
TWENTIETH ANNUAL
TestConX™
March 3 - 6, 2019
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive

COPYRIGHT NOTICE

www.testconx.org

Testing Challenges for Cu Pillar Wafer by Spring Probe

Khaled Elmadbouly
Long Zhang (Eric)
Jiachun Zhou (Frank)

Smiths Interconnect

TestConX™
Mesa, Arizona • March 3 - 6, 2019

2000 - 2019 · 20 YEARS · ANNIVERSARY

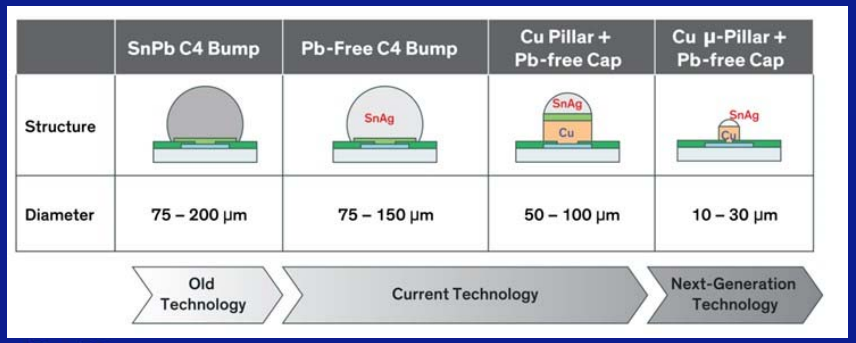
smiths interconnect
bringing technology to life

Content

- Cu Pillar WLCSP Introduction
- Existing Test Method and Challenges for Probing Cu Pillar Wafer with Spring Probes.
- Extensive Studies on Spring Probe Mark Analysis on Cu Pillar Wafer
- FDR Result
- Recommendation and Summary

Cu Pillar Introduction

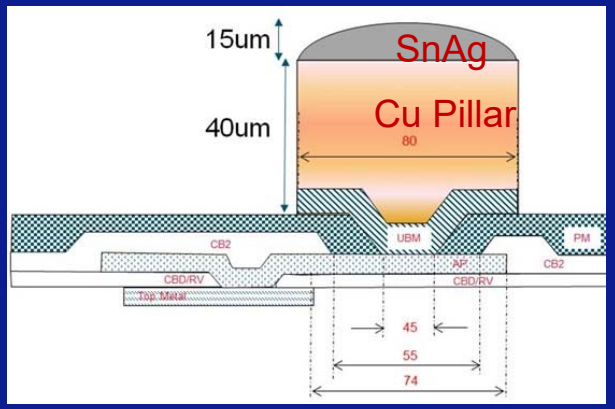
- WLCSP solder bump has reached its minimum limit in bump size and pitch
- The trend is increasing the number of IO pins in smaller die size at smaller pitch
- Cu Pillar is the next generation bump technology for greater density in smaller pitch
  - Lower cost
  - Ability to mix smaller more flexible shape with thin SnAg cap in finer pitch
  - Superior electrical and thermal performance than that of conventional solder bumps.



Cu Pillar Test Requirement

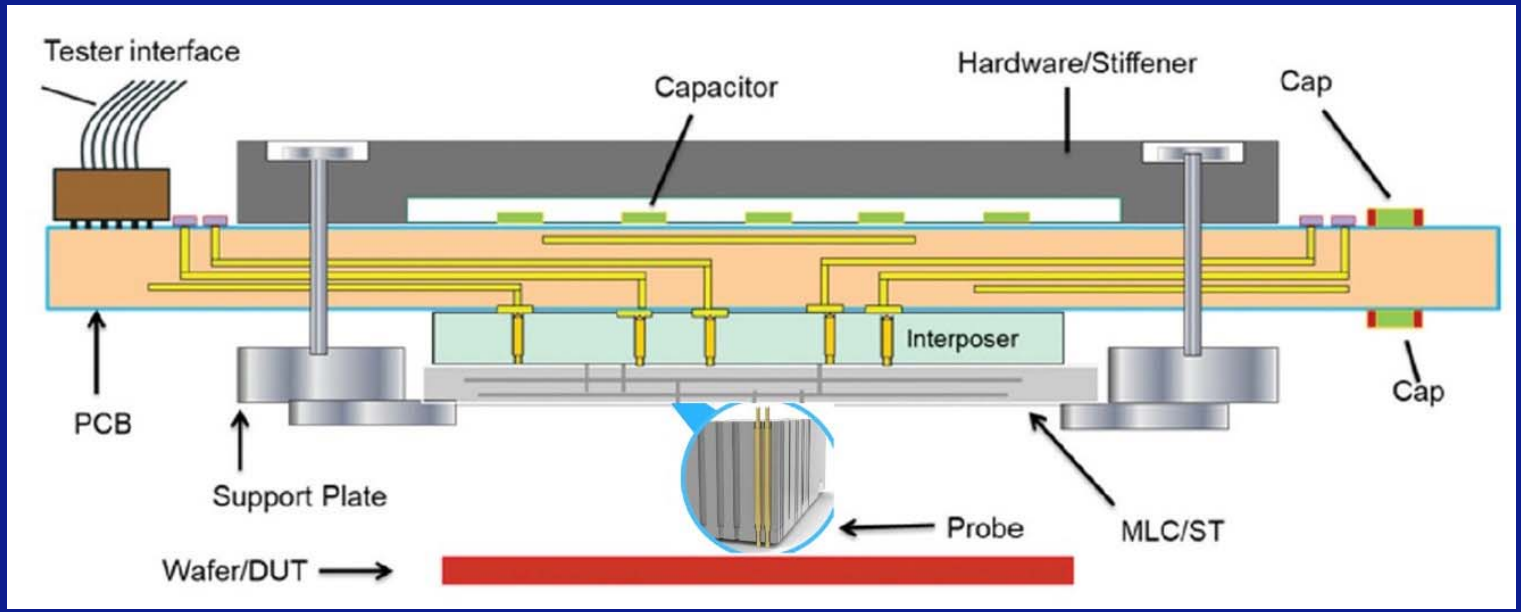
Probing on Cu Pillar:

- Spring Probes only need to penetrate the thin SnAg Cap for good Cres performance
- Spring Probes should not expose Cu Pillar, to prevent oxidation or create voids, as defects may occur in final SMT reflow process
- Spring Probe Force should not over stress Cu Pillar to avoid damaging the UBM (Under Bump Metallurgy) layer



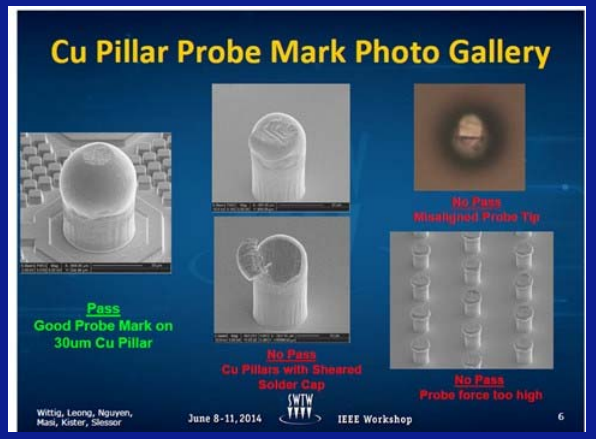
Cu Pillar Wafer Test Setup

Existing Cu Pillar WLCSP Test Method by Spring Probe Card

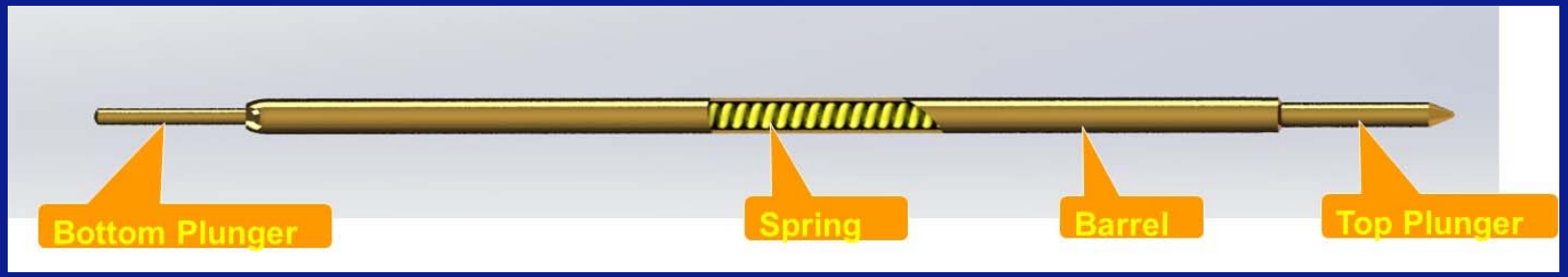


Cu Pillar Test Challenges with Spring Probe

- Probe Head with Spring Probe design must meet mechanical and electrical Cu Pillar test requirements
- Effect of contact mark by Spring Probe on Cu Pillar integrity
- Use FEA and FDR to confirm Spring Probe Design can meet test requirements



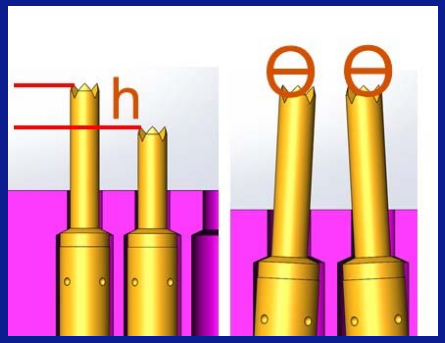
Spring Probe Design Challenge



- Thin cap of SnAg on Cu Pillar is much smaller than conventional solder bump which requires optimized spring probe design.
- Spring Probe must meet all minimum mechanical reliability requirements and at the same time to maintain good Cres performance.

Probe Head Design and Manufacturing Challenges

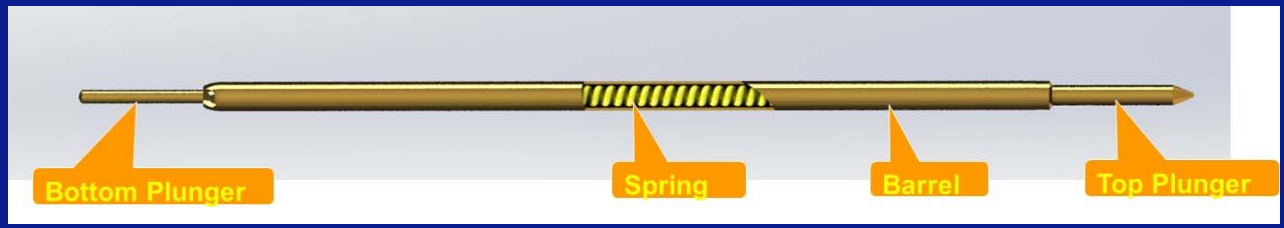
- Spring Probe Tip Tilting and Tip co-planarity
- Spring Probe Tip Material and Geometry
- Probe Head Deflection



  - Probe Head design needs to tolerate and consider the effective force of 1st to last touch and tip co-planarity due to manufacturing process.
  - Spring Probe Tip material and geometry must optimize to minimize the effect of probe mark on Cu Pillar.

Test Spring Probe Structures

Designed and manufactured 6 new Spring Probes with different spring force and plunger tip geometry



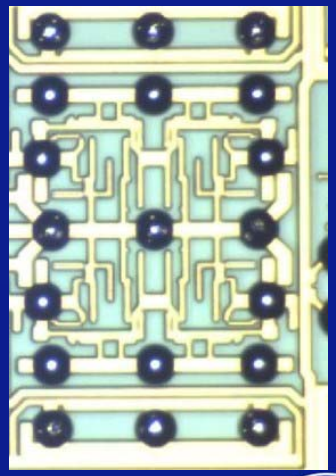
Type A Type B Type C

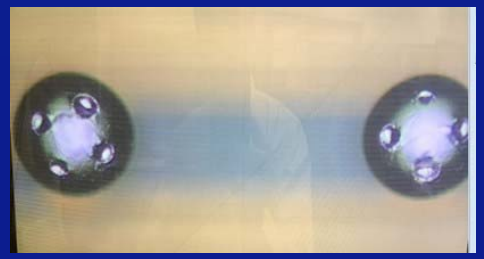
Cu Pillar Prober Test with Spring Probe

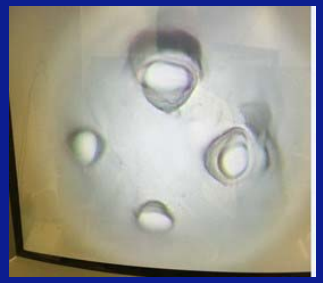
Extensive Probe Mark Analysis DOE

- Cycle 6 Probe Head with 3 different Plunger tip (A, B and C) with 2 different gram force springs on fresh wafer row each time, using Cu Pillar wafer.
- Analyze Probe Mark size and depth after each 1, 3 and 5 touch down, at 100 to 160um of over drive

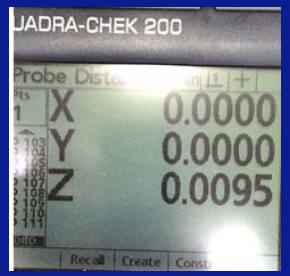
Example of probing 9 Cu Pillars on one Die
ID# Y33 – X58
5TD at 130um OD







Probe Mark Depth



TestConX™

Testing Challenges for Cu Pillar Wafer by Spring Probe 10

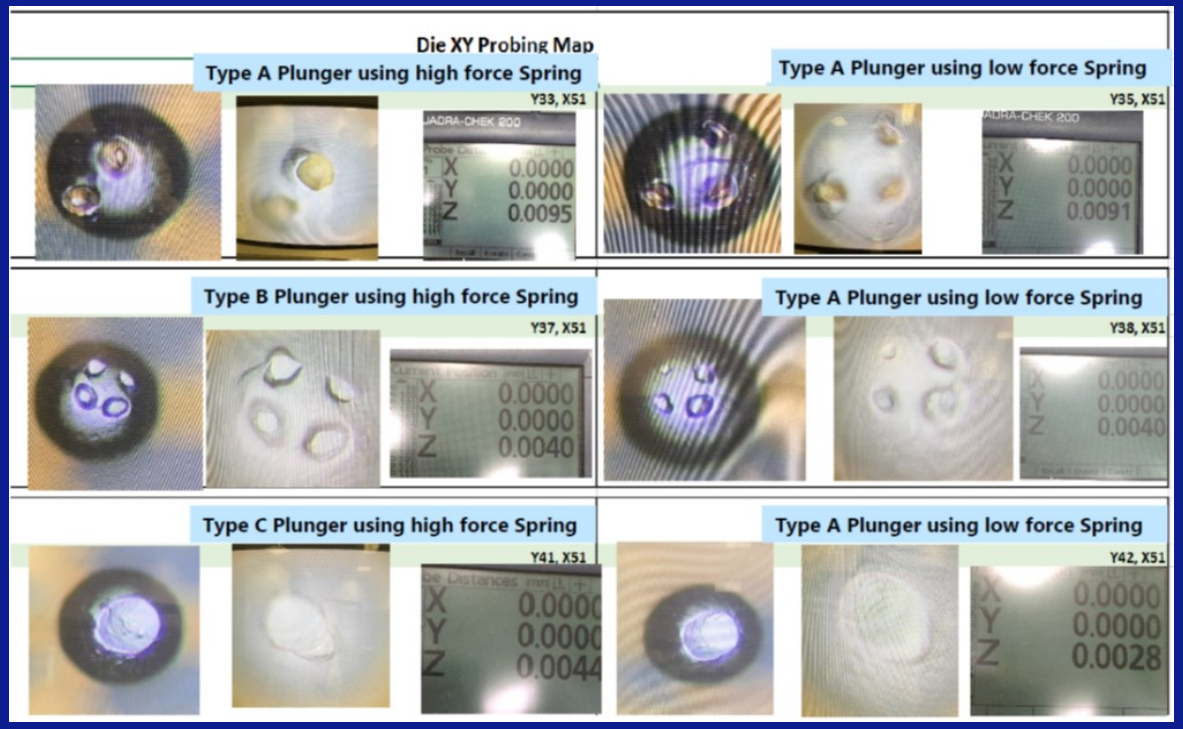
2000-2019 20 YEARS ANNIVERSARY

Cu Pillar Prober Test with Spring Probe

Failed Probe Mark Depth

Heavy Probe Mark

Heavy Probe Mark



Heavy Probe Mark

Okay

Okay

TestConX™

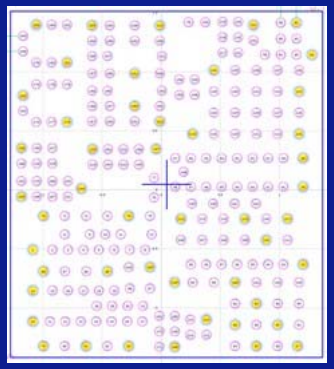
Testing Challenges for Cu Pillar Wafer by Spring Probe

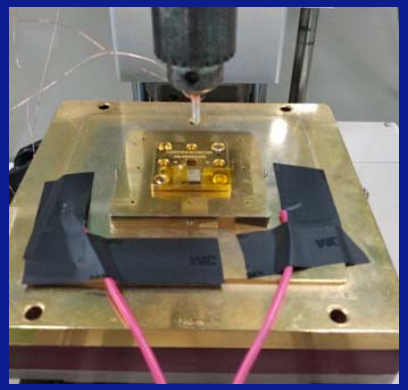
11

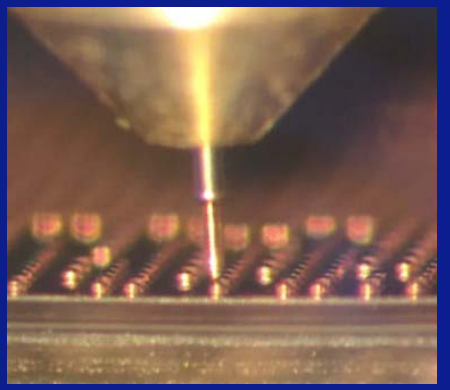
Cu Pillar Single Die Test with Spring Probes

Test Setup

- Designed a test fixture to align with single die and use FDR Tester and short some Cu Pillar to FDR Tester GND (Sense) Channel.
- Designed FDR Pin Adapter to hold Spring Probe (in preload condition) and connect the plunger to the FDR Force Channel.
- Align Cu Pillar with each type of Spring Probe and obtain FDR to highlighted Cu Pillars.
- Analyze Probe Mark and Cres vs Deflection vs Force for each type of spring probe.

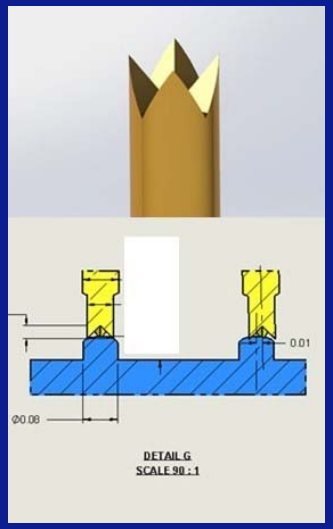




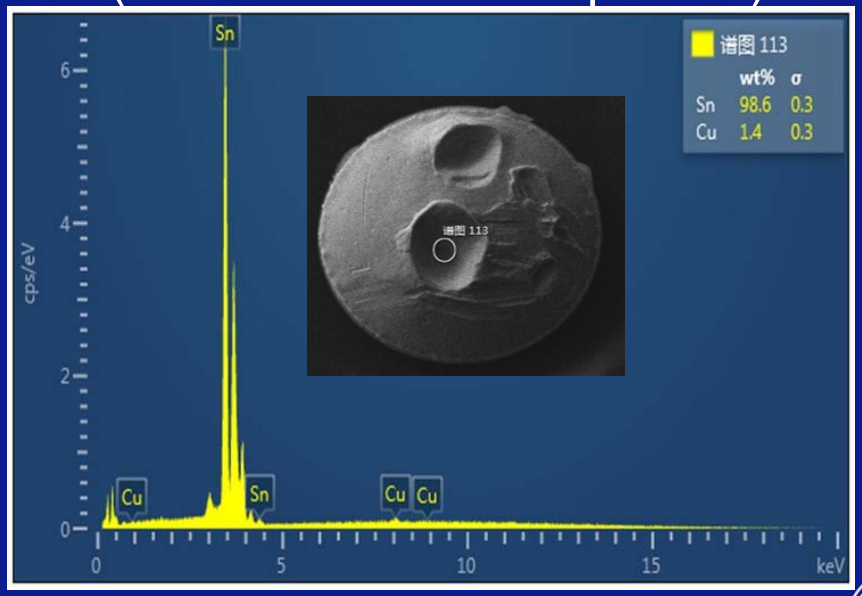


Probe Mark Analysis

Type A top plunger

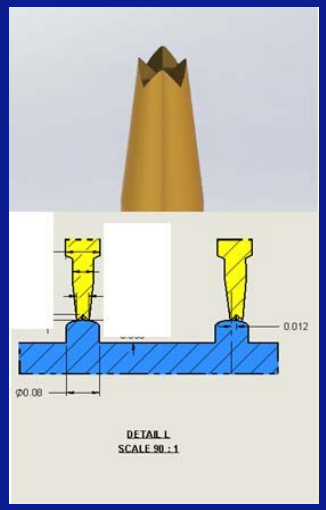


Type A with high force spring
(Failed due to Cu exposure)

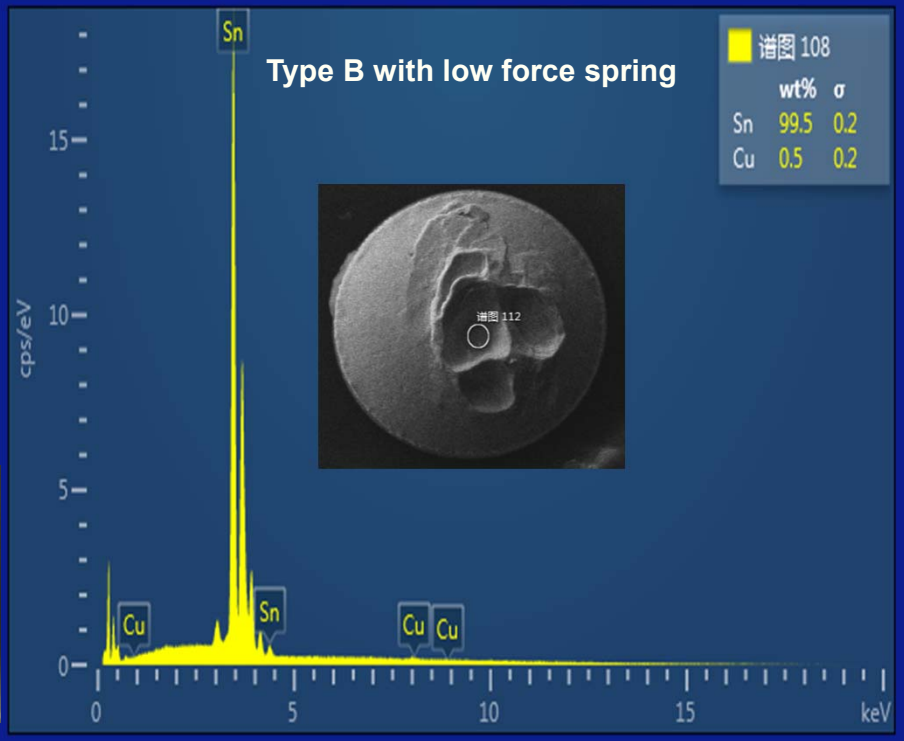


Probe Mark Analysis

Type B top plunger



Type B with low force spring



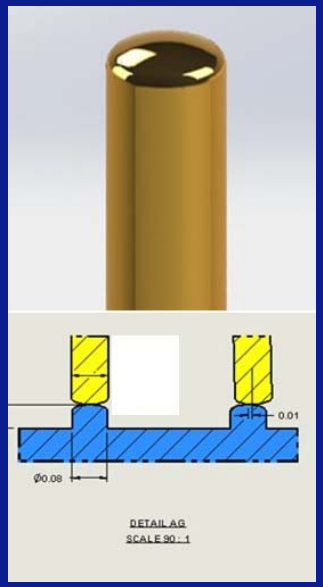
TestConX™

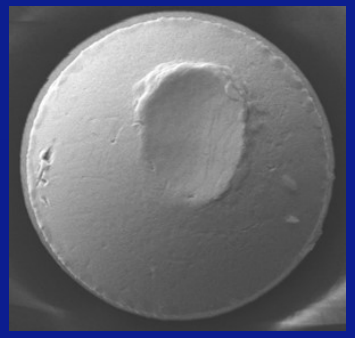
Testing Challenges for Cu Pillar Wafer by Spring Probe 14

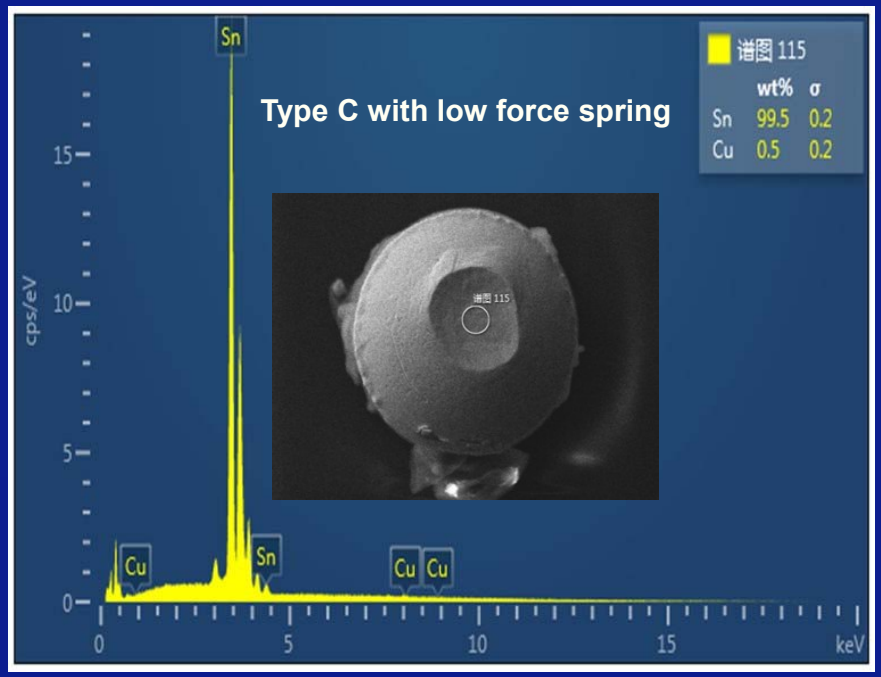
2000-2019 20 YEARS ANNIVERSARY

Probe Mark Analysis

Type C top plunger



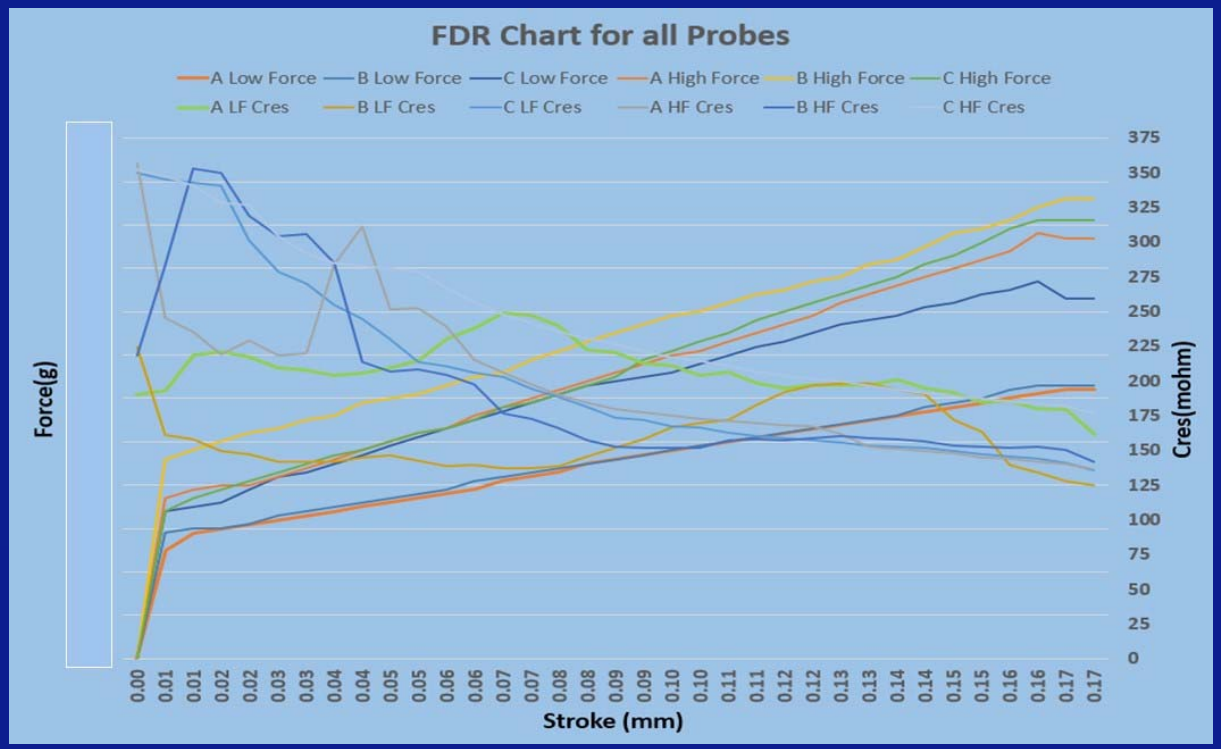




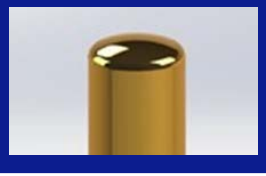
TestConX™

Testing Challenges for Cu Pillar Wafer by Spring Probe 15

FDR Chart For All Probes



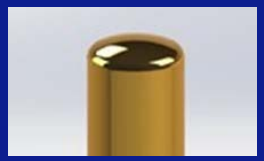
FDR Test Result Comparison

Spring Probe Tip Type		Cres (mOhm)
Type A with High and Low Spring Force		179.9
		154.8
Type B with High and Low Spring Force		152.4
		128.4
Type C with High and Low Spring Force		183.8
		142.4

TestConX™

Testing Challenges for Cu Pillar Wafer by Spring Probe 17

Recommendation and Summary



- Type A causing deep mark > 9 um too close to expose Cu and cause defect.
- Type B with optimized force is showing good Cres, acceptable probe mark, and will be released to production to evaluate life verse yield and performance.
- Type C with optimized force is showing good Cres, acceptable probe mark, and will be released to production to evaluate life verse yield and performance.

**** 2 PH with Type B and C will be released in HVM this spring for field validation.