

# Investigation into cause and effect of tin lead diffusion into copper plated through hole barrels during accelerated high temperature testing

Jason Furlong

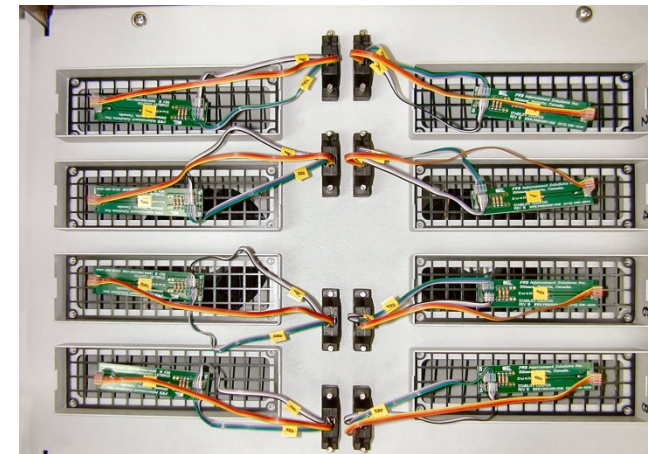
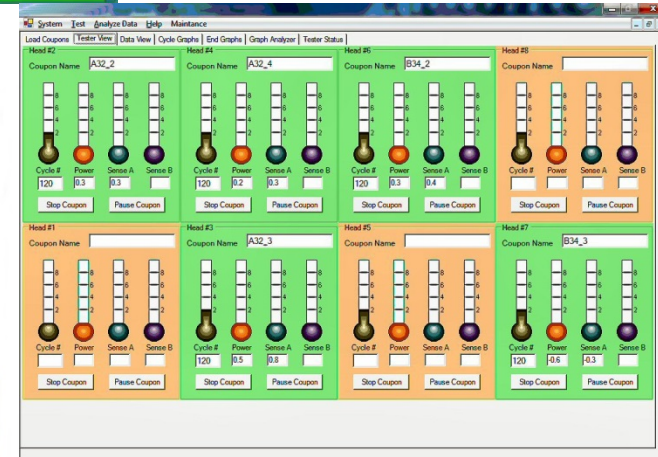
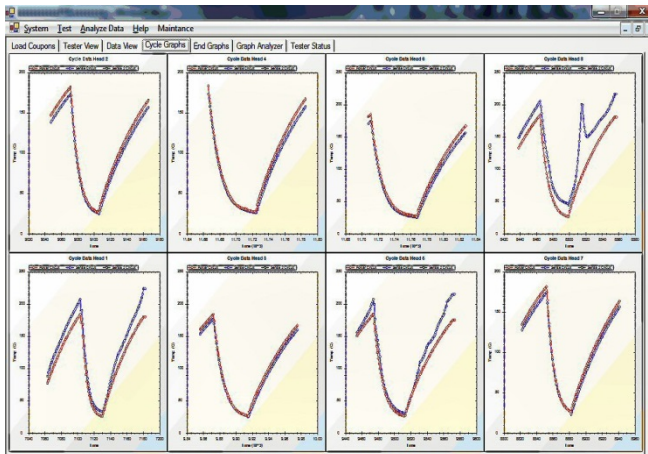
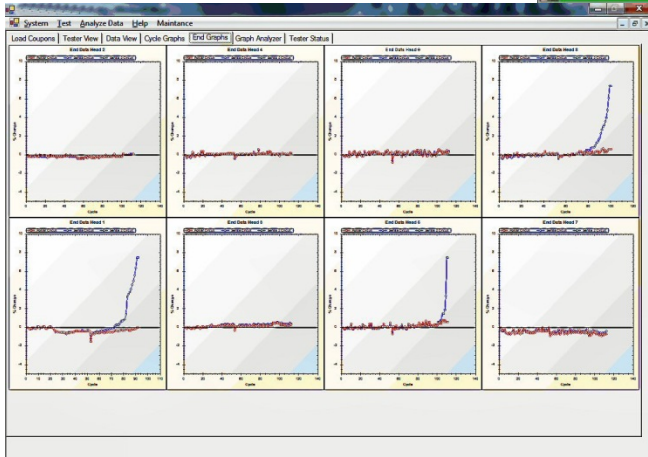
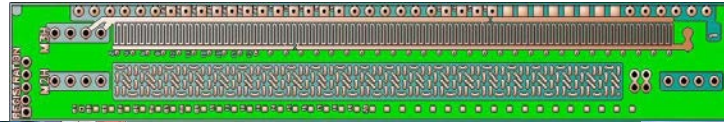
PWB Interconnect Solutions Inc.

# Agenda

- Introduction
- History of Issue discussed during IST workshop
- Results of removing reflow temperatures
- Removal of Tin lead
- Test Vehicle, Test Protocol & Reflow Conditions
- Results of IST Testing
- Failure Analysis
- Statistical Analysis
- Conclusions
- Q & A

# Introduction

## I.S.T. Accelerated Reliability Testing



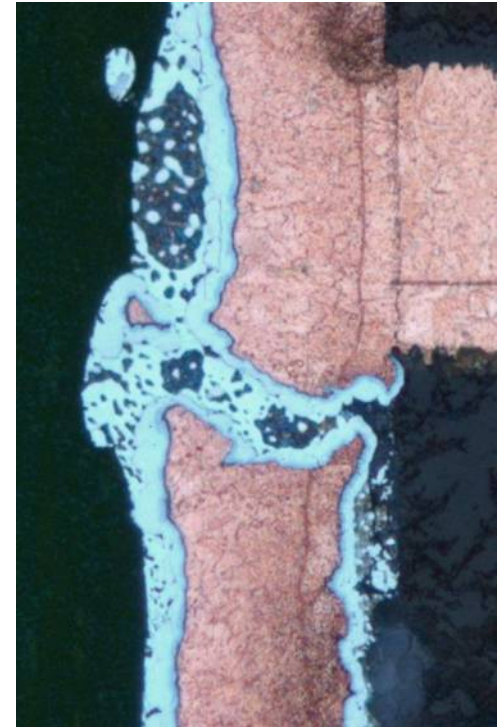
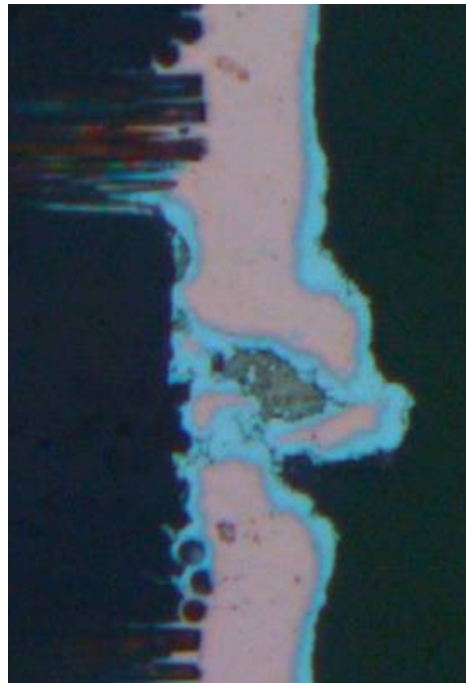
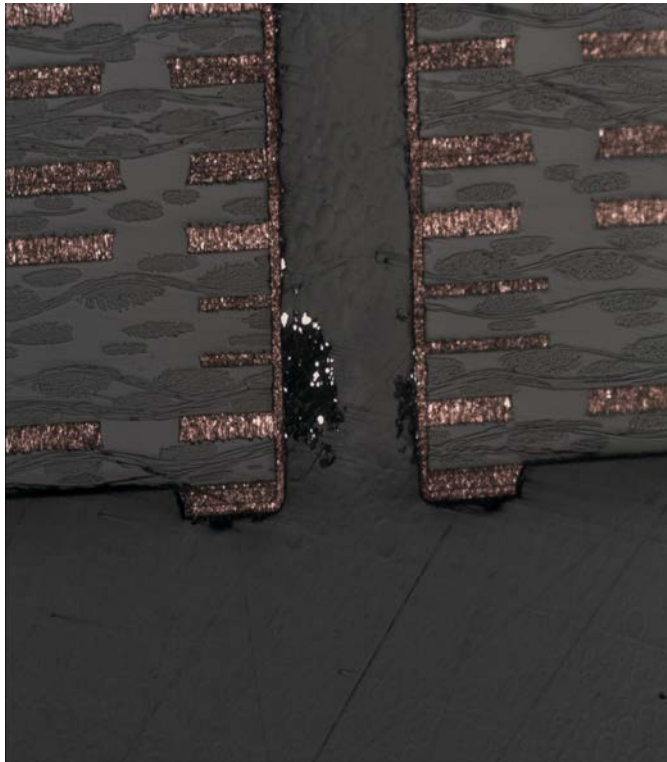
## History of Issues discussed during IST workshop

- IST Workshop, ESA Noordwijk ZH September 2013
- Current testing protocol
  - 6 Hour pre bake at 120°C for 6 Hrs
  - Relow simulation 230°C X 6 cycles
  - IST temperature cycling 170°C until 10% resistance change
- Tin lead “Reflowed” into crack locations
  - Tin lead reflowed into failure sites during Simulated reflow
  - Tin lead reflowed during IST testing
  - Possibility to remove Reflowed tin lead before IST cycling



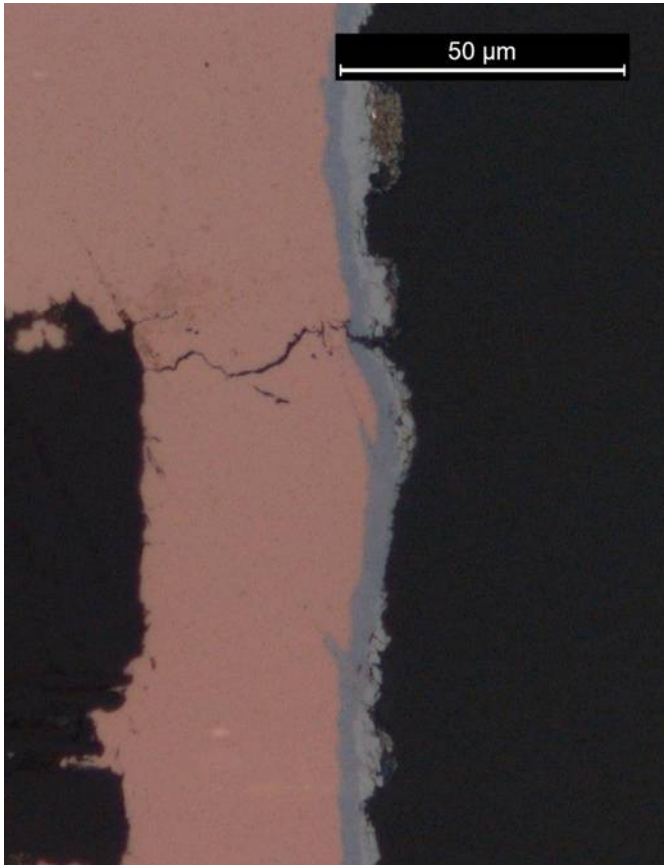
## History of Issues discussed during IST workshop

- Tin lead “Reflowed” into crack locations



## History of Issues discussed during IST workshop

- Tin lead “Not Reflowed” into crack locations (lower cycles)



## History of Issues discussed during IST workshop

- Remove Simulated Preconditioning from test, cycle at 170°C





## Removal of Tin lead

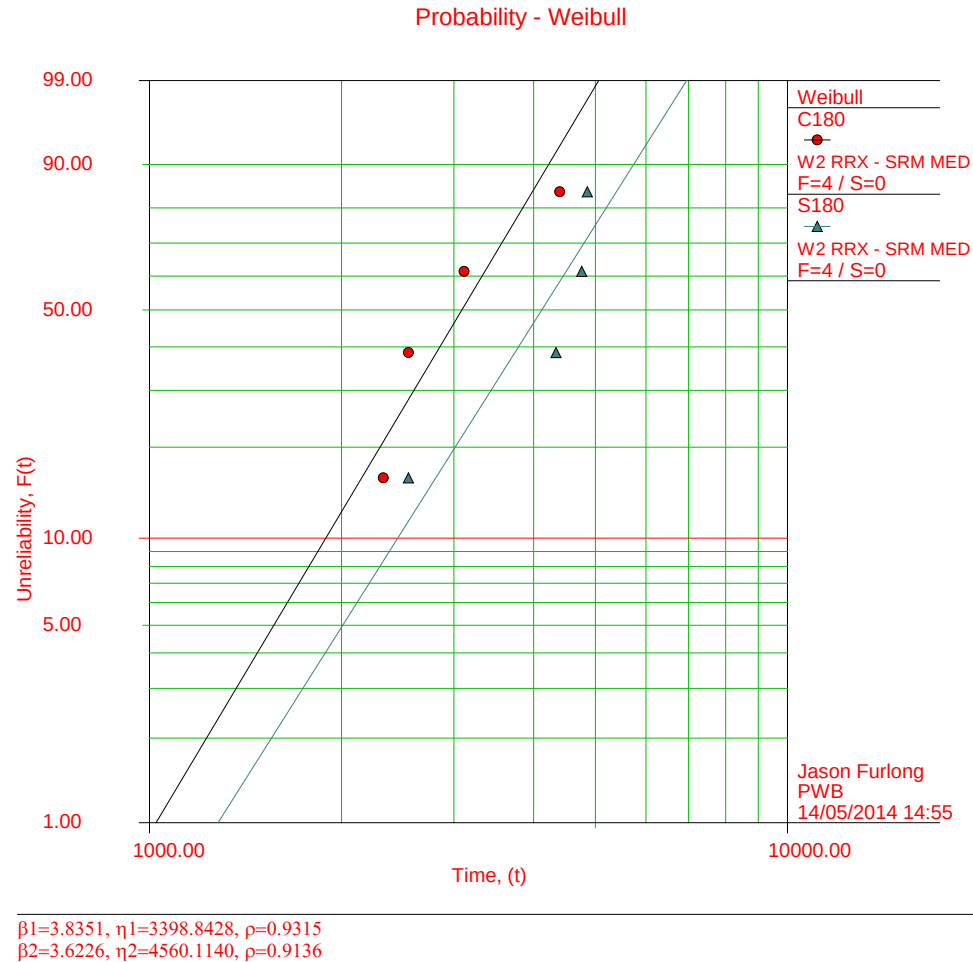
- Removal of tin lead considered to have little impact of copper thickness
- Test plan
  - 1 Panel
  - 16 coupons with Tin Lead removed
  - 16 coupons with Tin Lead present
  - All coupons to receive 6 X 230°C simulated reflow
  - All coupons cycled until 10% resistance change on PTH
  - 4 samples of each cycled at 180°C
  - 4 samples of each cycled at 190°C
  - 4 samples of each cycled at 200°C
  - 4 samples of each cycled at 210°C

## Test Vehicle, Test Protocol & Reflow Conditions

- Product Attributes - 18 Layers, 2.5mm thick, 0.8mm drilled PTH and a 0.6mm BV on a 1.3mm grid, built by 1 PWB fabricator
- Base Material - Polyimide Tg > 250°C (TMA)
- SL18037A 18 layer P = 2-17 S1 = 1-18 S2 = 2-17
- Interconnect Stress Testing (IST) of 4 coupons of each surface finish at each temperature level after reflow assembly
- Temperature ranges were from 23°C to 180°C, 190°C, 200°C and 210°C
- Simulated Reflow 6X 230°C

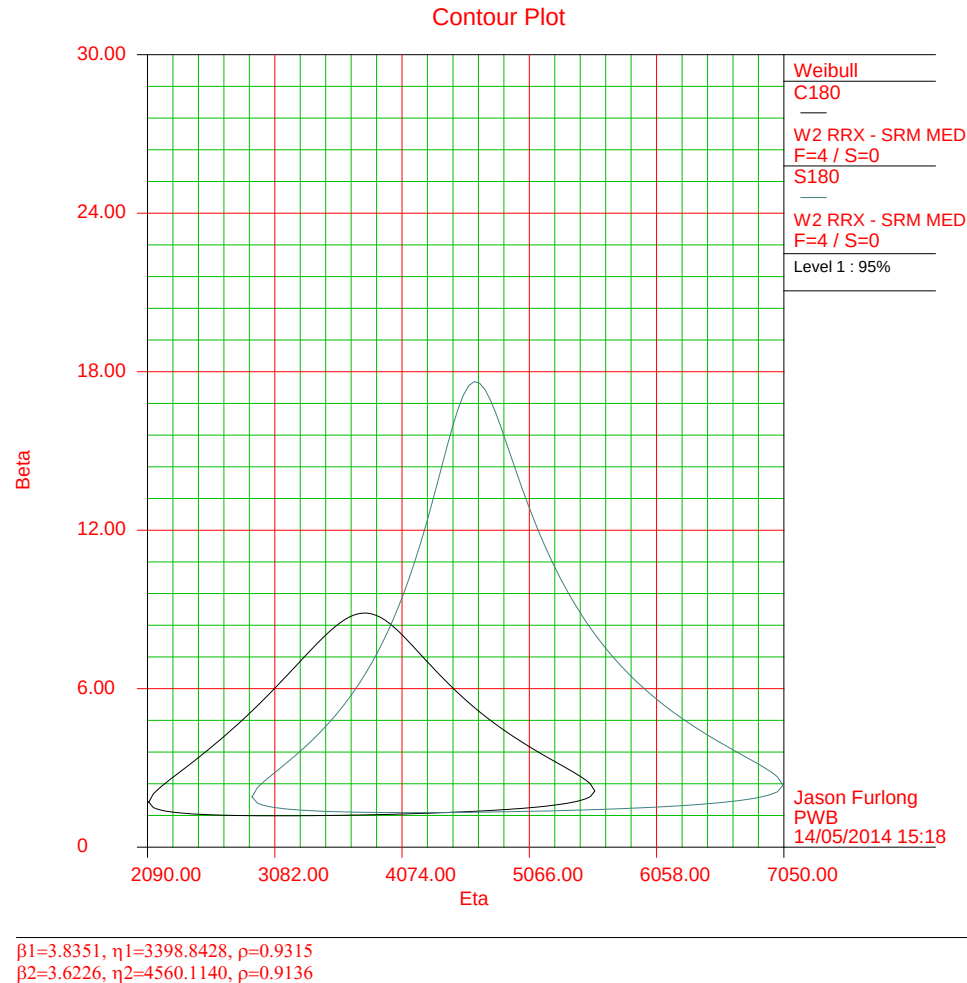
# Results of IST Testing (180°C)

ReliaSoft's Weibull++ 6.0 - www.Weibull.com



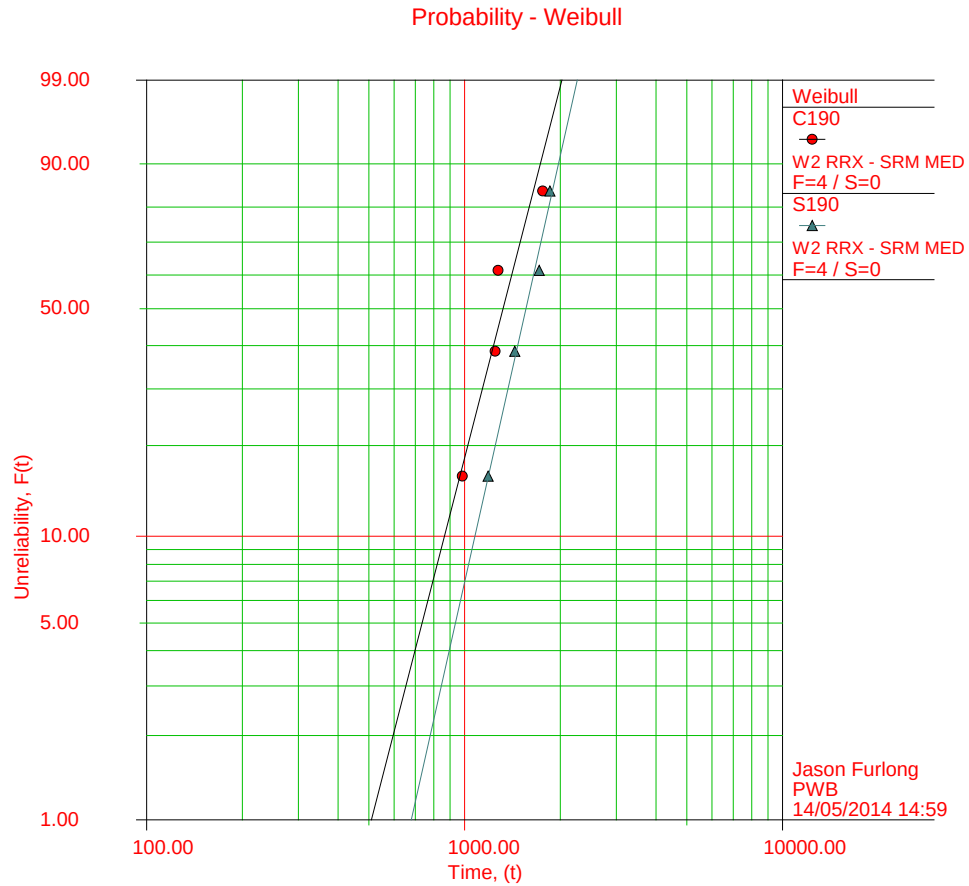
## Results of IST Testing (180°C)

ReliaSoft's Weibull++ 6.0 - www.Weibull.com



# Results of IST Testing (190°C)

ReliaSoft's Weibull++ 6.0 - www.Weibull.com



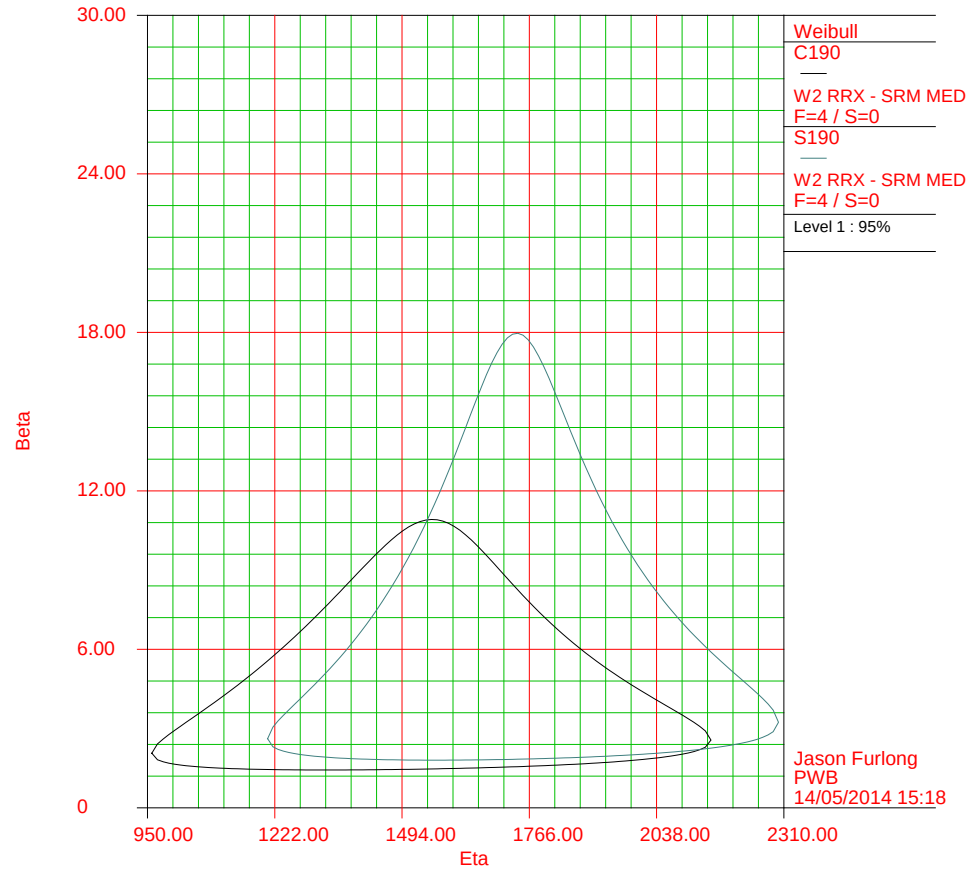
$\beta_1=4.4417, \eta_1=1434.9693, \rho=0.9495$   
 $\beta_2=5.0942, \eta_2=1676.7852, \rho=0.9932$



# Results of IST Testing (190°C)

ReliaSoft's Weibull++ 6.0 - www.Weibull.com

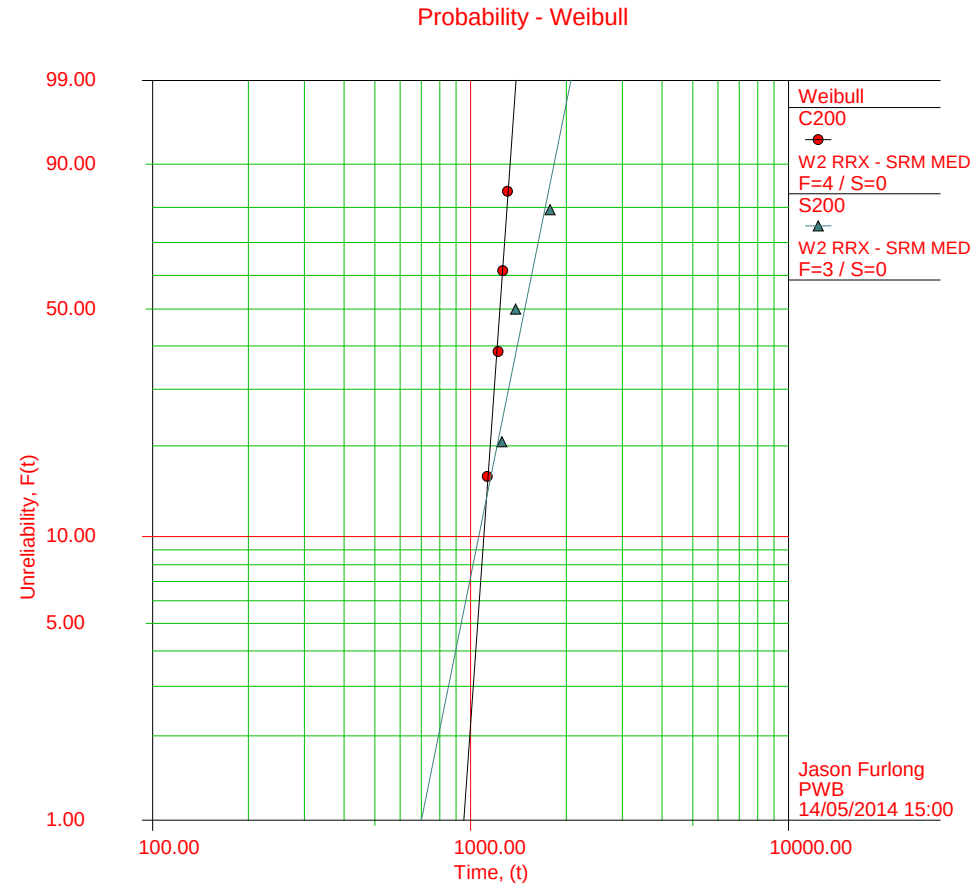
Contour Plot



$\beta_1=4.4417, \eta_1=1434.9693, \rho=0.9495$   
 $\beta_2=5.0942, \eta_2=1676.7852, \rho=0.9932$

## Results of IST Testing (200°C)

ReliaSoft's Weibull++ 6.0 - www.Weibull.com

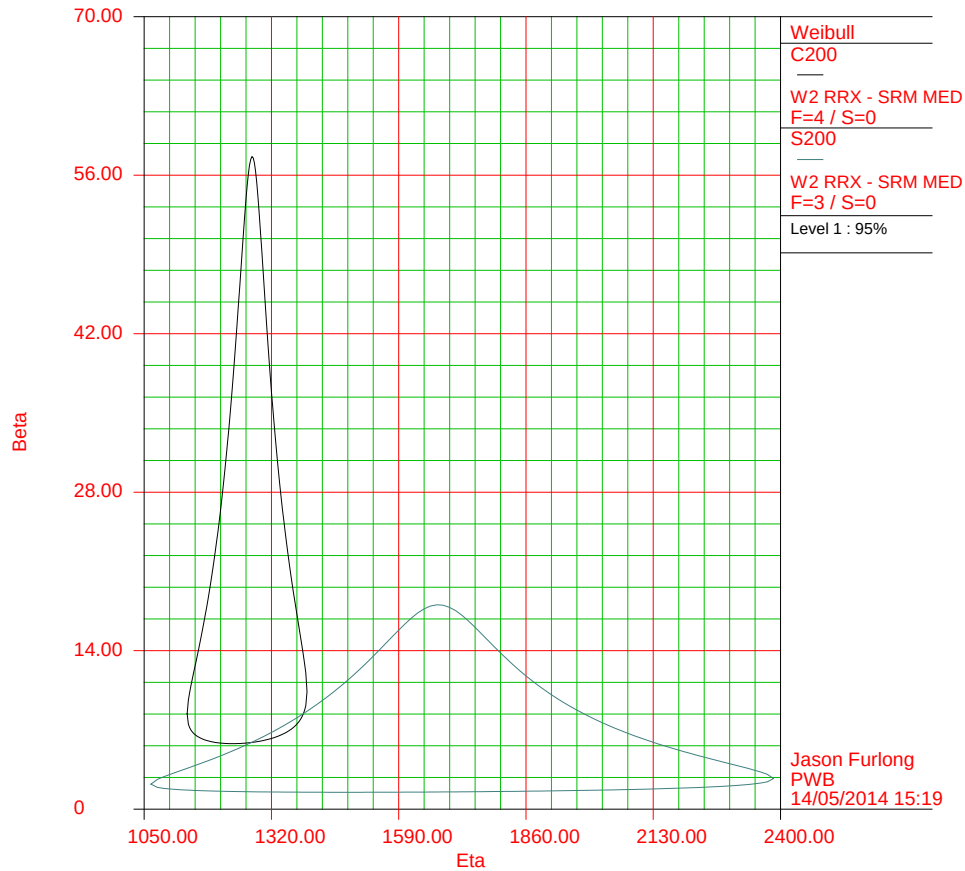


$\beta_1=16.1856, \eta_1=1265.0097, \rho=0.9942$   
 $\beta_2=5.6578, \eta_2=1579.1135, \rho=0.9472$

## Results of IST Testing (200°C)

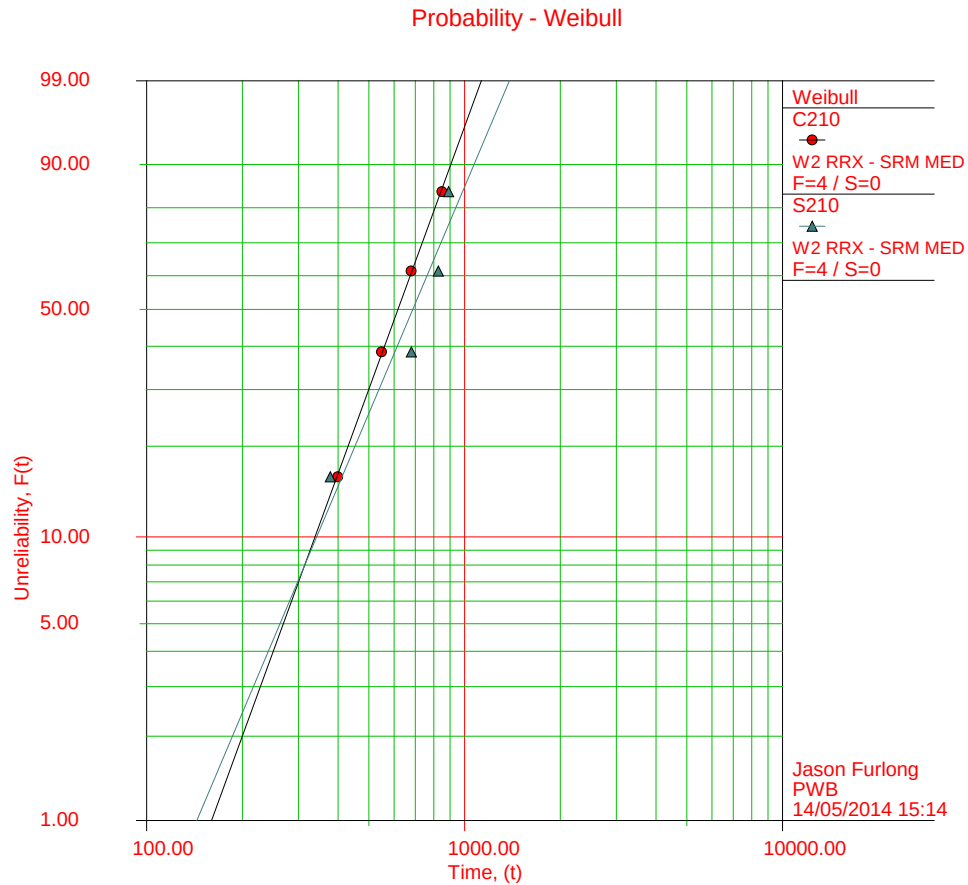
ReliaSoft's Weibull++ 6.0 - www.Weibull.com

Contour Plot



# Results of IST Testing (210°C)

ReliaSoft's Weibull++ 6.0 - www.Weibull.com

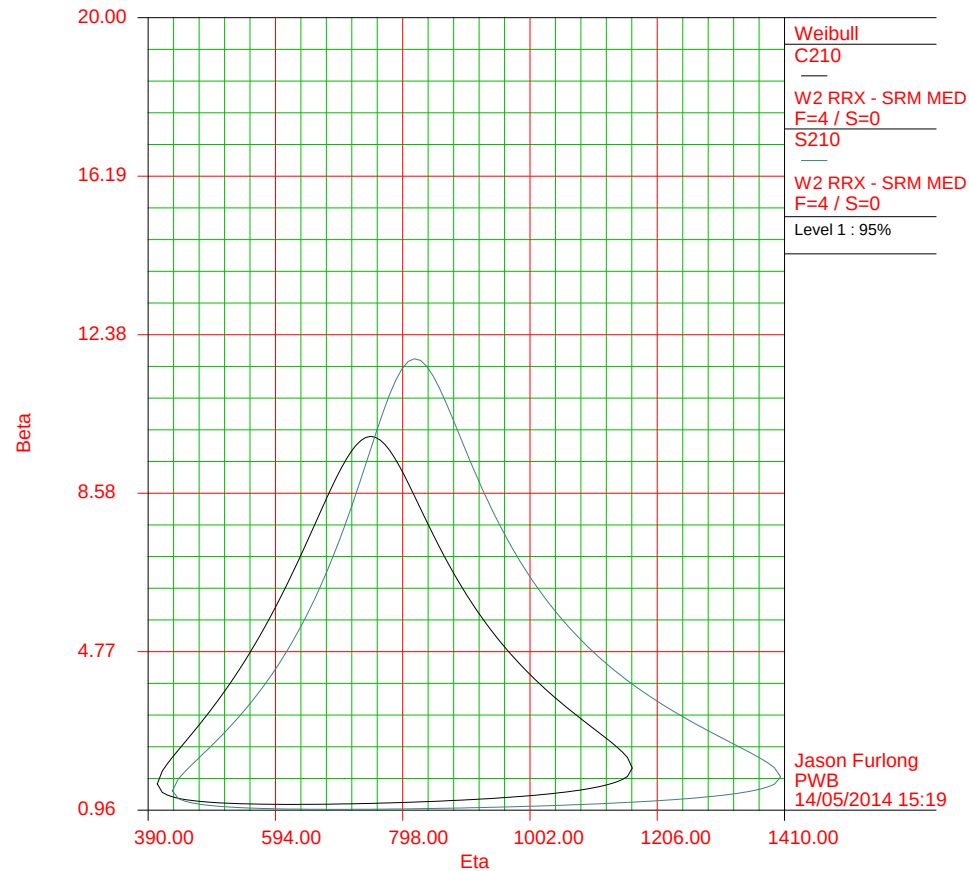


$\beta_1=3.1356$ ,  $\eta_1=693.9336$ ,  $\rho=0.9997$   
 $\beta_2=2.7067$ ,  $\eta_2=787.0770$ ,  $\rho=0.9590$

# Results of IST Testing (210°C)

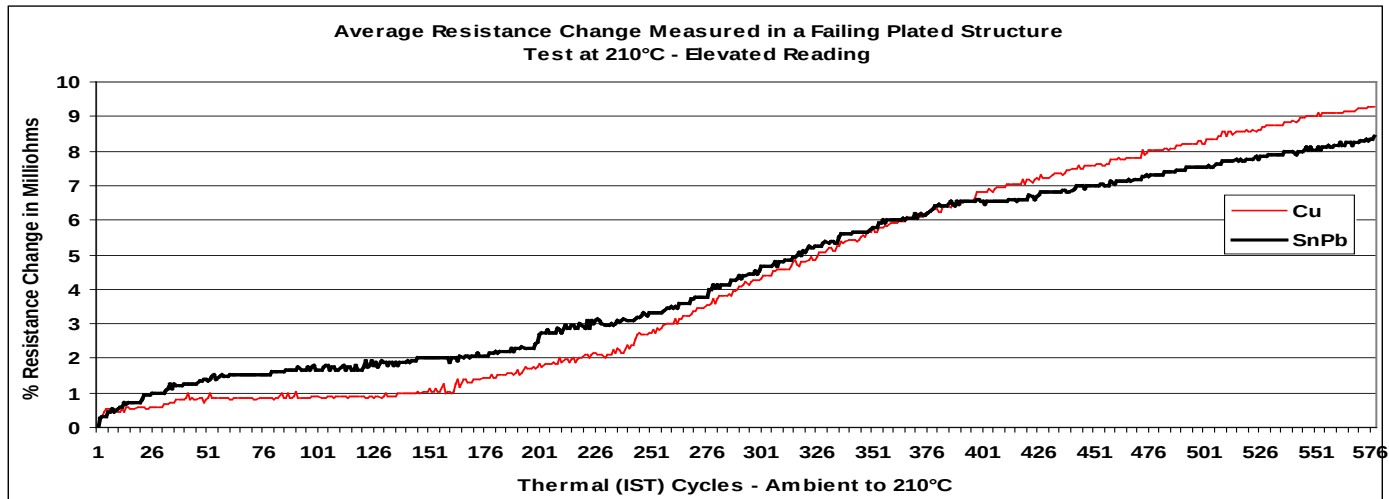
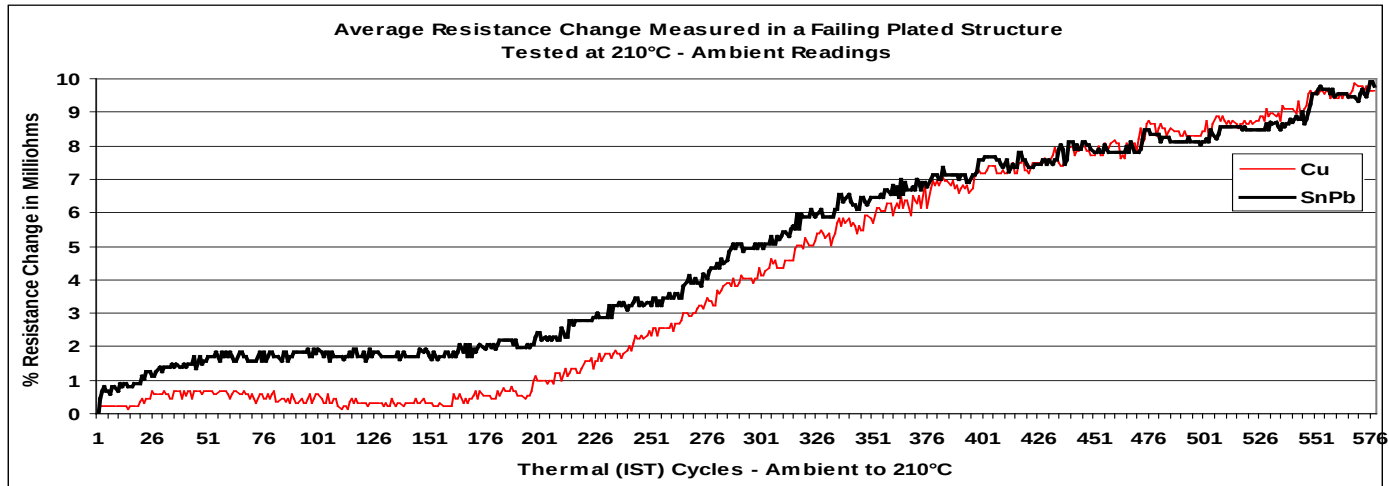
ReliaSoft's Weibull++ 6.0 - www.Weibull.com

Contour Plot



$\beta_1=3.1356, \eta_1=693.9336, \rho=0.9997$   
 $\beta_2=2.7067, \eta_2=787.0770, \rho=0.9590$

## Results of IST Testing

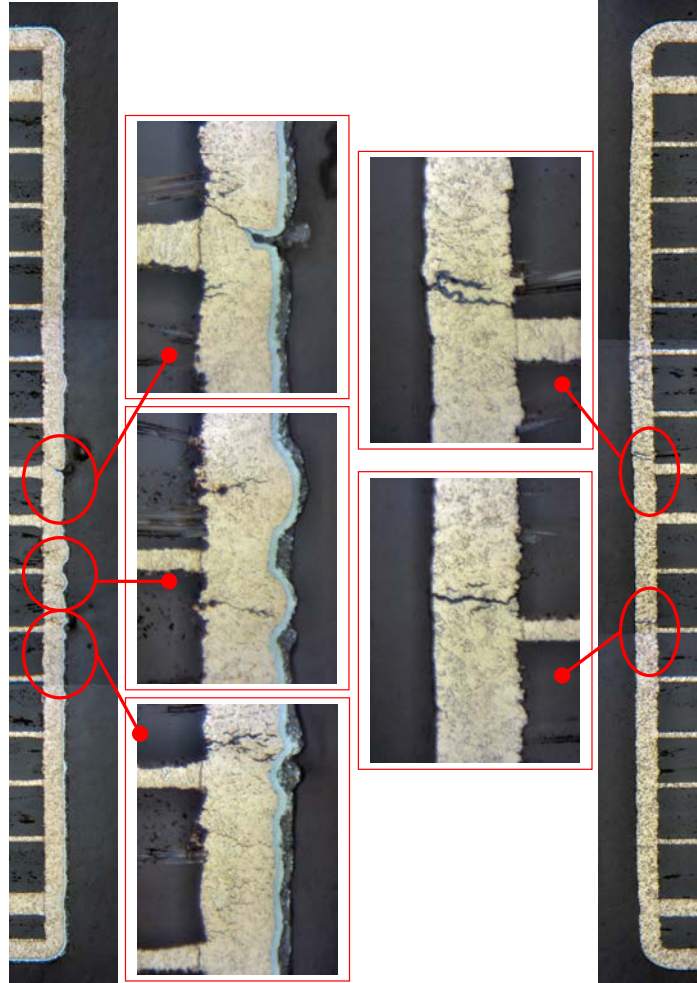


## Results of IST Testing

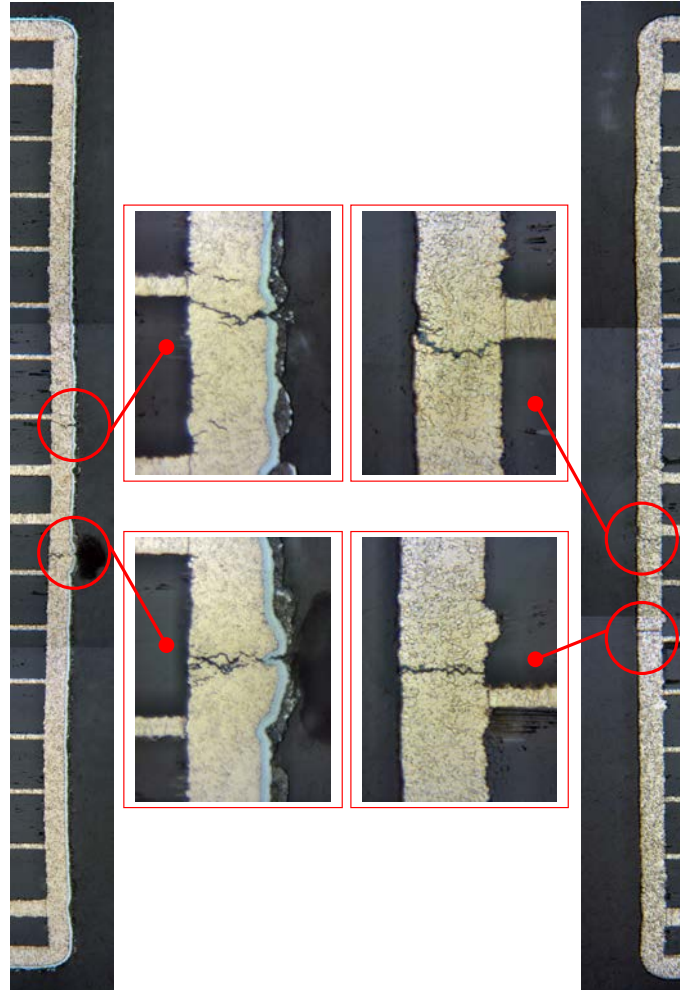
- IST results produced similar results when testing coupons with and without tin lead surface finish
- IST Contour plot analysis show all distributions similar at a 95% confidence interval
- Weaker correlation in 200°C testing possibility due to lower sample size and one outlier



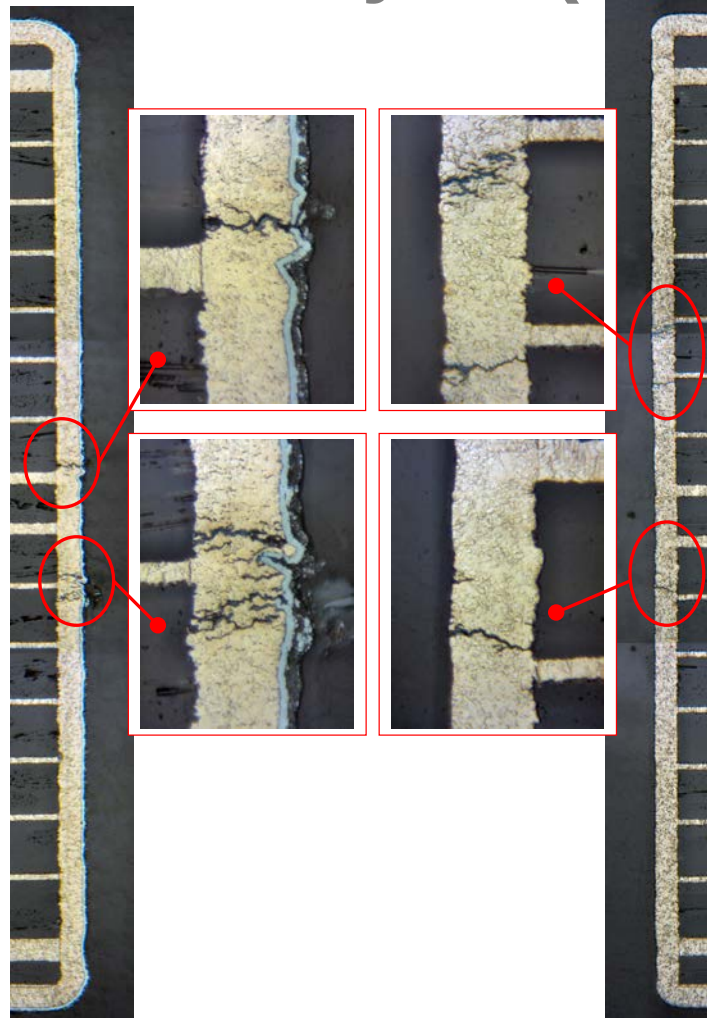
## Failure Analysis (180°C)



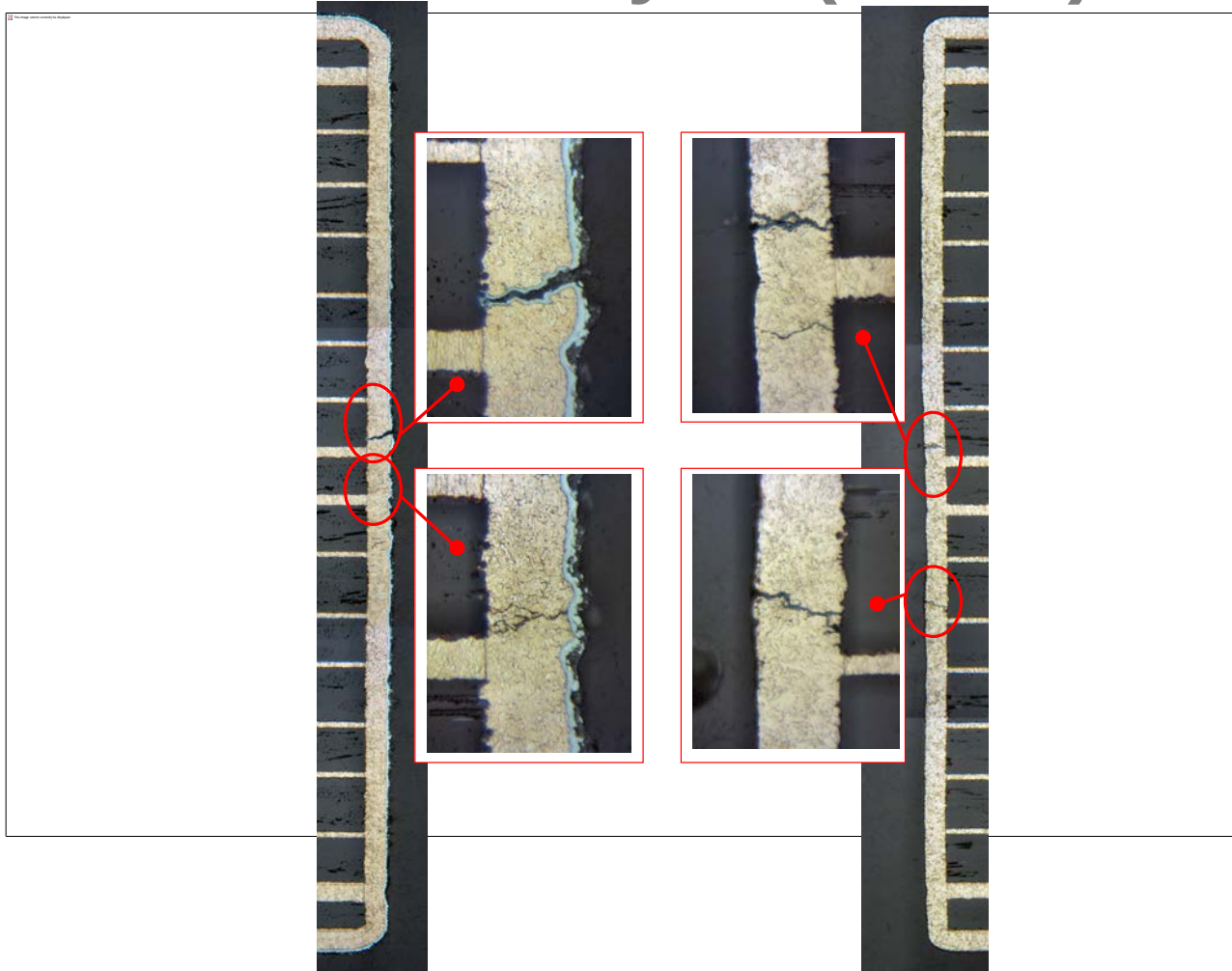
## Failure Analysis (190°C)



## Failure Analysis (200°C)



# Failure Analysis (210°C)



## Overall Study Conclusions/Comments

- Samples with and without Hot oil reflow performed similar in this study
- Should we remove the SnPb for future IST testing?
- Should higher test temperatures be considered for Space applications?
- Is this anomaly an indication of plating “Quality” (work being completed by Airbus Defence and Space).

# Acknowledgements

# Thank you for your attention!

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