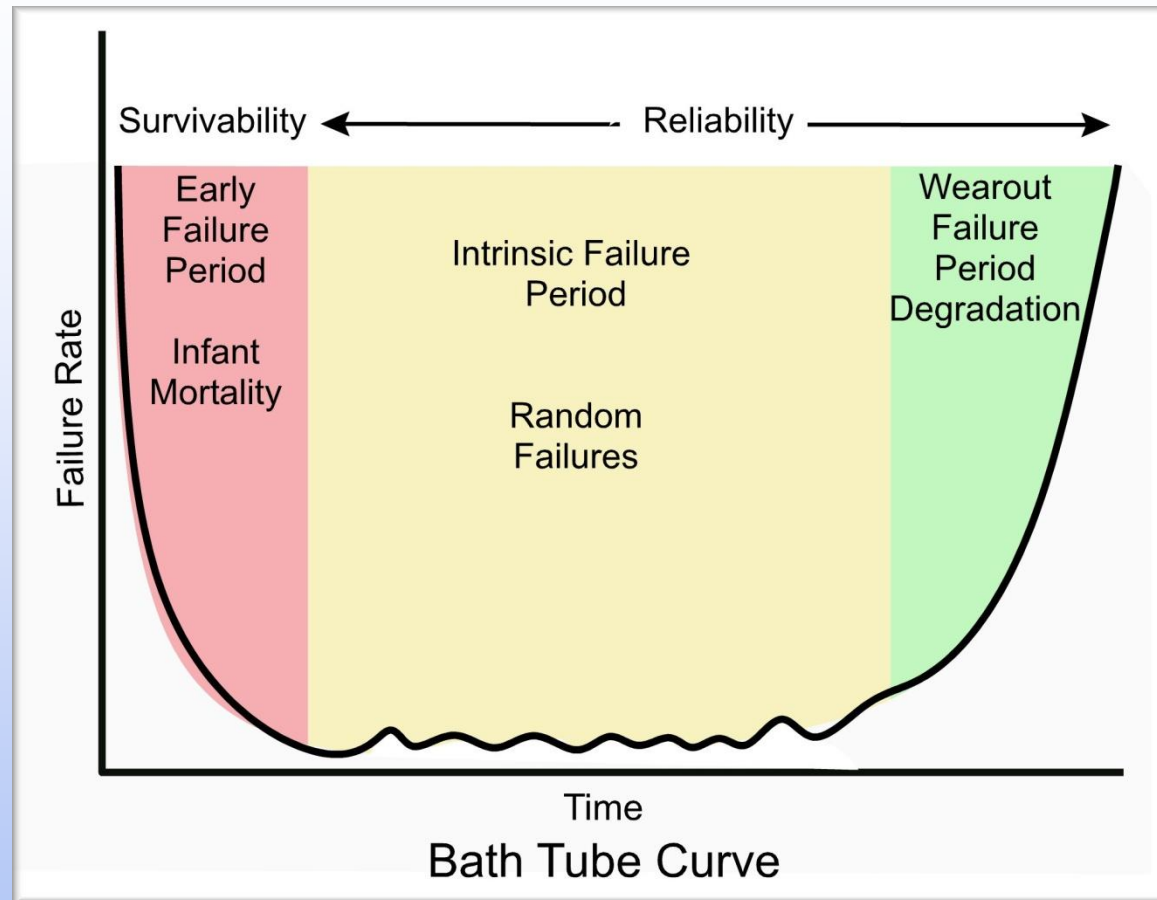


# IST Interconnect Stress Test – der neue Standard für die Zuverlässigkeitsprüfung von Leiterplatten

Hermann Reischer/Polar Instruments GmbH



# Was ist “Zuverlässigkeit”?



**Zuverlässigkeit** ist die **Wahrscheinlichkeit**, dass ein Produkt die beabsichtigte Funktion für einen **angegebenen Zeitraum** unter **definierten Bedingungen** erfüllt.

## Zukünftige Anforderungen an die Leiterplatte:

### Bleifrei-Lötprozesse:

Löttemperaturen > 260°C

Hot Air Levelling

6-fach Rework

### Hohe Zuverlässigkeit:

Medizintechnik

Luft/Raumfahrt

Rüstung

Automotive/Bahnbereich

## **Testmethoden:**

**Temperaturwechseltest (TWT)** – Prüfling wird wechselweise in zwei Klimakammern mit  $-40^{\circ}\text{C}$  und  $+125^{\circ}\text{C}$  eingefahren, 500 – 1500 Zyklen.

**IST Interconnect Stress Test** - Spezieller Testcoupon mit Durchkontaktierungen, elektrische Aufheizung des Coupons auf  $150^{\circ}\text{C}$  für 3 Minuten, Abkühlung auf Raumtemperatur in 2 Minuten

IPC-TM650.2.6.26

*Association Connecting Electronics Industries*



3000 Lakeside Drive, Suite 309S  
Bannockburn, IL 60015-1249

## **IPC-TM-650 TEST METHODS MANUAL**

**1 Scope** These methods determine the physical endurance of representative coupons of printed boards to a series of high temperature excursions from ambient. The temperature excursions cause thermo-mechanical fatigue of the electrical interconnect structures.

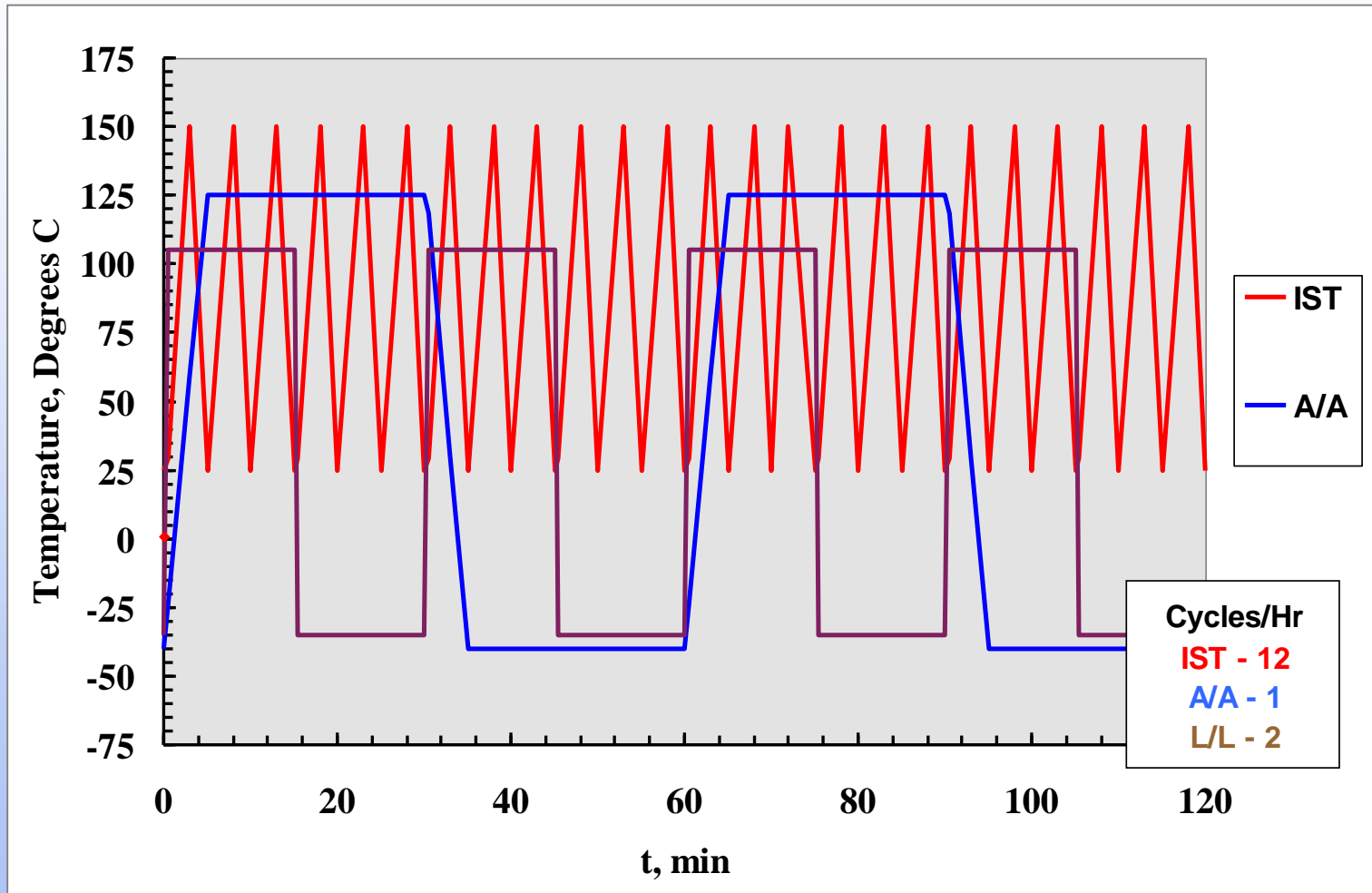
The test coupon is resistance heated by passing DC current through the coupon to bring the temperature of the copper to a designated temperature. Switching the current on and off creates thermal cycles between room temperature and the designated temperature within the sample. The laminate and surrounding materials are heated to different extents depend-

Number <b>2.6.26</b>	
Subject <b>DC Current Induced Thermal Cycling Test</b>	
Date <b>5/14</b>	Revision <b>A</b>
Originating Task Group <b>PTV Reliability Test Methods (6-10c)</b>	

**1.2 Method B Description** Method B uses a coupon with one electrical net. The net consists of via structures connected by external and/or internal circuit lines in a daisy chain. DC current is passed through the electrical net to heat the coupon to a designated temperature. When the electrical net is at the designated temperature, the DC current is turned off and a cooling fan is turned on to cool the coupons to ambient temperature. One heating and cooling sequence represents a thermal cycle. Thermal cycling is continued to either a set number of cycles or a failure. Temperature coefficient of resistance (TCR) is measured.

Quelle: [https://www.ipc.org/TM/2-6\\_2-6-26A.pdf](https://www.ipc.org/TM/2-6_2-6-26A.pdf)

## Vergleich IST Interconnect Stress Test vs. Klimakammer



1000 Zyklen: IST ~ 4 Tage, Klimakammer ~ 42 Tage

# Increasing Demand for Demonstrated Reliability



Consumer Electronics



Telecom



Aerospace



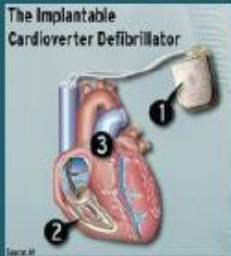
Automotive

50    100    150    200    250    300    350    400    450    500

Customer Spec's for Minimum IST Cycles to Failure After Assembly



High End Computers



The Implantable  
Cardioverter Defibrillator

Medical Devices

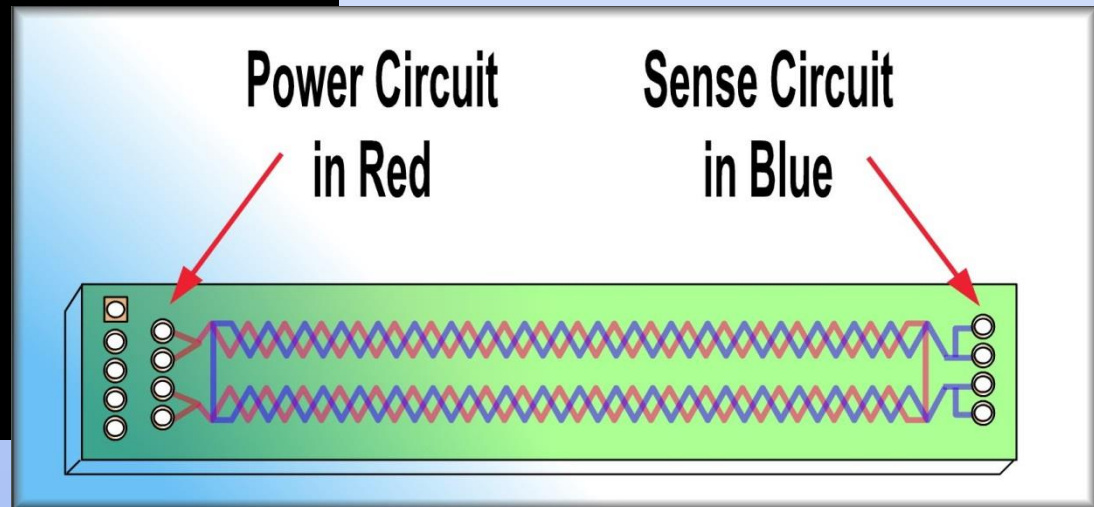
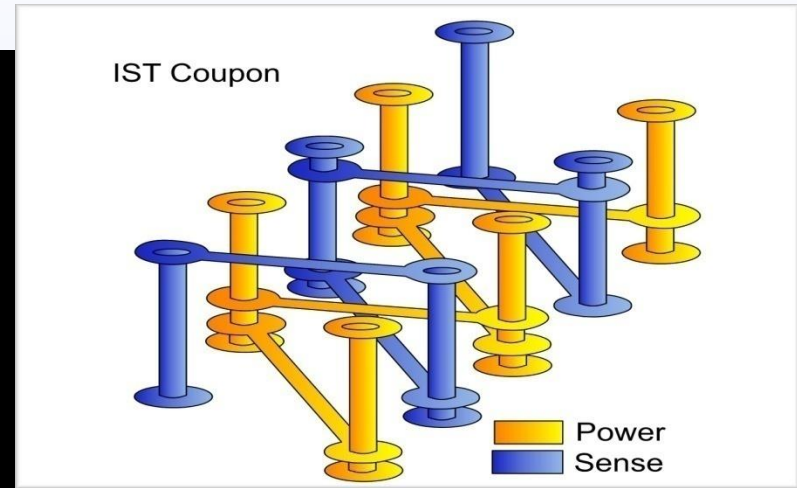
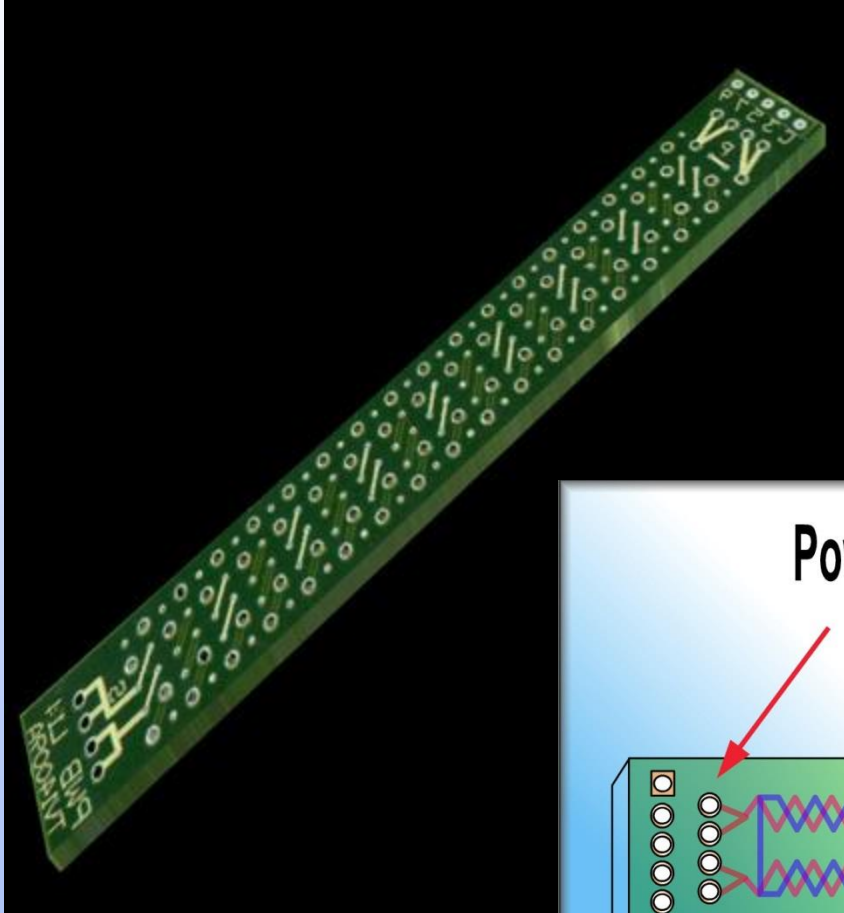


Commercial Aviation



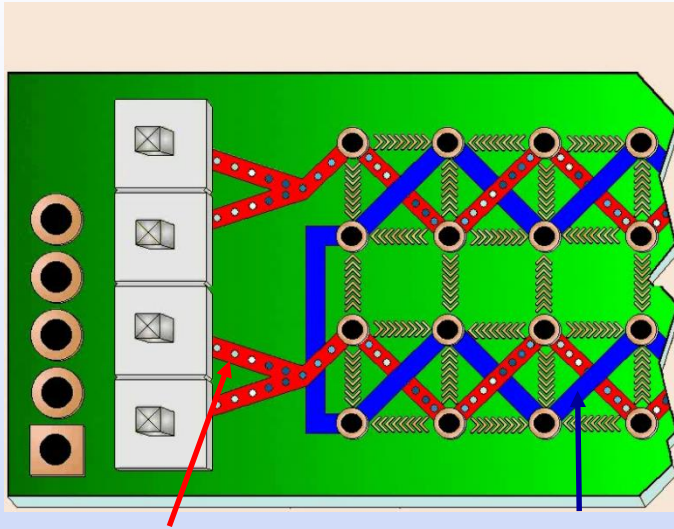
Space

## IST Testcoupon:



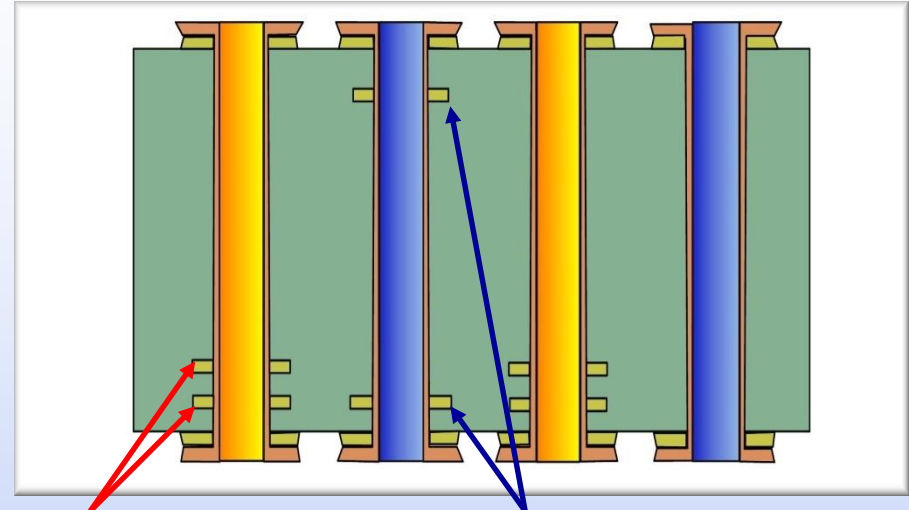


## IST Testcoupon:



Heizkreis

Meßkreis

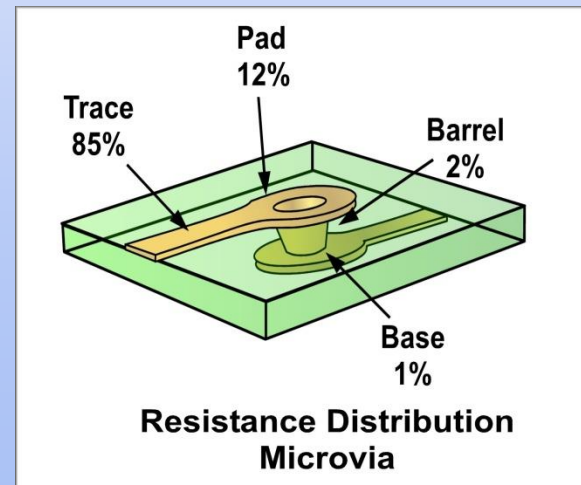
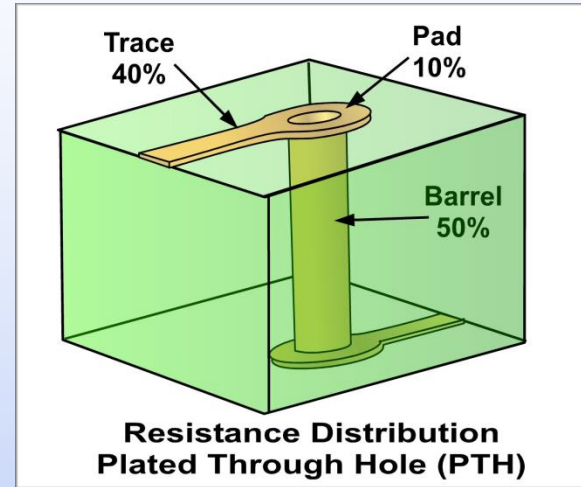
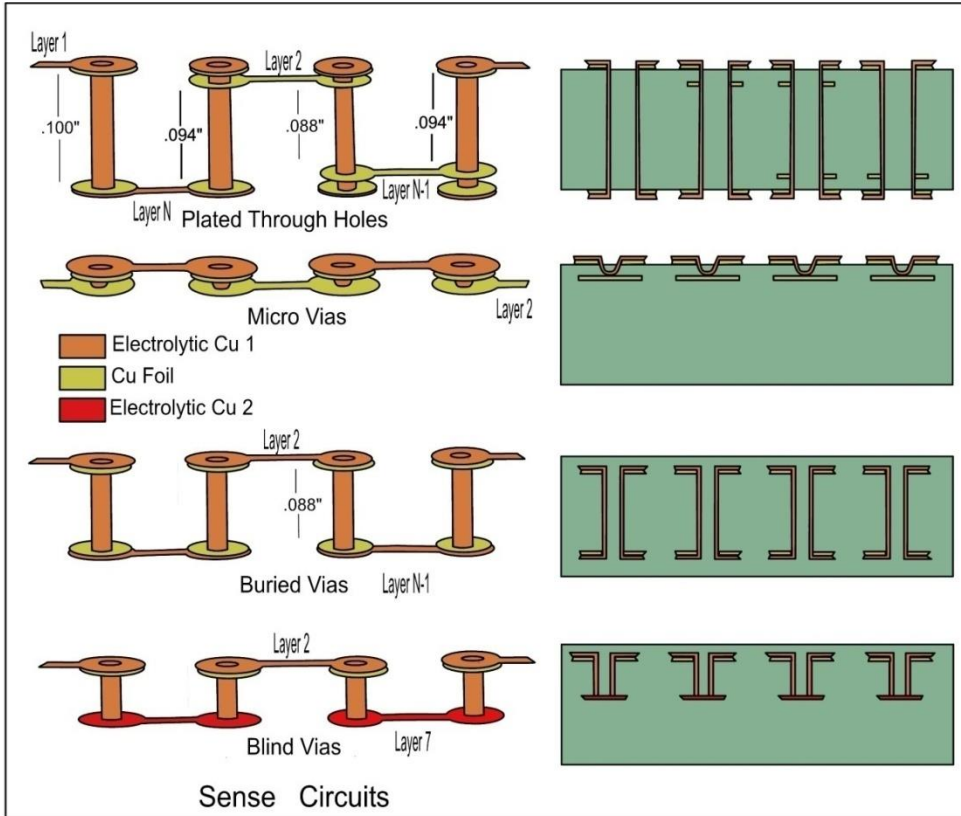
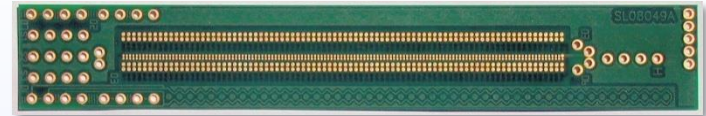


Heizkreis

Meßkreis

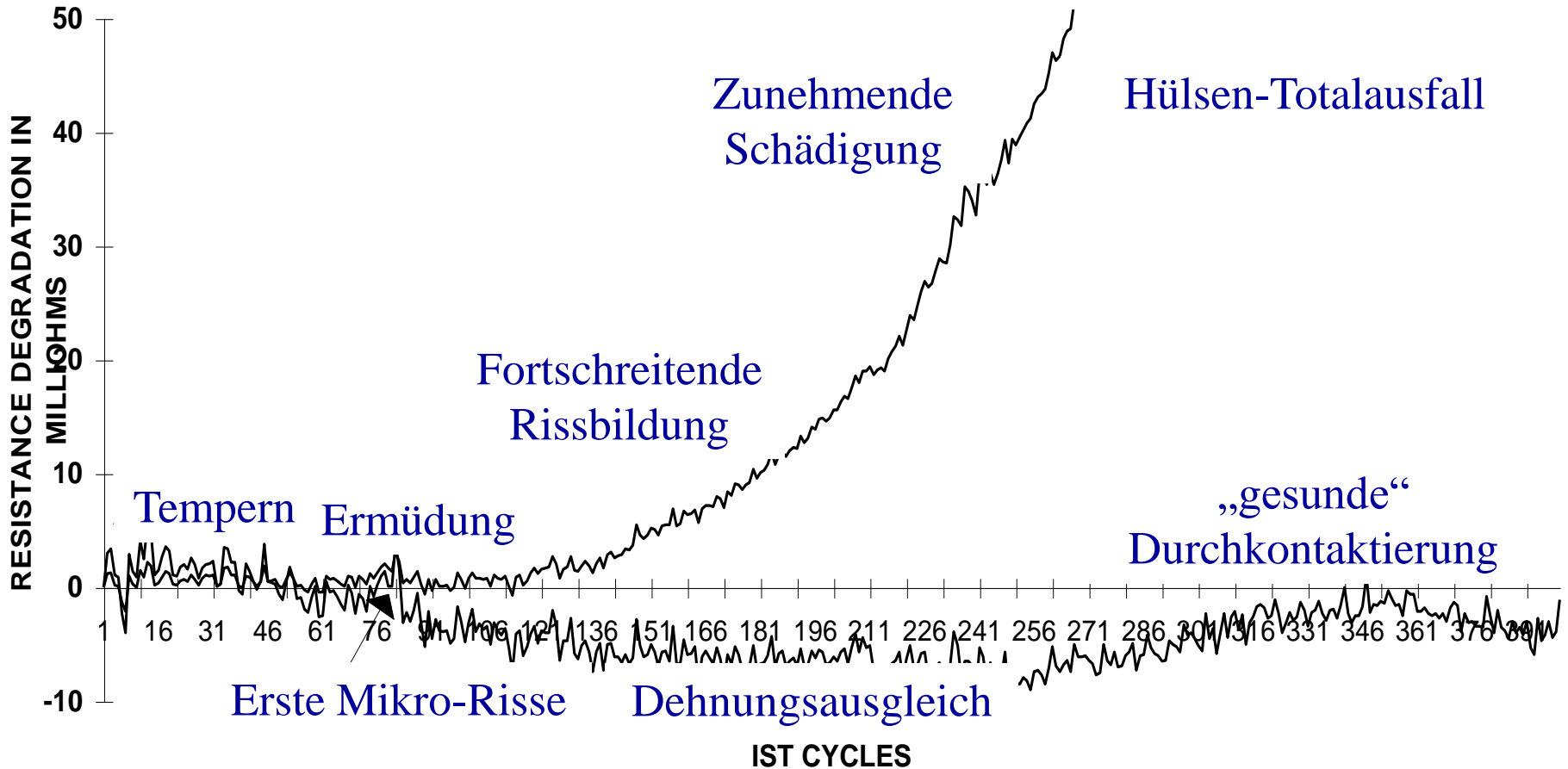
- Die Temperaturverteilung erfolgt vom Heizkreis auf den Meßkreis
- Es fließt nur Meßstrom durch die Durchkontaktierungen des Meßkreises
- Kupferlagen unterstützen eine gleichförmige Temperaturverteilung
- Durchkontaktierungs-Raster bestimmt die Temperaturdifferenz zwischen Heiz- und Meßkreis
- zusätzlicher "Superheat-Kreis" möglich für noch homogenere Temperaturverteilung

# IST Testcoupon:



# Widerstandserhöhung durch therm. Belastung:

RESISTANCE DEGRADATION OF THE PTH INTERCONNECT



Typisches Abbruchkriterium nach IPC: 10% Widerstandserhöhung

# IST-HC System:

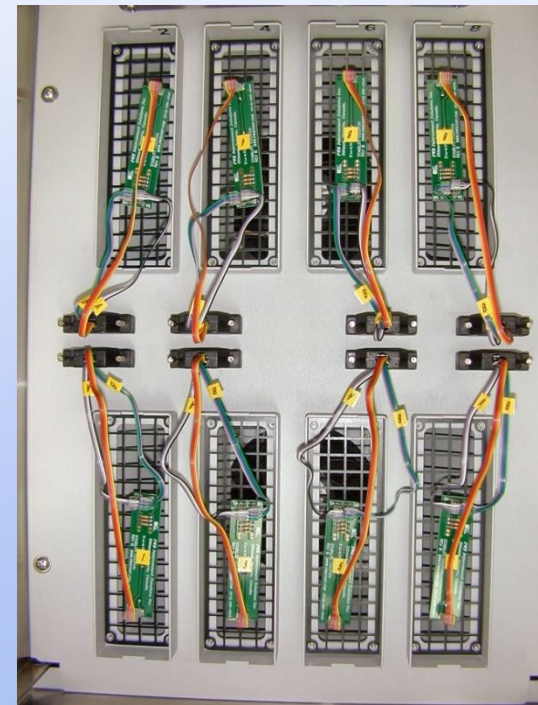


The Institute for Interconnecting and Packaging Electronic Circuits  
2215 Sanders Road Northbrook IL 60062-6135

**IPC**

IPC-TM-650  
Test Methods Manual

Number 2.6.26	
Subject DC Current Induced Thermal Cycling Test	
Date 11/99	Revision Proposal
Originating Committee: Test Methods Subcommittee (7-11)	



**8-Kanal Couponaufnahme**

# Coupondaten 8-Kanal-Darstellung:

The image displays a software interface for a tester control panel, showing coupon data for 8 channels. The interface is divided into two main sections: a data table for heads 2, 4, 6, and 8, and a graphical representation for heads 1, 3, 5, and 7.

### Table 1: Coupon Data for Heads 2, 4, 6, and 8

Head	Coupon Name	Power	Sense A	Sense B
Head 2	TestCoupon3	715	762.8	935.6
Head 4	TestCoupon4	765	728.5	896.9
Head 6	TestCoupon5	772	728.5	905.8
Head 8	TestCoupon6	771	726.8	895.5

Head	Coupon Name	Start Res	Fail Res	Res	Temp	Delta Res
Head 2	TestCoupon3	1171.1	1249.3	1532.4	34	0
Head 4	TestCoupon4	1253	1193.2	1469	32.2	0
Head 6	TestCoupon5	1264.4	1193.2	1483.6	32.9	0
Head 8	TestCoupon6	1262.8	1190.4	1466.7	33	0

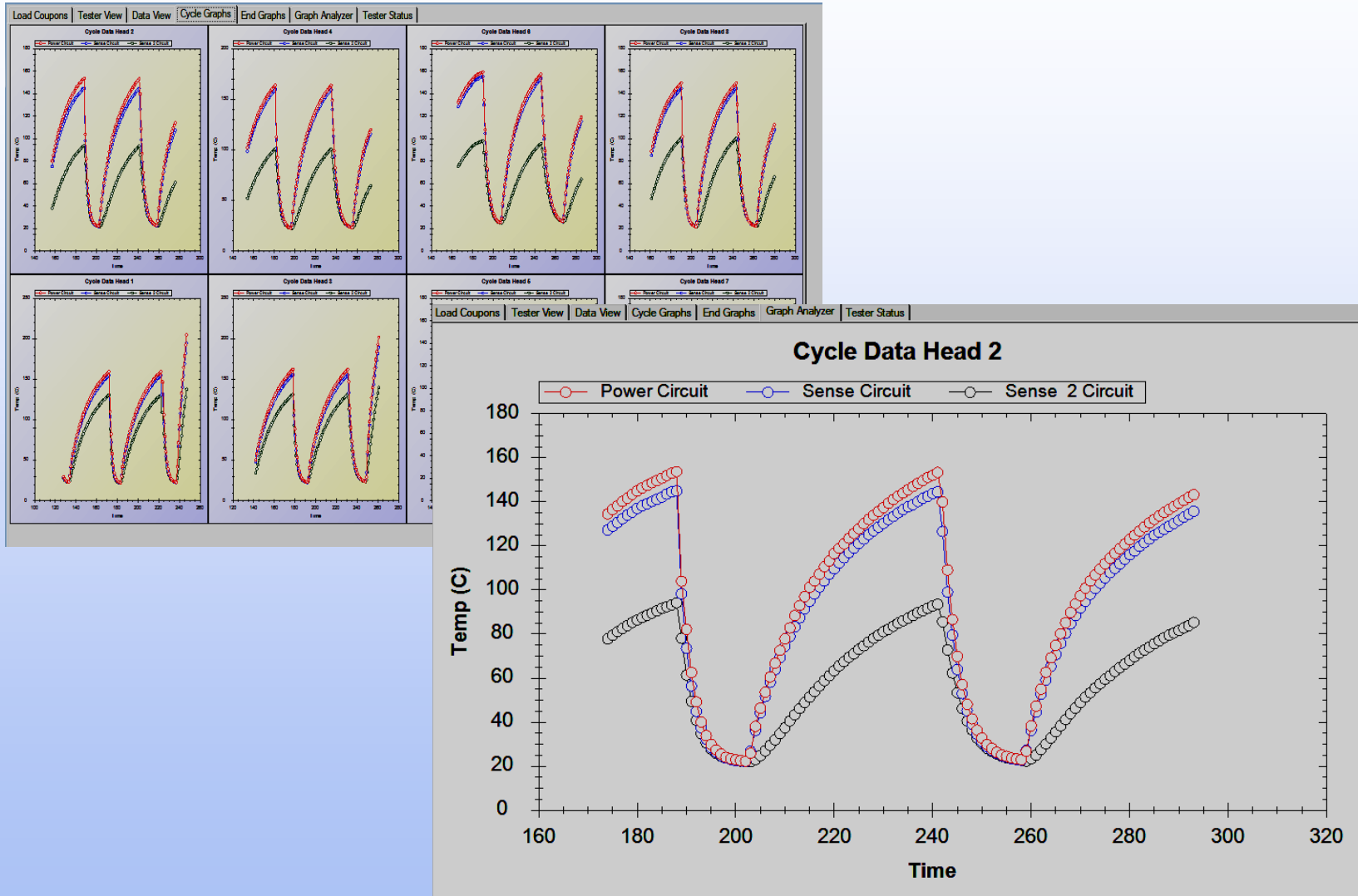
Head	Coupon Name	Current	Voltage	Power	Time	Status
Head 2	TestCoupon3	2.048	1.527	3.1	14	Heating Pre-cycle # 0
Head 4	TestCoupon4	1.98	1.569	3.1	14	Heating Pre-cycle # 0
Head 6	TestCoupon5	1.971	1.58	3.1	13.9	Heating Pre-cycle # 0
Head 8	TestCoupon6	1.973	1.579	3.1	13.9	Heating Pre-cycle # 0

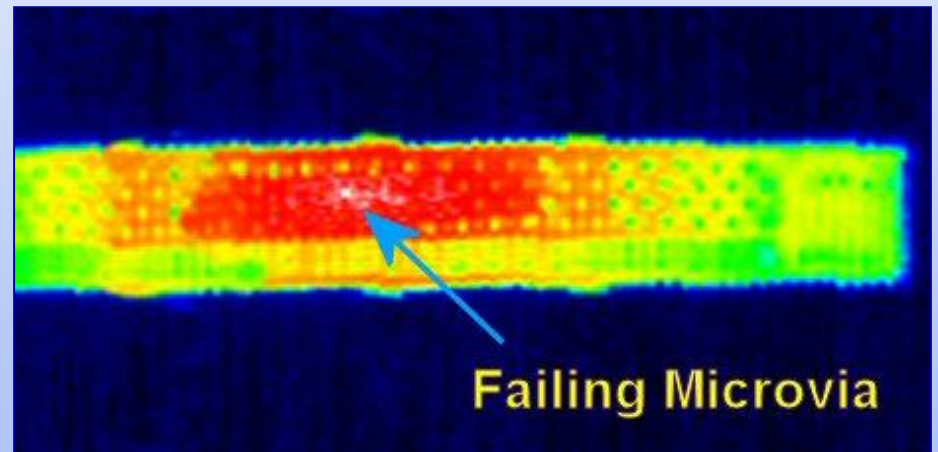
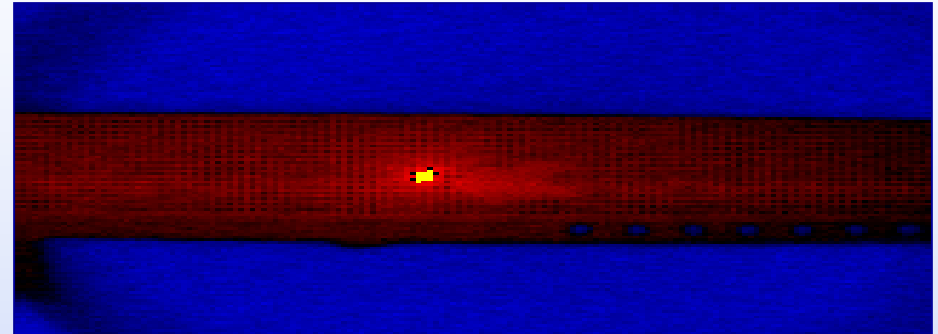
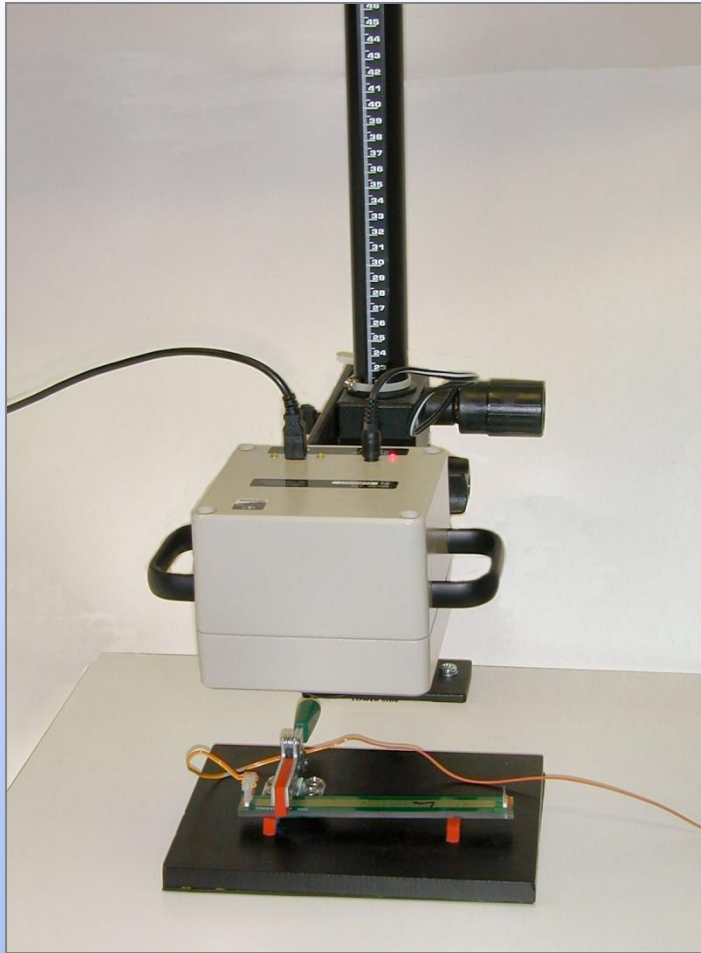
### Table 2: Coupon Data for Heads 1, 3, 5, and 7 (Graphical View)

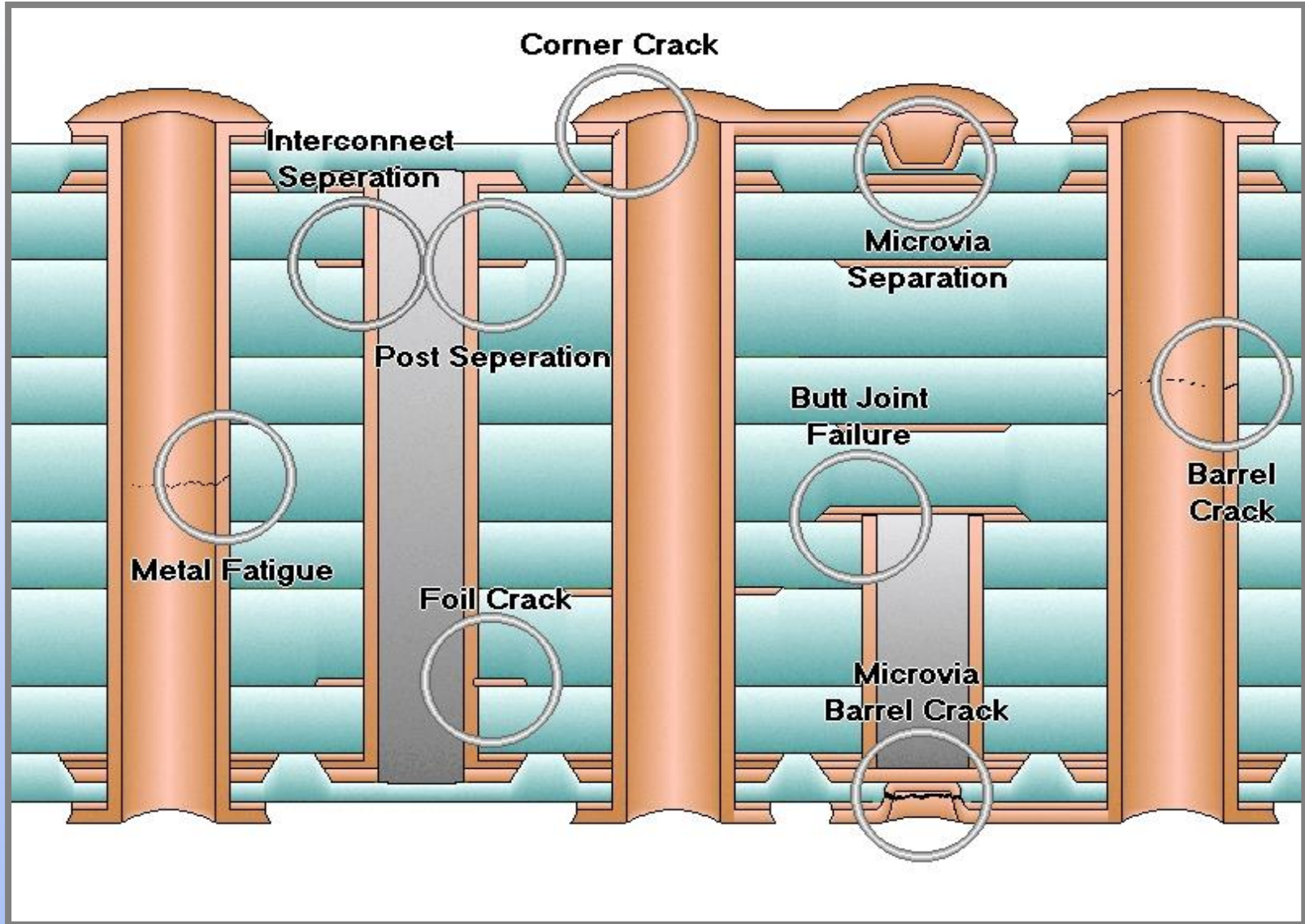
Head	Coupon Name	Cycle #	Power	Sense A	Sense B
Head #2	A32_2	112	0.1	0.1	
Head #4	A32_4	112	0.2	0.1	
Head #6	B34_2	112	0.3	0.4	
Head #8	B34_4	100	0.6	7.4	
Head #1	A32_1	92	0	7.5	
Head #3	A32_3	112	0.3	0.4	
Head #5	B34_1	111	0.6	7.5	
Head #7	B34_3	112	-0.7	-0.4	

# Temperaturverläufe an 8 Coupons:



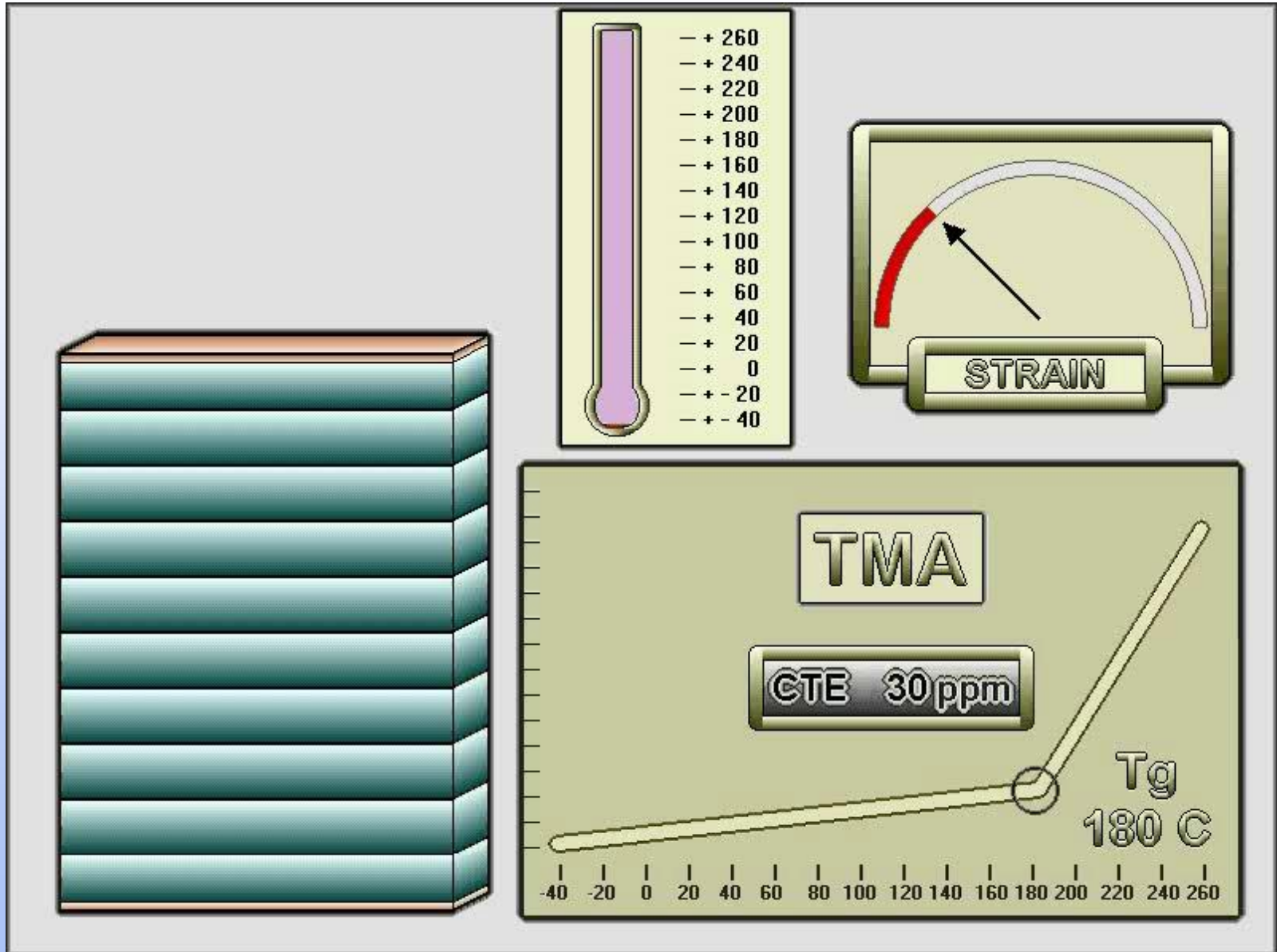
## Fehlerlokalisierung mit Infrarotkamera:



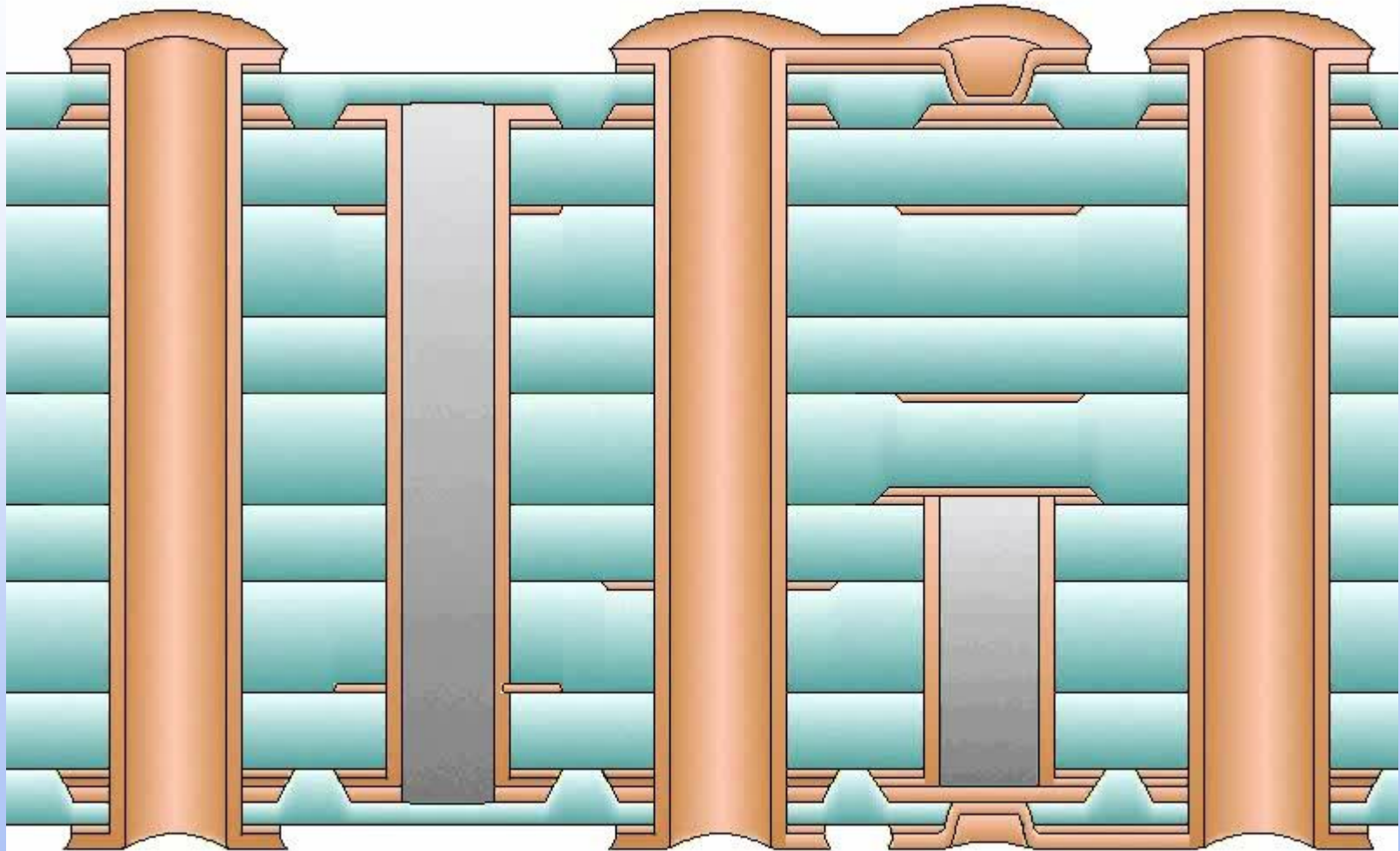




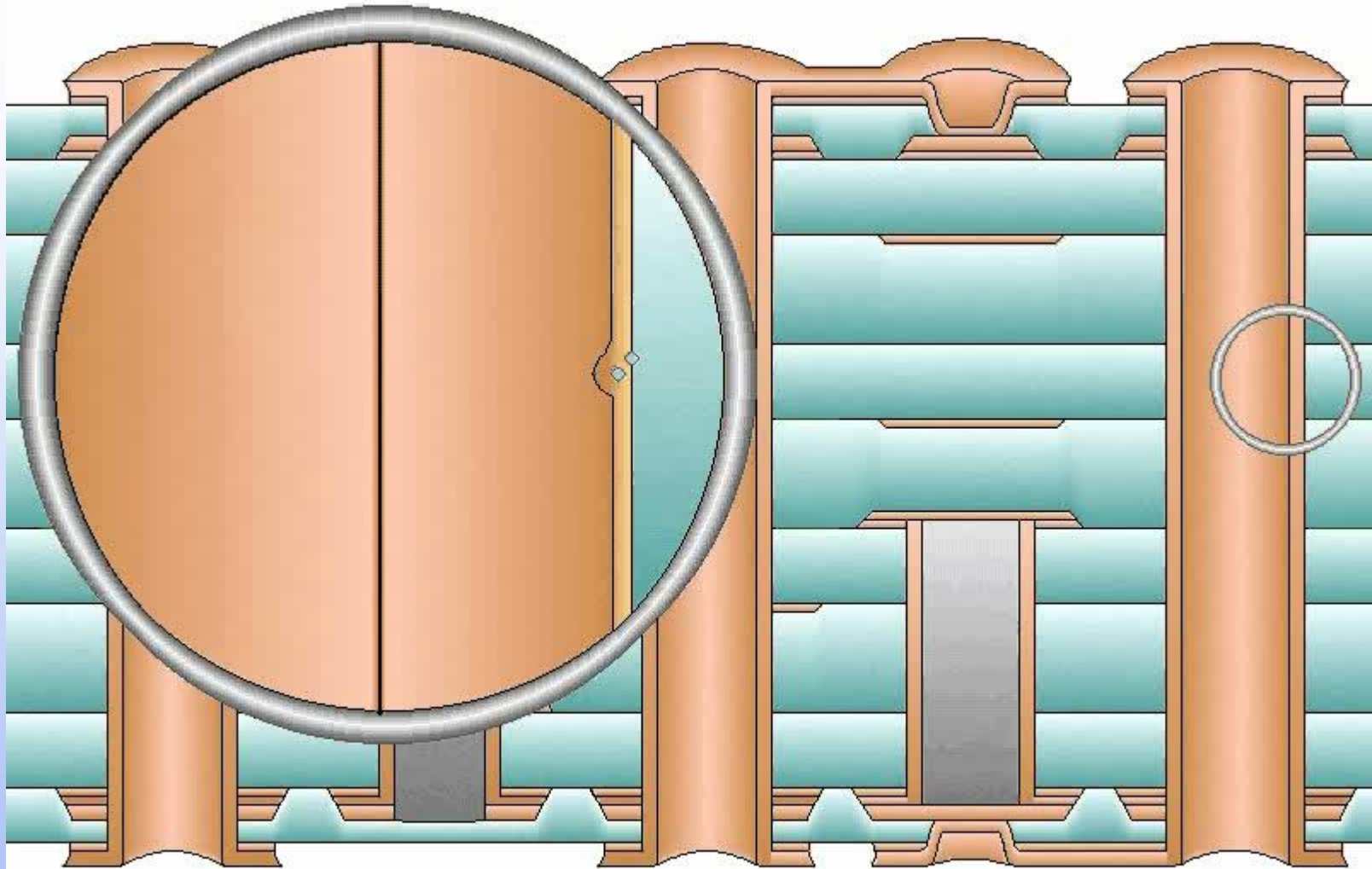
# Temperatur-Ausdehnungsverhalten:



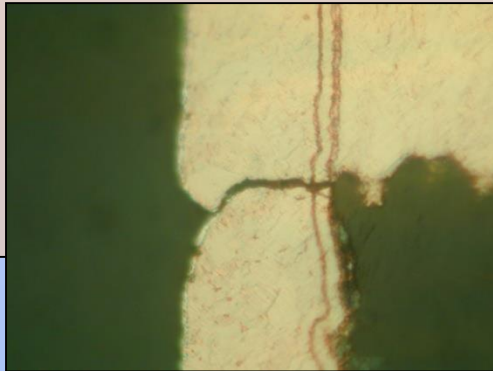
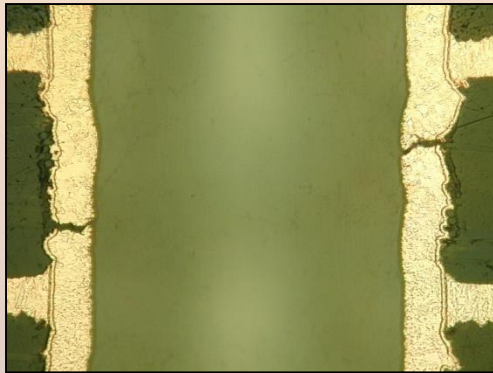
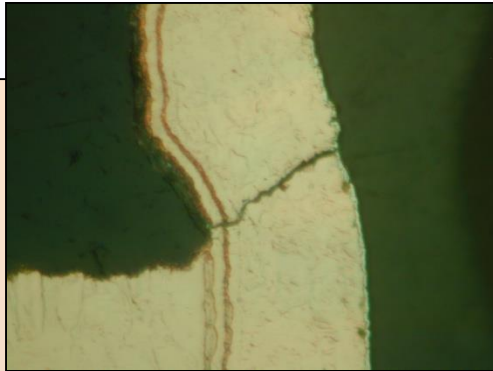
# Heiz- und Abkühlzyklus in Leiterplatte:



# Hülsenrisse:

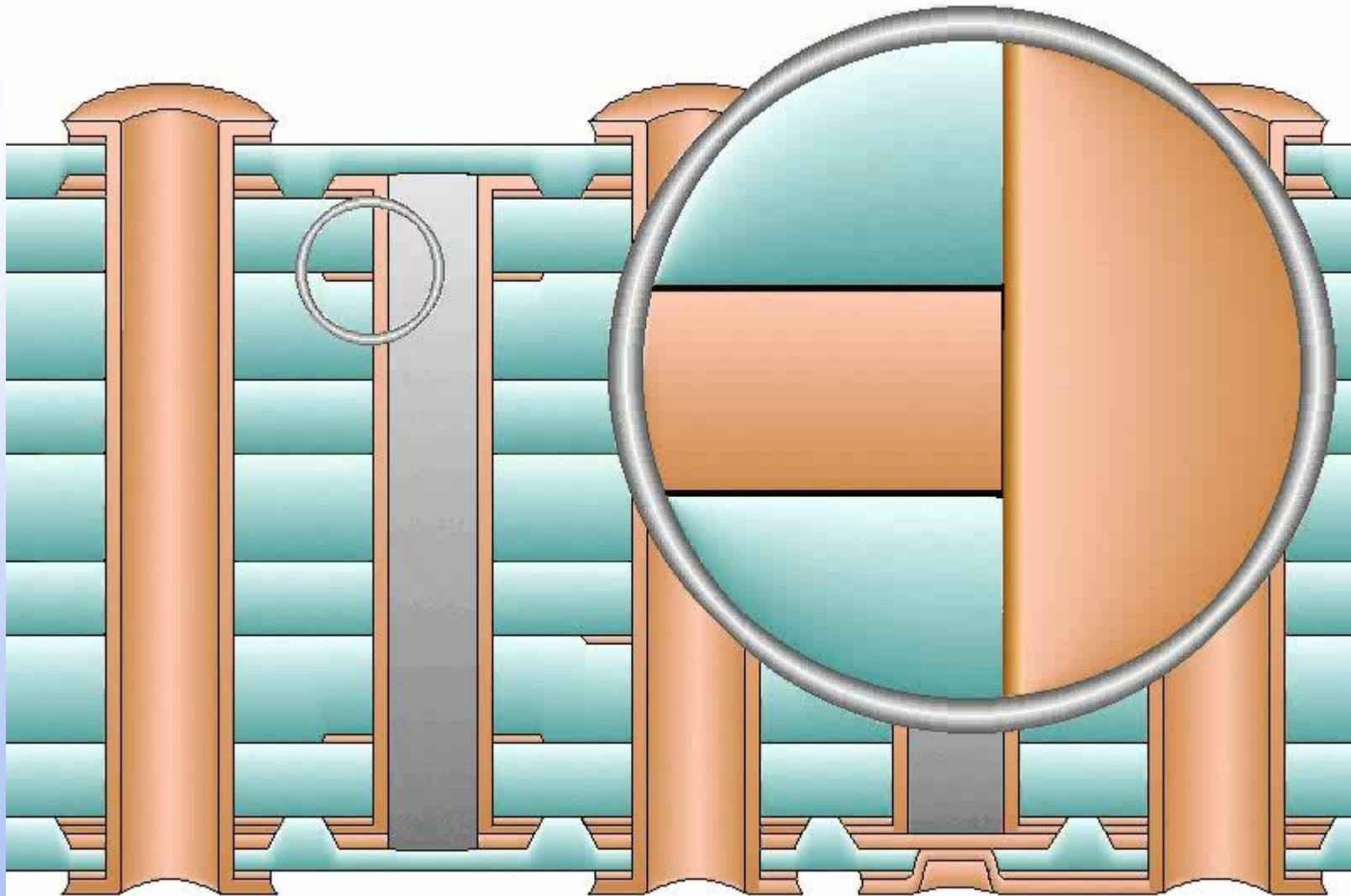


## Typische Fehlerbilder - Hülsenrisse:

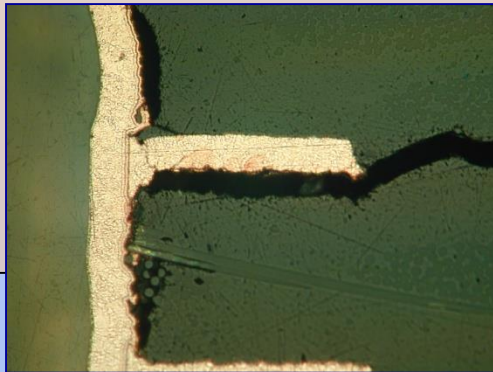
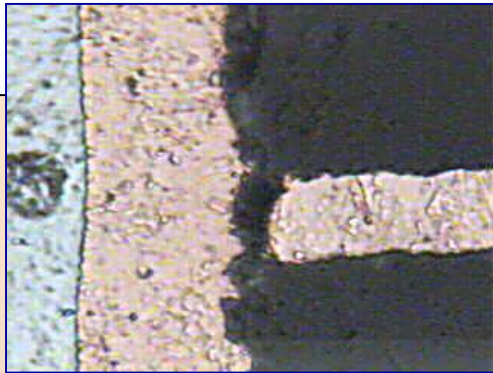


- **Kupferhülse wird in Längsrichtung gedehnt**
- **Riss in der Wand der Durchkontaktierung**
- **Rascher Schädigungsfortschritt**
- **meist große Rissbreite**
- **Unterbrochen bei Raumtemperatur**

# Innenlagenabriss:

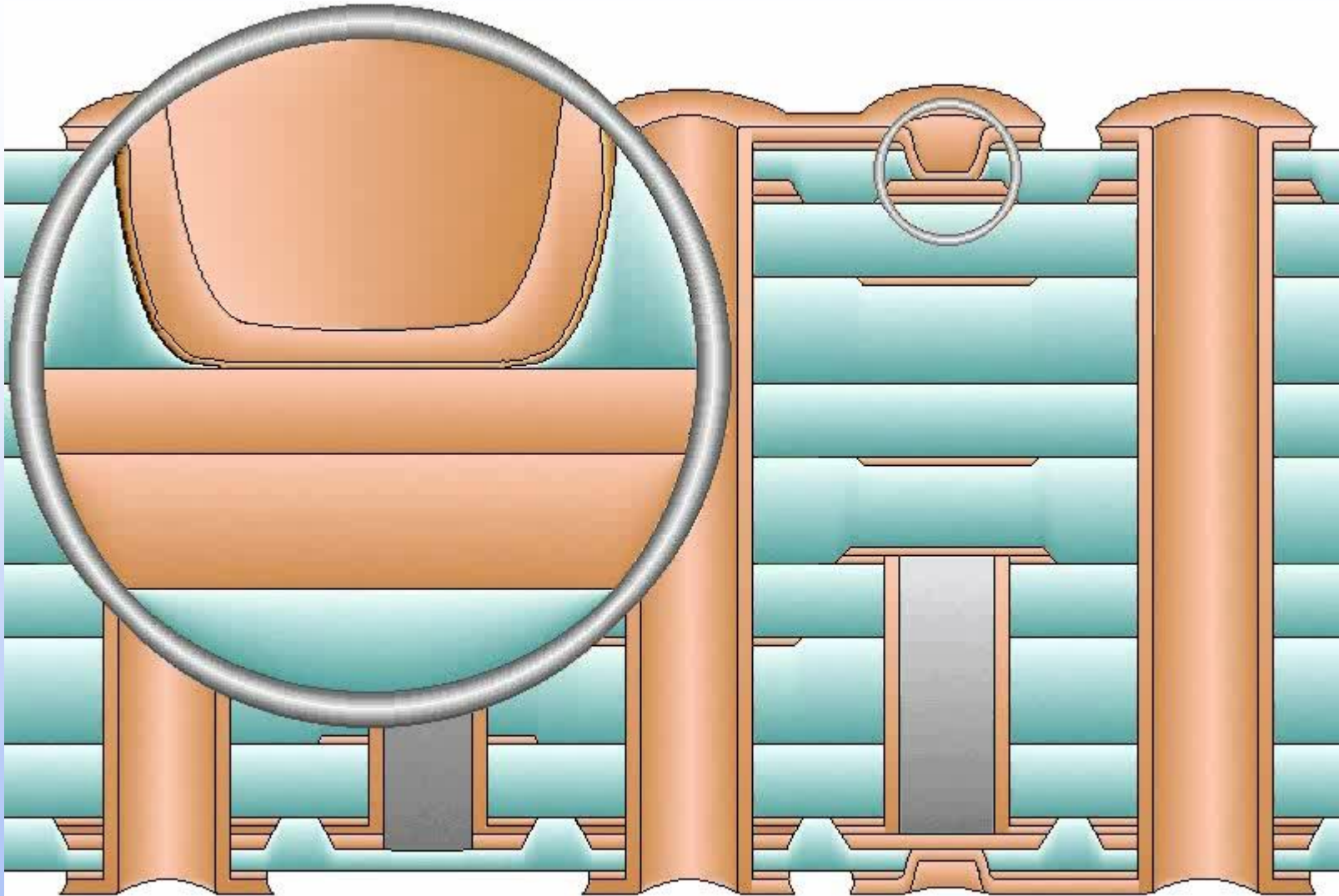


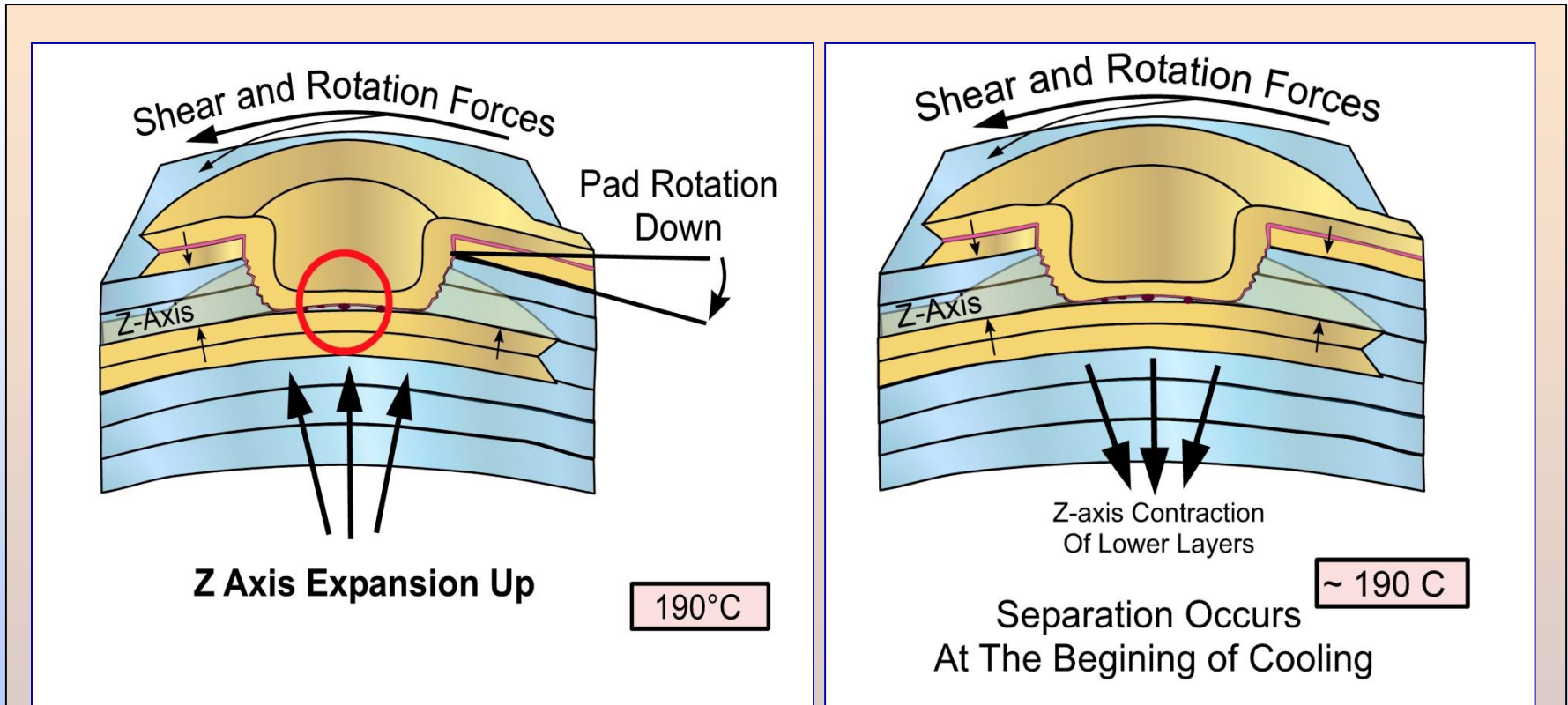
## Typische Fehlerbilder - Innenlagenabriss:



- **Rascher Schädigungsfortschritt**
- **meist große Rissbreite**
- **Unterbrochen bei Raumtemperatur**

# Mikrovia-Targetpad-Abrisse:

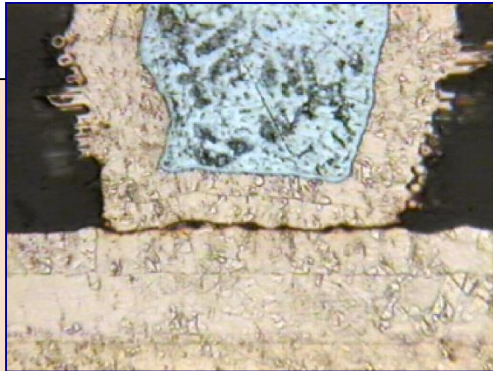




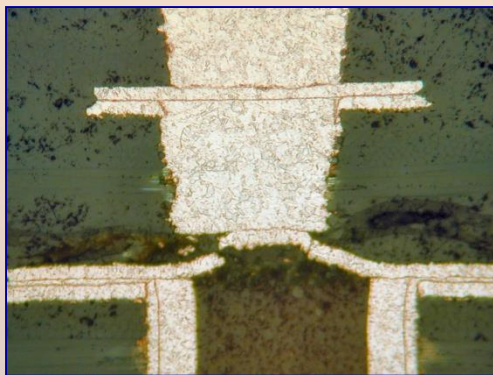
- **Schädigung meist erst ab 190°C**
- **Abriss vom Capture Pad bei Kontraktion (Abkühlung)**



## Typische Mikrovia-Schädigungsbilder:



- Target-Pad Abriss

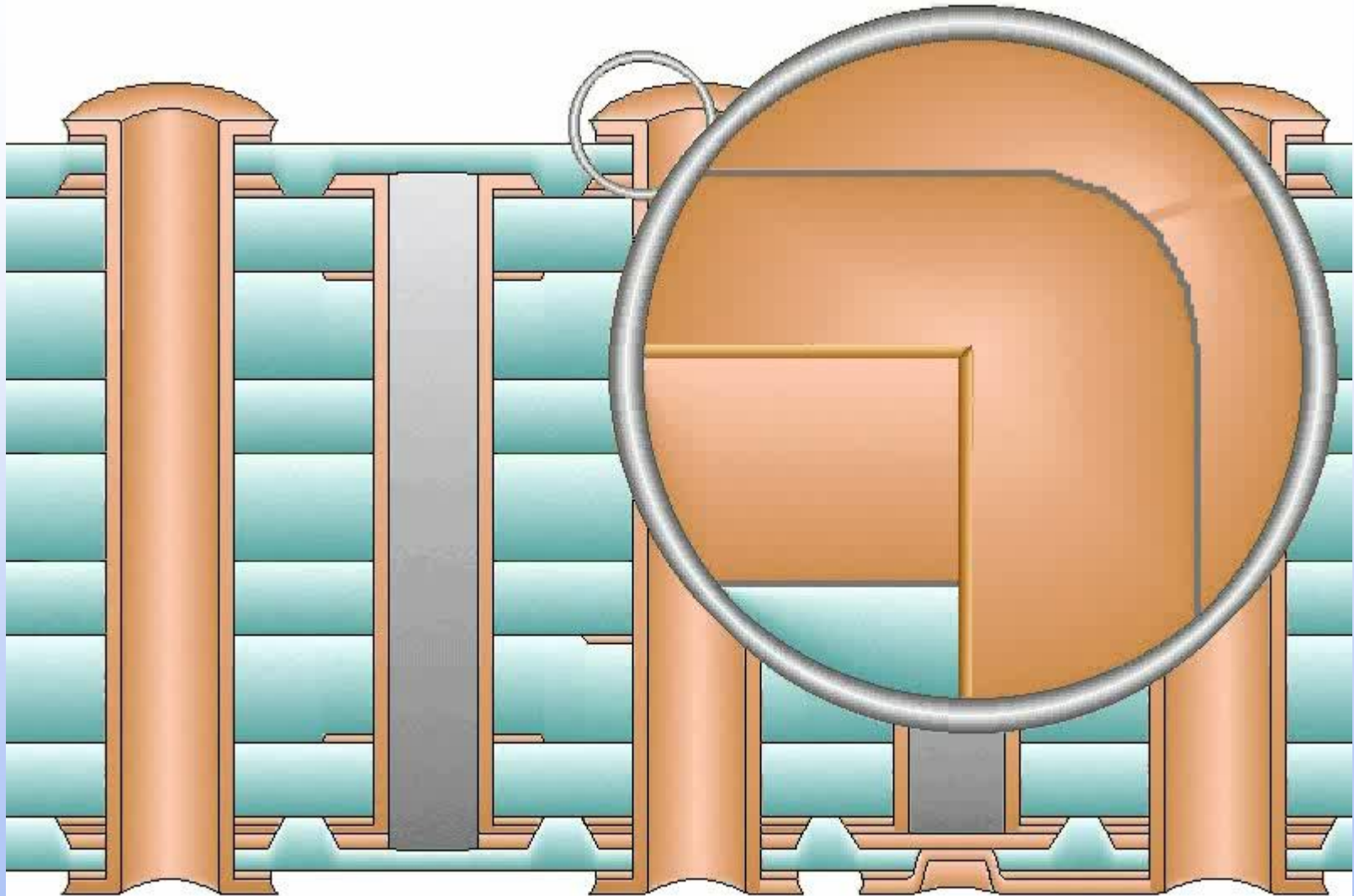


- Abriss Capture Pad

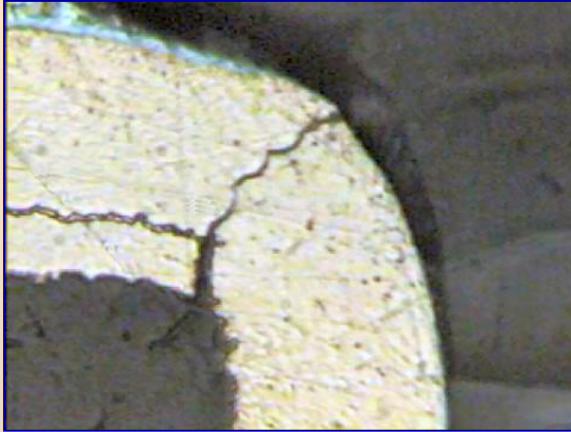


- Microvia Corner Cracks

## “Corner Cracks”:

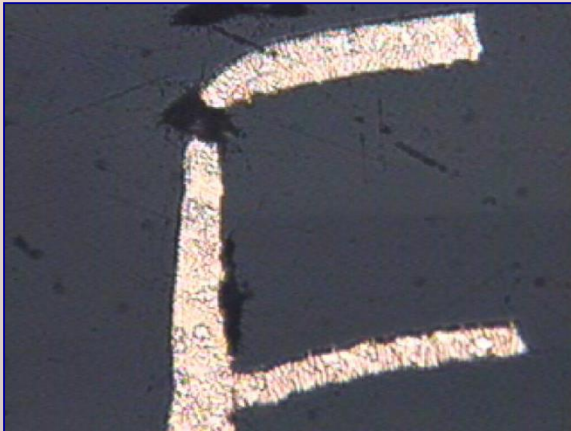


## Typische Corner-Crack-Schädigungsbilder:



- Riss im 90° Knie

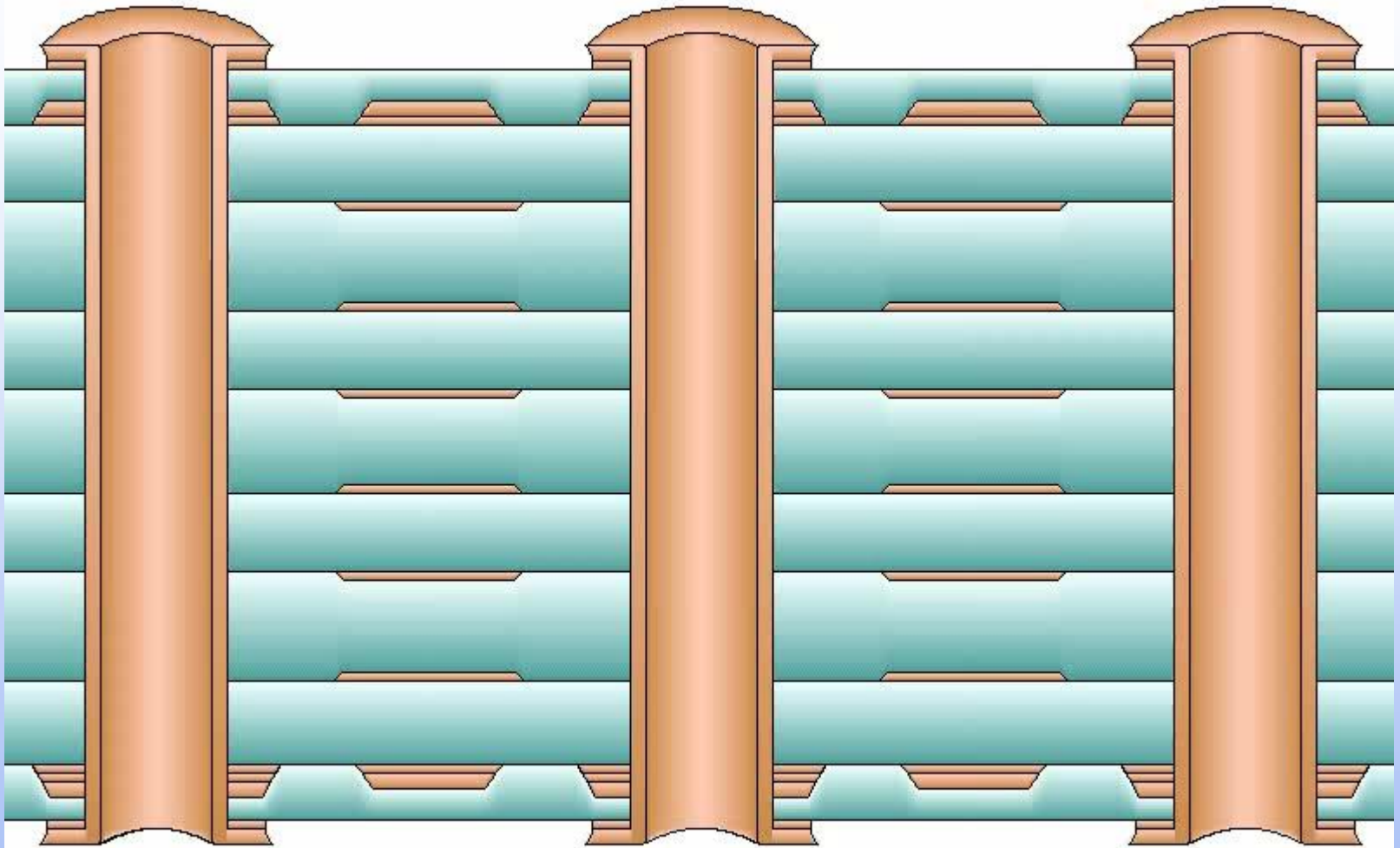
- häufiger bei Bleifrei-Technologie



- mech. Belastung wird an Oberfläche  
gedrängt

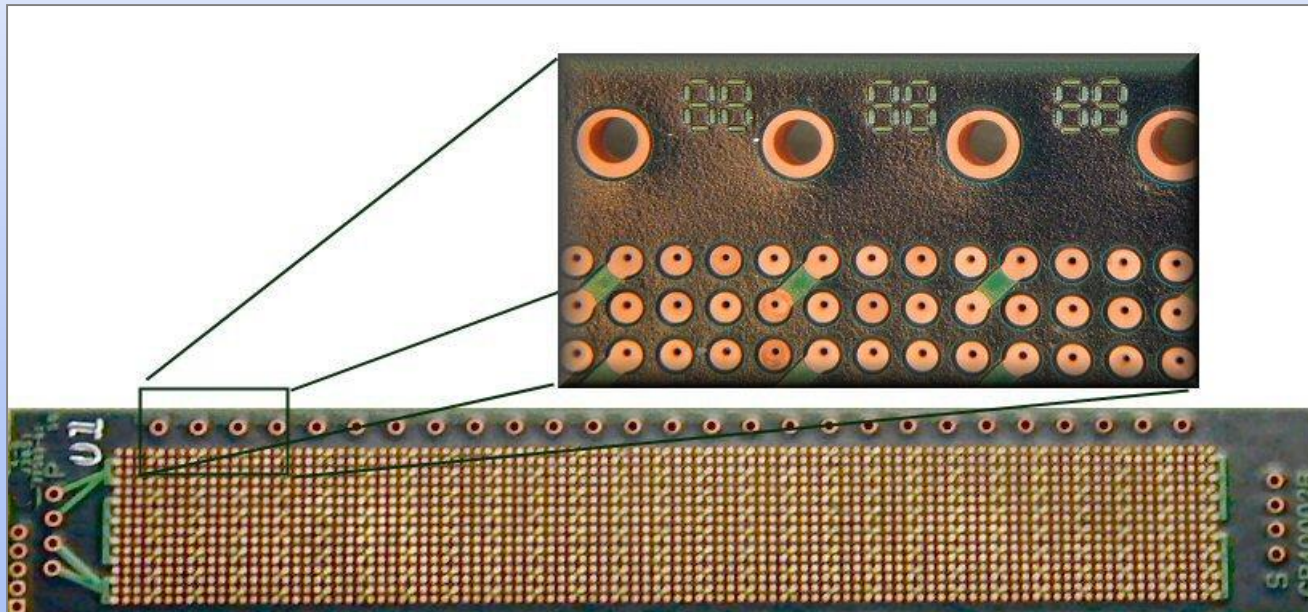
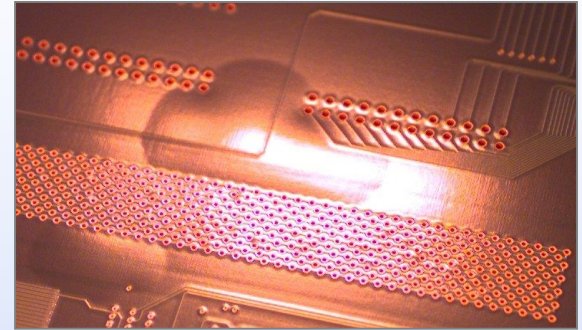
- typisch kleine Risse

# Delamination

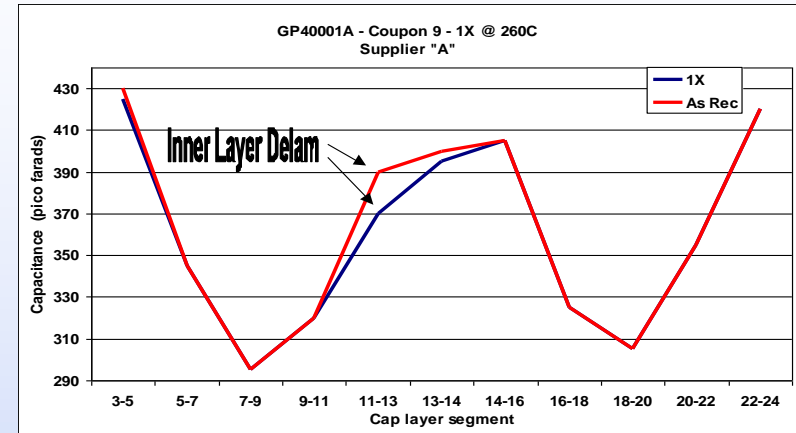
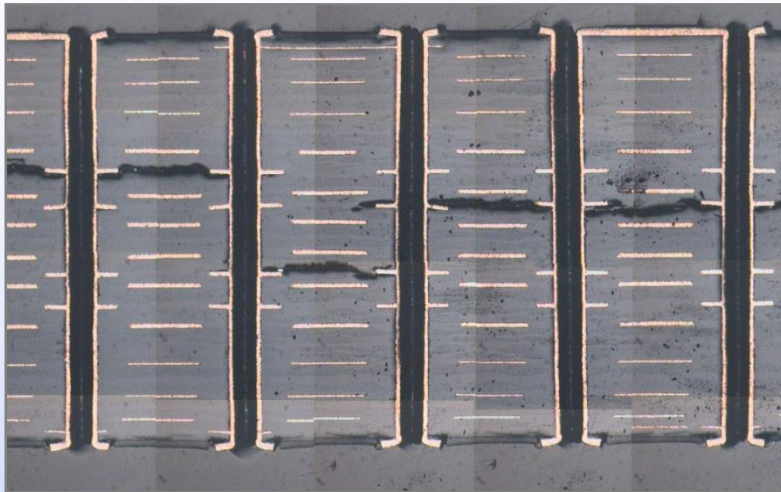


## Delaminationstest:

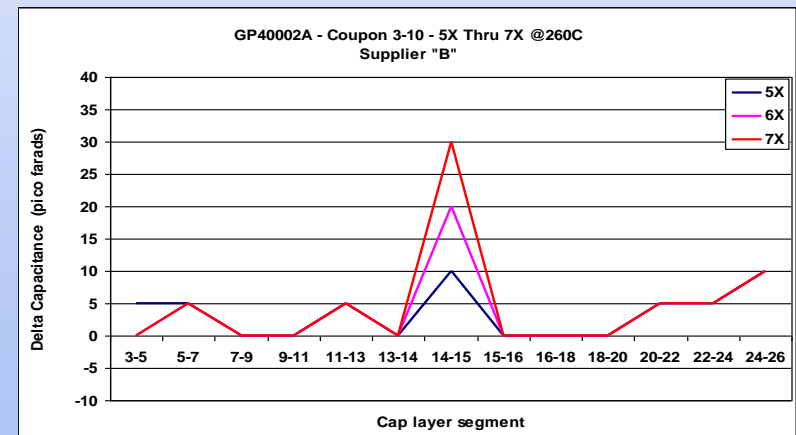
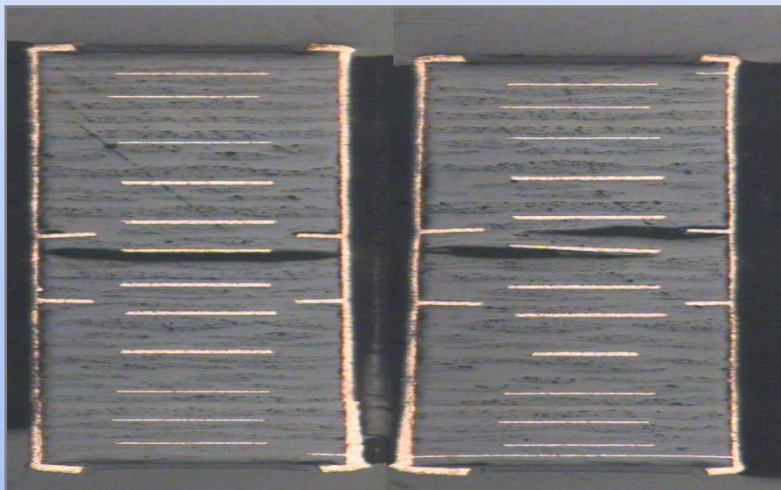
- Prüfung auf Delamination über Kapazitätsmessung
- Testpunkte in IST Coupon integriert
- Vergleich Kapazität vor und nach IST Test



# Delaminationstest:

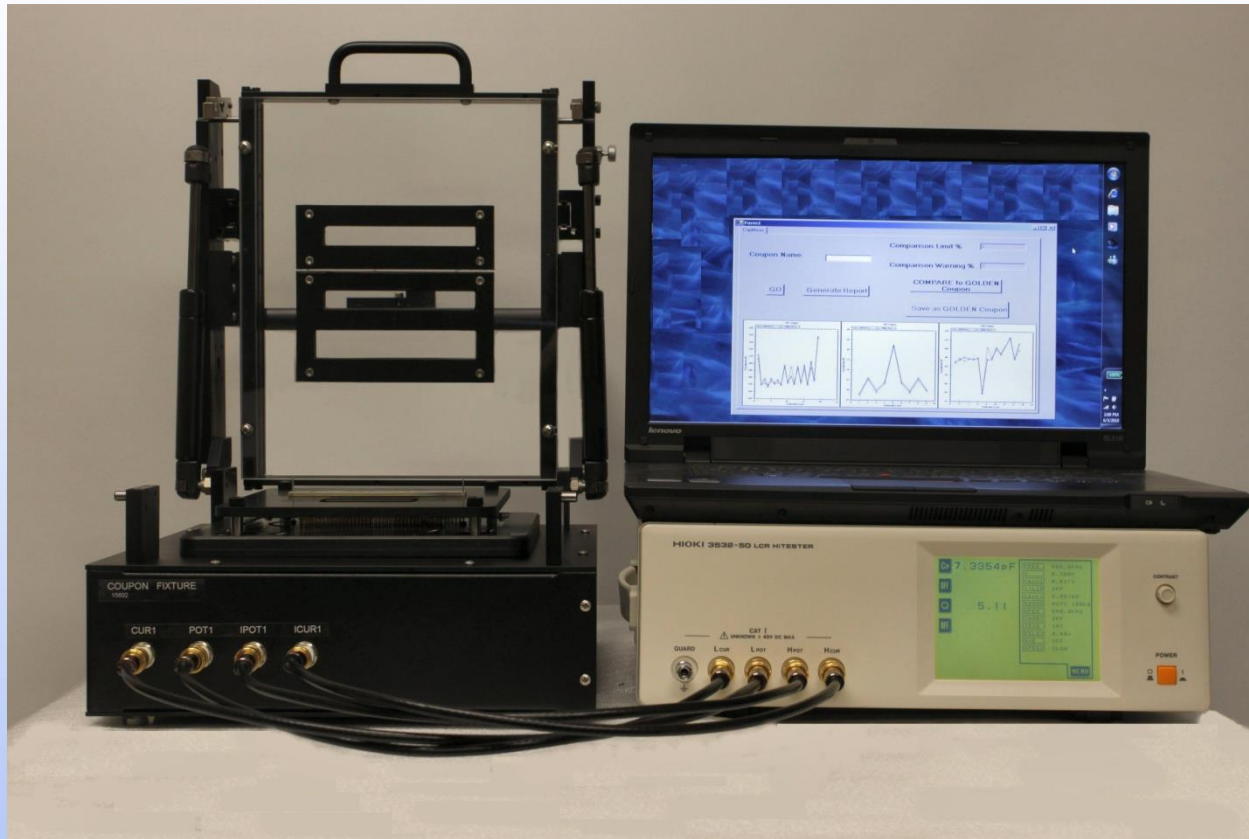


Absolute Kapazitätswerte vor und nach IST Test



Relative Kapazitätsänderung durch IST Test

## DELAM-Tester:

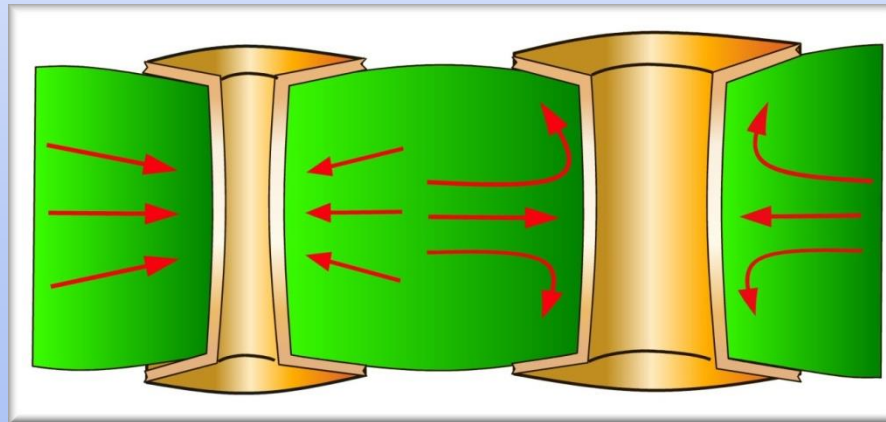


- PC-gesteuerte Auswertung der Kapazitätsänderung
- Testpunkte in IST Coupon integriert



## Einflussgrößen auf Zyklenfestigkeit:

- Temperatur
- Bohrlochdurchmesser
- Leiterplattendicke
- Ausdehnungskoeffizient des Basismaterials (CTE)
- Kupferdicke in der Hülse
- Abstand der Bohrungen (Raster)



Verteilung der Druckkräfte abhängig vom Bohrlochdurchmesser



## IST Referenzen Europa:

- Astrium UK
- Atotech
- Dyconex (3 Systeme)
- ESA
- Graphic PLC
- GS Swiss PCB
- Invotec UK
- Optiprint AG
- Schweizer
- Tesat
- Würth (3 Systeme)

# Vielen Dank!

## **Polar Instruments GmbH**

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Aichereben 16

[hermann.reischer@polarinstruments.eu](mailto:hermann.reischer@polarinstruments.eu)

[www.polarinstruments.com/de](http://www.polarinstruments.com/de)

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Fax +43 7666 20041-20

