
EIGHTEENTH ANNUAL
BiTS
Burn-in & Test Strategies Workshop
March 5 - 8, 2017
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive – Session 8
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Session 8

Hongjun Yao

Session Chair

BiTS Workshop 2017 Schedule

Solutions Day

Wednesday March 8 - 10:30 am

Contact Frequency

" Small Form Factor Cantilever Concepts for High Performance Analog / RF Applications"

Gerhard Gschwendtberger – Cohu

"MRC (MEMS Rubber Contact) Socket Bump Particle Structure & Performance Analysis"

BoHyun Kim, Dave Oh, Justin Yun - TSE Co., Ltd

"Flat Probe Technology For High Frequency Test"

Jason Mroczkowski, Nadia Steckler - Xcerra

MRC (MEMS Rubber Contact) Socket Bump Particle Structure & Performance Analysis

Justin Yun
Bo Hyun Kim
Dave Oh

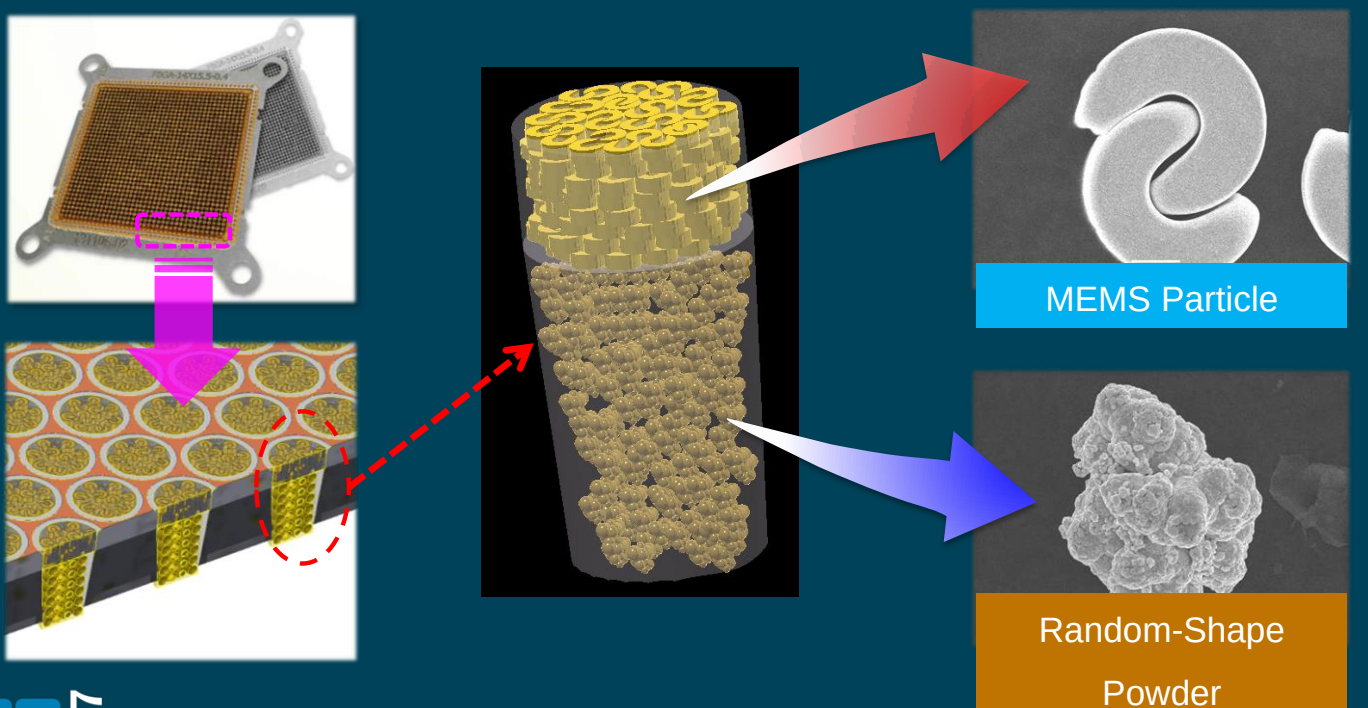
BiTS Workshop
March 5 - 8, 2017

Overview

- MRC Socket Background
- Investigation
- Lab & Production Test Results Review
- Analysis
- Summary & Conclusion

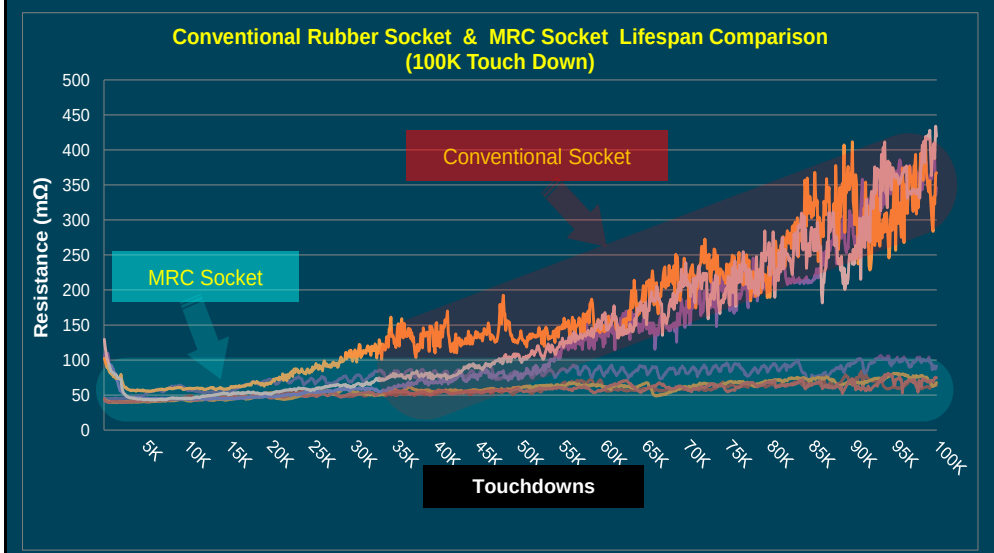
MRC Socket Background

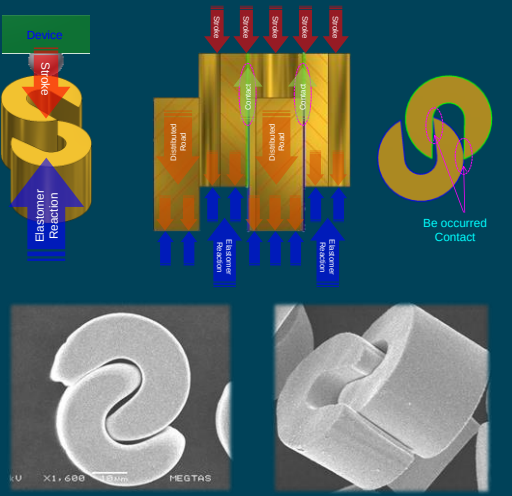
- **MEMS particle is applied to bump for good contact with balls of Package**
  - ✓ **Abrasion, Deflection and Tin build-up are improved**



MRC Socket Background

- **MRC vs Conventional Rubber Socket Lifespan**
  - ✓ **MRC : Consistent Cres. over 100K Touchdown**



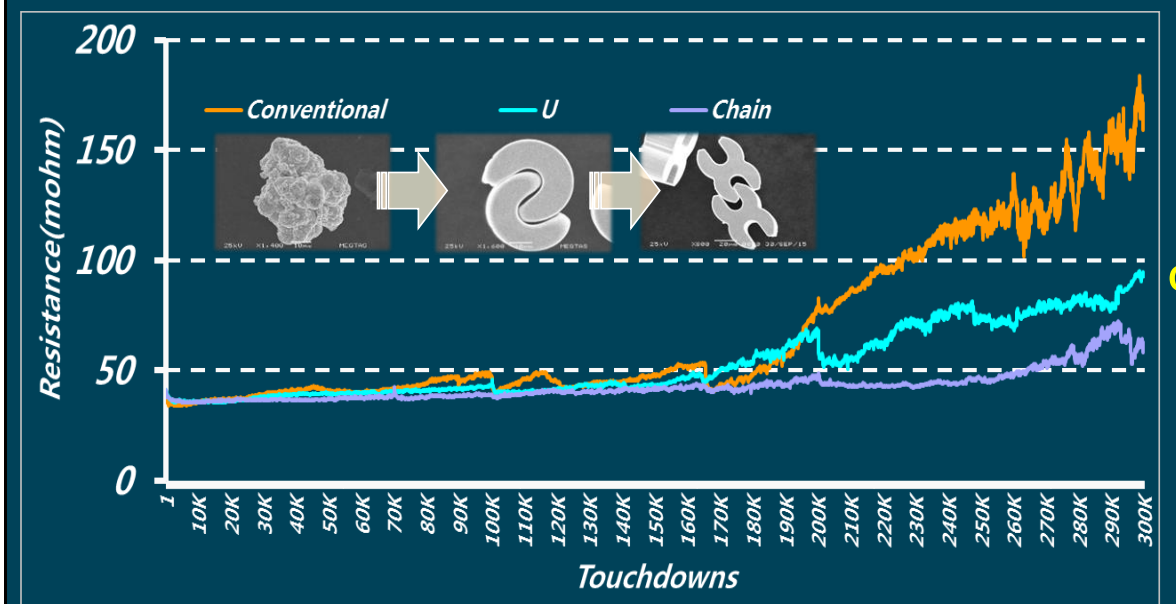


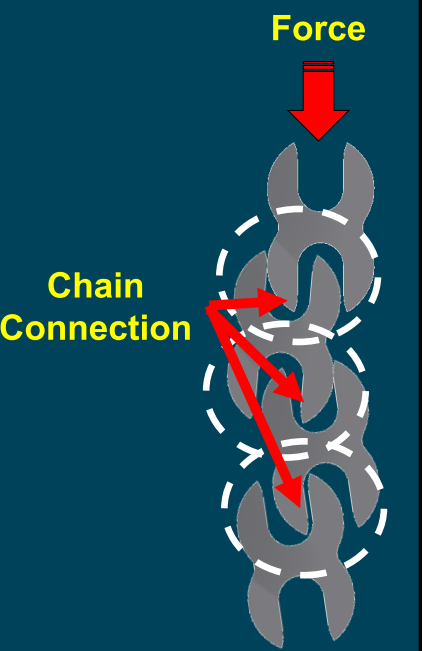
Docking!!

- **Why is MRC socket performance better than conventional rubber socket?**
  - ✓ **Contact reliability is improved by electromechanical docking of MEMS particles.**

MRC Socket Background

- **Docking Chain Effect of MEMS Particle**

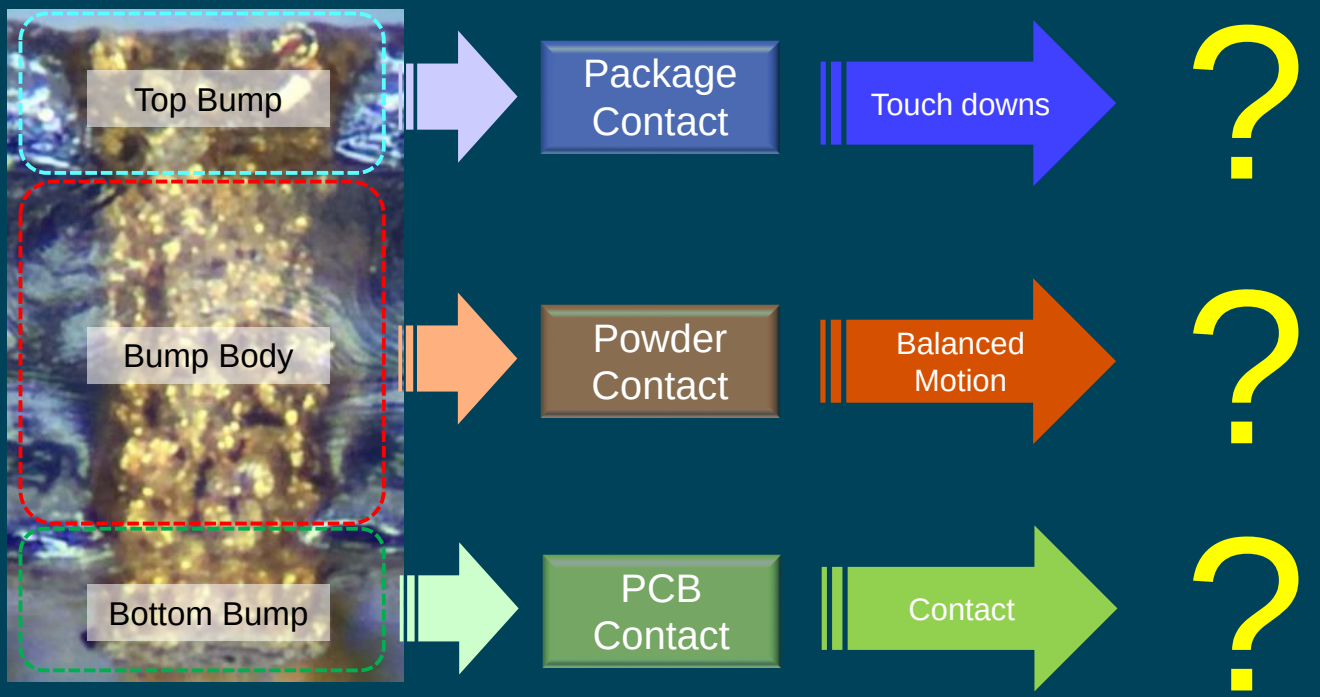




- ✓ Alternative particle shape increased contact area and improved docking
- ✓ Improvement in electrical performance (Resistance, C.C.C, Lifespan)

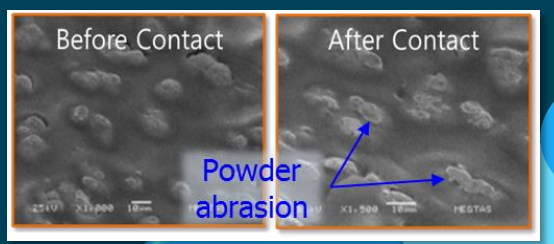
Investigation

- **What kind of particle on each layer is good for durability ?**
  - ✓ **Each bump has 3 layers – Top, Body, Bottom**

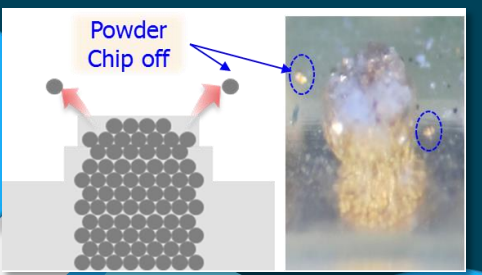


Investigation

- What is the characteristic of particle?

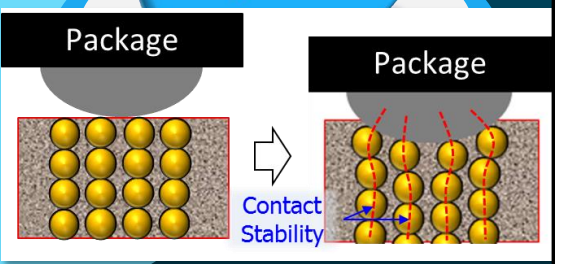


ADHESION with SILICONE



HARDNESS

CONSISTENT CONTACT

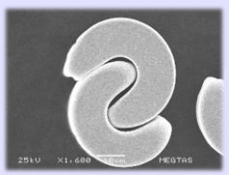
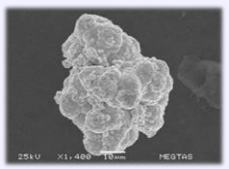
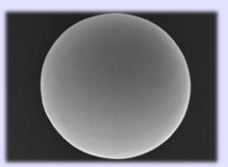


COST

MRC (MEMS Rubber Contact) Socket Bump Particle Structure & Performance Analysis 10

Investigation

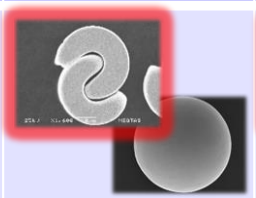
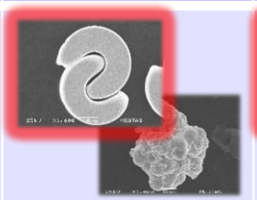
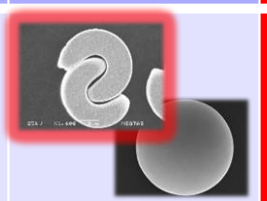
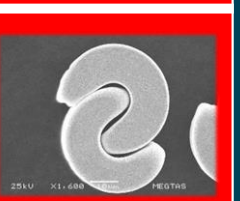
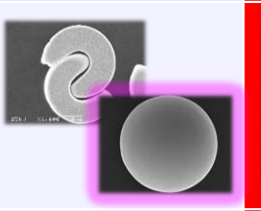
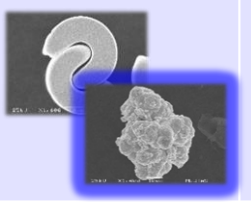
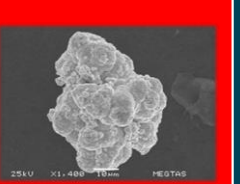
- **Characteristic comparison for each particle shape**

PARTICLE	HARDNESS	ADHESION with SILICONE	CONSISTENT CONTACT	COST
	O	O	O	X
	X	O	O	O
	O	X	O	O

<O : GOOD, X : BAD>

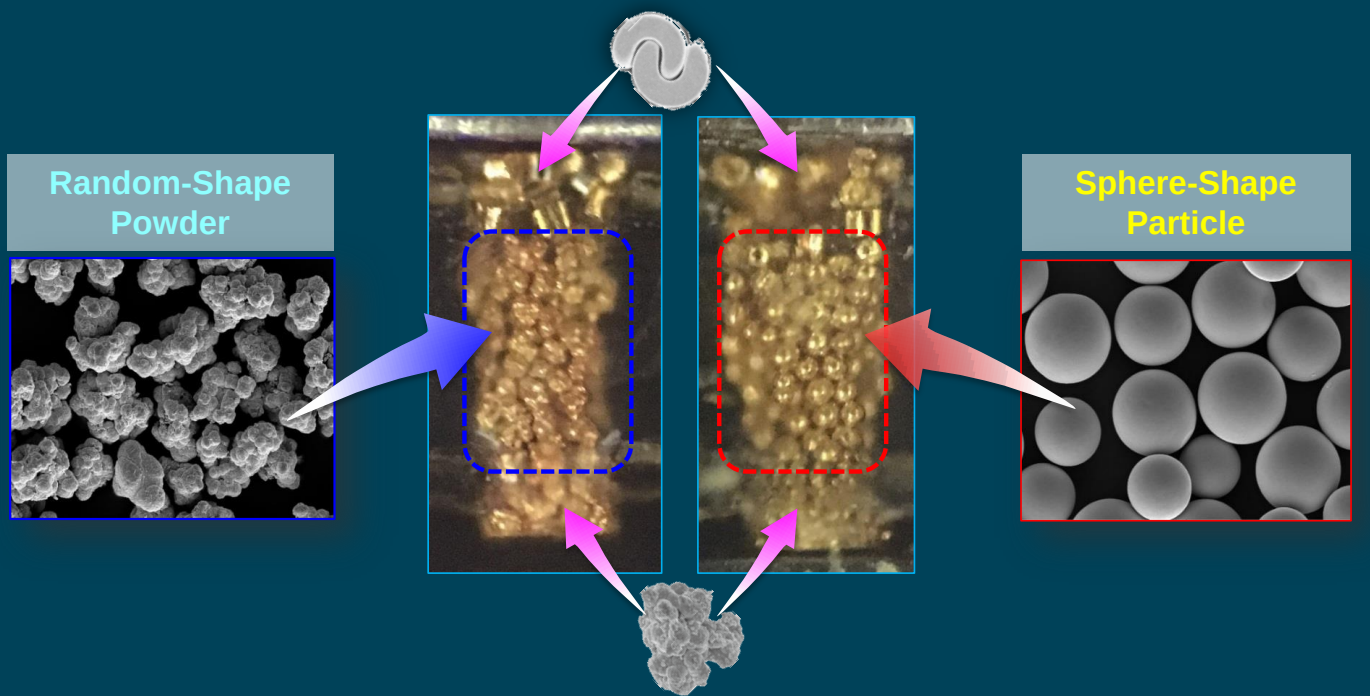
Investigation

- What is the requirement & best choice for each layers?

LAYERS	CONTACT OBJECT	HARDNESS	ADHESION with SILICONE	CONSISTENT CONTACT	BEST CHOICE
TOP	Ball				
BODY	Each Particle	N/A	N/A		
BOTTOM	PCB Gold Pad	N/A		N/A	

Investigation

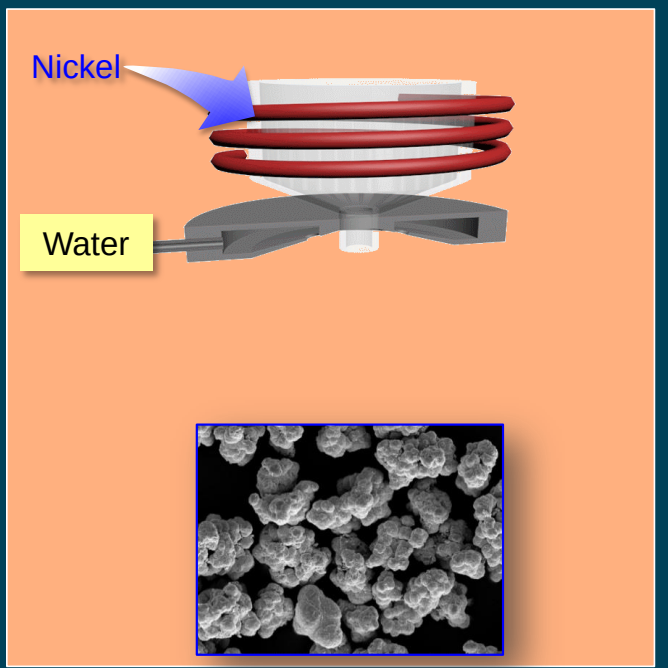
- How to improve contact durability of the Bump body?

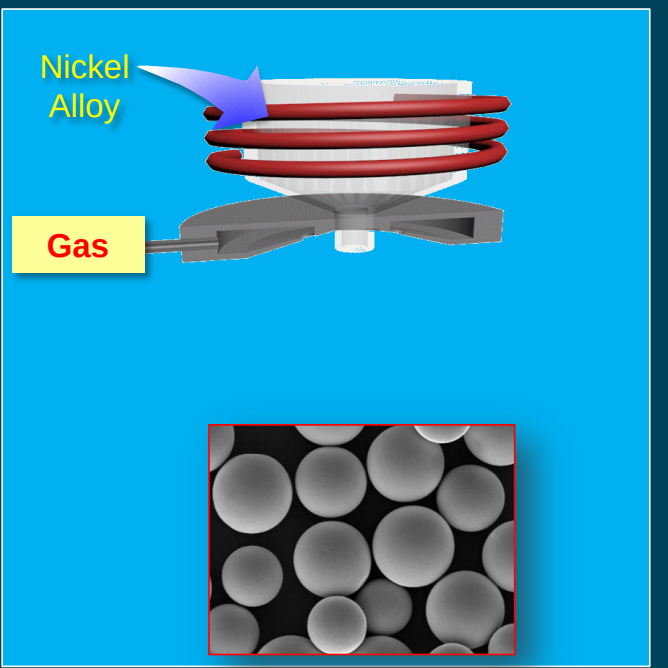


- ✓ Do spherical-shaped particles increase elastomer socket lifecycle?
- ✓ Do spherical-shaped particles improved contact stability and repeatability?

Comparison

- **Random-shape Powder vs. Sphere-shape Particle**

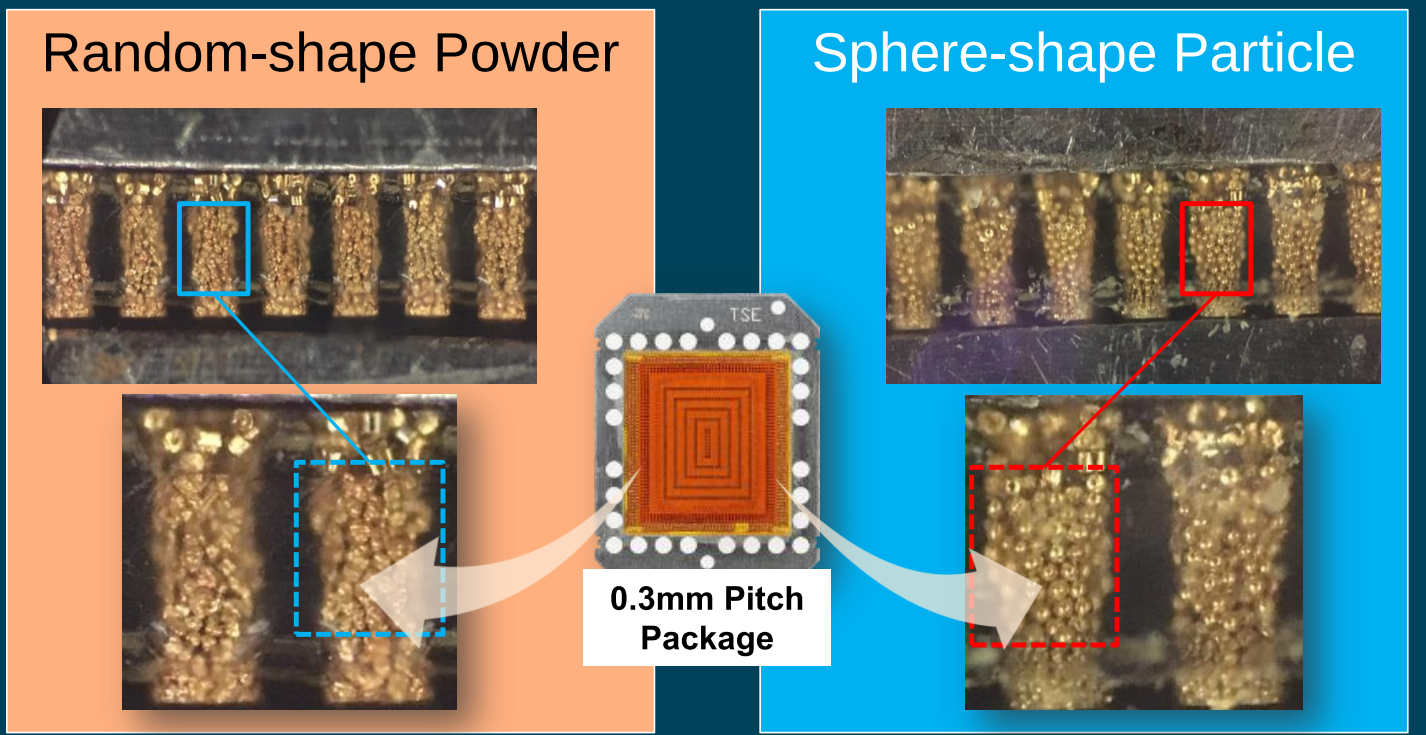




- ✓ **Random-shape powder is made by water atomization process.**
- ✓ **Sphere-shape particle is made by gas atomization process.**

Test Sample

- **Random-shape Powder vs. Sphere-shape Particle**



Evaluation

- **Resistance / Lifespan / Current Carrying Cpacity**

✓ **Tester : TSE IT-490**

✓ **Temp : 23℃**

✓ **Probe Size : ø0.19mm**

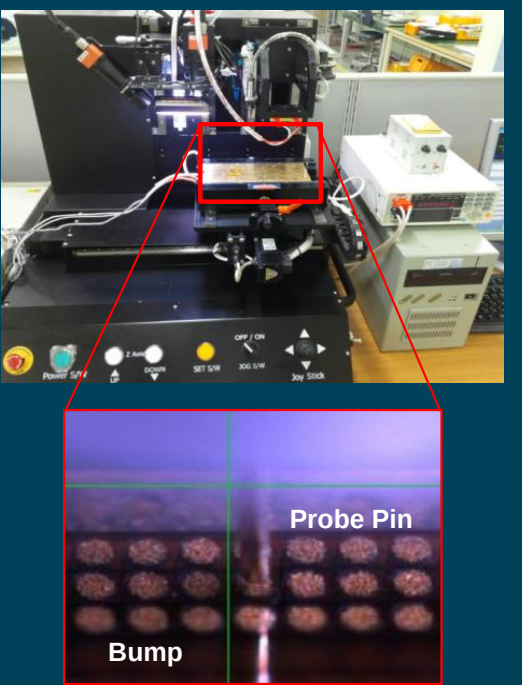
✓ **Probe Material : BeCu + Plating Au**

✓ **Lifespan Stroke : 100um**

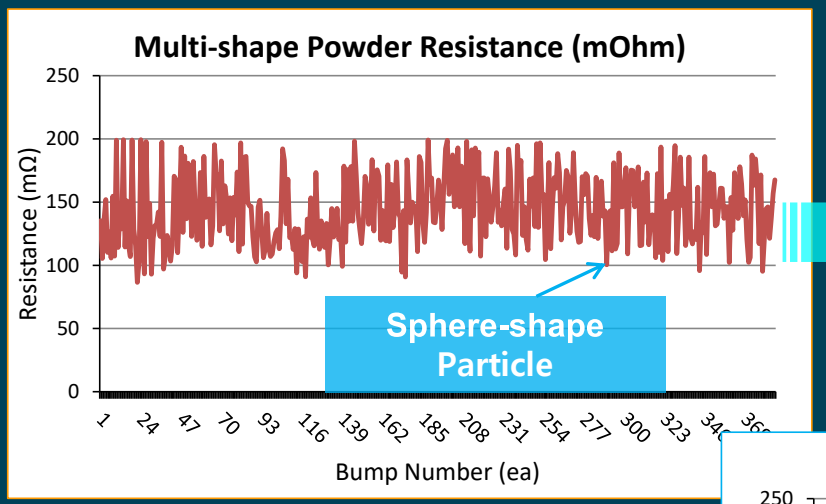
✓ **Lifespan : Touch Down 300K**

✓ **C.C.C Contact stroke : stroke @Force 10g**

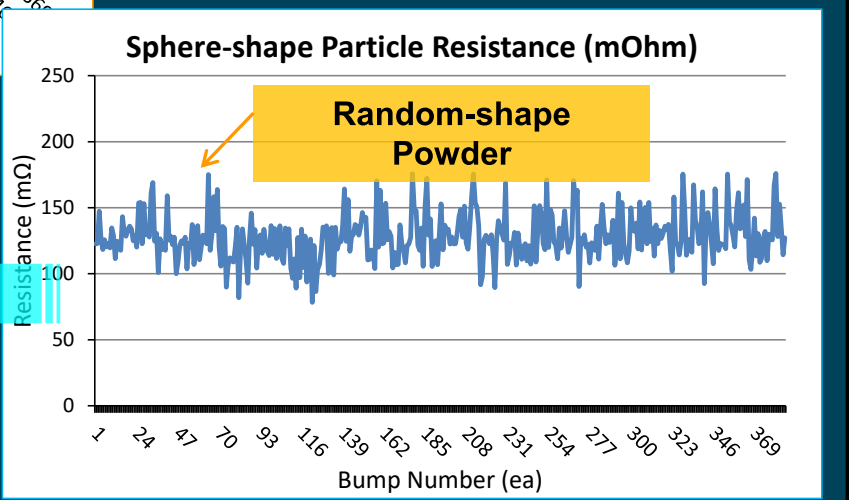
✓ **DC Power Supply 3306D (Max. 6A)**



Evaluation – Resistance

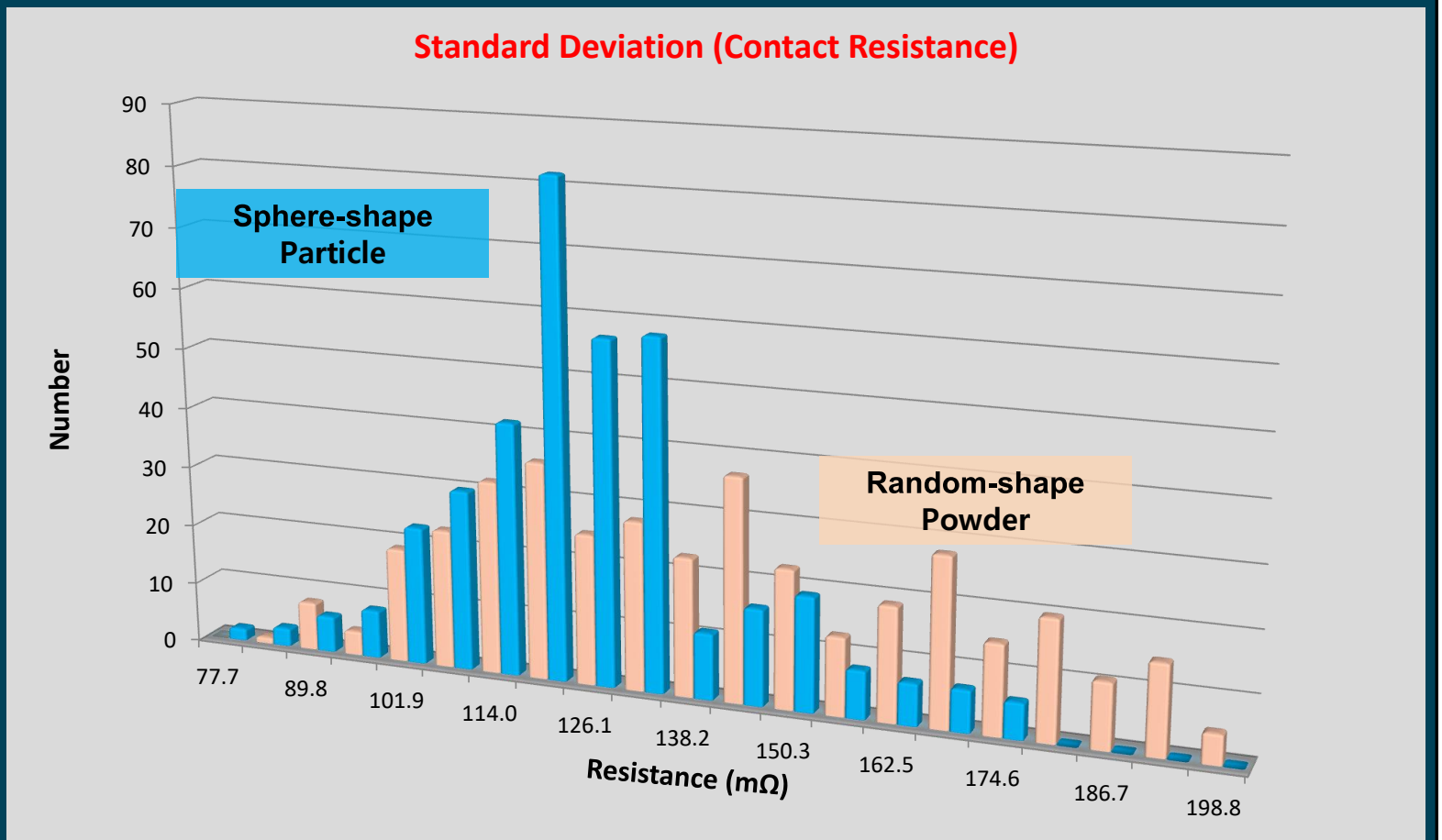


Resistance (mΩ)	
Minimum	86.5
Maximum	199.37
Average	**144.15**
Standard Deviation	**27.7**

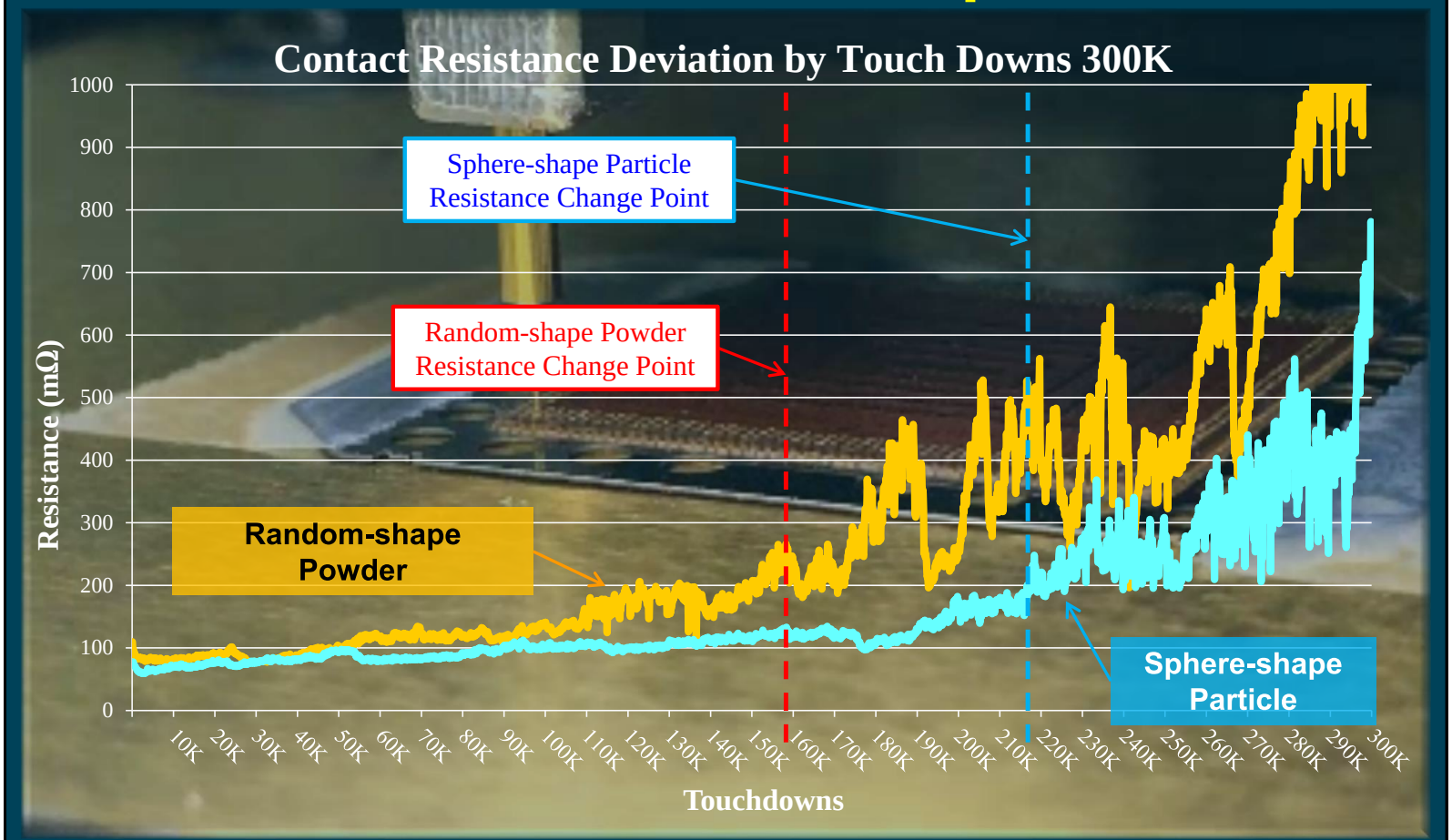


Resistance (mΩ)	
Minimum	78.32
Maximum	175.95
Average	**127.82**
Standard Deviation	**17.51**

Evaluation – Resistance

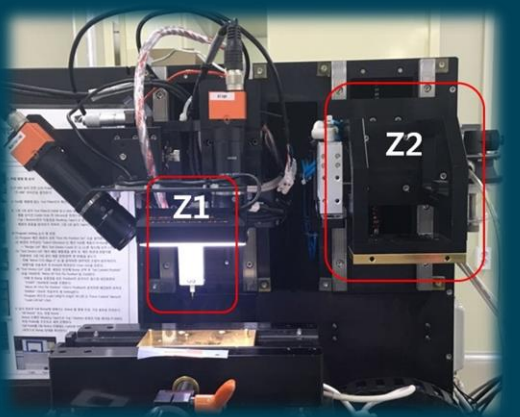


Evaluation - Lifespan

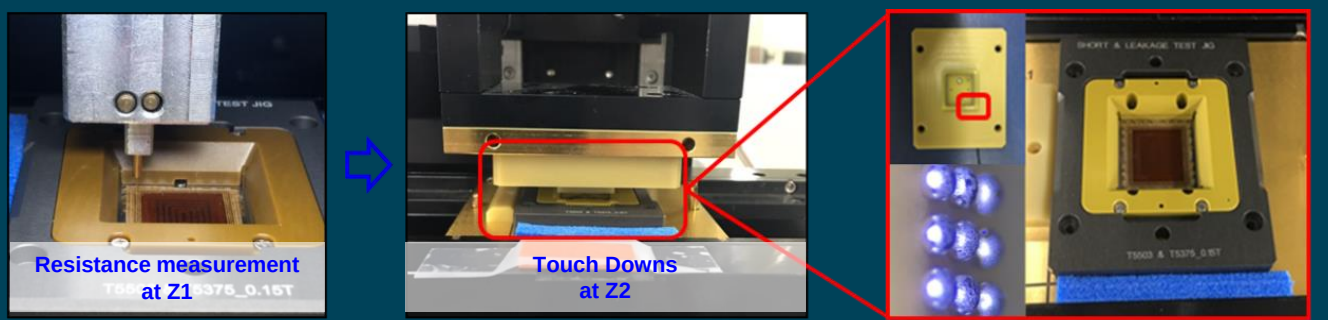


Evaluation – Lifespan (Whole Bump)

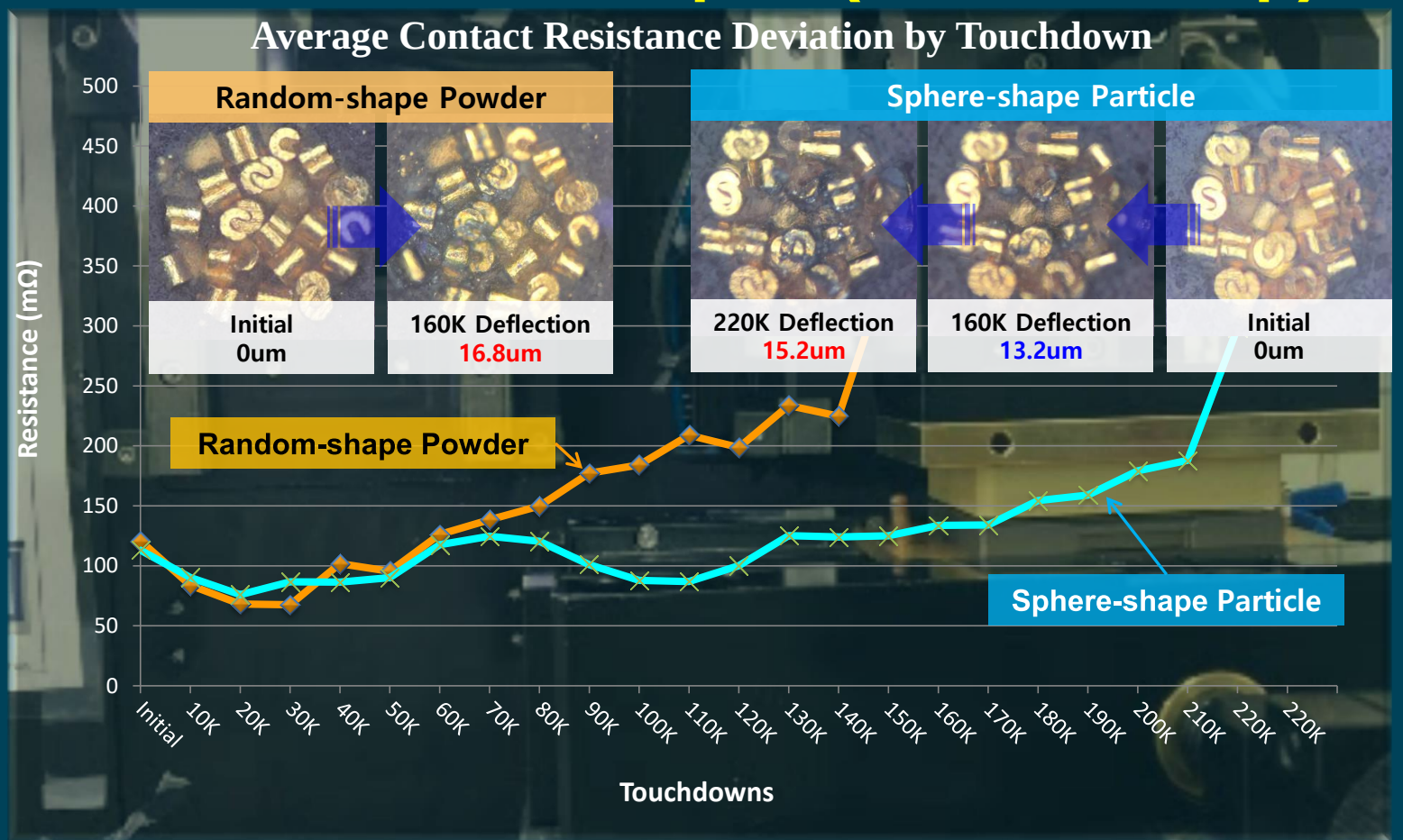
- **Lifespan Evaluation Condition**



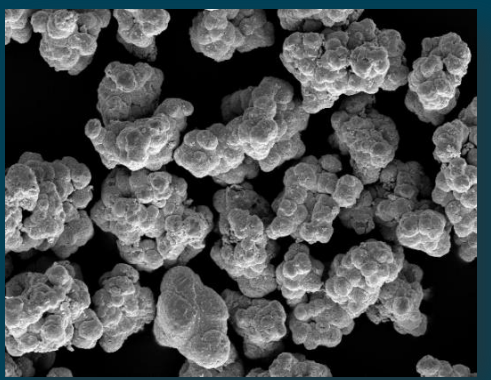
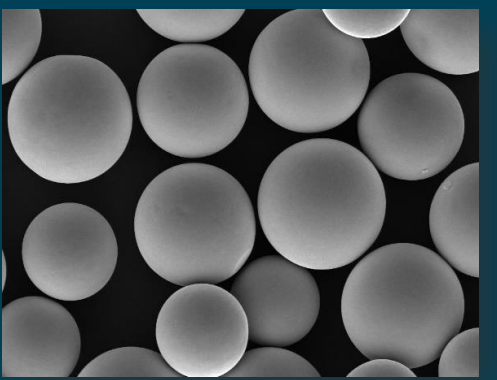
- ✓ Tester : TSE IT-490
- ✓ Temp : 23℃
- ✓ Dummy Device Ball Size : ø0.23mm
- ✓ Dummy Device Ball Material : (Pb Free) Sn
- ✓ Stroke : 100um
- ✓ Lifespan : Resistance Change Point
- ✓ Dummy Package was changed after every 10K touchdown.



Evaluation – Lifespan (Whole Bump)



Evaluation – C.C.C

	Random-shape Powder	Sphere-shape Particle
		
Min.	1.42A	1.82A
Max.	2.49A	2.33A
Average	1.78A	1.95A
STD	0.39	0.19

Evaluation – Customer Production Site

▪ Package Specification

✓ Time Controller 112BGA 0.65Pitch / Max Speed 3Gbps

✓ Facility : V93K – Handler (Seiko Epson NS7080)

▪ Lifespan

✓ Test Start Date June 10th, 2016

✓ Socket with Random-shape Powder : Test Ended after 78.5K Touch Down

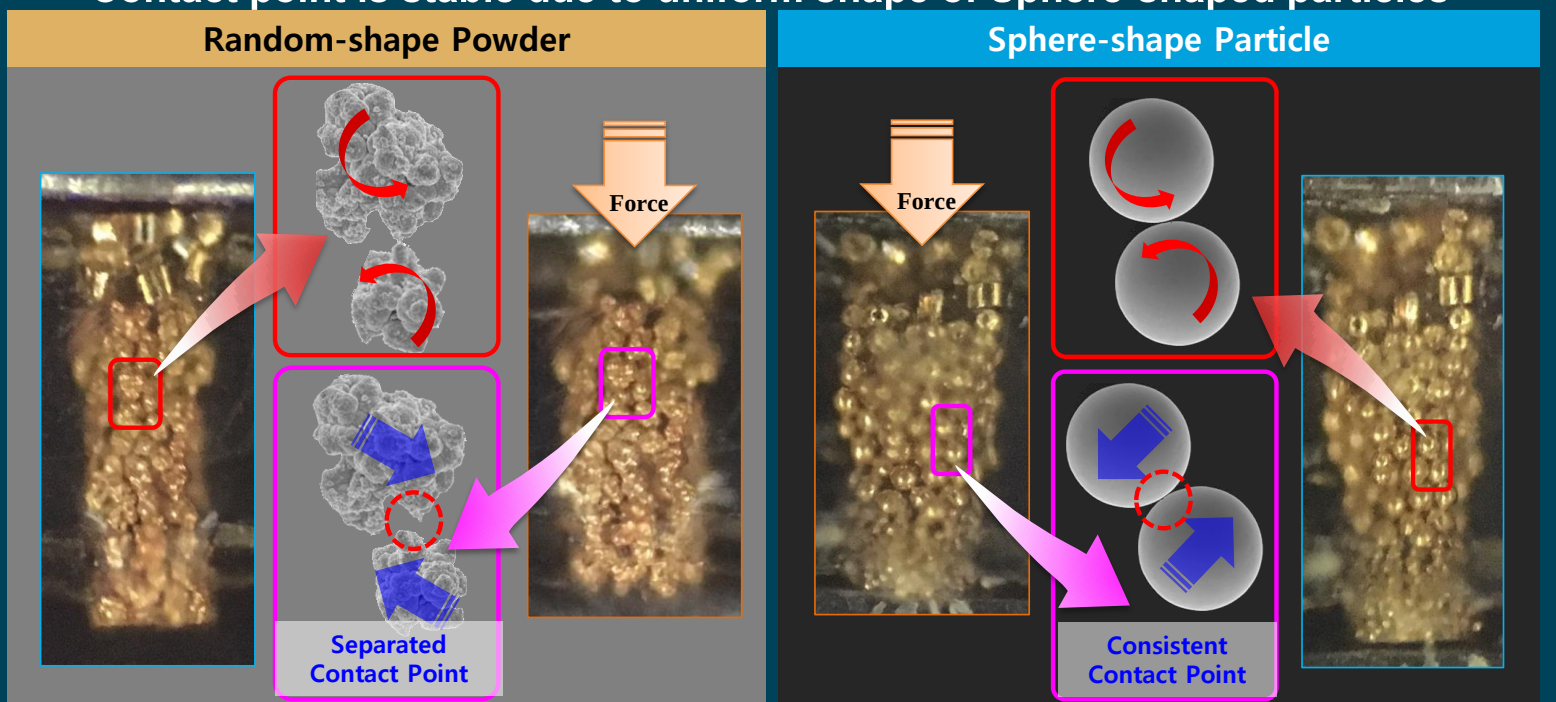
✓ Socket with Sphere-shape Particle : 175.5K Tested since Oct. 14th

✓ Accumulated Average Yield was Increased 3~4% up to 78.5K

	SITE	IN QTY	OUT QTY	FAIL QTY	PASS RATE	OS QTY	OS RATE
Multi-shape Powder	S1	78531	67304	11227	85.704	198	0.253
	S2	78561	69319	9242	88.236	80	0.102
Sphere-shape Particle	S3	175500	164135	11365	93.524	56	0.032
	S4	175620	163349	12271	93.013	42	0.024

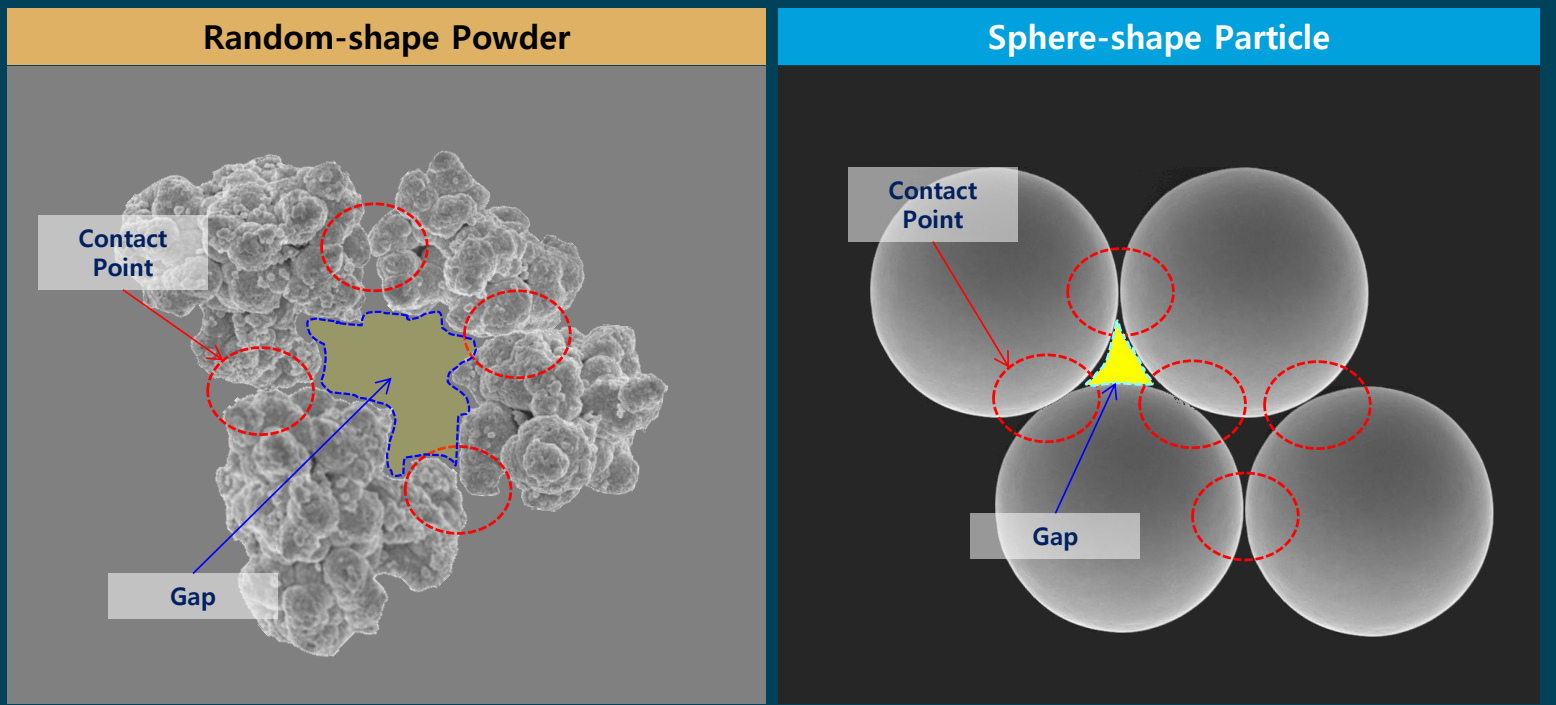
Analysis

- **Consistent Contact Point**
  - ✓ Elastomer & Powder are not damaged due to smooth particle surface & sliding contact motion
  - ✓ Contact point is stable due to uniform shape of Sphere-shaped particles



Analysis

- **Continuous Contact Point**
  - ✓ S-shaped particles provide geometrically uniform distribution of contact force
  - ✓ S-shaped particles minimize gaps and provide more consistent contact force



Summary

- **Short Term Resistance**
  - ✓ **Sphere-shape particles provide stable contact resistance compared to Random-shape powder**
- **Lifespan (Resistance Increase by Touchdown)**
  - ✓ **Sphere-shape particles improve bump body durability compared to Random-shape powder**

Summary

- **Deflection**
  - ✓ **Sphere-shape particles reduces deflection compared to Random-shape powder**
- **C.C.C**
  - ✓ **Sphere-shaped particles improve current capacity compared to Random-shape powder**

Conclusion

- **Particle Shape**
  - ✓ Particle conductivity is improved by altering the particle shape
- **Sphere-shape Particle**
  - ✓ Controlled sphere-shaped particles creates a repeatable and robust electromechanical contact
  - ✓ Utilization of Sphere-shape particles in the Bump Body prevents silicon damage and contact pressure concentration which improves the long-term mechanical performance of MRC sockets
    - Durability improved
    - Contact point stability improved
    - Deflection decreased