SWTEST

PROBE TODAY, FOR TOMORROW

2023 CONFERENCE

Thermal Challenges in the Fine Pitch Testing Solutions

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- Probe cards & advanced packaging market
- Thermal challenges of probe card
- CHPT fine pitch solutions for high & low temperature
- NS35 fine pitch needle intro
- Summary

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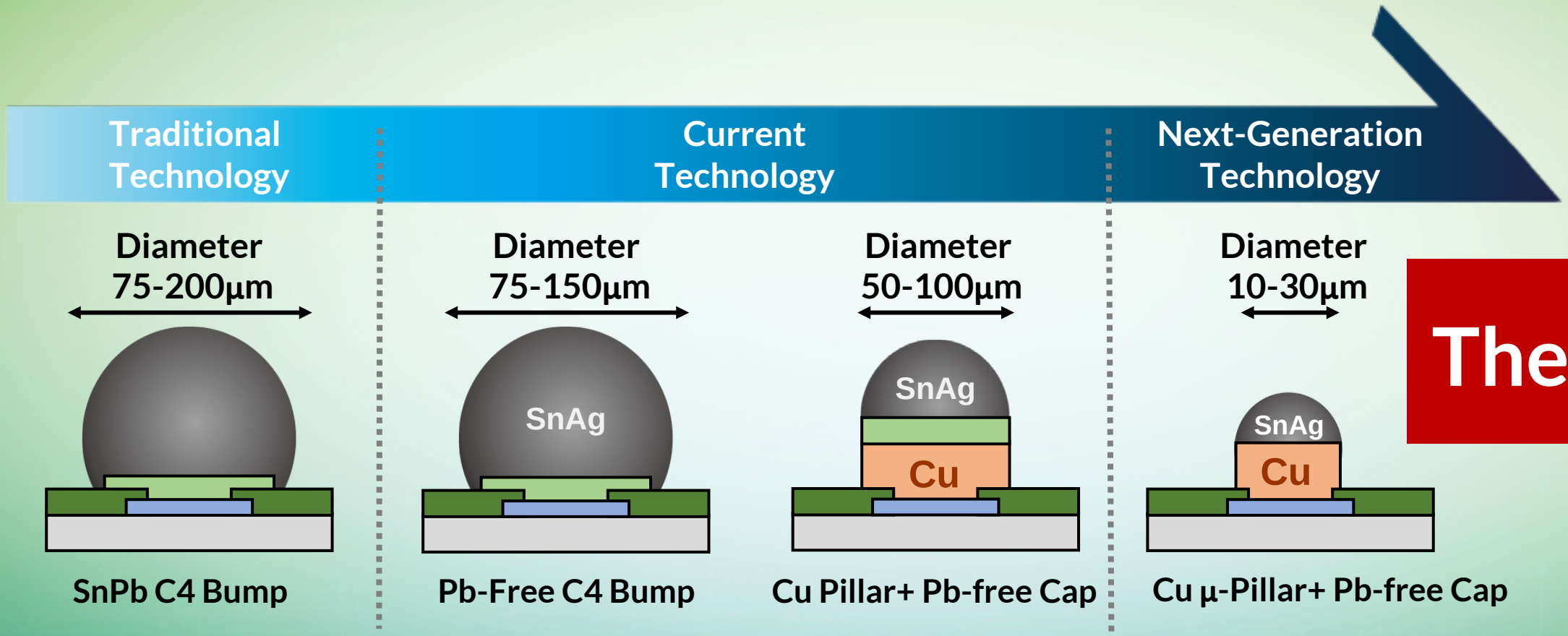
Advanced packaging market trend



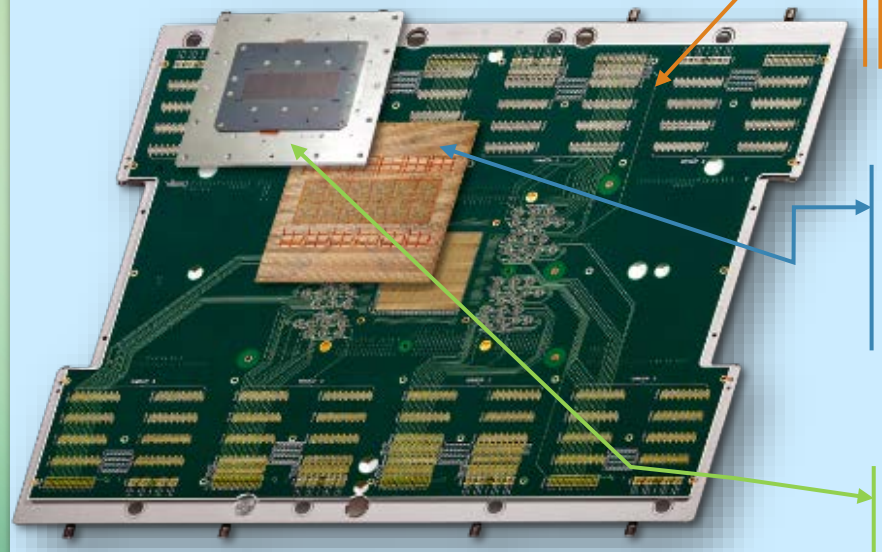
Thermal

Resource: Dow Chemicals

CHPT all in house

3H Probe Card

- High pin count
- High Current
- High Speed



PCB Capability

- Up to 100 layers
- A/R 60
- Pitch 0.3mm
- Material: FR4, M6, M7, MW2000, MW4000

Substrate Capability

- Site: 20+
- C4 Count: 50,000 pins
- C4 Pitch: 45um ⇨ 35um

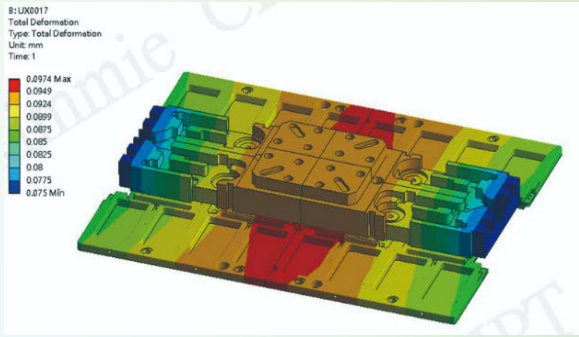
Probe Head Capability

- Min. Pitch: 45um ⇨ 35um
- Max Pin Count: 50,000 pins
- -40~175 ℃

All in House

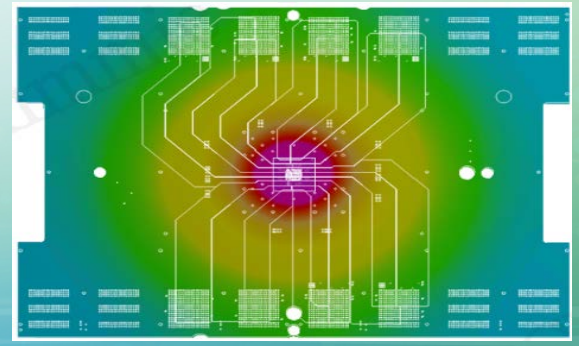
Mechanical Simulation

During mechanical simulation, we are able to calculate the amount of probe card deformation caused by the force of the testing process. CHPT then optimizes the design of each section of the probe card based on this information.



Thermal Simulation

Thermal simulation is performed on heated probe cards to highlight changes in their characteristics. The data is then used to optimize and enhance the probe cards for the improvement of testing stability at high temperatures.



* CHPT's technology has been patented or patent pending.

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Fine pitch challenges of probe card

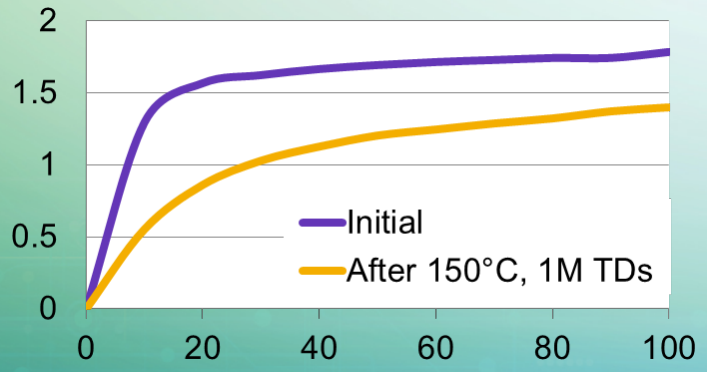
CHALLENGES

Thermal

The components of the probe card will cause decay and deformation due to heat, especially when the pitch is getting smaller and smaller.

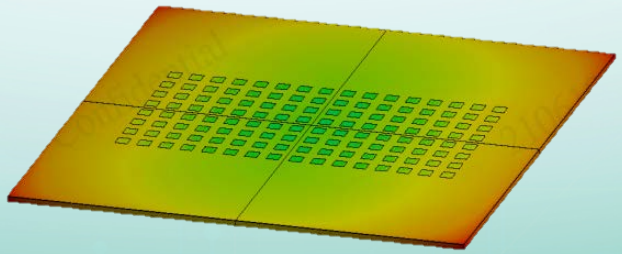
Probe

Force decay after 1M touchdown at high temp.



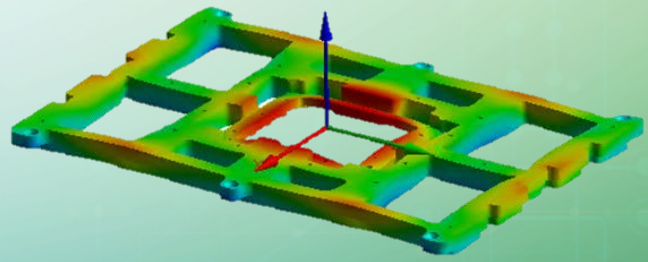
Substrate

CTE mismatch and deformation at high & low temp.



Mechanical Parts

Inlay deformation at high & low temp.



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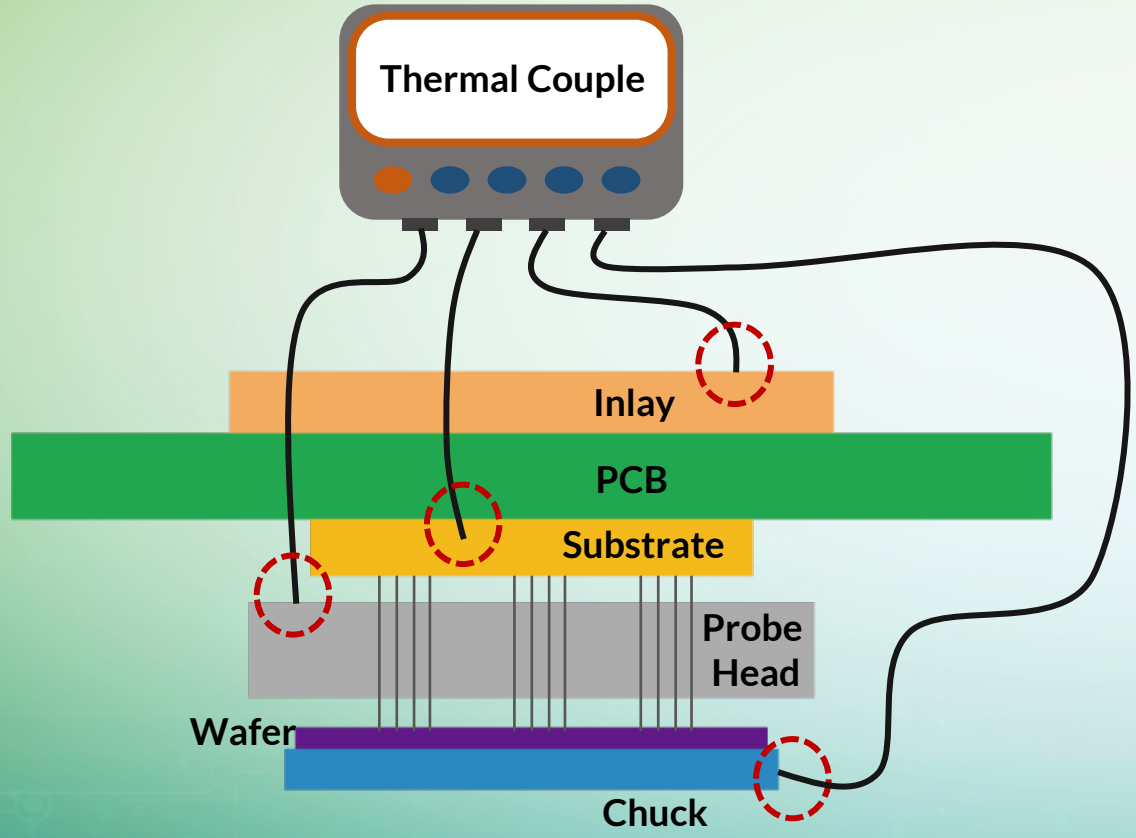
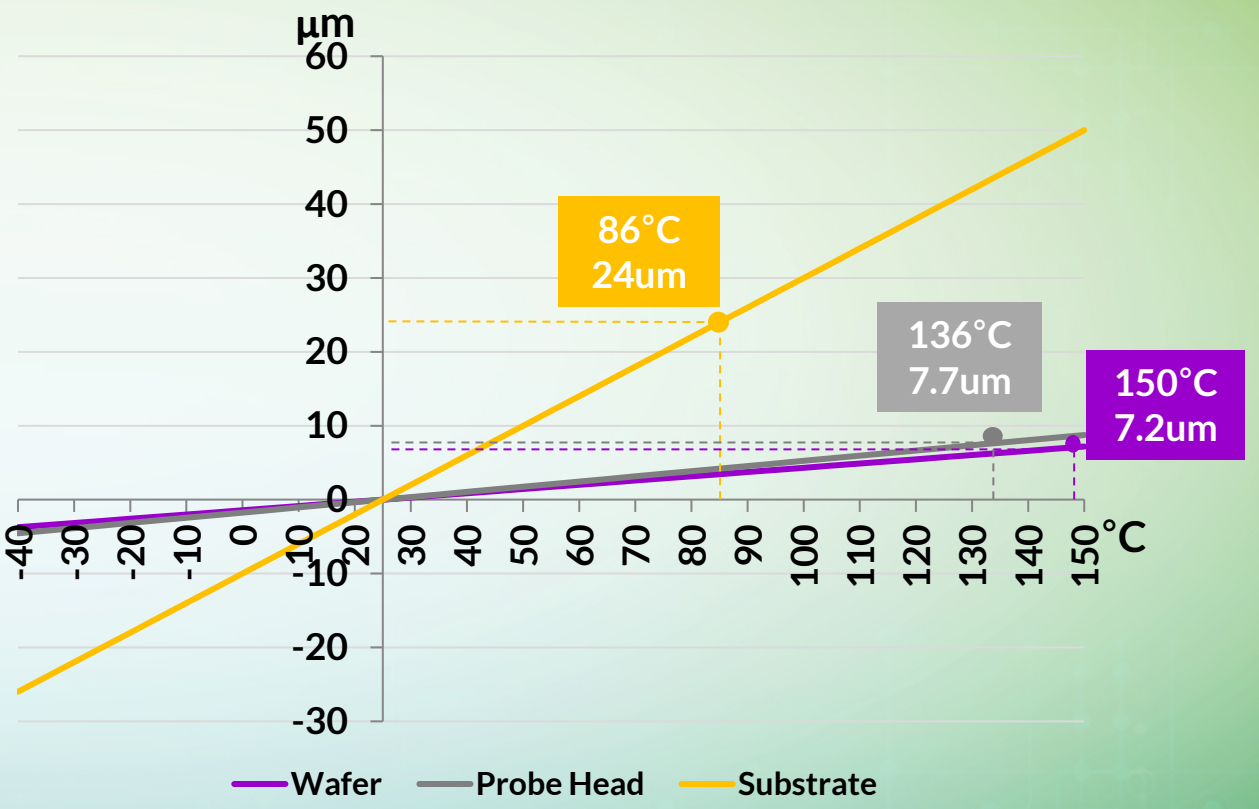
Testing error due to CTE mismatch

Under the influence of temperature changes, the contact points of various components will shift, which leads to poor inaccurate result.



Probe Card Architecture



CTE property and actual temperature of different materials

[1] : Coefficient of Thermal Expansion

[2] : The test area is set to 50x50mm.

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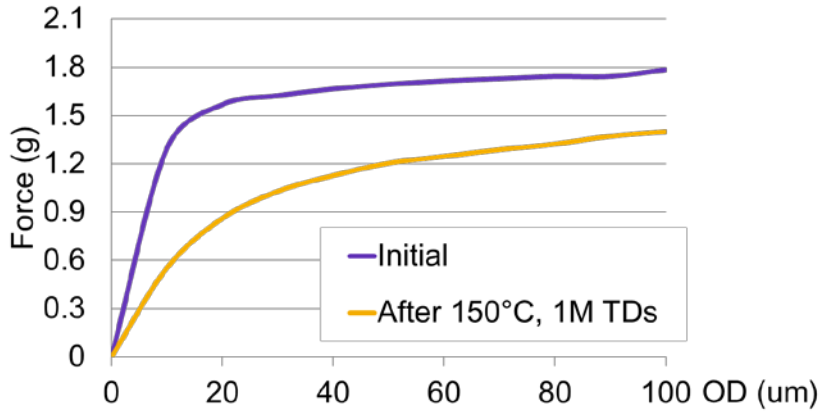
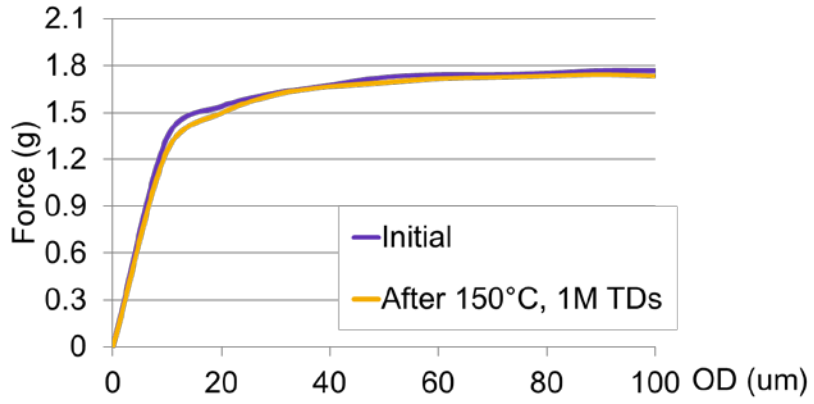
Probe material improvement

The new material showed good mechanical properties after being tested at high temperature.

Actual measurement of 1 million touchdown force decay at high temperature		
Item	Current Material	**New Material**
Pattern simulation		
Force drop	1.8g > 1.4g, -22%	1.8g > 1.76g, -2%

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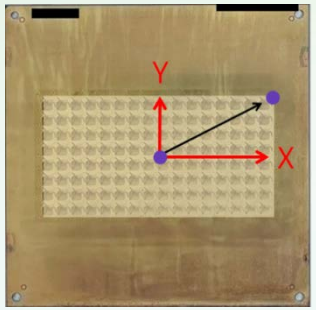
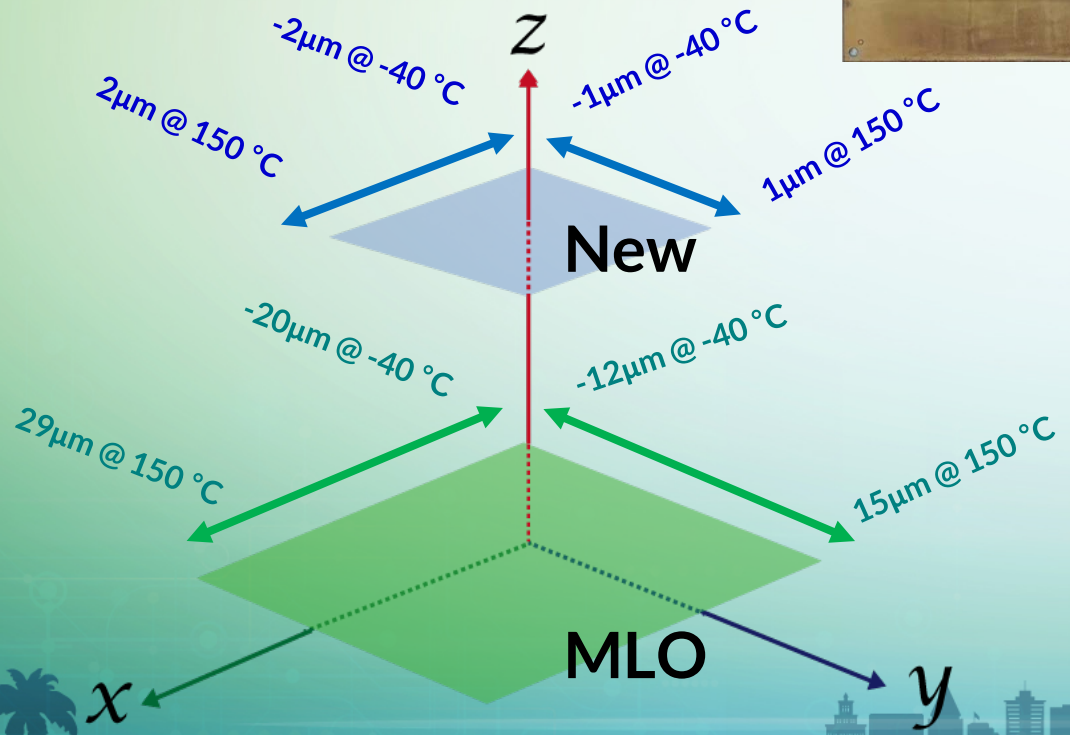
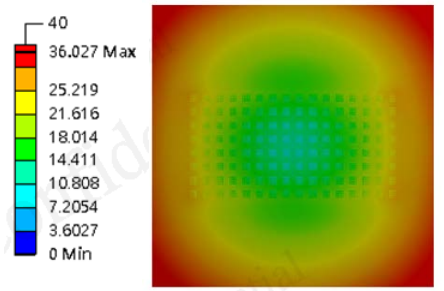
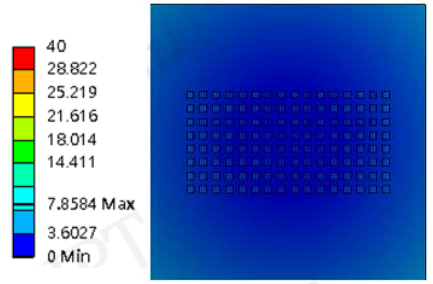
Substrate material improvement

By controlling the expansion and contraction caused by different temperature, making probe contact with C4 pad more stable.





Simulation of thermal expansion at high temperature		
Item	MLO	New Substrate
Pattern simulation		
Maximum deformation	25 ~ 40 μm	< 5 μm

Actual measurement of thermal expansion at high temperature				
Materials	MLO	MLO	New	New
Axial	X	Y	X	Y
Chuck Temp: -40°C	-20μm	-12μm	-2μm	-1μm
Chuck Temp: 25°C (Original point)	0	0	0	0
Chuck Temp: 150°C	29μm	15μm	2μm	1μm

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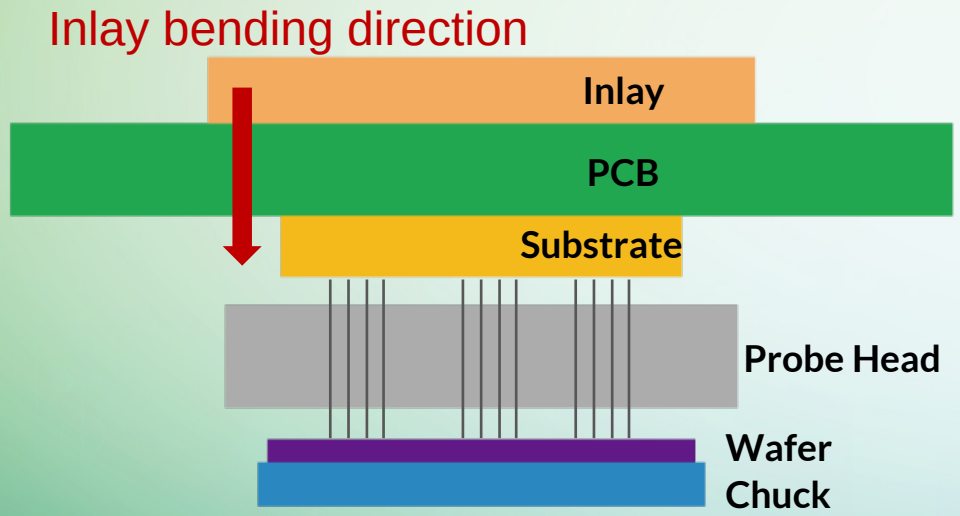
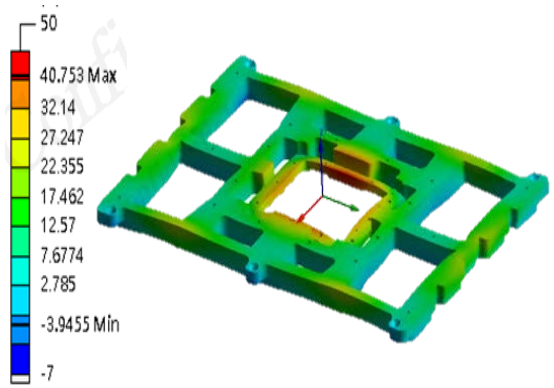
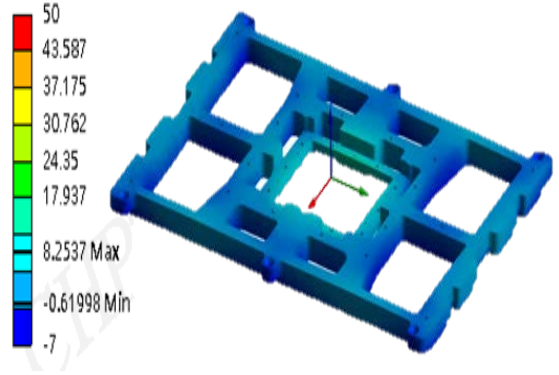
Mechanical parts material improvement

By controlling the expansion and contraction in the Z direction, the planarity of the probe card at different temperatures can be improved.



Probe Card Architecture

Simulation of thermal expansion at high temperature		
	Current Material	New Material
Pattern simulation		
Z-axis deformation	40.8 µm	8.2 µm

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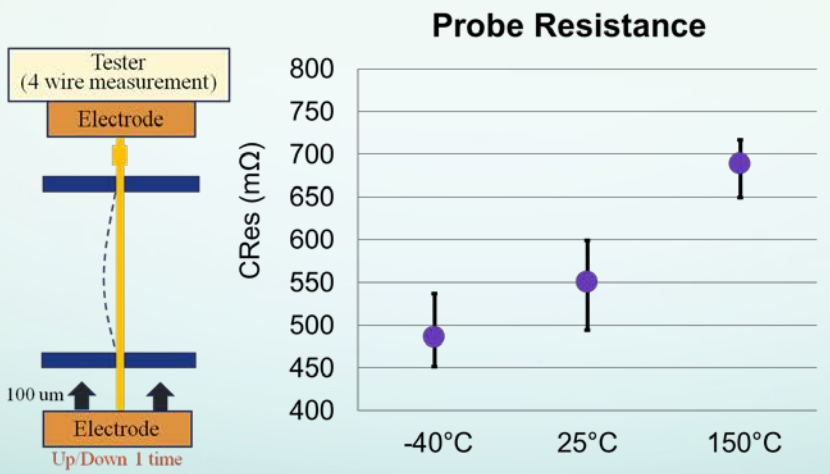
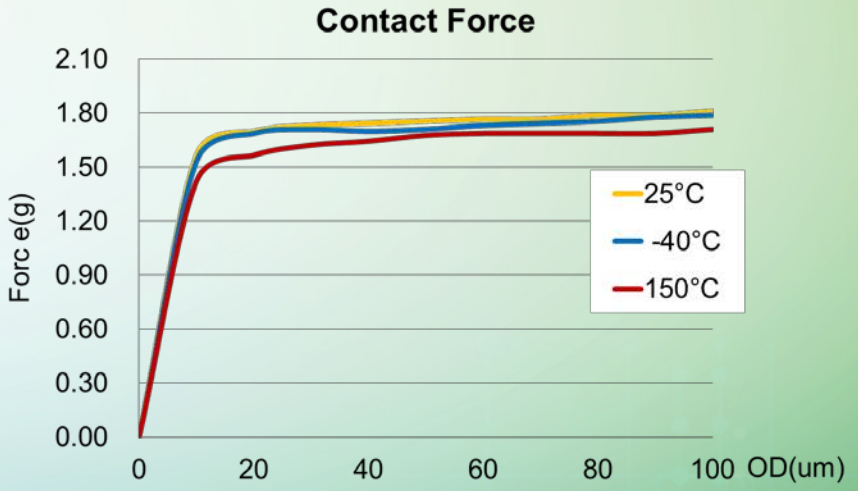
CHPT fine pitch solution—NS45

NS45 solution has excellent design, stable probe resistance, consistent contact force and excellent current carrying capacity. This solution also shows excellent performance in the full temperature range from -40 to 150 degrees.

Parameter	NS45
Pitch minimum	45 um
Tip shape	Point (Option : Flat)
Temperature	-40~150°C
Contact force	1.8 g
Contact resistance	600 mΩ
CCC	450 mA
Alignment XY	< 8 um
Planarity Z	Δ 25 um



Probe resistance at different temperature



Contact force at different temperature

[1]: The mechanical properties remained almost unchanged after 2M touchdowns at -40˚C & 150˚C.

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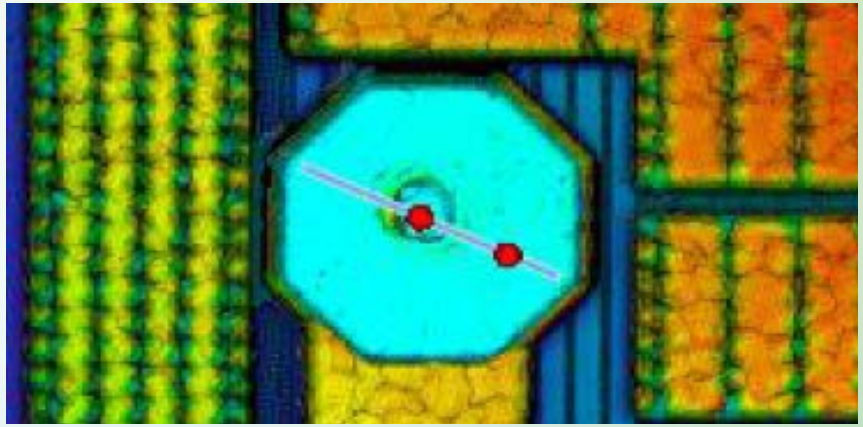
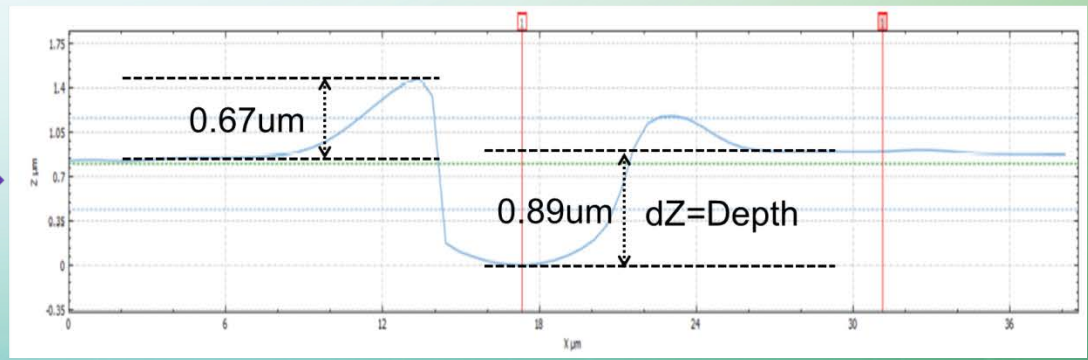
Probe mark stability

After 10 repeated tests under 150 degrees, the NS45 probe only causes scratches with a depth of <0.9um, which is lower than the customer's requirement of <1.4um.

	100um		
	-40°C	25°C	150°C
1st	size 11 x 10 um Depth 0.39 um	size 12 x 12 um Depth 0.50 um	size 13 x 14 um Depth 0.57 um
5 times	size 13 x 12 um Depth 0.65 um	size 14 x 13 um Depth 0.53 um	size 14 x 14 um Depth 0.78 um
10 times	size 15 x 12 um Depth 0.74 um	size 14 x 13 um Depth 0.69 um	size 16 x 14 um Depth 0.89 um

Probe mark depth at different temperature and touchdown





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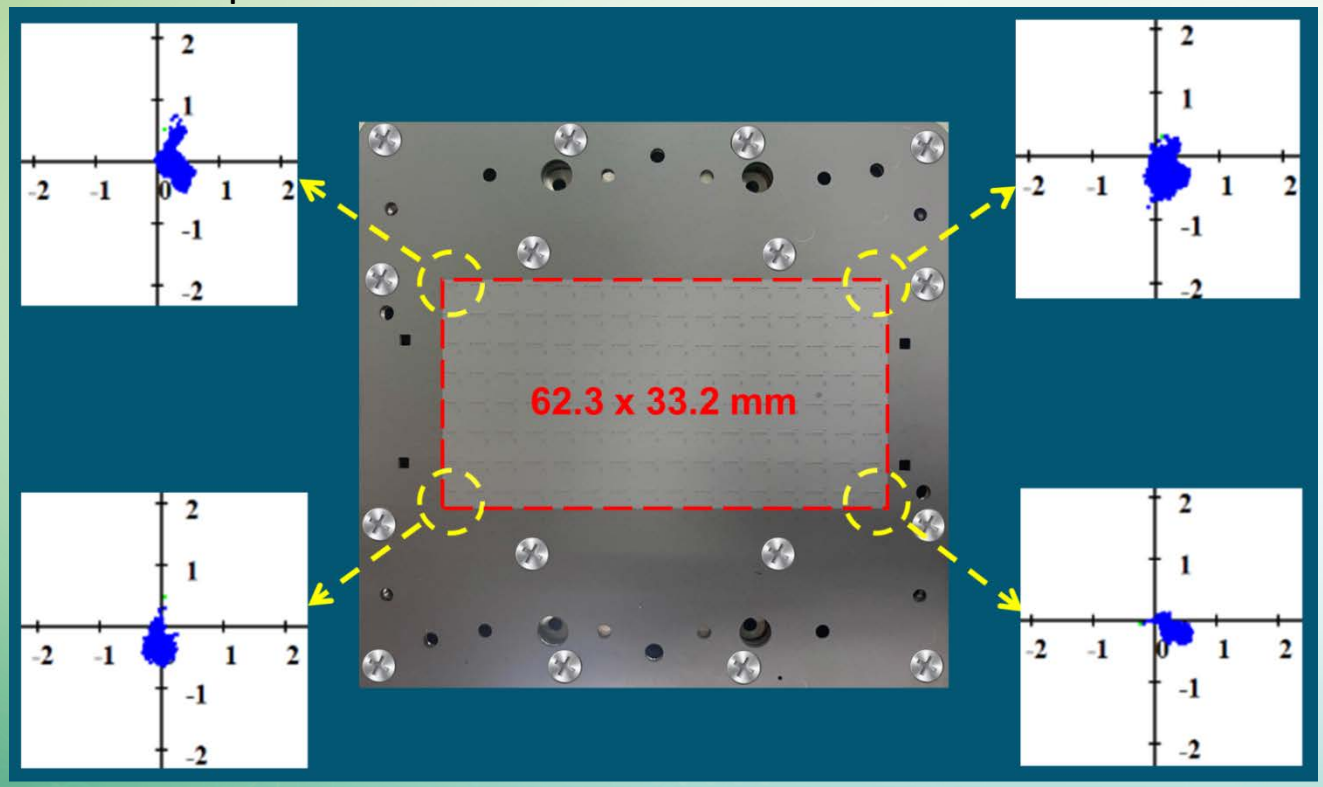
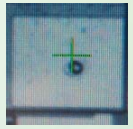
Alignment stability—NS45

Probe marks are all distributed within 2μm.



OD 3mil, 150˚C, touchdown 200K

Position Temp.	Top Left	Top Right	Bottom Left	Bottom Right
25°C	 4.0 μm	 4.5 μm	 3.4 μm	 3.9 μm
150°C	 5.0 μm	 5.4 μm	 6.5 μm	 6.8 μm

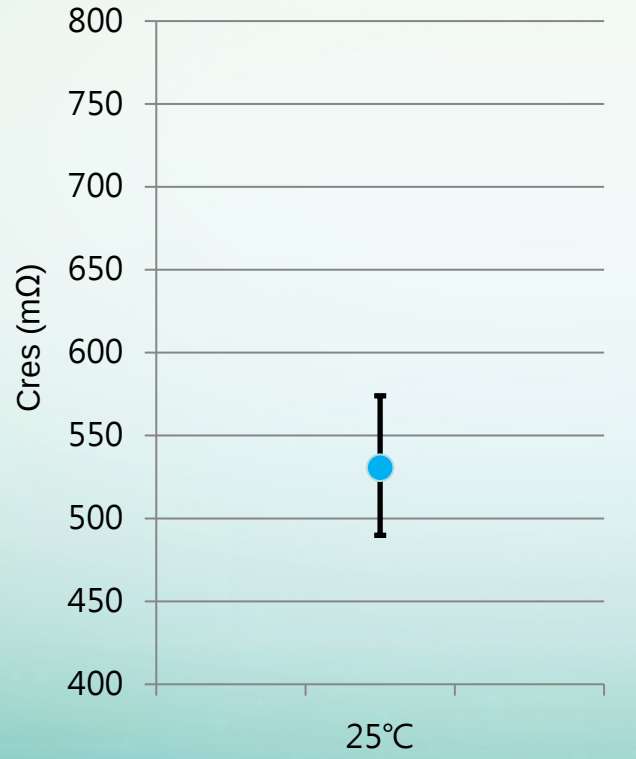
probe mark actually tested by the customer

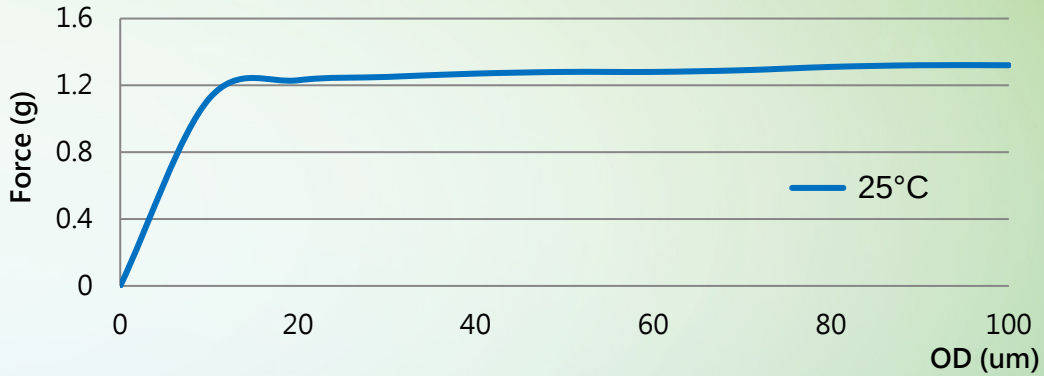
* CHPT's technology has been patented or patent pending.

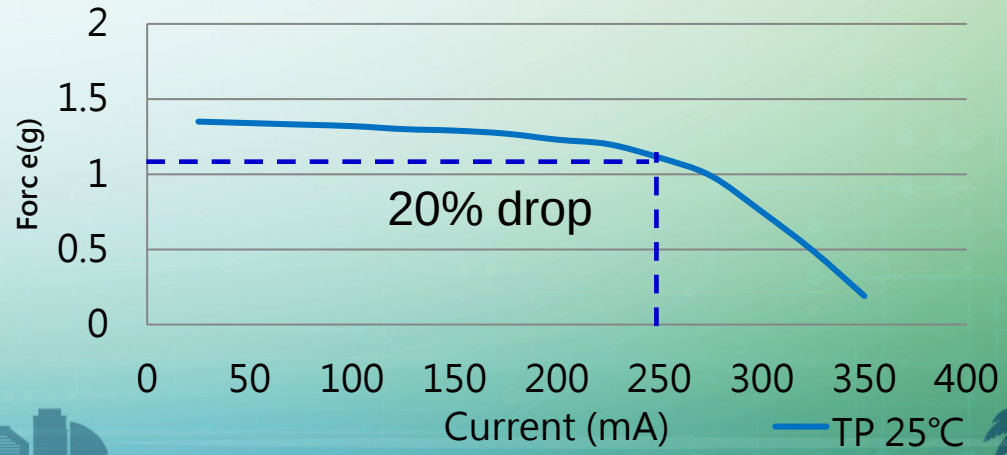
CHPT fine pitch solution—NS35

The preliminary verification results of NS35 solution are currently being developed in collaboration with a customer.

Parameter	NS35
Pitch minimum	35 **µm**
Tip shape	Point (Option : Flat)
Temperature	-40~150°C
Contact force	1.3 g
Contact resistance	530 mΩ
CCC	250 mA







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The Challenges of NS35

PROBE

Shrinking probe size alone is insufficient; innovative alloy materials and probe design changes are necessary.

SUBSTRATE

New materials and validation standards are needed for precise thermal expansion control.

MECHANICAL PARTS

Accurate control of thermal expansion requires machine-assisted alignment and assembly techniques

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Summary

- CHPT has engineered NS45 probe card products with a 45um minimum pitch using advanced materials and optimized design.
- Extensive optimization ensures improved test stability.
- A self-developed probe material offers optimal electrical and mechanical properties, high and low-temperature stability (-40°C to 150°C), and superior test quality.
- The NS35 solution has achieved initial success and can be customized to meet customer requirements.

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