ARCHIVE 2012

OPERATIONS MATTER

It's amazing what streamlining burn-in and test operations and processes can do for your bottom line. This session focuses on optimized methods developed to improve throughput, increase yields and extend the life of the equipment itself. First, you'll hear about using test-in-tray methods to effectively test devices under rigorous thermal regimes and power levels. The second speaker will explain an alternative manufacturing method for rapid prototyping of test socket. A presentation on optimized online socket cleaning promises improved yields and reduced retest. Wrapping up the session will be a paper on how alternative coatings can improve contact life.

High Performance Testing in Test-in-Tray Formats

Thomas H. Di Stefano—Centipede Systems

Using Alternate Manufacturing Methods for Rapid Prototyping of Test Sockets

James Migliaccio—RF Micro Devices

Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest

Jerry Broz, Ph.D., Bret Humphrey—International Test Solutions, Inc.

Achieving Extreme Contact Life Through the Application of Alternative Coatings

Erik Orwoll—Contact Coatings, LLC

High Performance Testing in Test-in-Tray Formats

Thomas Di Stefano
Centipede Systems

2012 BiTS Workshop
March 4 - 7, 2012

Centipede Systems

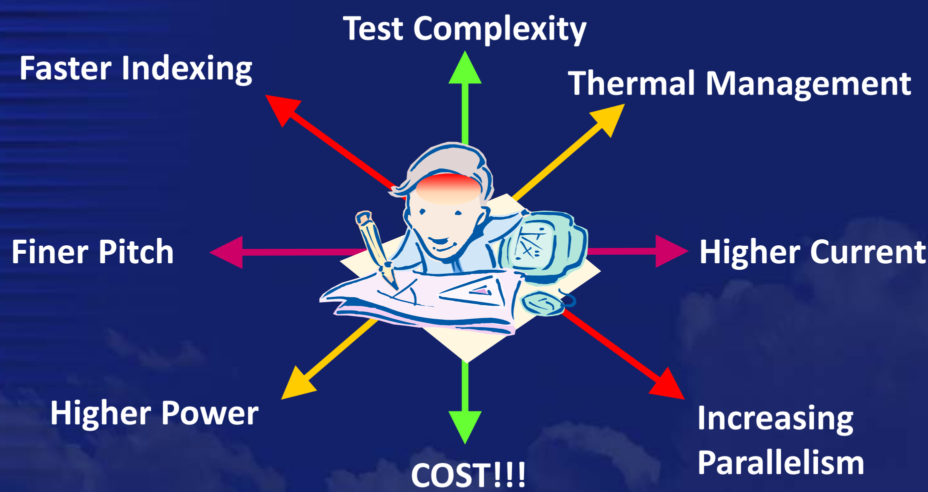
Challenges in High Performance Test

- Increasing Reliability
- Broader Temperature Ranges
- Higher Currents
- Parallel Test
- Bare Die Formats (WLP, KGD, TSV, …)

Cost Down

3/2012 High Performance Testing in Test-in-Tray Formats 2

Test Engineering is Stretched in all Directions



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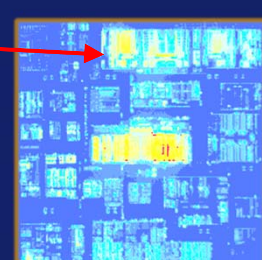
Soooo … What's the Problem?

Get Power into and out of the Chip

- Hot Spots
- Extreme Test Temperatures
- Power Variations
- Test Time



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Biggest Challenge -> Thermal

Set Temperature Accurately Across Chip

- Mechanically Compliant Contact
- Low Thermal Resistance to Ambient
- Fast Response to Set and Maintain Temperature

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Penalty for Failure

Yield Loss

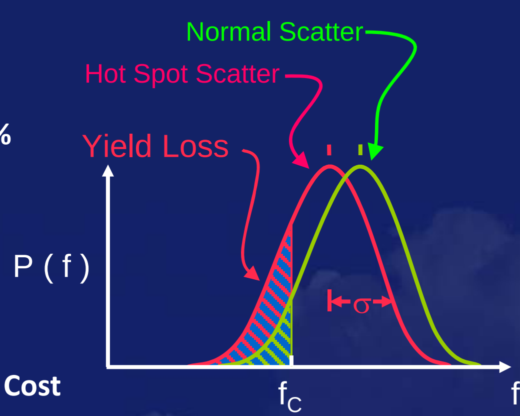
- 15°C Shifts Timing[1] by 15%

Test Escapes

- Field Failures

Low ATE Utilization

- Major Component of Test Cost



1. Andrew Yang, TSMC EDN Sept /2005

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Objectives

- Compliant Thermal Contact
- High Conductivity to Transfer Fluid
- Uniform Contact Pressure
- Rapid Thermal Response
- Controlled Environment
- Parallel Test Configurations

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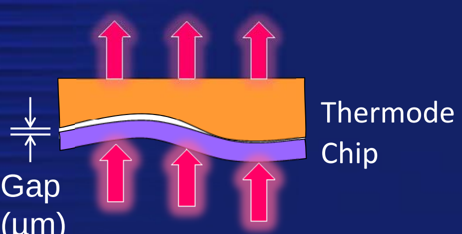
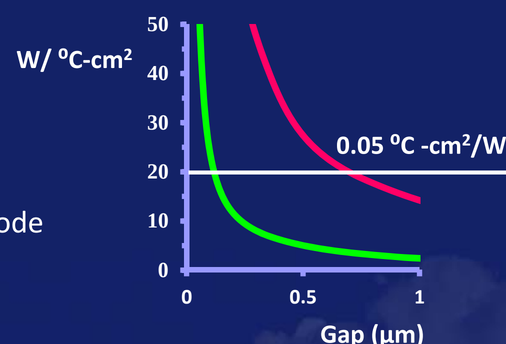
Compliant Thermal Contact





Mechanical Compliance Minimizes Gap

- Chip Warp
- Particles or Contamination
- Surface Irregularities

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Compliant Thermal Contact

Thermode Module*

- Thin Metal Membrane
- Dry Contact Surface
- No Residue
- Compliant to ±50 µm

* Patents Issued and Pending

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High Conductivity to Transfer Fluid

Thermal Resistance 0.05 ⁰C–cm² / Watt*

- Minimum Path to Transfer Fluid
- Power to 200 Watts / cm²

* In He Ambient

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High Conductivity to Transfer Fluid

Fluid Compatibility

- All Metal Construction
- Fluorocarbon Seals
- Fluid Pressure to 150 psig
- Temperature Range -65°C to +160°C
- Liquid or Gas Transfer Fluid

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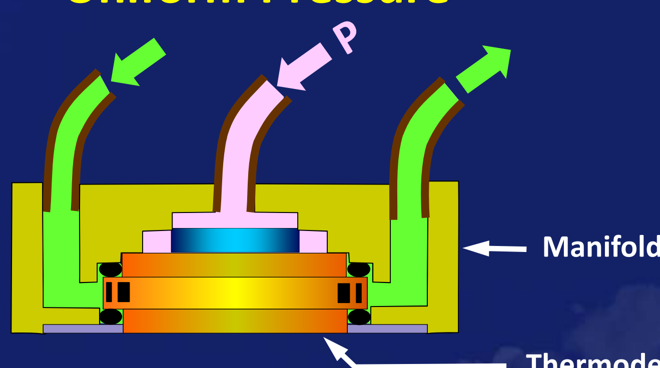
Uniform Pressure



Pneumatically Actuated Thermode

- Clamping Action over a 0.5mm Range
- Gimbal Action of Active Thermode Element

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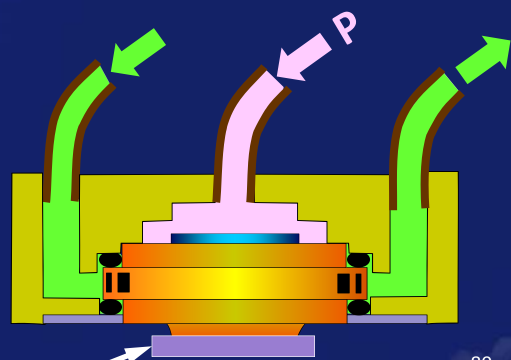
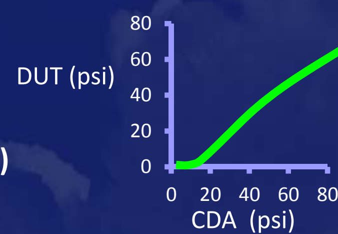
Uniform Pressure

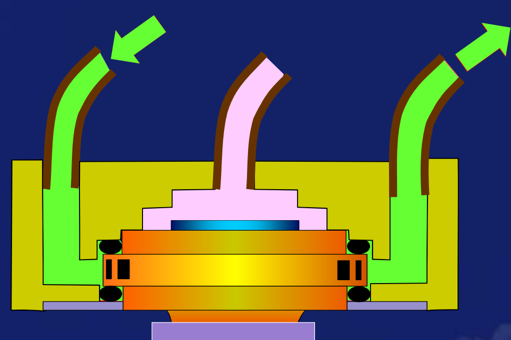


DUT in Clamp

- **Uniform Pressure**
- **Computer Controlled (with regulator)**

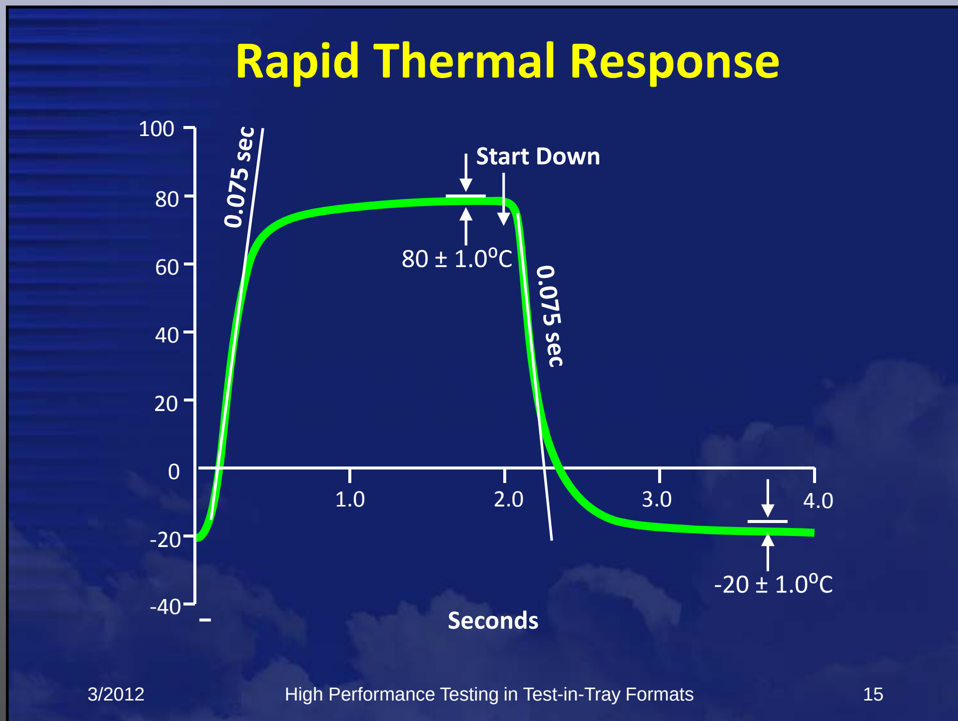


Rapid Thermal Response



Response Time

- **Rapidly Switched Fluid Flow**
- **Total Heat Capacity < 0.45 J / ^{o}C**
- **Short Thermal Path**


Rapid Thermal Response
100
80
60
40
20
0
-20
-40
0.075 sec
Start Down
80 ± 1.0°C
0.075 sec
1.0
2.0
3.0
4.0
-20 ± 1.0°C
Seconds
3/2012
High Performance Testing in Test-in-Tray Formats
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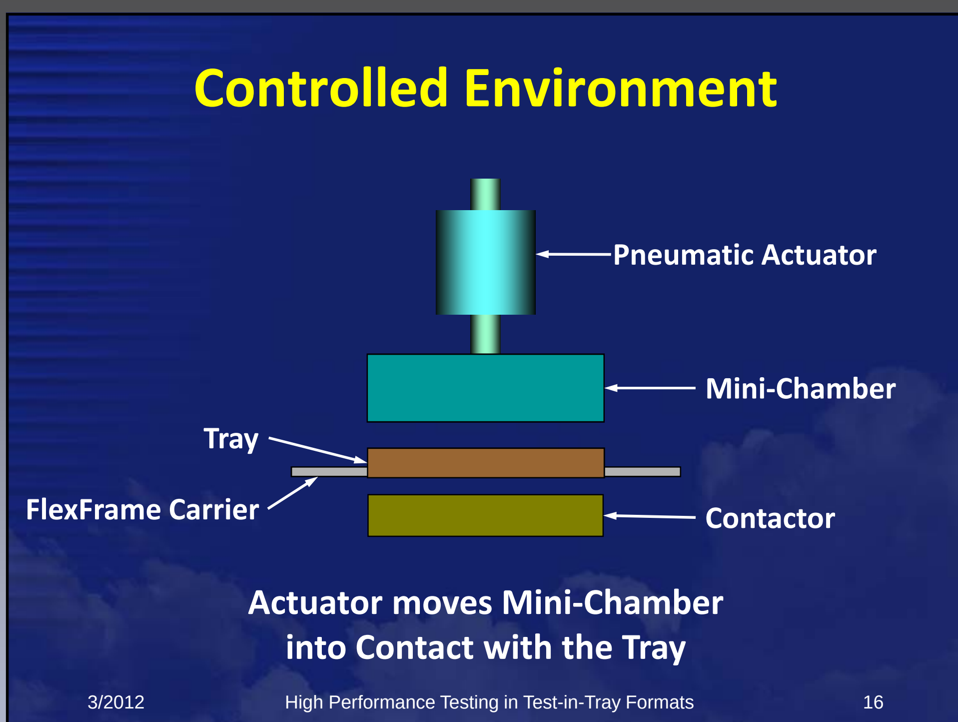
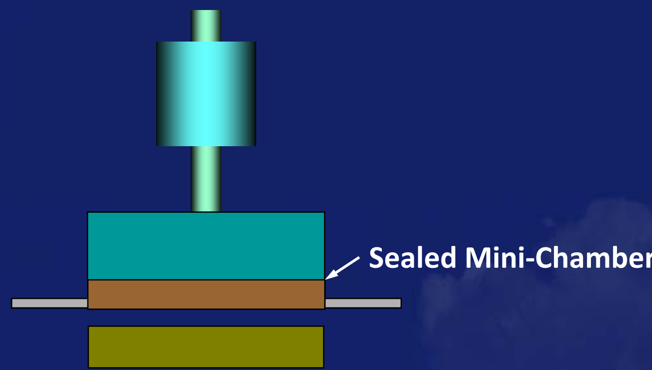

Controlled Environment
Pneumatic Actuator
Mini-Chamber
Tray
FlexFrame Carrier
Contactor
Actuator moves Mini-Chamber
into Contact with the Tray
3/2012
High Performance Testing in Test-in-Tray Formats
16

Controlled Environment



Mini-Chamber Seals Tray to Contactor Forming an Environmental Chamber

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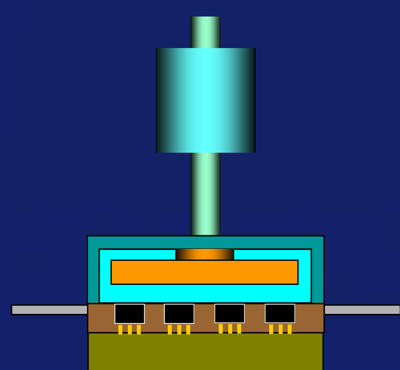
Controlled Environment



Environmental Gas (He, N_2, …) Introduced into Chamber
Thermode Clamped to DUTs with Controlled Pressure

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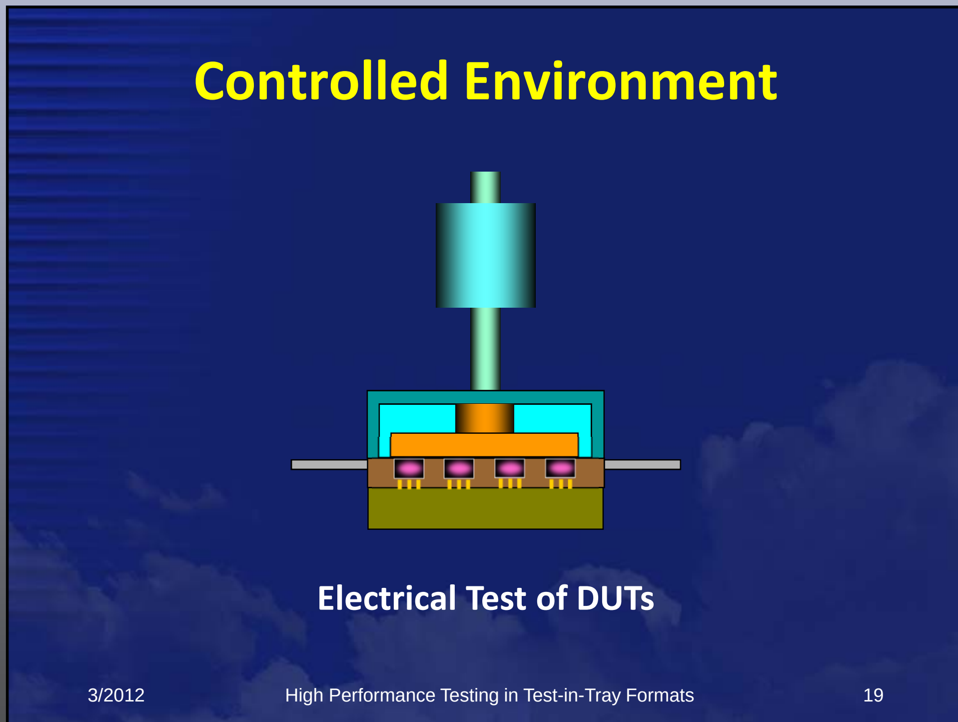
Controlled Environment
Electrical Test of DUTs
3/2012
High Performance Testing in Test-in-Tray Formats
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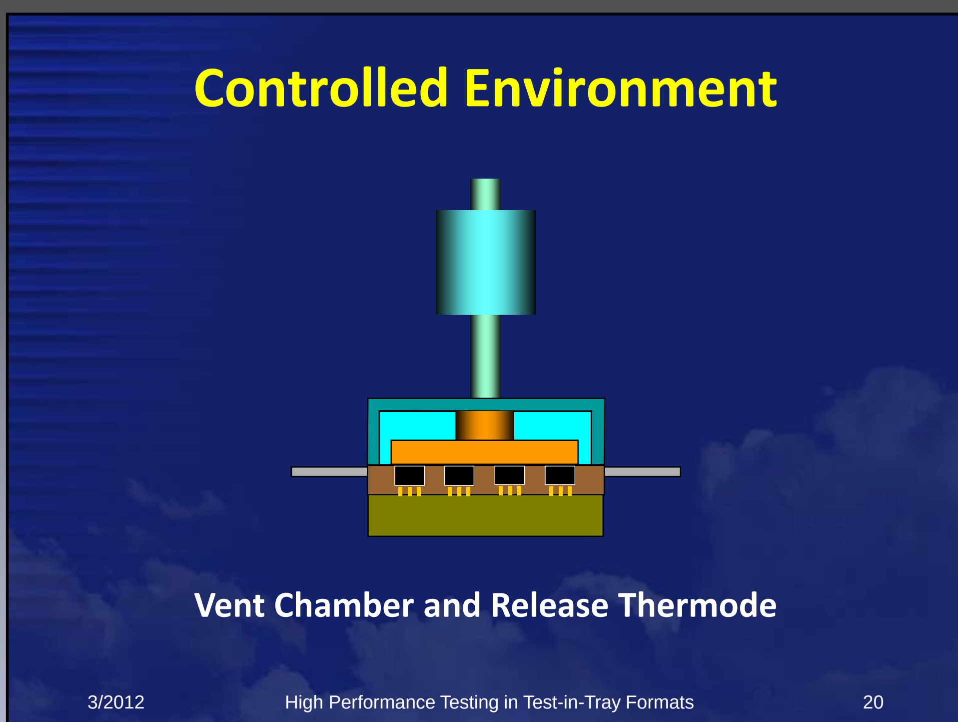
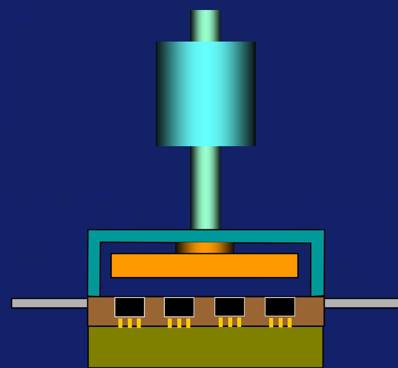

Controlled Environment
Vent Chamber and Release Thermode
3/2012
High Performance Testing in Test-in-Tray Formats
20

Controlled Environment



Open Chamber

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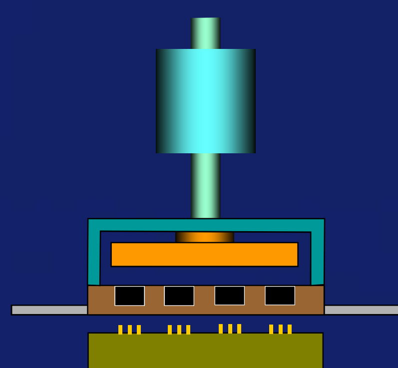
Controlled Environment



Disengage and Remove Tray

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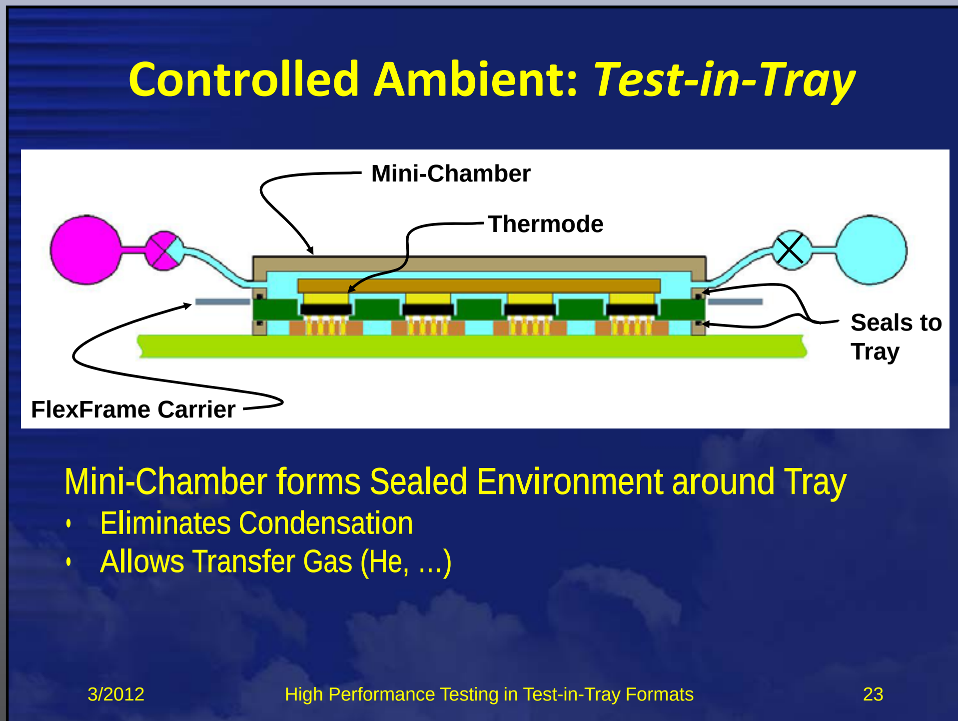
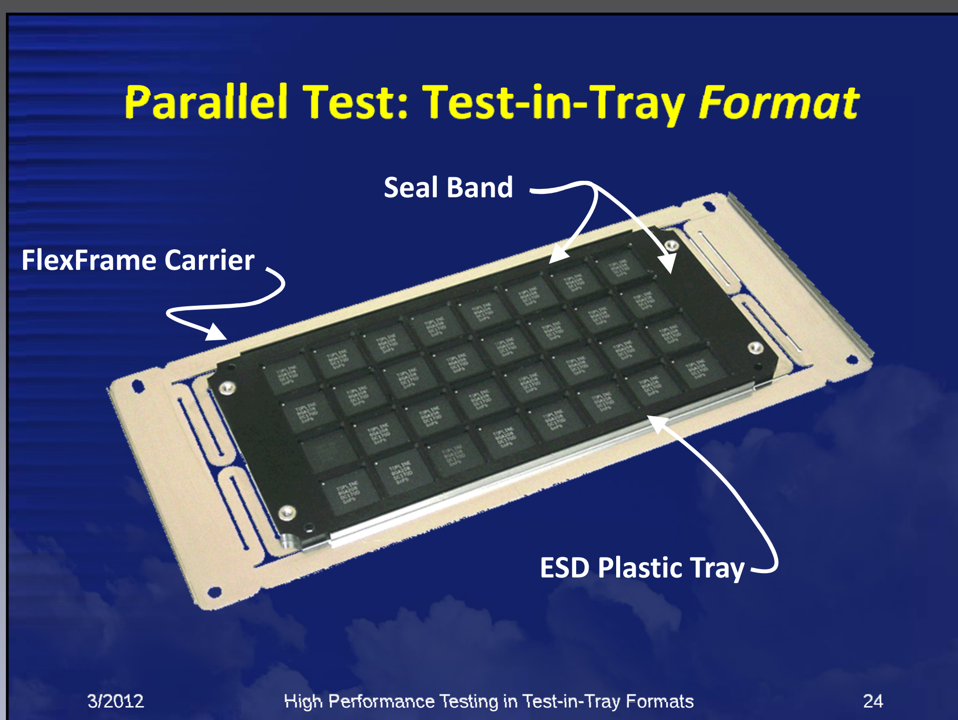

Controlled Ambient: *Test-in-Tray*
Mini-Chamber
Thermode
Seals to Tray
FlexFrame Carrier
Mini-Chamber forms Sealed Environment around Tray
• Eliminates Condensation
• Allows Transfer Gas (He, ...)
3/2012
High Performance Testing in Test-in-Tray Formats
23


Parallel Test: Test-in-Tray *Format*
Seal Band
FlexFrame Carrier
ESD Plastic Tray
3/2012
High Performance Testing in Test-in-Tray Formats
24

Conclusion

Test-in-Tray Facilitates High Performance Test

- Highly Parallel Test
- Controlled Ambient
- High Performance Thermodes
- Independent Thermal Control at Each DUT

3/2012 High Performance Testing in Test-in-Tray Formats 25

Using Alternate Manufacturing Methods for Rapid Prototyping of Test Sockets

James Migliaccio
RF Micro Devices

2012 BiTS Workshop
March 4 - 7, 2012

Motivation

The need to create a unique test socket for limited use or an experimental socket comes up on occasion.

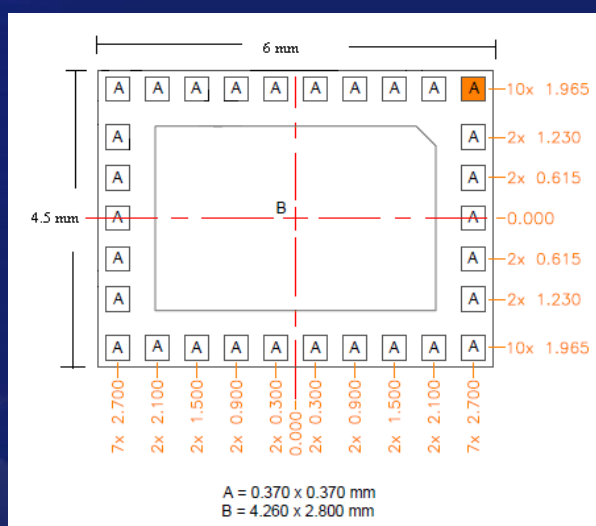
Using rapid prototyping manufacturing methods a prototype socket can be designed and manufactured in as little as one day.

The Example

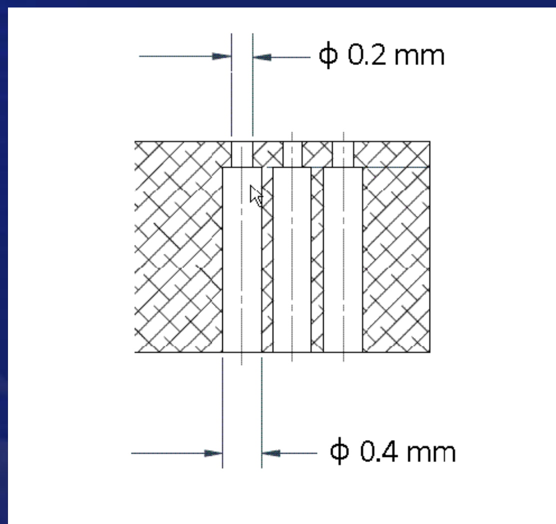
Provide a test socket to test a one time build of a couple hundred pieces for part functionality with the following:

- Socket needed in under two weeks
- One time test need – not being reused
- Utilize one of several spring-pins already inventory
- Simple part geometry and large pads
- Low cost

The Package



Hole Cross Section for Spring Pins

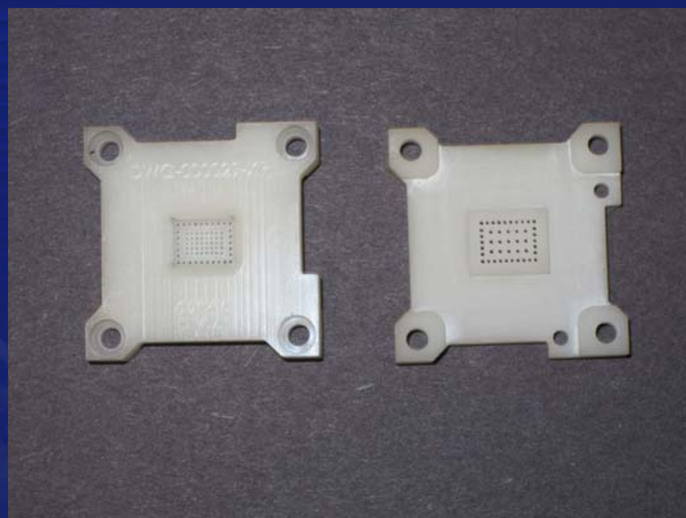


Stereolithograpy (SL)

SL uses an ultraviolet laser focused to a small point, drawing on the surface of a liquid thermoset resin. Where it draws, the liquid turns to solid. This is repeated in thin, 2-dimensional cross-sections that are layered to form complex 3-dimensional parts.

A variety of materials are available along with different equipment giving different resolution and material properties.

A Pair of SL Sockets



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First Pass (DUT Side)

Note hole sizes

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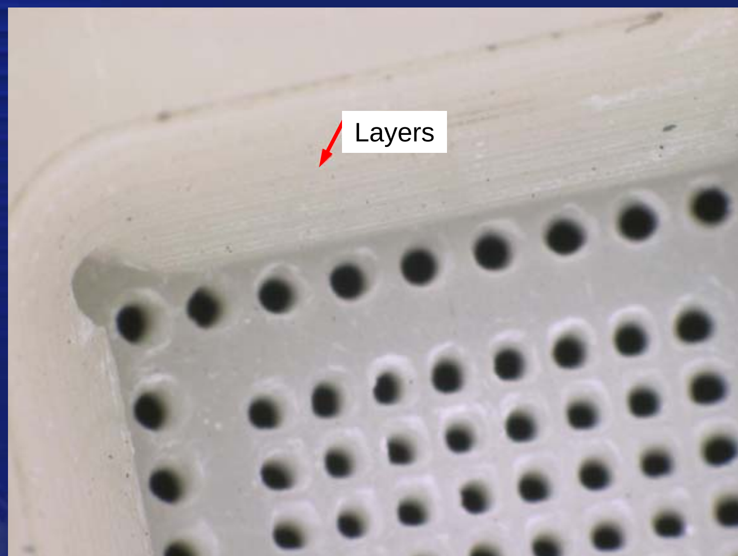
Close-up of Socket



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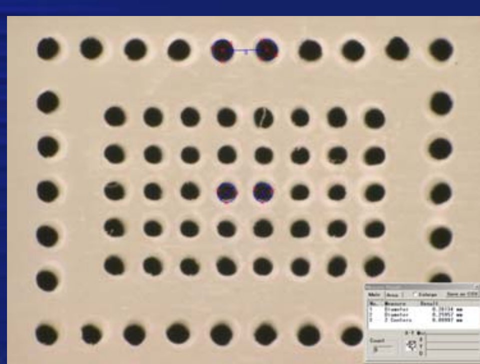
First Pass (Backside)



- All holes had the same design
- Center–to-center spacing is accurate
- Array holes diameter about 0.25 mm, ~ 37% smaller than design
- Material curing caused hole distortion

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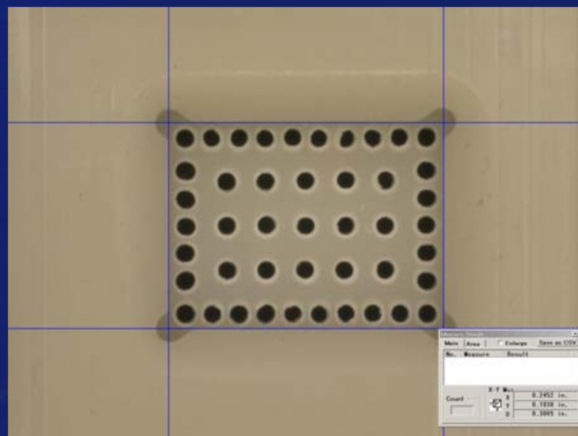
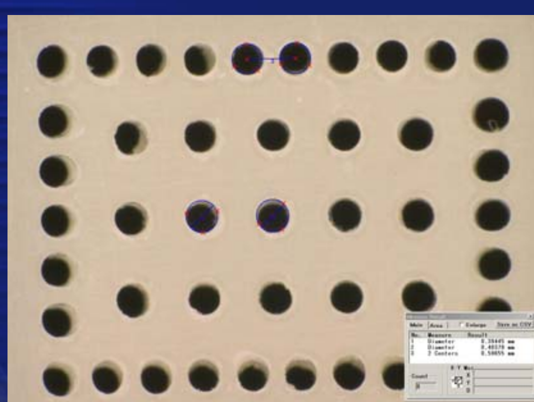
SL Socket 2nd Pass



Note consistent hole size

SL Socket 2nd Pass (Backside)



- Reduced # holes
- Only provided the X,Y location
- Center–to-center spacing is accurate
- Array holes diameter about 0.4 mm, on target
- Straight holes – no reduction in diameter

Close up of Backside

SL Results

Pros:

- Manufacture turned sockets in one day
- Socket held pins in position
- Aligned part
- Worked good enough for the testing needed

Cons:

- Pins not constrained
- Not suitable for use on handler

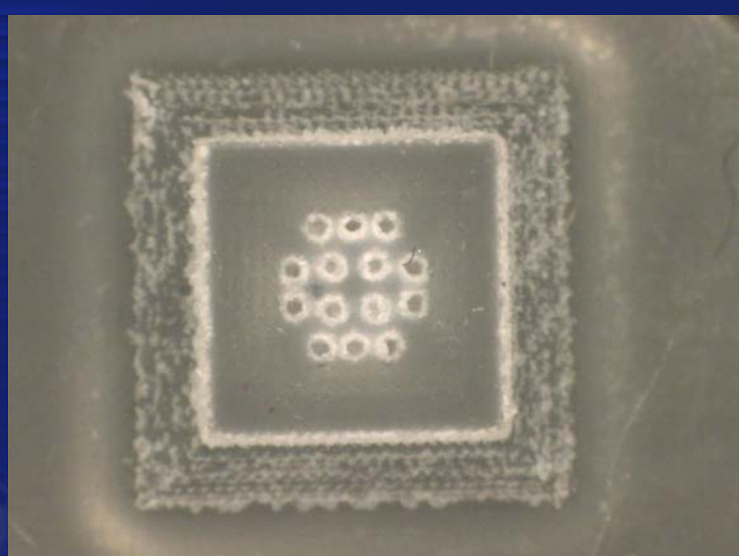
3D Printing

Many 3D rapid prototyping machines — but not all — use ink-jet technology in some way to deposit material in 2D layers that build up to 3D structures.

Our example socket exhibited poor features. The printing process is clearly visible as the structure resembles Styrofoam.

3/2012 Using Alternate Manufacturing Methods for Rapid Prototyping of Test Sockets 15

3D Printed Socket (Backside)



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Summary

- Rapid prototyping of sockets is viable option for some low use sockets
- Stereolithography exhibited much better feature accuracy than 3-D printing in our trial
- Other methods of rapid prototyping exist that may be viable options, e.g., Perfactory®, SLS, FDM

Acknowledgment

RFMD Mechanical Engineering Team

–Barry Landi

–Mark Lanowitz

Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest

Jerry Broz, Ph.D. and Bret Humphrey
International Test Solutions, Inc.

2012 BiTS Workshop
March 4 - 7, 2012

Outline

- Background
- Online Cleaning For Test Sockets
- Practical Results from HVM Environments
  - Customer Case Studies
    - Spring Contactors
    - Multiple Socket Solutions
    - Online Cleaning + Offline Laser
- Summary / Conclusions

3/2012 Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest 2

Package Test is a "Dirty Business"

- Semiconductor packages carry adherent debris and other contaminants that affect electrical contact integrity
- Debris / contaminants will be found on tip contact surfaces, around the pins, along guide plates, and across the socket bed
- Contactors must physically touch the I/O's (pads, bumps, pillars, etc.) of the DUT for test programs to be executed
- "Contact and slide" is CRITICAL to break surface oxide(s), but creates more debris and material transfer to contactors

3/2012 Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest 3

Many Sources of Contamination

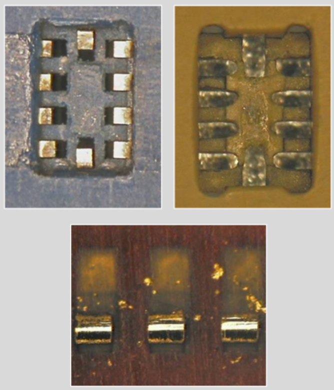
- Material transfer from the device
- Localized material loss and pick-up
- Debris accumulation on contacts and across socket bed
- Intermetallic formation on the test pin contact area
- Oxidation (thick and thin non-conductive films)
- Mechanical wear and tip shape change over time
- Plating related issues (cracking, flaking, etc.)

Contamination generates more contamination !

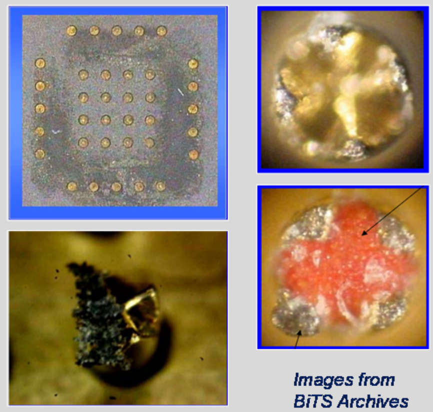
3/2012 Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest 4

Just a Few Examples …

CONTACTORS



SPRING PINS



Images from BiTS Archives

3/2012 Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest 5

Contact Resistance (CRES)

- "Contactors Touch the Device and the Current Flows"
- Contact Resistance (CRES) is the most CRITICAL parameter in all electrical testing
  - "Metal on Metal Contact" between a probe tip and the pads, bumps, pillars, etc.
  - Non-conductive films will build-up and interfere with the "Metal on Metal Contact"
  - Film resistance is affected by absorbed materials various oxides and compounds, and miscellaneous contaminants
  - Film resistance will eventually dominate contact reliability

3/2012 Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest 6

Classical CRES Definition

- Contact Resistance (CRES)
  - CRES stability (and instability) is entirely attributable to interfacial phenomena across contact areas (Metallic Contact) and with adherent contaminants (Film Resistance)

METALLIC CONTACT

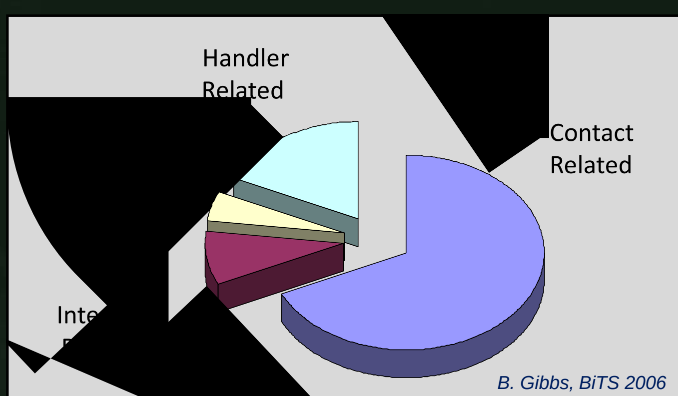
$$C_{RES} = \frac{(\rho_{probe} + \rho_{pad})}{4}\sqrt{\frac{\pi H}{P}} + \frac{\sigma_{film} H}{P}$$

R. Holm, 1967

FILM RESISTANCE

Unstable Contact Affects Performance

- Clear majority of yield fallout and re-screen problems can be attributed to contact related issues



Revised CRES Definition

- High CRES results in low First Pass Yield (FPY), high rescreen rates, and continuity fallout

$$C_{RES} = \frac{(\rho_{probe} + \rho_{pad})}{4}\sqrt{\frac{\pi H}{P}} + \frac{\sigma_{film} H}{P} \propto \$\$\$\$$$

FPY, Throughput, Up-time, Rescreen Socket Wear, Etc.

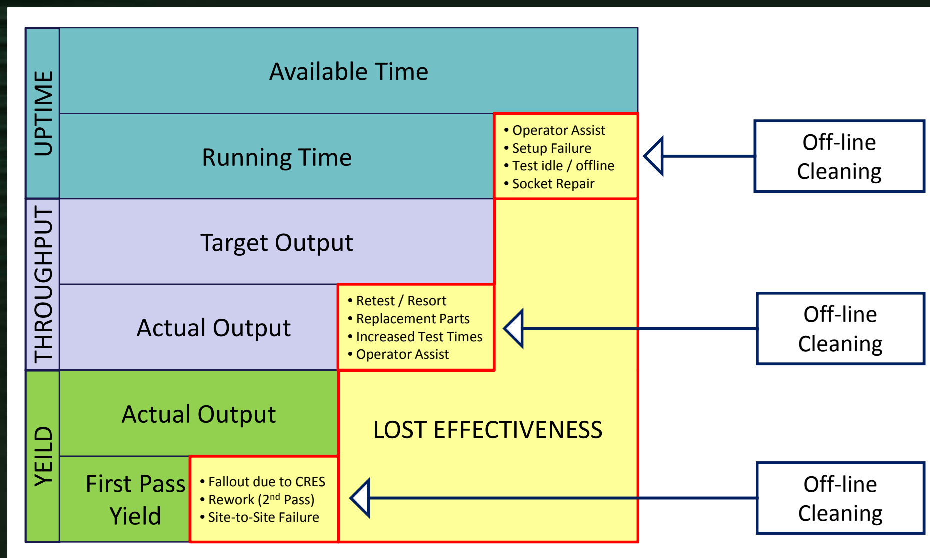
R. Holm, 1967
J. Forster, BiTS 2011

Controlling Film Resistance Is CRITICAL for Performance

Film Resistance is Controlled with Contactor / Socket Cleaning

- Socket maintenance is critical to control CRES and maximize contactor electrical performance
- Off-line cleaning (idle state with potentially long downtime)
  - Pins in sockets and sockets in load-boards are replaced at added cost
  - Socket lifetime can be reduced due to cleaning related damage.
  - Excessive cleaning can reduce test throughput without yield benefits
- On-line cleaning (consistent CRES control and limited downtime)
  - Socket and load boards remain docked (no idle state needed)
  - Debris and adherent materials are removed from socket in-situ
  - Consistent cleaning to maintain high FPY yields and without downtime

Manual (Offline) Cleaning OEE



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Online Socket Cleaning

www.kita-mfg.com
or
local hardware store

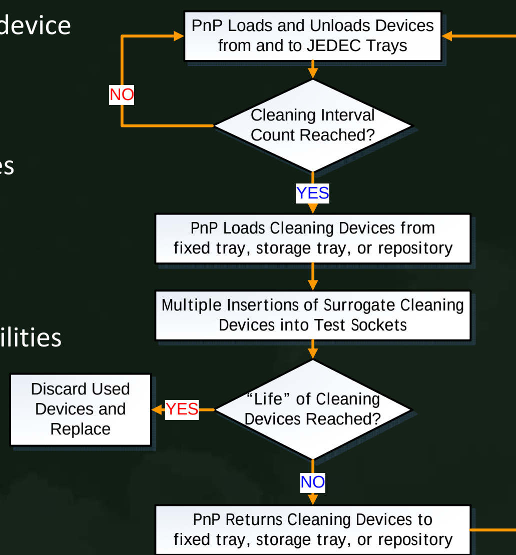
www.deltad.com

- Operators perform online socket cleaning with handler in "down state"
- 2001: Inabata discusses "contact cleaner sheet" for manual "online" cleaning.
- 2004: ITS introduces "surrogate cleaning chip" designed to collect debris / clean contactors; unsupported by handler and yield software
- 2006: Texas Instruments and Delta Design present handler supported automated contact cleaning (ACC) for "true" online cleaning function
- 2006 to 2011: High volume handlers makers incorporate automated online cleaning functionality on new units, upgrades, and retrofits

3/2012 Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest 12

High Volume Online Socket Cleaning

- Hardware to store cleaning device
  - Fixed trays
  - Repository
- User defined cleaning recipes
  - Cleaning materials tracked
  - Compatible with yield management software
- HVM Online Cleaning Capabilities
  - Delta Design with ACC
  - Seiko Epson
  - Multi-Test
  - Rasco
  - Others …



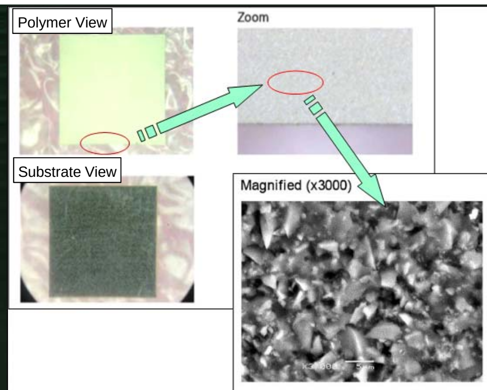
Socket Cleaning Device

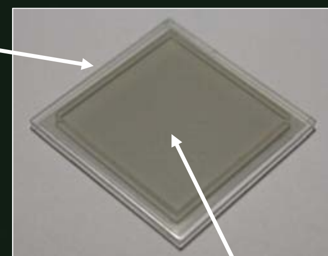
- Socket cleaning device (SCD) or test cell conditioner (TCC)
  - Compatible with sockets used for testing leadless and BGA packages
  - Devices compatible with leaded packages (*under development*)
  - Pick & Place handler compatible (logic and memory)
- Polymers have polishing efficiency and tacky surface properties
  - Highly engineered polymers remove and collect many types of debris
  - Effective for sliding, crown spring, and other contact types
- Turnkey solution for tri-temperature handling requirements
  - Polymer and adhesive have stable properties across -50 to +200C
  - Substrate solutions can operate up to +165C
  - Substrates for temperatures above +165C under development

Socket Cleaning Device

Substrate

TCC Polymer Material Polishes and Collects Debris





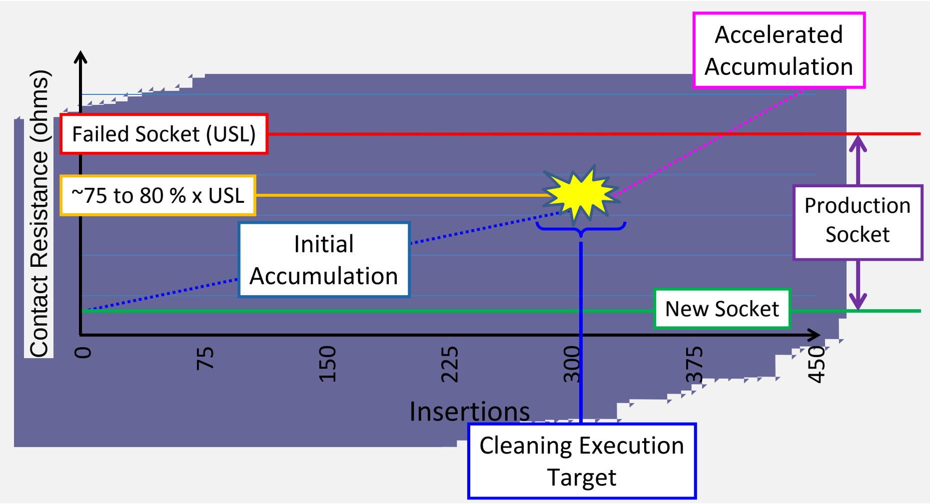
TCC Polymer

Abrasive particles distributed within proprietary, 100% cross linked and completely solid polymer material

Determining Cleaning Settings

- Cleaning parameters for optimal stability and socket lifetime must be developed for each unique testing environment
  - Determine the cleaning interval to maximize stability
    - Depends on socket and contactors as well as USL for CRES
    - "Rule of Thumb" based on experience of ~75 or 80% USL for CRES
  - Determine the number of insertions per cleaning cycle
    - Depends on the dirtiness (debris, contaminations, etc.) of the socket
    - NOTE - **ALL** cleaning insertions do occur in the same location
  - Determine the optimum TCC lifespan
    - Over-saturation will affect cleaning efficiency
    - CRES recovery and FPY will be affected by over-saturated devices

When To Clean ???



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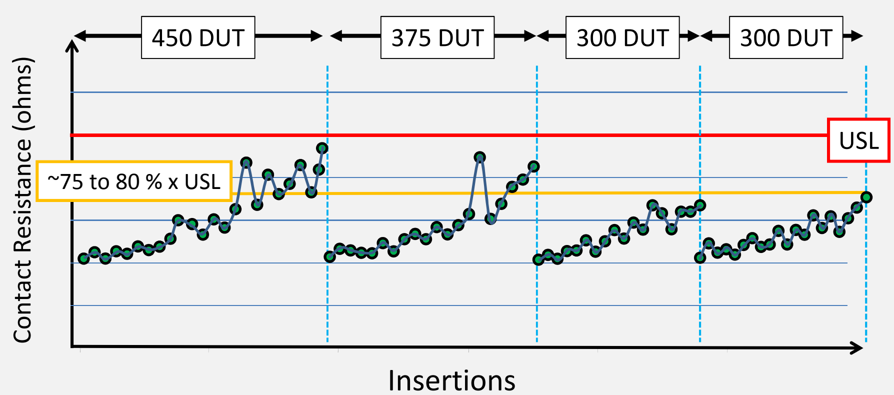
Sanitized Customer Data

Automated and Frequent Cleaning



Automated online cleaning functionality on the handler is a critical requirement to attain maximum performance benefits

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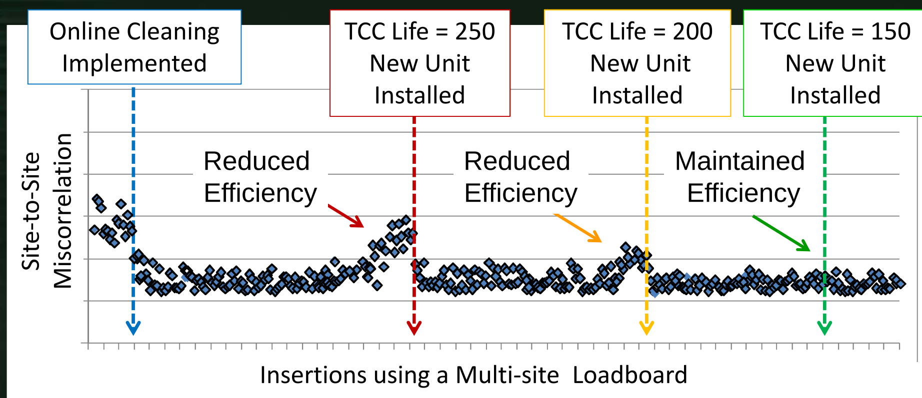
Sanitized Customer Data

TCC Lifetime vs. Site-to-Site Fails

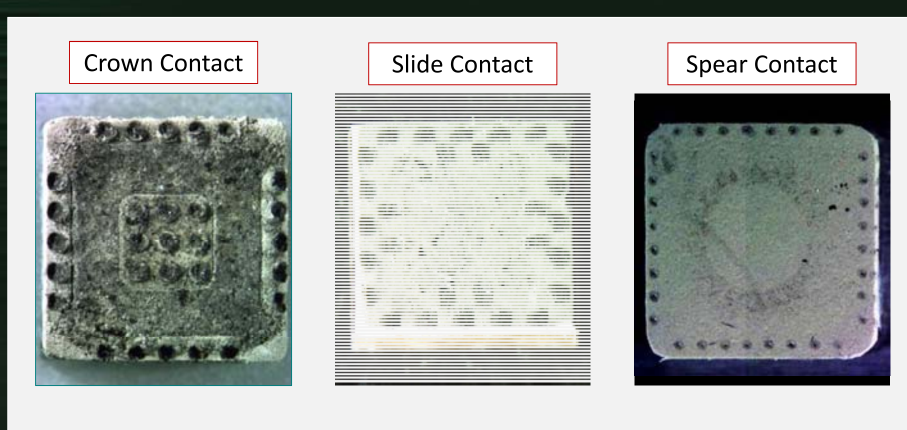
- Over-saturation and over extending will affect cleaning efficiency
- A "saturated" unit should be disposed and replaced
- Unit life depends on process "dirtiness", socket type, CRES limits, etc.



Sanitized Customer Data

Overutilization Examples

- "Saturated" units will have poor cleaning efficiency



Implementation

Customer Case Studies

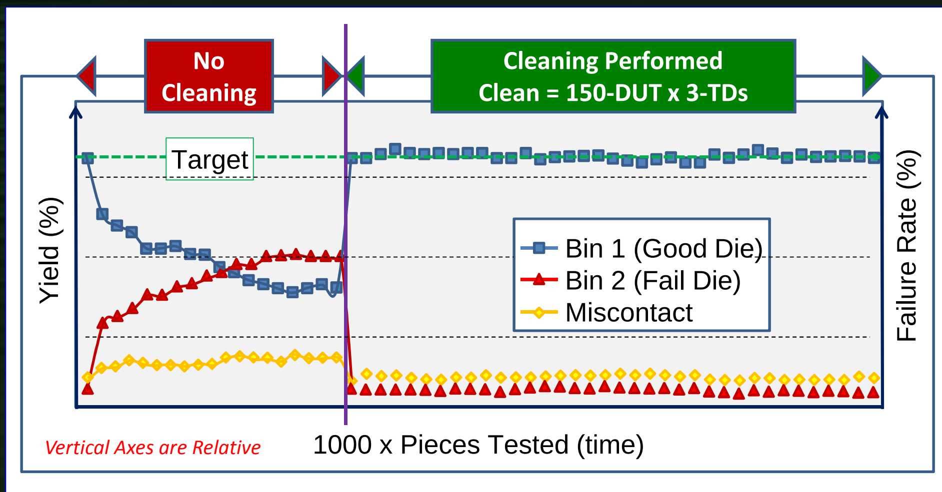
- Case 1: End-Customer located in Asia
  - Spring Contactor Applications
- Case 2: IDM with WW test sites
  - Multiple Contactor Applications
- Case 3: High Volume Subcon Test House
  - Online Cleaning + Laser

Case 1: End-Customer in Asia

- Problem Overview
  - Rapid reduction in first pass yield that requires downtime
    - FPY of new socket initially meets target specification
    - Within several LOTs, FPY and continuity falls below allowable limits
  - Delamination of plating due to debris occurs within 100K contacts
    - Short MTBR of socket due to plating damage (< 20K insertions)
    - Exposure of under-plate creates CRES instability
- Objectives for Process Improvement
  - Online socket cleaning to stabilize CRES and FPY
  - High durability pins to address performance degradation
    - Plated pin: high hardness plating, resistance to delamination
    - Alloy pin: no delamination of the surface layer

Sanitized Customer Data

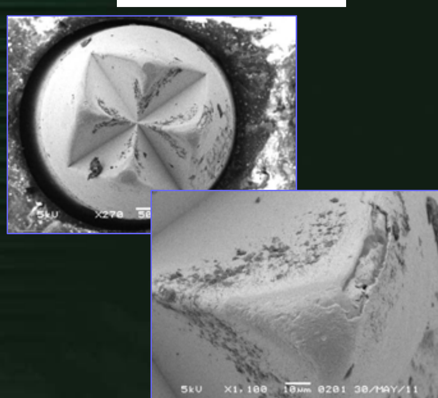
Plated Spring Pin Performance



Sanitized Customer Data

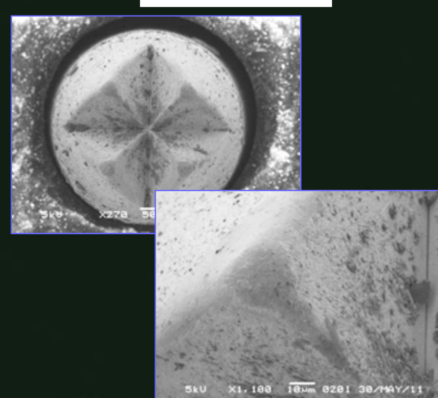
Plated Spring Pin

No Online Cleaning

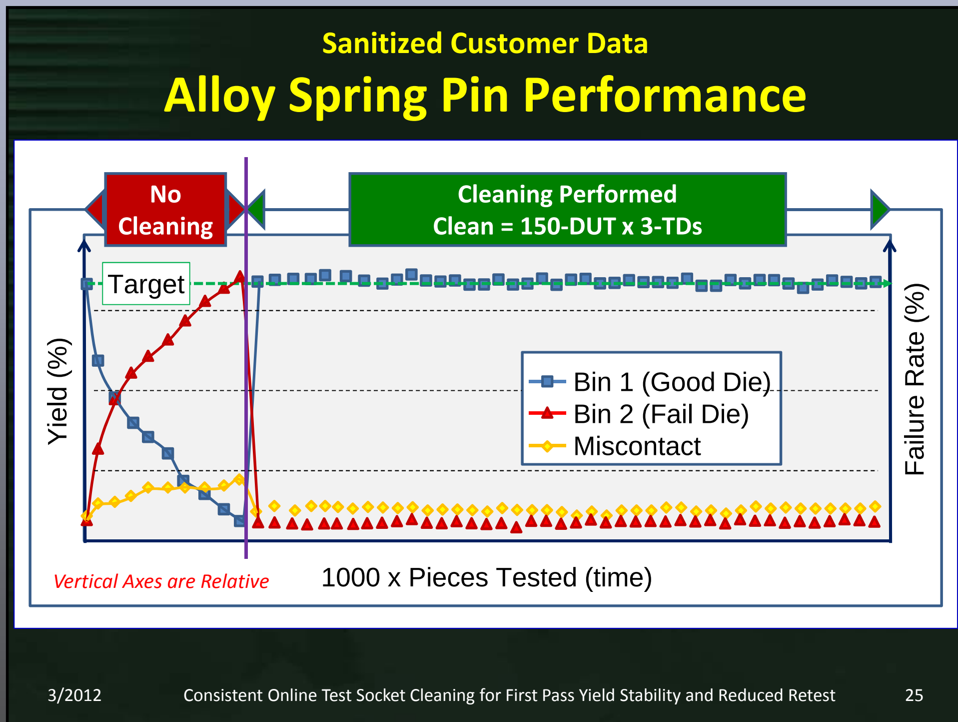


- Debris = much
- Plating = degraded

Online Cleaning



- Debris = small
- Plating = unaffected


Sanitized Customer Data
Alloy Spring Pin Performance
No Cleaning
Cleaning Performed
Clean = 150-DUT x 3-TDs
Target
Yield (%)
Failure Rate (%)
Bin 1 (Good Die)
Bin 2 (Fail Die)
Miscontact
Vertical Axes are Relative
1000 x Pieces Tested (time)
3/2012
Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest
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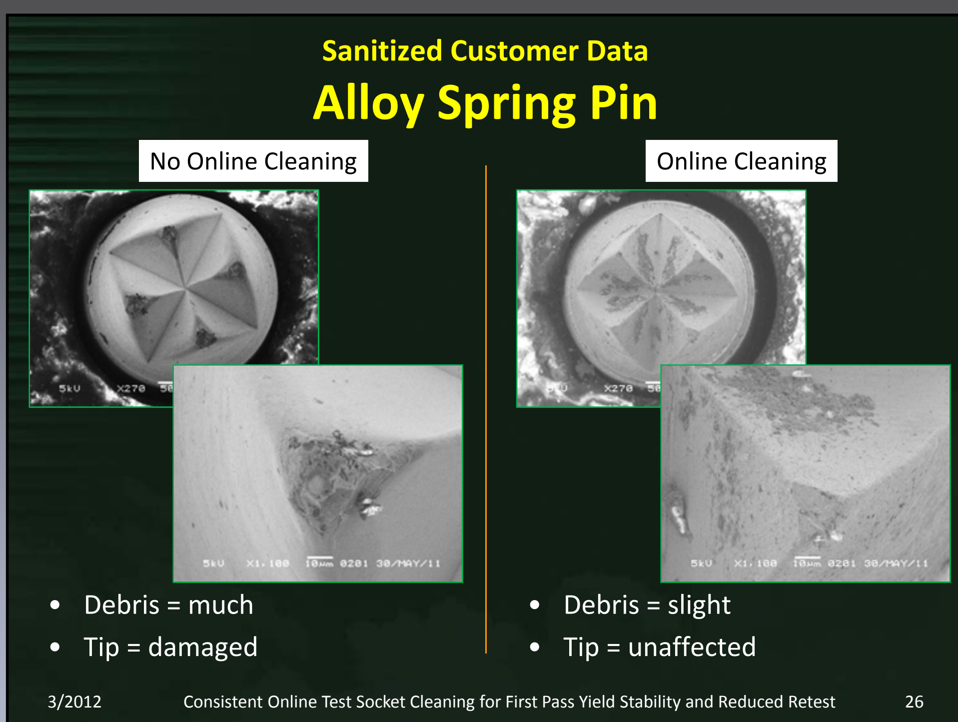
Sanitized Customer Data
Alloy Spring Pin
No Online Cleaning
Online Cleaning
• Debris = much
• Tip = damaged
• Debris = slight
• Tip = unaffected
3/2012
Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest
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Case 2: IDM with WW test sites

- Problem Overview
  - Unstable FPY with added High Recovery Yield testing to meet the Final Yield metrics
  - Short MTBR to manually clean and recover CRES performance during tri-temperature testing
  - Debris accumulation for unacceptable mis-contact metrics
- Objectives for Process Improvement
  - Online socket cleaning to control CRES and debris build-up
  - Improve First Pass Yield to reduce the amount of retesting
  - Reduce operator intervention for improved uptime metrics

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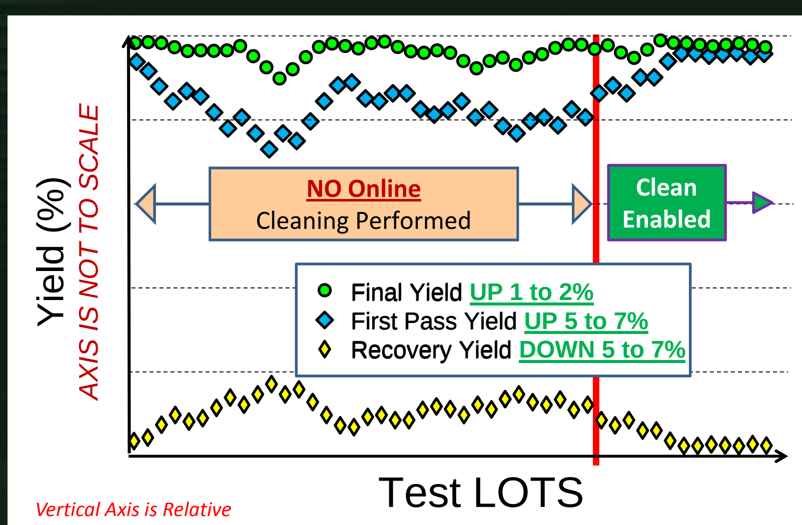
Sanitized Customer Data

Yield Tracking Metrics



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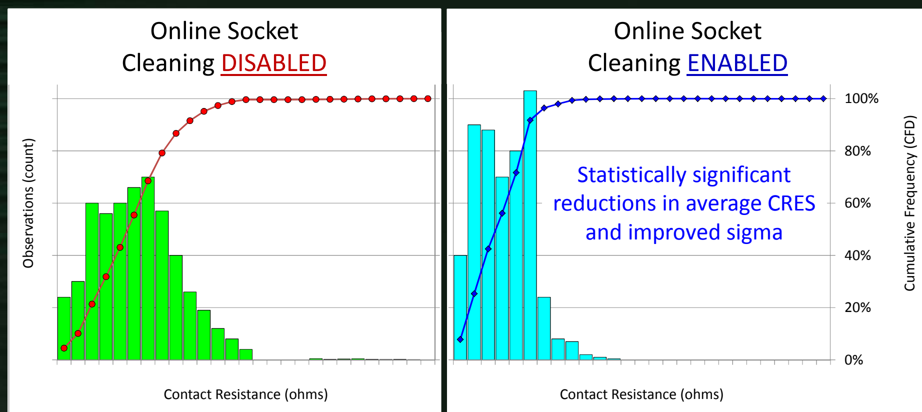
Sanitized Customer Data

Improved Process Stability



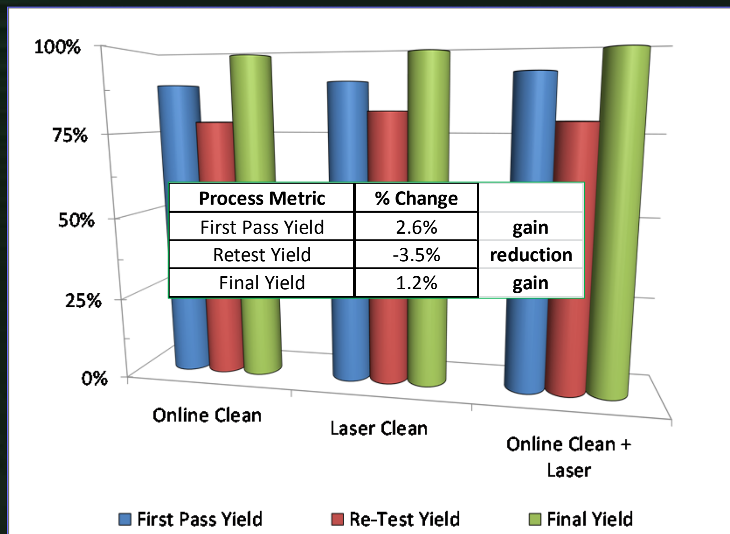
- Reduced average CRES for increased FPY
- Overall reduction in Continuity Failures (opens)

Case 3 – Laser + Online Cleaning

- Problem Overview
  - Periodic laser cleaning of sockets has been shown effective for socket performance recovery and contactor maintenance
  - Handlers must be idled (although socket is not removed) to implement manual laser cleaning (~10-min to 30-min)
  - Debris accumulation from packages does create contact issues
- Objectives for Process Improvement
  - Implement regular online cleaning to reduce debris buildup
  - Supplement laser cleaning to further improve yield metrics.
  - Extend the interval between laser cleaning operations.

Sanitized Customer Data

Yield Gains with Online Debris Removal



Process Metric	% Change	
First Pass Yield	2.6%	**gain**
Retest Yield	-3.5%	**reduction**
Final Yield	1.2%	**gain**

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In Summary / Conclusion …

- Customers expect and demand processes that maximize OEE and help reduce the overall cost of test.
- Regular online cleaning during package test (similar to wafer sort), improves contactor performance, increase uptime, and reduce retest.
- Defining proper "cleaning recipes" is a crucial step to optimize performance and maintain CRES control.
- Development of customized online cleaning devices can provide the end customer a substantial competitive advantage.
- Non-optimized cleaning processes compromise test results, reduce test hardware life, affect throughput, and affect equipment up-time.

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Acknowledgements …

- ITS WW Applications Team
- ITS Technical Partners … THANKS !
  - End customers and technologists that must unfortunately remain "nameless".
- IEEE SW Test Workshop 2012
  - http://www.swtest.org

3/2012 Consistent Online Test Socket Cleaning for First Pass Yield Stability and Reduced Retest 33

Achieving Extreme Contact Life Through the Application Of Alternative Coatings

Erik Orwoll
Contact Coatings, LLC

2012 BiTS Workshop
March 4 - 7, 2012

Topics Covered

- **Probe Life – Production vs. Lab (Why do these differ?)**
- **Alternative Cres Test Method**
- **Modified CCC (Current Carrying Capacity) Test Method**
- **Extend Cycle Life Through:**
  1) **Cleaning**
  2) **Re-Plating**
  3) **Enhanced Coatings**

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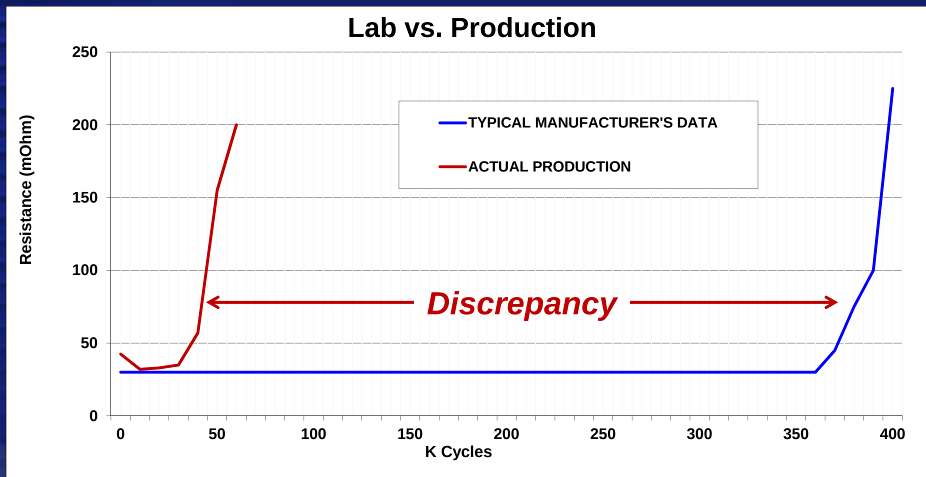
Probe Life – Production vs. Lab



Blame The Probe Manufacturer?

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Production Test Variables

- Device Type (Solder Ball, QFP, QFN, etc.)
- Material Contacted (SAC105, NiPdAu, etc.)
- Test Time
- Current Applied (Diffusion Rates)
- Lag Time Between Test (Oxidation)
- Test Voltage
- Device Age (Leads may be oxidized)
- Thermal issues (Heat Sinking, Test Temp)
- Humidity
- Cleanliness
- Test Sensitivity To Parasitics
- Etc…

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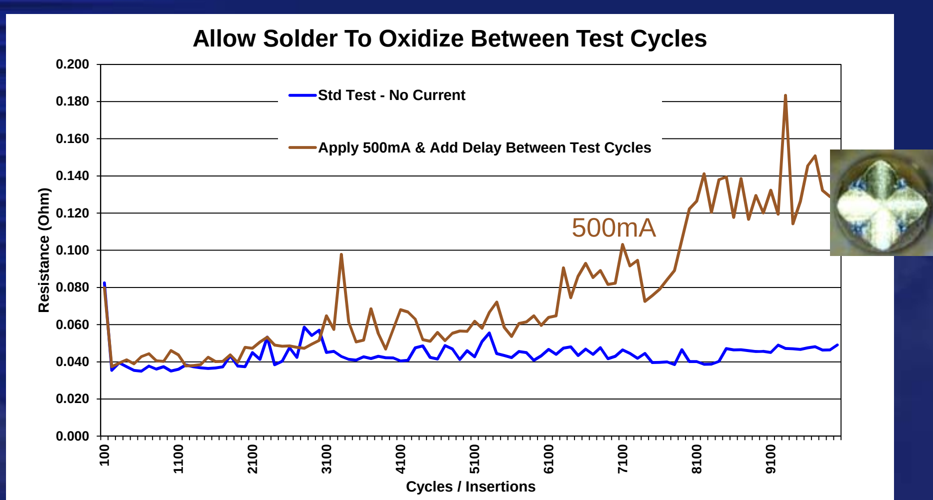
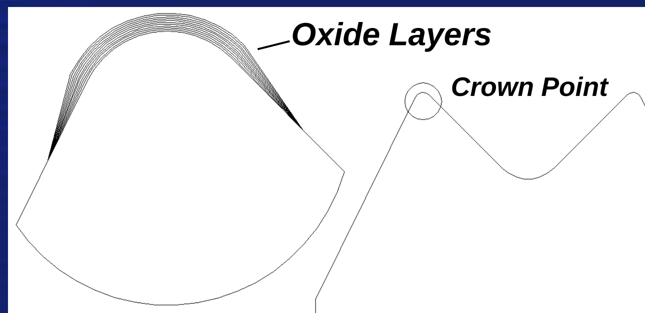
Package Type

Primary focus of this paper:
Ball Grid Arrays

Topics Covered



Solder Contamination



- Surface Oxides Form
- Stannous Oxide (SnO) Converts to Abrasive Stannic Oxide (SnO_2)
- Intermetallic Diffusion (Reduces Conductivity)
- Surface Finish Degrades
- Gold Loss

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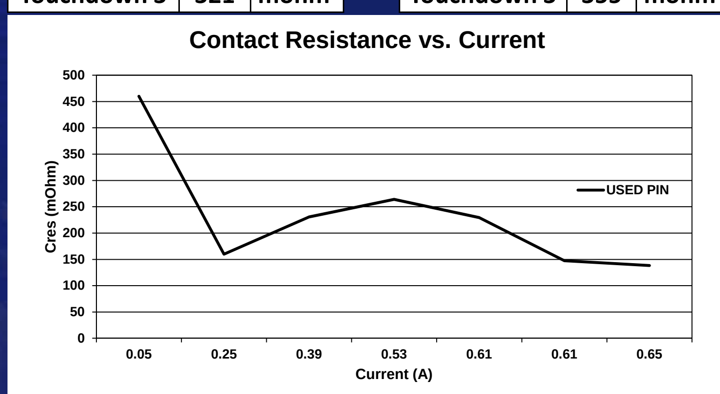
Effect of Current on Cres

Probe removed from production contactor

Cres – Tested Immediately		
Touchdown 1	427	mohm
Touchdown 2	385	mohm
Touchdown 3	321	mohm

Cres – Test After 1 Week		
Touchdown 1	865	mohm
Touchdown 2	745	mohm
Touchdown 3	355	mohm



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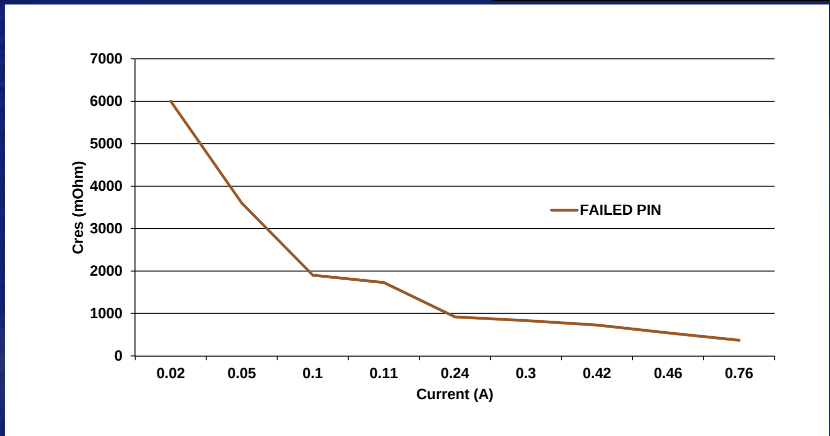
Effect of Current on Cres

Probe removed from production contactor
Contactor Bin 1 Yield <50%

Cres – Failed Probe		
Touchdown 1	4787	mohm
Touchdown 2	3643	mohm
Touchdown 3	8572	mohm



Cres Testing

Standard Method

DESCRIPTION	ISSUE
Ag or Au interface	Interface favors probe life. Does not test for interface failures (solder contamination).
No Current Applied	Current degrades contactor (exponentially)
No Delay between cycles	Solder contamination is not allowed to oxidize between cycles.

Cres Testing

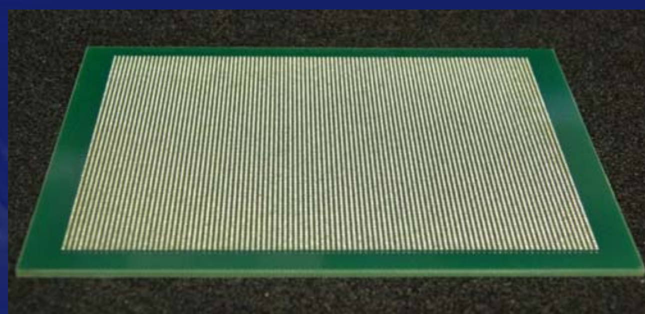
10K Method

Utilize 10,000 ball device (provides consistent interface for each cycle)

Apply Current (Simulates Actual Usage Conditions)

Delay Between Cycles

Avoids Issues Cited on Previous Slide



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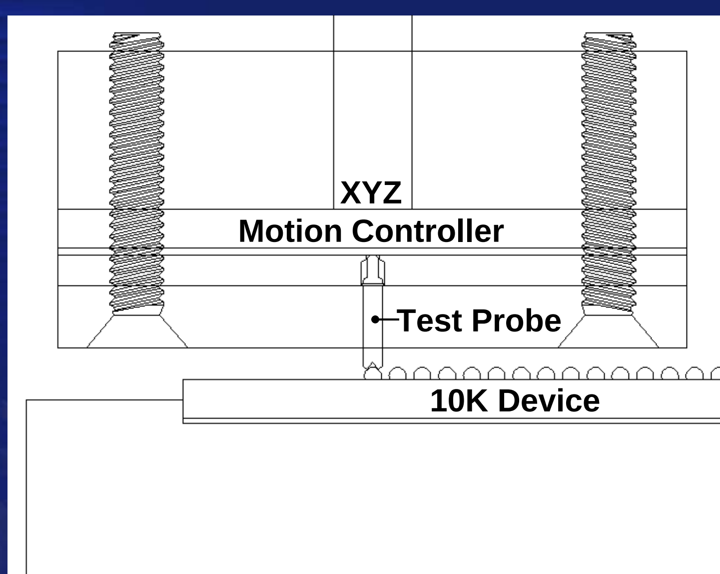
10K Test Method



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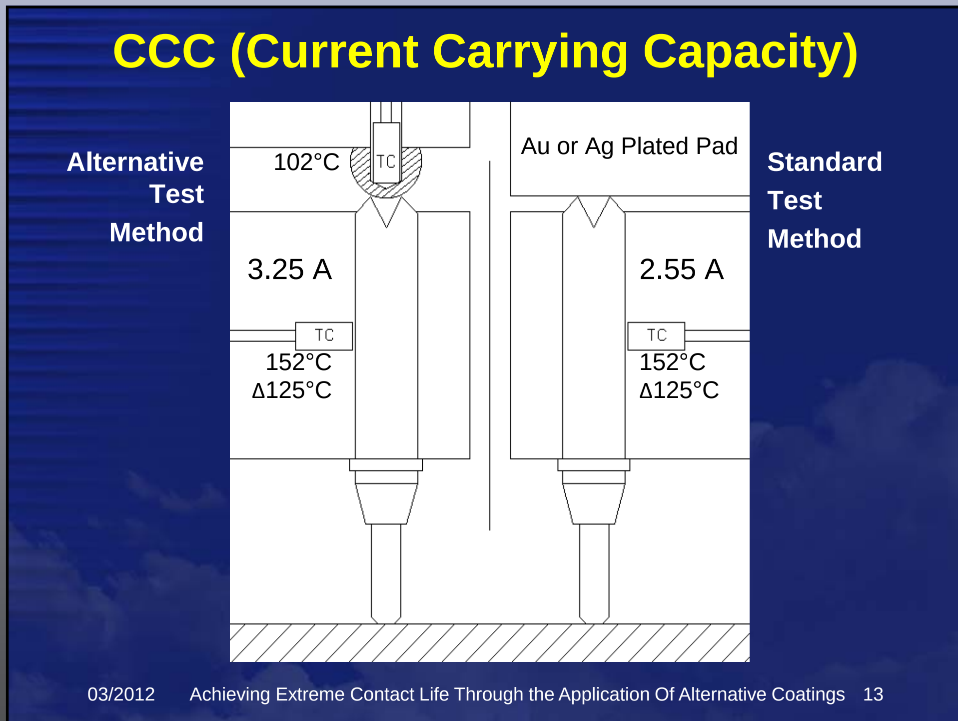
CCC (Current Carrying Capacity)
Alternative Test Method
102°C
TC
Au or Ag Plated Pad
Standard Test Method
3.25 A
2.55 A
TC
152°C
Δ125°C
TC
152°C
Δ125°C
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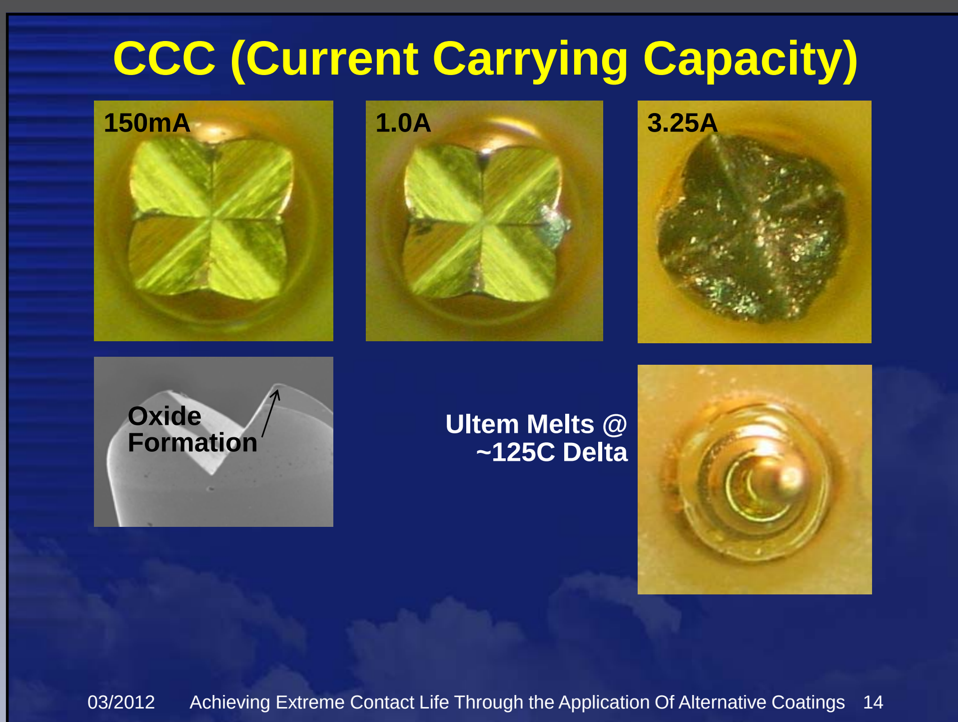
CCC (Current Carrying Capacity)
150mA
1.0A
3.25A
Oxide Formation
Ultem Melts @ ~125C Delta
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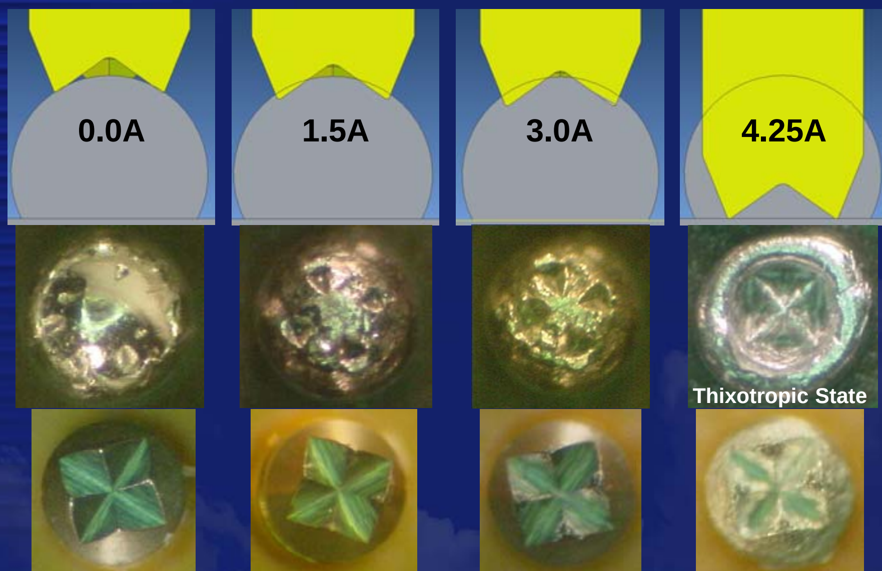
14

CCC (Current Carrying Capacity)



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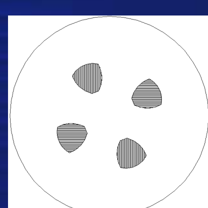
CCC (Current Carrying Capacity)

Ball Penetration

Force vs. Pressure



Force / Area = Pressure

Current / Area = Current Density

Solder Ball Material Properties (SAC305)
Yield Stress ~ 40MPa @ 25C
Yield Stress ~ 29MPa @ 150C

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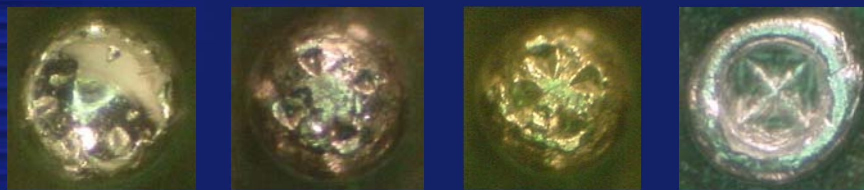
CCC (Current Carrying Capacity)



Current	0	1.5	3	4.25	A
Current Density	0	57834	40743	11547	A/in2
Current Density	0.0	89.6	63.2	17.9	A/mm2
Compressive Stress	5500	2378	838	168	psi
Compressive Stress	37.9	16.4	5.8	1.2	MPa

CCC (Current Carrying Capacity)

Degrading Effects of Current:

- Accelerated Metallic Diffusion
- Accelerated Solder Accumulation
- Accelerated Oxide Formation
- Spring Relaxation
- SnO transformed into $Sn0_2$ (Cassiterite) at rapid rate

Re-Design to Increase CCC

1) **Utilize Solid Core Probe - Increase Heat Sinking Capability**

2) **Enhance Contact Surface (Apply Advanced Au Coating)**
   Resists Metallic Diffusion
   Resists Solder Oxide Accumulation

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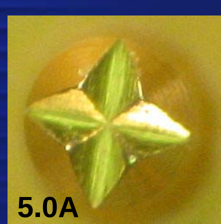
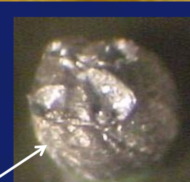
Increased CCC





Solder Ball Surface Degraded

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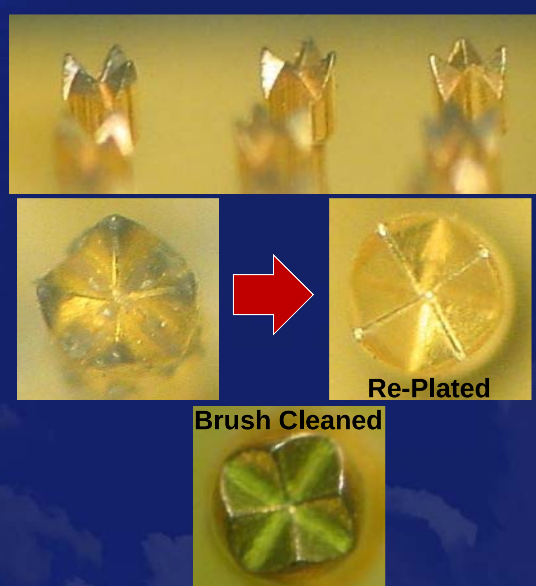
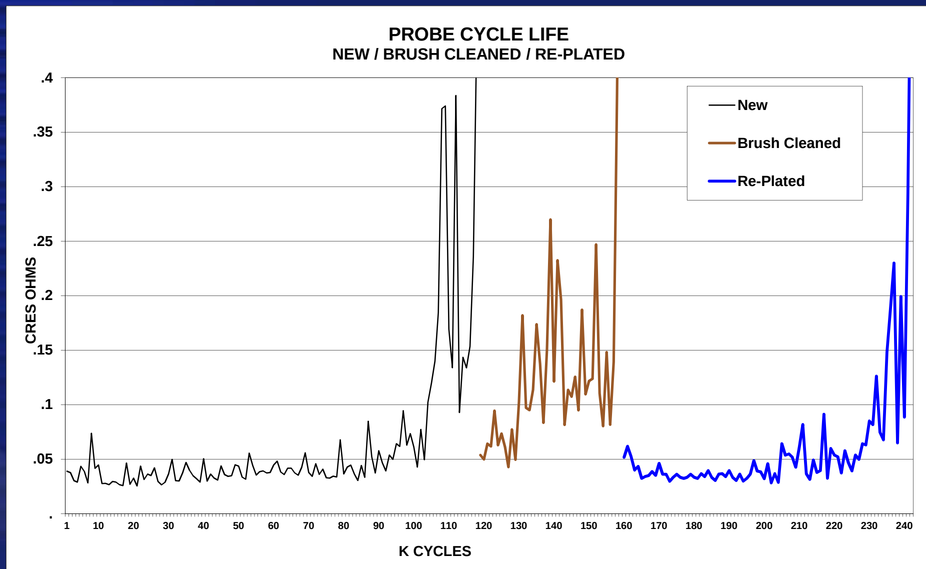
Increased CCC

Current	0	5.0	7.59	9.10	Amps
Current Density	0	84903	103079	68594	A/in2
Current Density	0.0	131.6	159.8	106.3	A/mm2
Compressive Stress	5500	1047	838	465*	psi
Compressive Stress	37.9	7.22	5.77	3.21*	MPa

Extending Probe Life



Extending Probe Life



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Coatings and Materials

Base Material Options

Hardened Copper, Hardened Steel, Homogenous Pd Alloy (Palliney)

Standard Over-Plating Options

Ni/Au, Ni/Pd

Disadvantage

Pd – Fails due to current (great in lab)

Au – Affinity for Sn

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Enhanced Options

Anti-Diffusion Gold Alloy Coating

- Ultra-Low / Stable Contact Resistance
- High Conductivity / High Current Density Capability
- Anti-Diffusion Properties
- Superior Recovery When Cleaned

LP Alloy Coating

- Low Porosity Alloy
- Low Affinity for Sn and Sn Compounds (Prevents Solder Accumulation)
- High Abrasion Resistance
- Lower Cost

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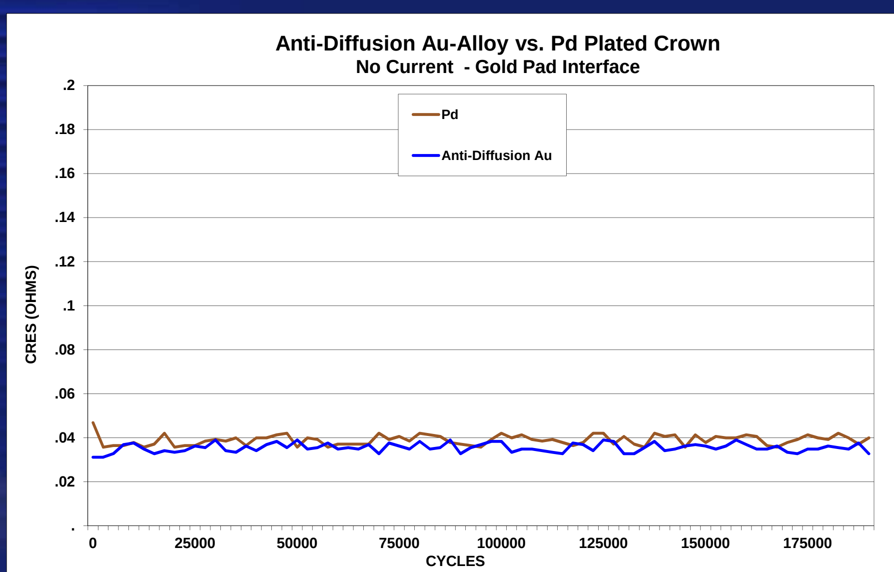
Enhanced Probe Life



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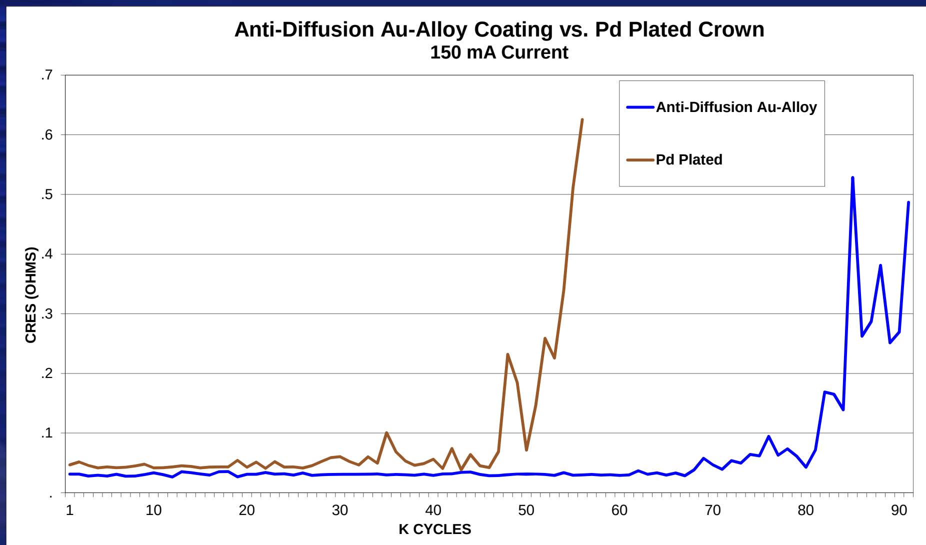
Enhanced Probe Life



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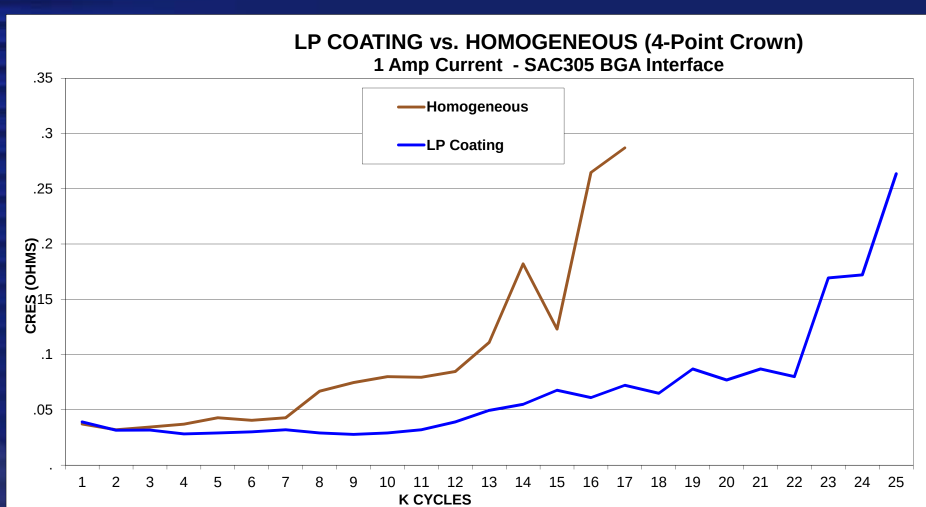
Enhanced Probe Life



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Conclusions

- Cycling Data without current applied has limited value.
- Contactors oxidize when not in use (and between Test cycles).
- Type of contact interface does affect Current Carrying Capacity
- Enhanced coatings are available to improve cycle life (and should be tested with current applied).

References

- QA Technology Company, Inc.
- Dr. James Forster, WELLS-CTI
- EIA364-70 Standard