
SIXTEENTH ANNUAL
BiTS
Burn-in & Test Strategies Workshop
March 15 - 18, 2015
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive – Session 4
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Session 4
Rafiq Hussain
Session Chair

BiTS Workshop 2015 Schedule

Performance Day

Tuesday March 17 8:00 am

Material Magic

"Reliability and Failure over Time"

Mike Gedeon - Materion

"Using Cold Heading Technology and Deutsch Coat to Produce Test Probes & Spring Contacts "

Jimmy L. Johnson - Tyco Electronics

"APEX Glass for Burn-In and Test Sockets"

Jeb H. Flemming & Tim Foster - 3D Glass Solutions, Inc.

"C3 Coating : Solution for IC Testing"

Bert Brost & Valts Treibergs - Xcerra Corporation

Nakaya Katsura - Kobelco Research Institute, Inc.

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C3 Coating : Solution for IC Testing
(Reduction of Solder Migration)

Bert Brost, Valts Treibergs
Xcerra Corporation

Nakaya (Nick) Katsura
Kobelco Research Institute Inc.

2015 BiTS Workshop
March 15 - 18, 2015

Presentation Agenda

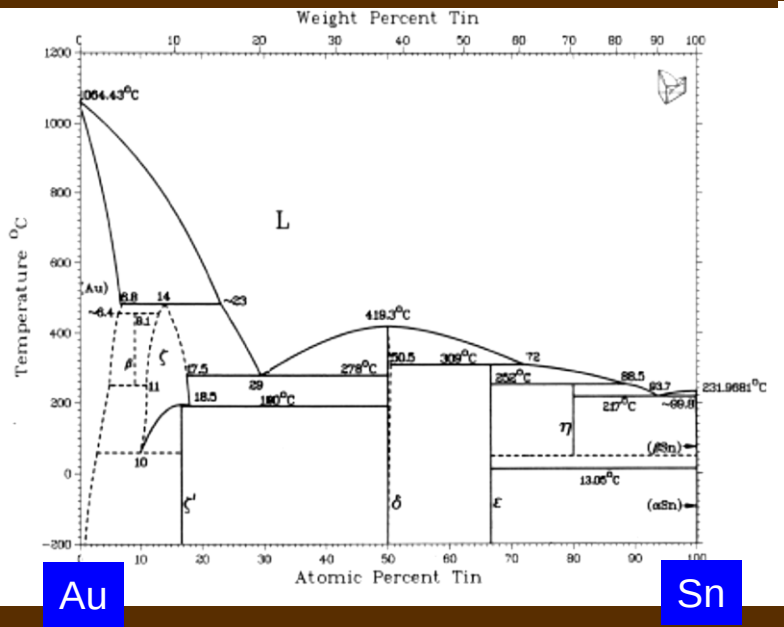
- What is DLC and C3?
- In-house testing of C3
  - Cycle testing
  - RF Testing
- Field evaluation results
  - Matte Sn QFN evaluation with Kelvin pin
  - Production evaluation at ambient/hot
- Advantages of C3

What is DLC (Diamond-Like Carbon)?

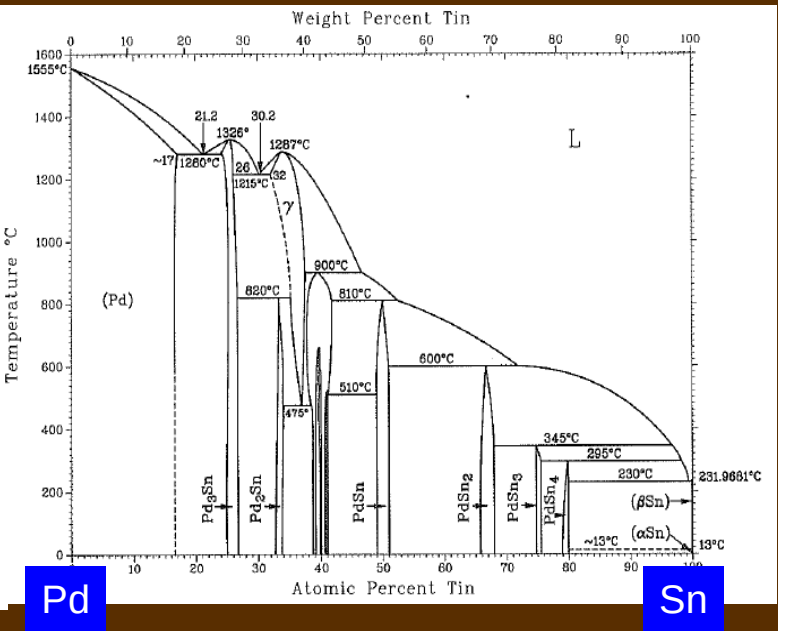
Features of DLC	Typical Application of DLC	
High Hardness & Wear Resistance	Cutting Tools	
Low Coefficient of Friction		
Chemical Resistance	Shaver	
Gas Barrier	Inner Wall of Plastic Bottles	
Biocompatibility	Stent (Medical)	

Features of DLC and Typical Applications (Source : Japan New Diamond Forum)

DLC Prevents Solder Migration



Binary Phase Diagram of Au-Sn

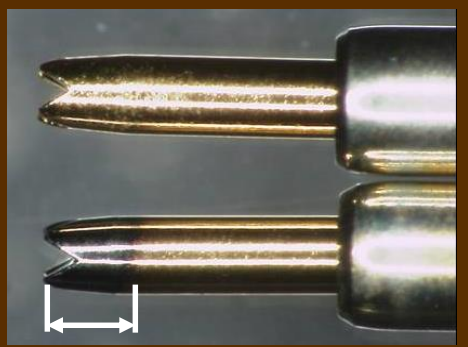


Binary Phase Diagram of Pd-Sn

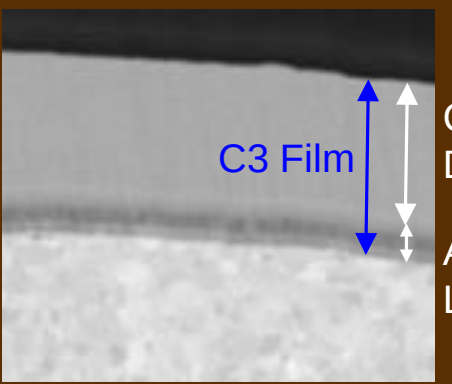
Source : Binary Phase Diagrams, Thaddeus B. Massalsky
The Materials Information Society

Development of C3 Coating

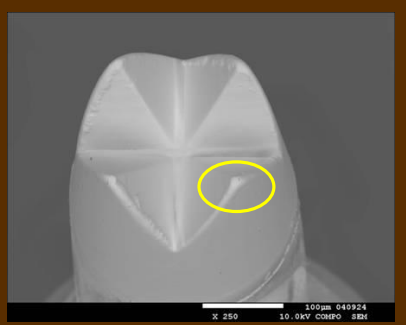
(C3 Conductive Carbon Contact)



C3 Coated

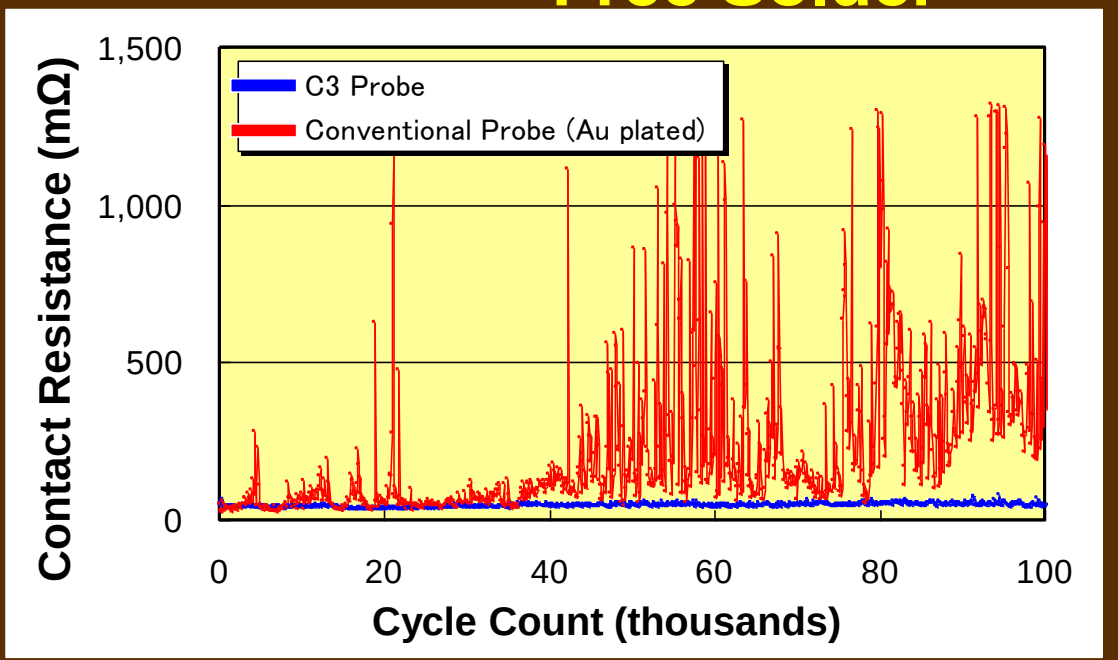


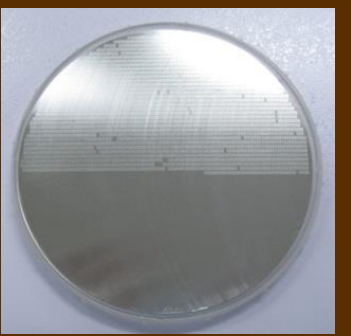
Cross Section Of Plunger (Enlarge)



Cross Section of Plunger

In-house Testing: Stable Contact to Pb-Free Solder



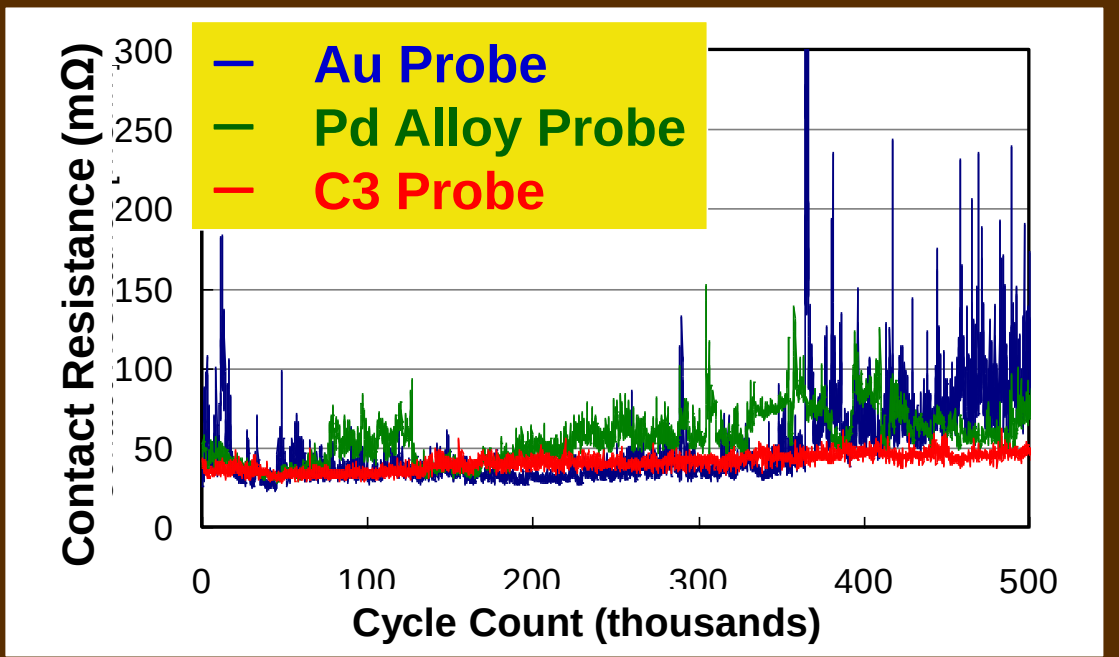


Pb Free Solder Plate (Φ150mm)

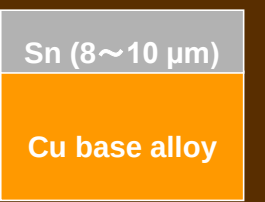
Contact Resistance (100k contacts w/o cleaning)

- Pb-Free Solder : Sn-3Ag-0.5Cu (SAC305)
- Current : 100 mA, Data are plotted every 100 contacts
- Full-Auto Wafer Prober is used
- Temp: Ambient

In-house Testing: Stable Contact to Matte-Tin



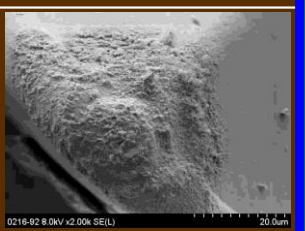
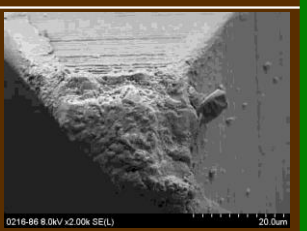
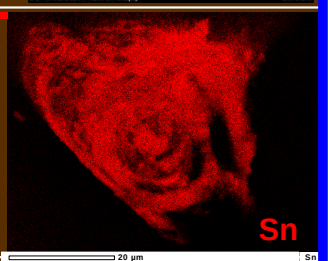
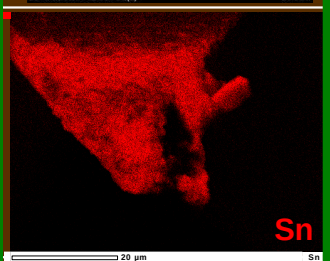
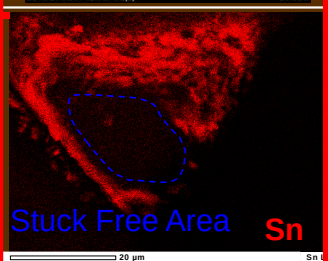
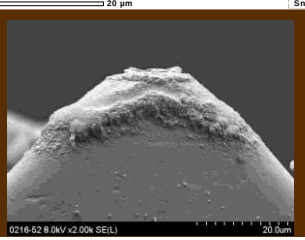
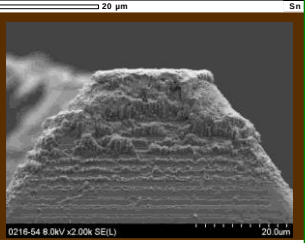
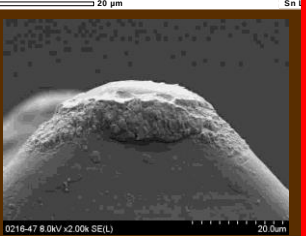
Structure of Matte Tin Plate

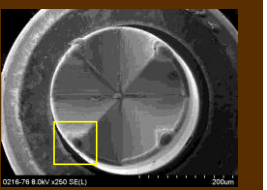


Contact Resistance (500k contacts w/o cleaning)

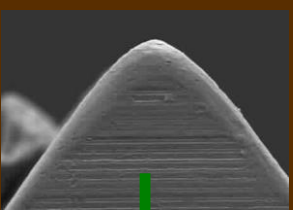
- Pb-Free Solder : Matte Tin Plate
- Current : 100 mA, Data are plotted every 100 contacts
- Full-Auto Wafer Prober is used
- Temp: 85° C

Durability & Less Solder Migration

		Au	Pd alloy	C3 on Au Pin
Top view	SEM			
	EDX-mapping			
Side view	SEM			

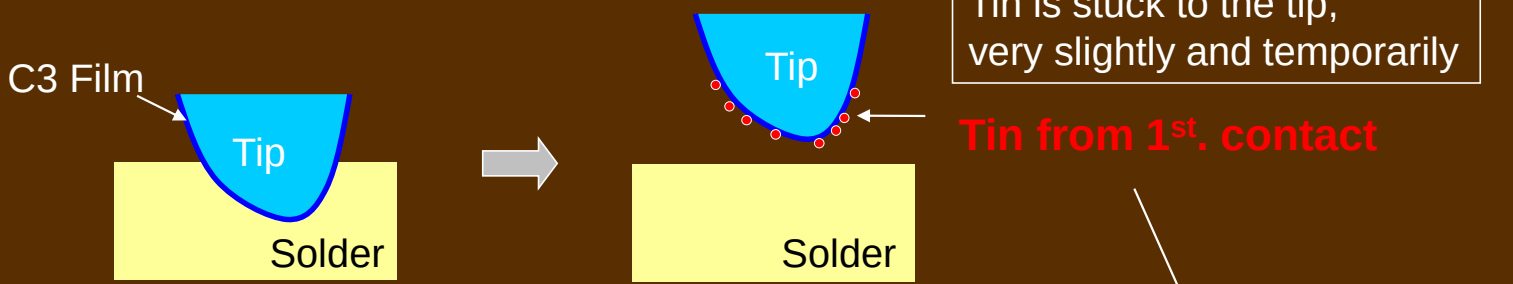


Initial State of Pd Alloy Pin has Very Sharp Profile

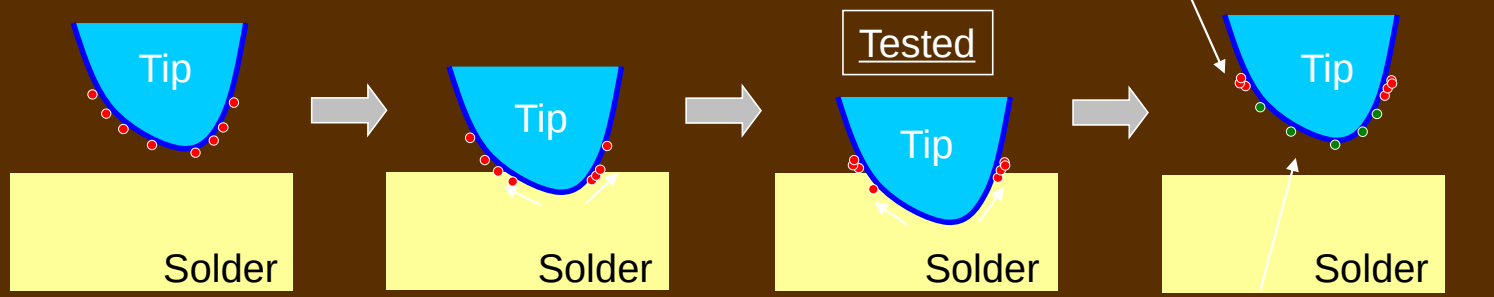


Self-Cleaning Effect of C3 Coating

◆1st. Contact : Tin Stuck to the tip (Temporarily)



◆2nd. Contact and after : (Repeatedly)



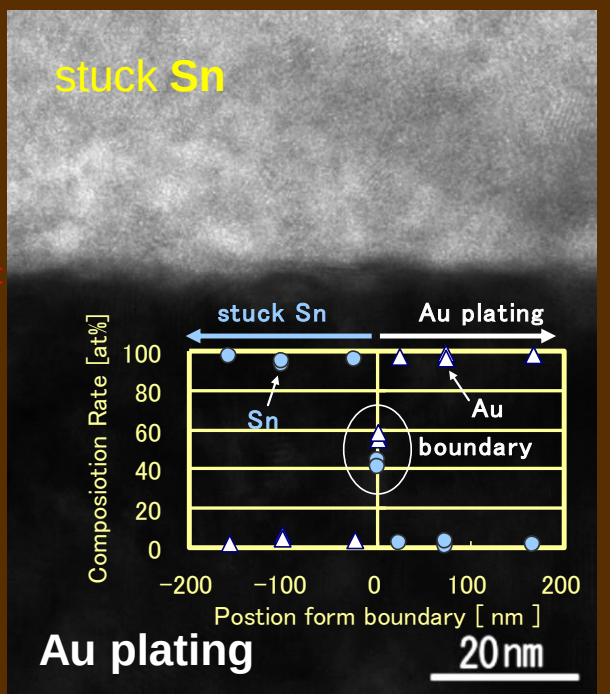
Self-Cleaning Effect
(Tin is rejected from a contact region)

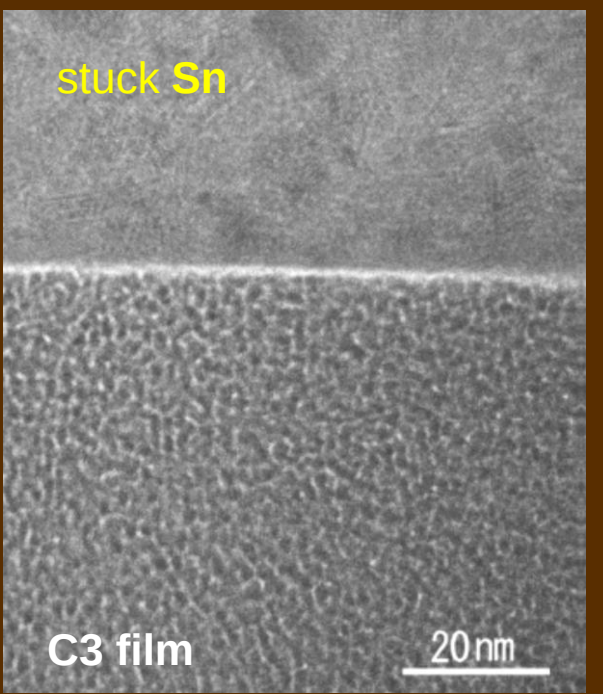
Reduction of Sn Transfer (Why?)

Au plating

C3 film

Au–Sn Alloy



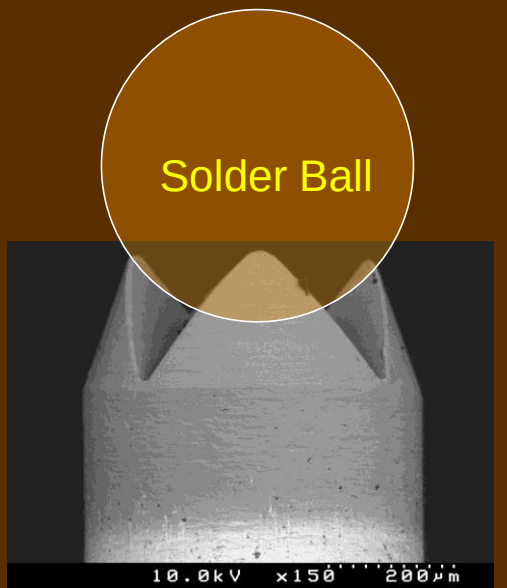


Inserted Figure : EDX result

Cross sectional TEM & EDX

Optimal Probe Tip Geometry For C3

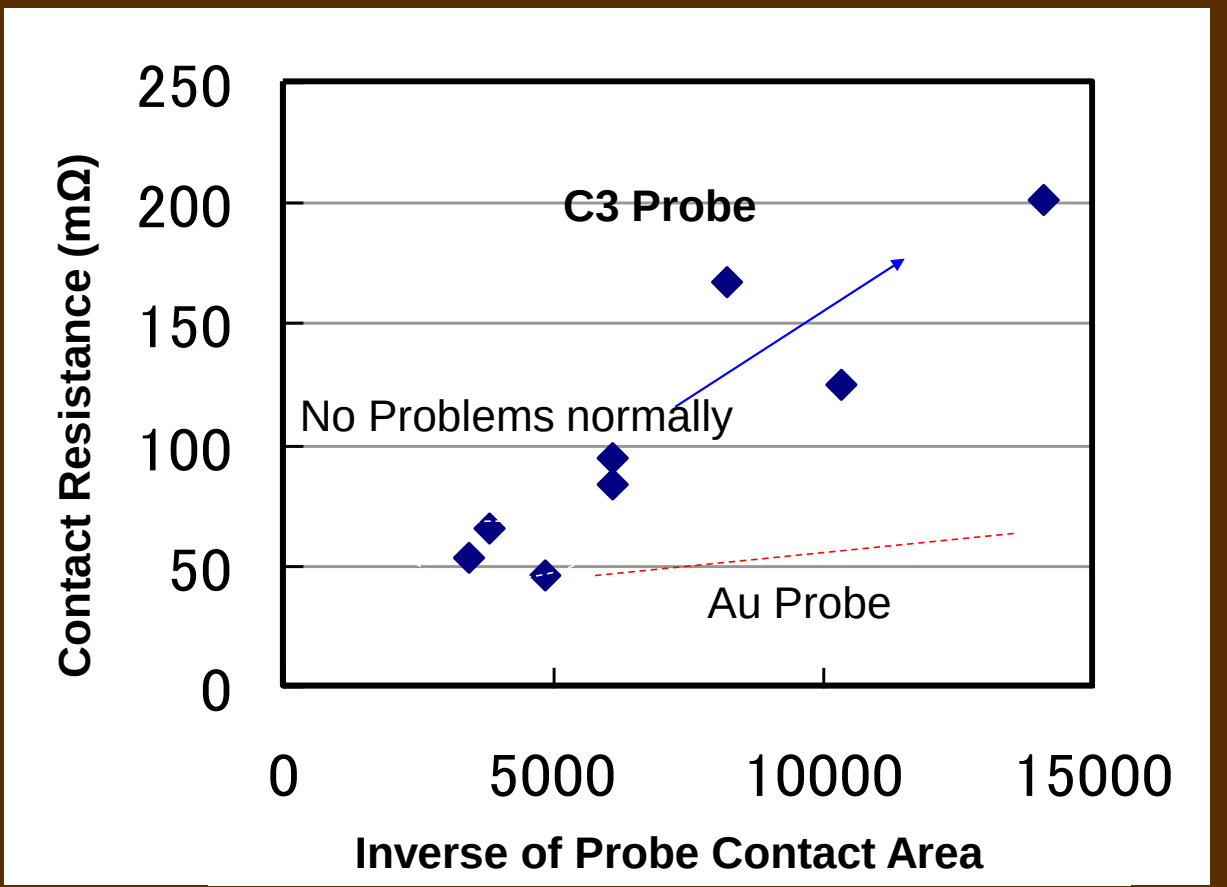
- C3 probe "Dual-Edge" shape is optimal BGA
- Optimal probe shape to be $D_{crown} < D_{ball} \times 0.5$



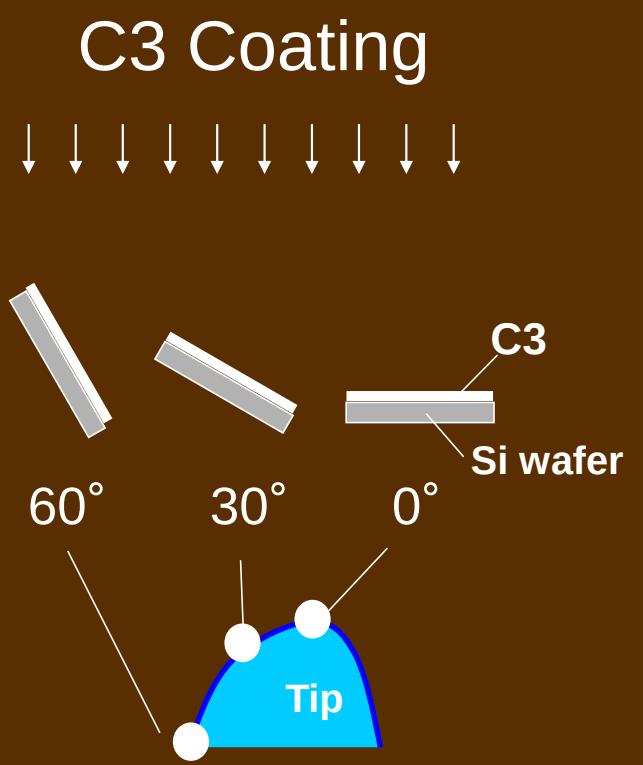
$D_{crown} = D_{ball} \times 0.7$

$D_{crown} = D_{ball} \times 0.5$

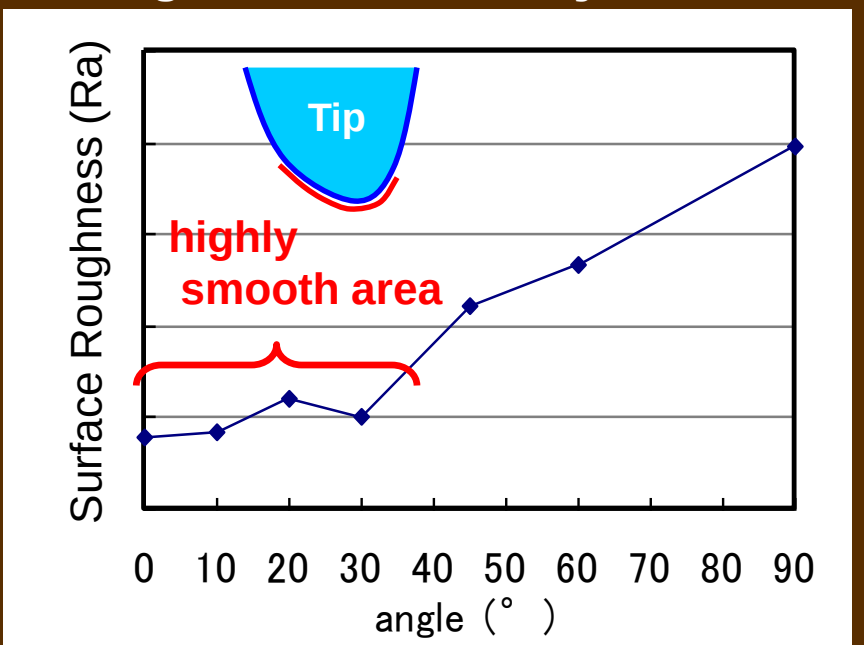
Geometry Probe of C3 Coating



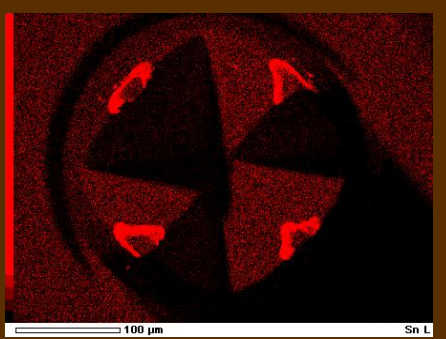
Smoothness of C3 Around Pin Tip



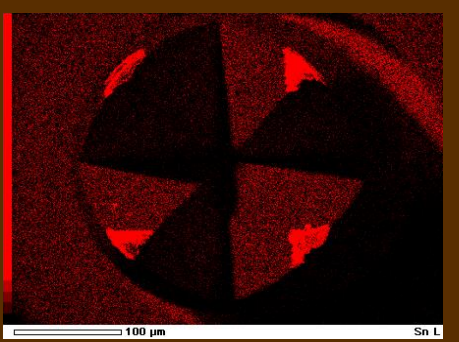
Roughness measured by AFM

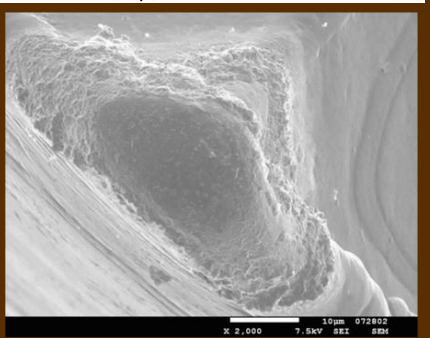


Suitable Tip Shape for C3 Coating

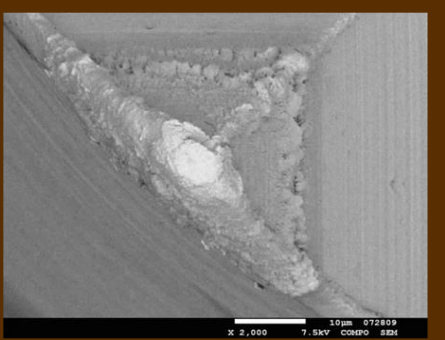


EDX Mapping (Tin)





SEM Image (Enlarged)



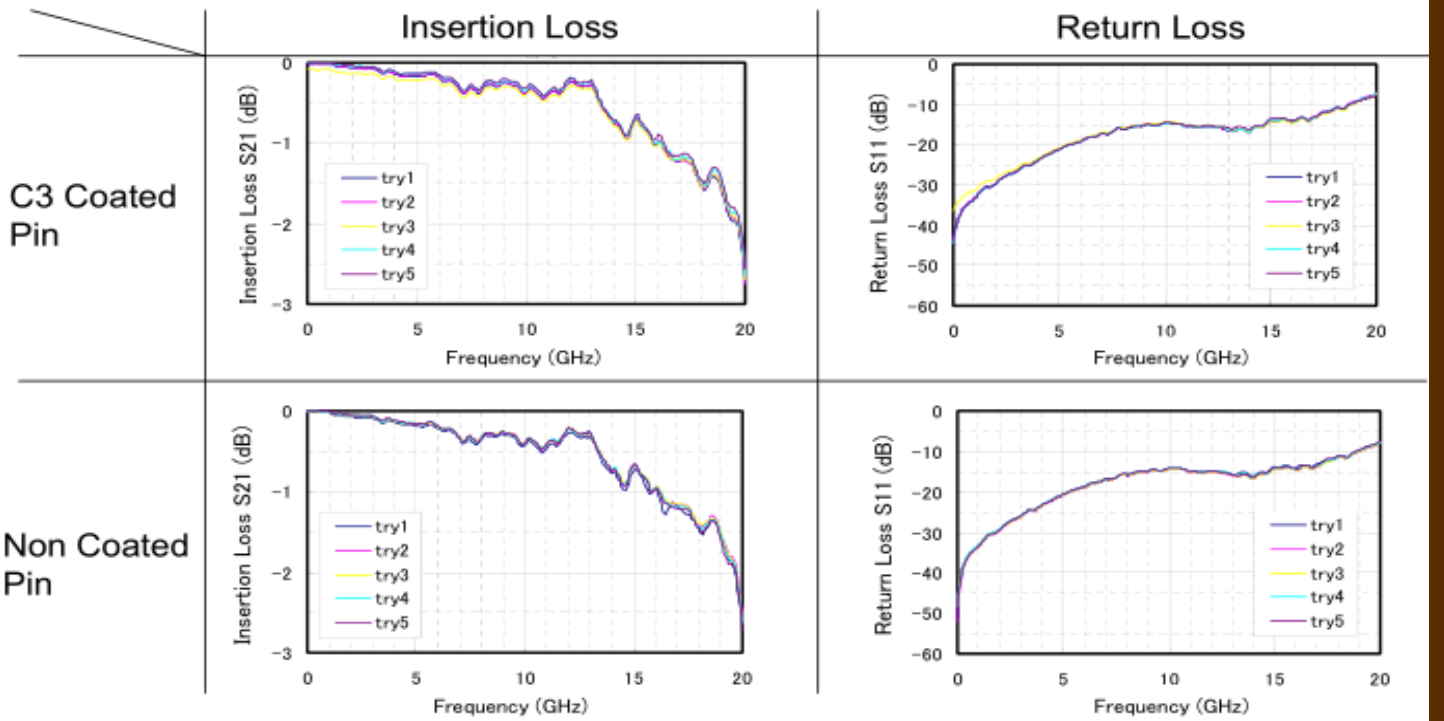
C3 on Au Plated Probe
(Tip is less sharp)

C3 on Pd Alloy Probe
(Tip is much sharper)

Pin Tip Condtion after 100k Contacts to Pure Tin (85℃)

RF Performance Comparison Between C3 Coated and Gold Plated Pin

- ☐ Probe Set: "GSG". Pin Pitch: 0.5mm.
- ☐ Insertion Loss and Return Loss of C3 Coated Pin is as same as Non Coated Pin. C3 Coating does not affect Insertion Loss and Return Loss of the Pins.

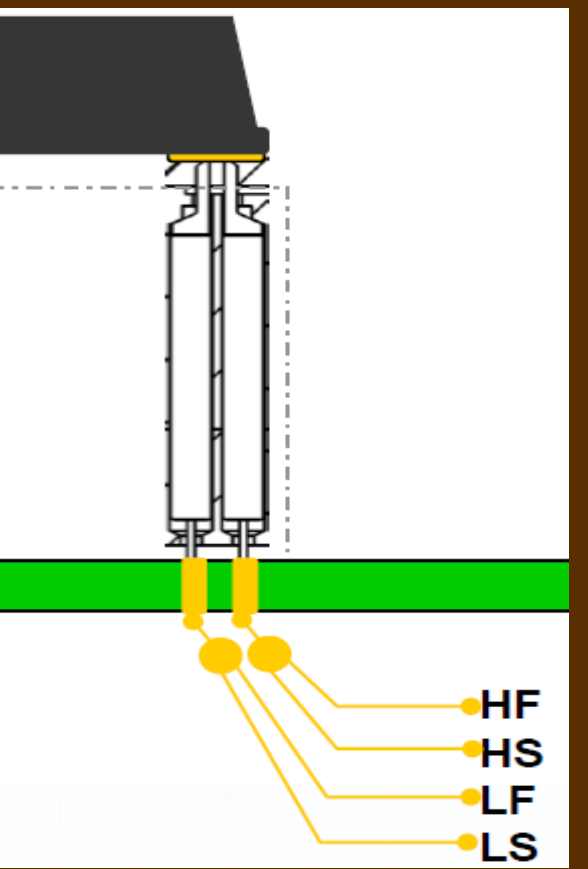


C3 Cleaning

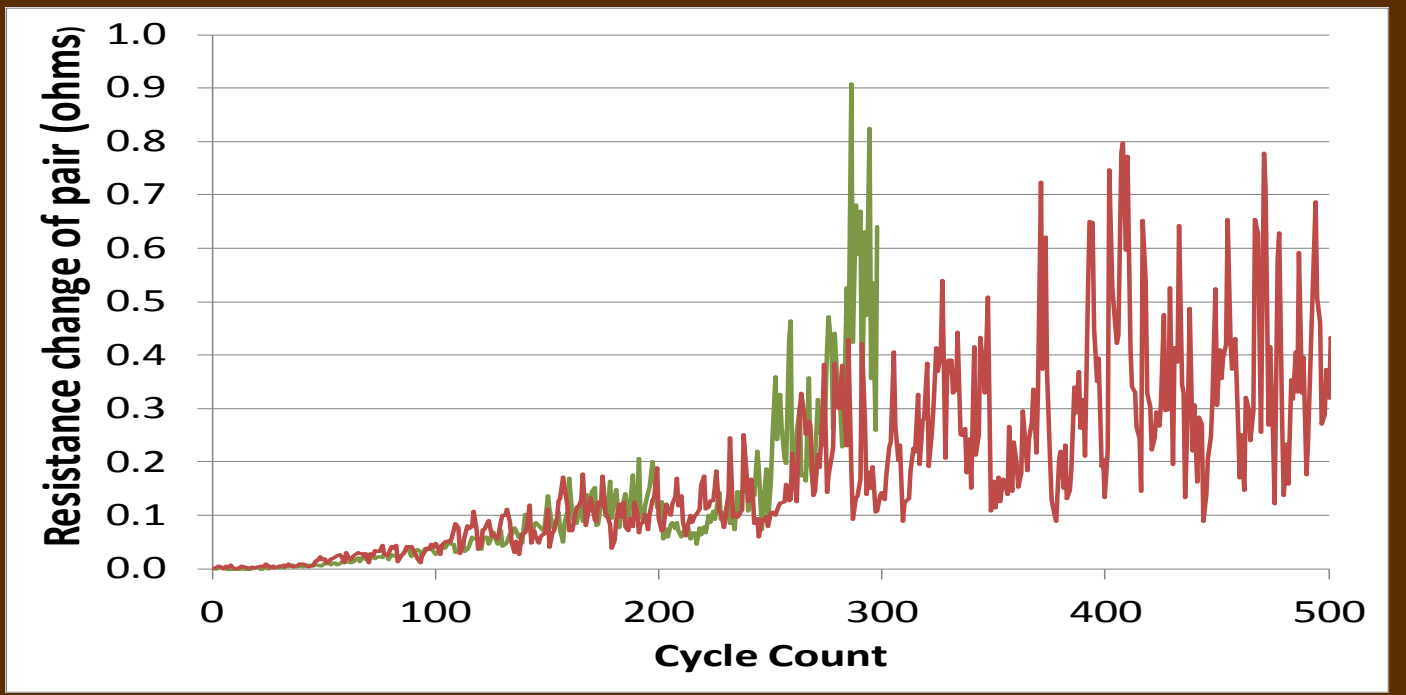
- C3 is designed to be minimally cleaned
- Air blow-off is usually that all is needed
- Light plastic brush and thin SUS wire brush cleaning can be used
- Automated cleaning media: recommend to use soft sheets with fine abrasive particles:
  - MIPOX SWE WA8000
  - ITS materials can also be used

Field Evaluation: C3 in Matte Sn QFN Application

- Controlled lab application using virgin matte Sn QFN packages – very low current applied (1mA)
- Ambient pick and place test handler
- Standard MT GMK Kelvin test socket – Cres measured through 2 probes and 2 DUT-Probe interfaces

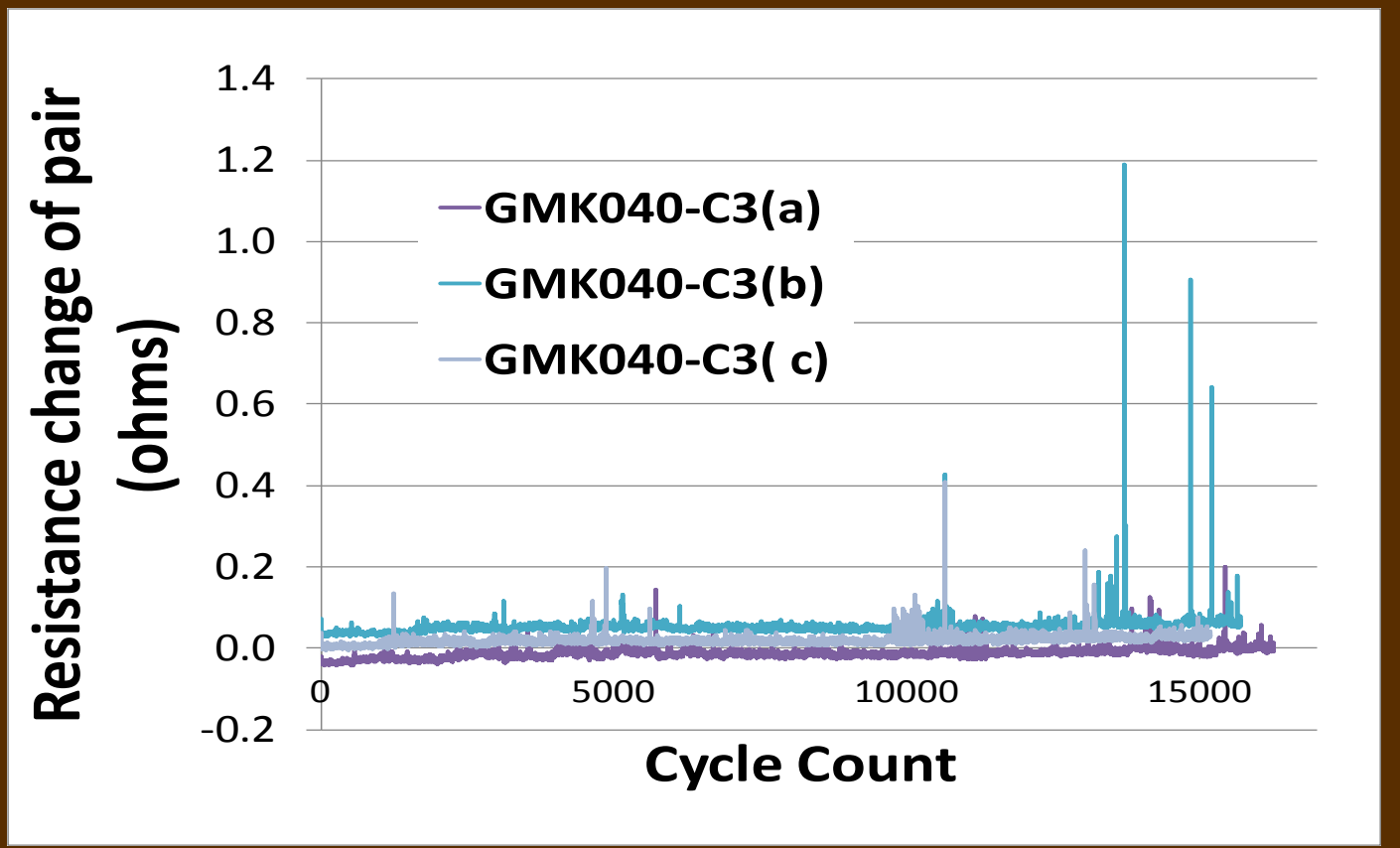


Baseline Cres of Gold Plated GMK040 (Pair)

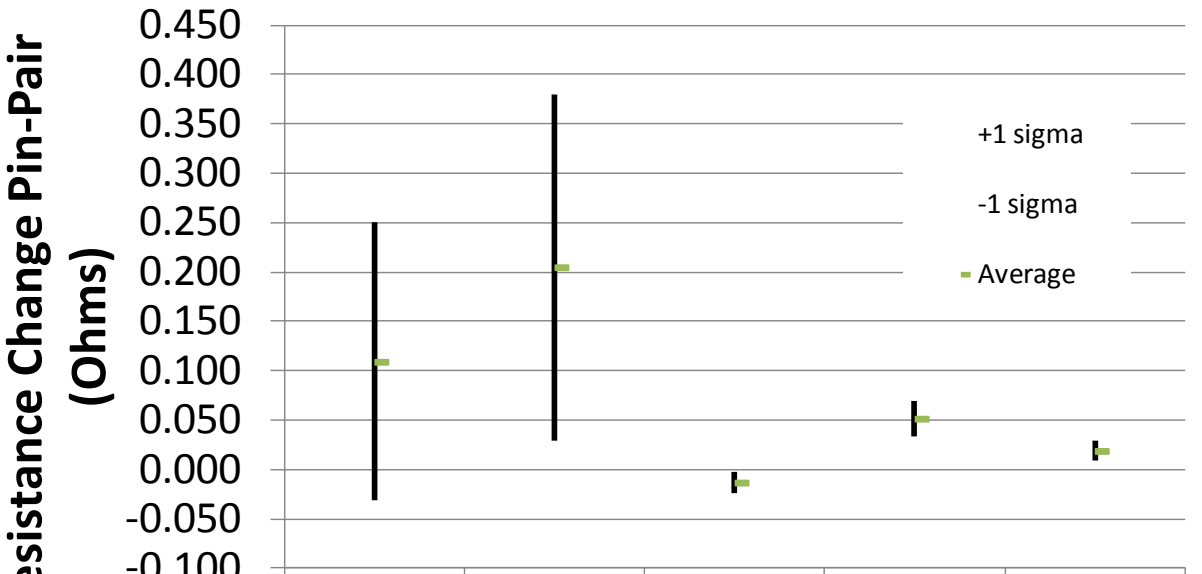


Pin-pair resistance quickly unstable in this test condition with customer devices

Cres of C3 GMK040 (Pair)



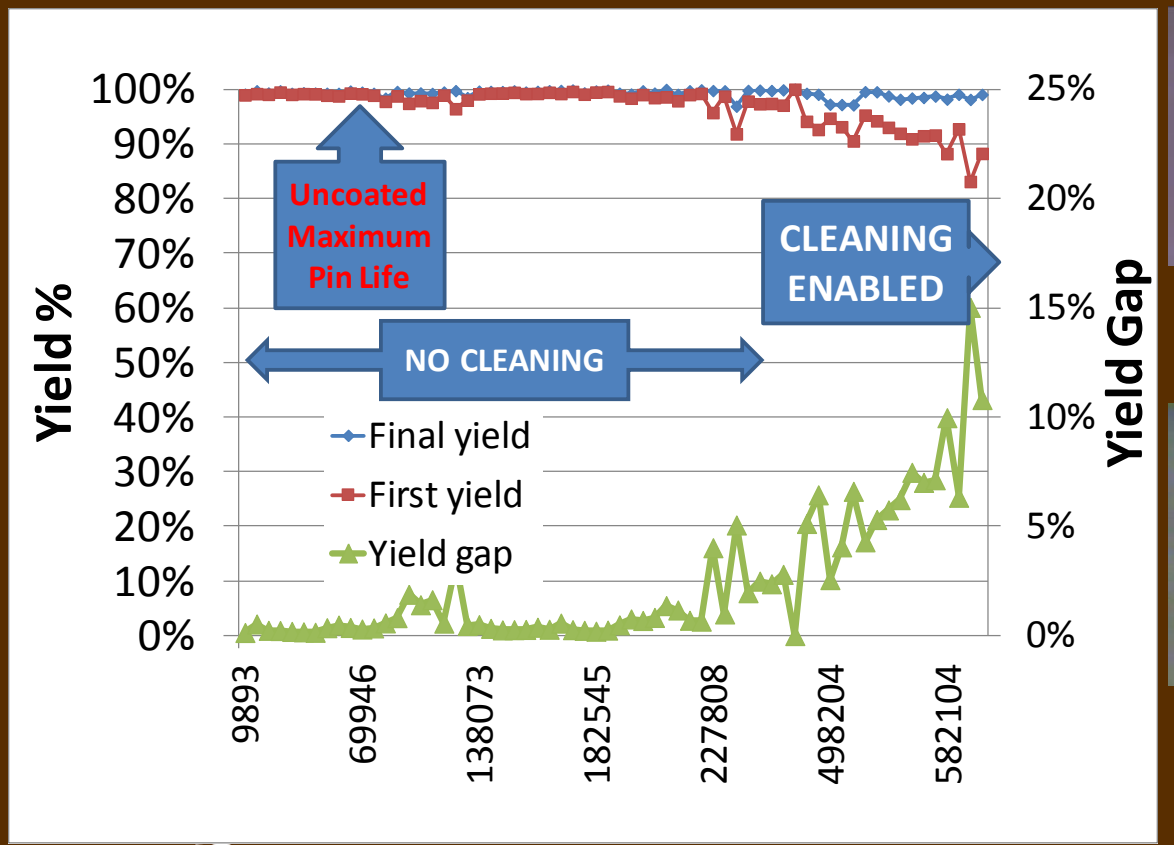
Summary Comparison Au vs. C3



	GMK040(Au - run1)	GMK040(Au - run 2)	GMK040-C3(Run 1)	GMK040-C3(Run 2)	GMK040-C3(Run 3)
+1 sigma	0.250	0.380	-0.002	0.069	0.029
-1 sigma	-0.031	0.030	-0.024	0.034	0.009
Average	0.109	0.205	-0.013	0.052	0.019

Field Application #2

QFN Application – RF Device - MT Gemini C3 Probe - MT9510 Handler- Hot/Ambient Test



0K

190K

Advantages of C3 Coating

■ Functional

① Reduction of Sn Migration

- DLC does not form alloy with Tin (Sn).

⇒ Stable Contact to Solder

② Hardness and Low Friction

- DLC is a very hard material.
- DLC is low-frictional material.

⇒ High Durability

■ Users' Merits Total Cost Saving in IC Testing

① Cost Savings in Testing Operations

- Enhancement of Test Yield
- Reduction of Re-Test Operation
- Reduction of Maintenance / Longer MTBF (Less Cleaning)
- Improvements of Tester Operation Ratio

② Cost Saving of Probes

- Longer Life of Probes