SWTEST

PROBE TODAY, FOR TOMORROW

Advances in Vertical Probe Material for 200℃ Wafer Test Applications

Author & presenter, Mitsuhiro Moriyama

Co-Author, Stephane Denarnaud

Co-Author, Hiroyuki Ichiwara

SV TCL KK, JAPAN

Nidec SV TCL

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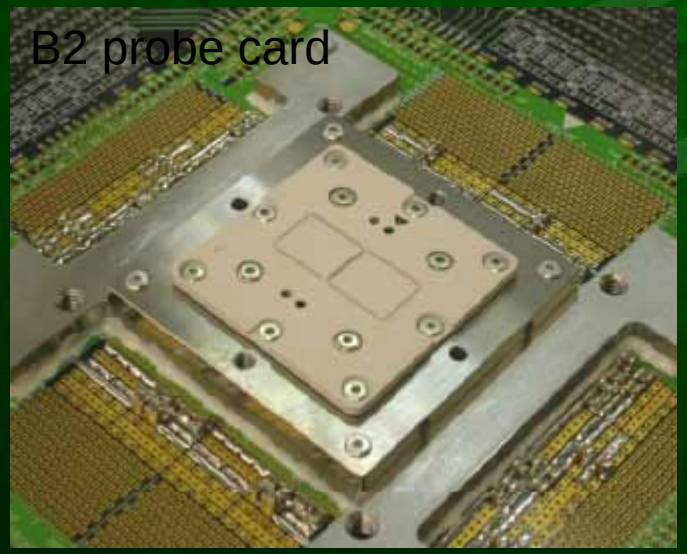
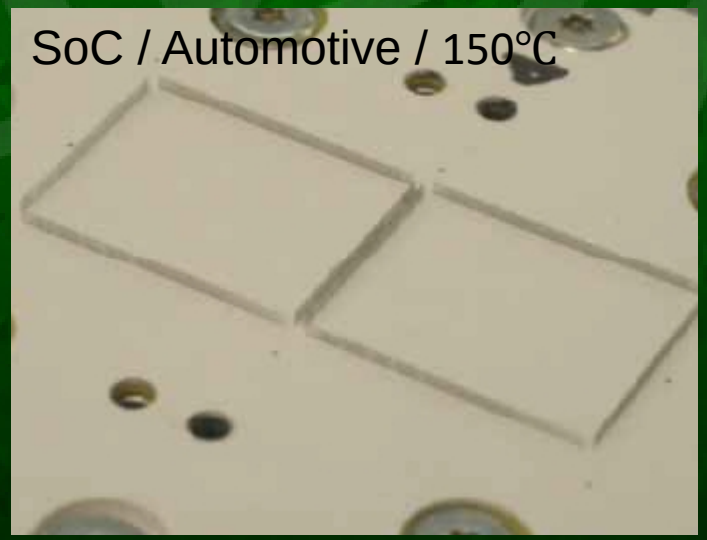
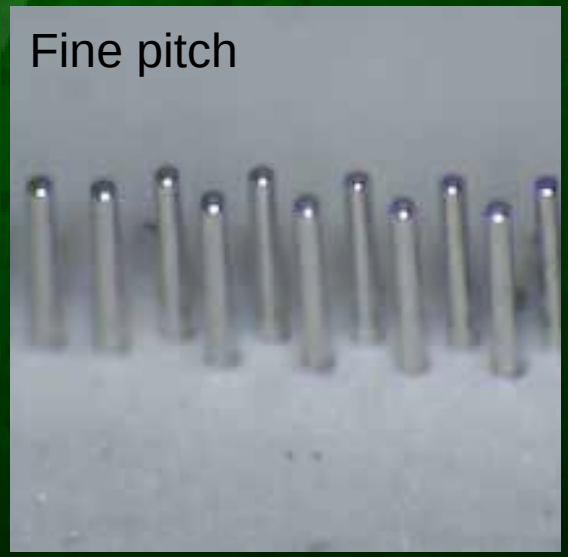
introduction

- **Application for automobile require test temperatures of 180℃ and above.**
- **Our B2 vertical standard cards can address the pitch and pin counts for such devices and has been used up to 150℃**



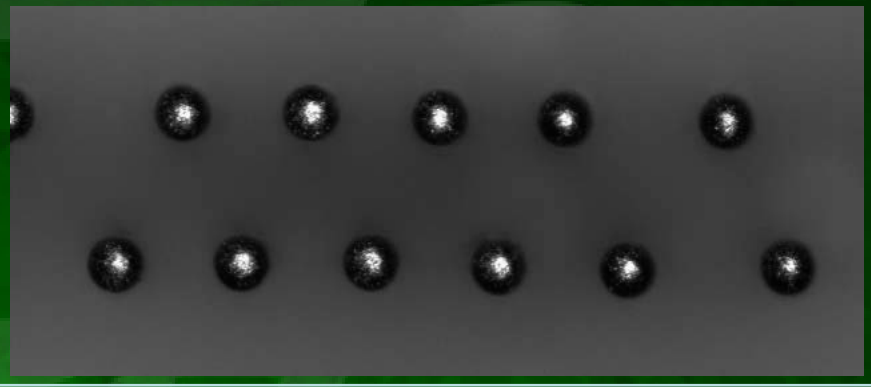
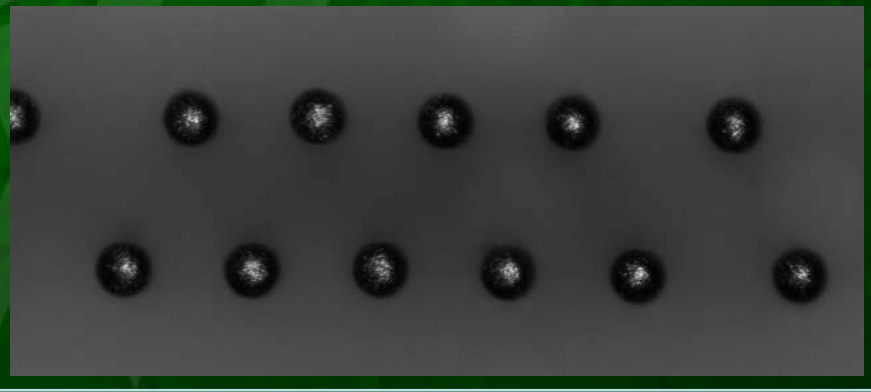




Agenda

- **Current B2 probe at 200℃.**
- **Development of a new material.**
  - Discoloration
  - Wire breakage
  - Wire softening
- **Probe material evaluation results.**
  - Head design
  - General characterization
  - Durability test

First test at 200°C

	Wire sample	Probe tip as viewed on the prober
STD Initial		
After heating		

Probe tip discoloration.

The darker tip results in prober alignment errors!

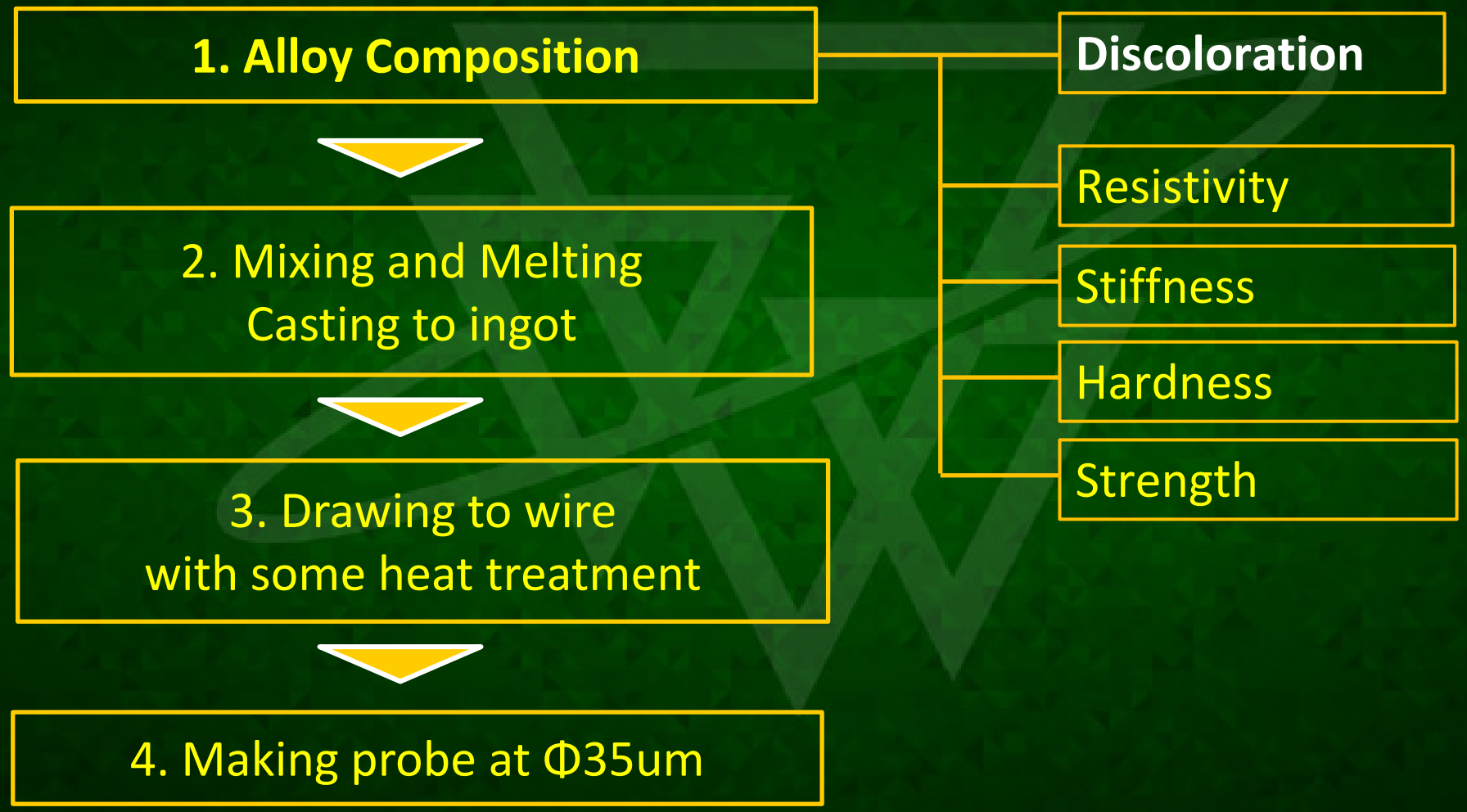
Other common probe materials

We considered most common materials:

		STD	AgPdCu	Rh	Ir	W
Chemical	Discolor	NG!	OK	OK	OK	OK
Mechanical	Stiffness	OK	OK	OK	NG!	NG!
	Drawing thin wire	OK	OK	OK	NG!	OK
Electrical	CCC	OK	NG!	OK	OK	OK
	Cres at high temp	OK	OK	NG!	not clear	NG!

No suitable material is readily available, we will develop our own!

Process and effective factor



Improvement for discoloration at 200℃

We after several composition changes we resolved the discoloration problem

STD	Composition changes				
	Test1	Test2	Test3	Test4	Test5
					
			Acceptable	**Acceptable**	**Acceptable**

Process and effective factor

1. Alloy Composition

2. Mixing and Melting
Casting to ingot

3. Drawing to wire
with some heat treatment

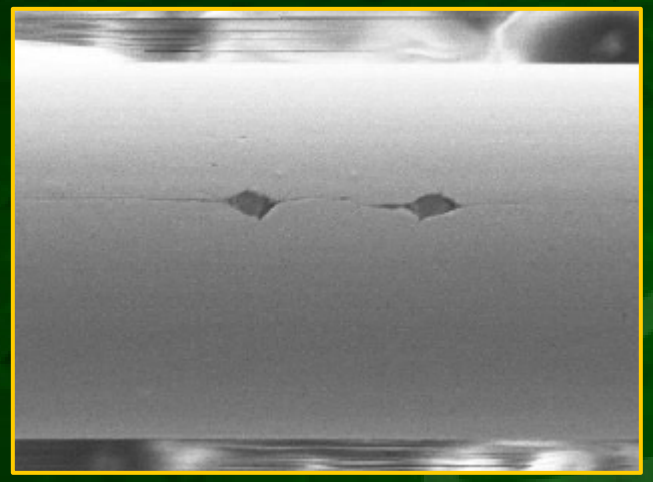
4. Making probe at Φ35um

Broken wire

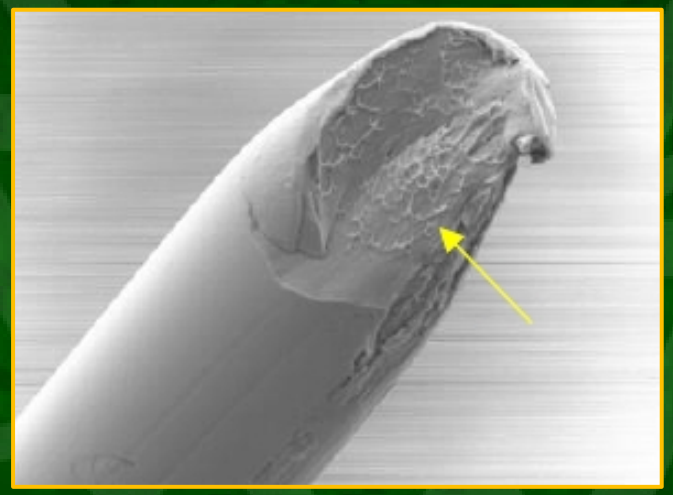
- Impurity
- Internal defects
- Segregation
- Brittleness

Broken wire in drawing process

Impurity defect



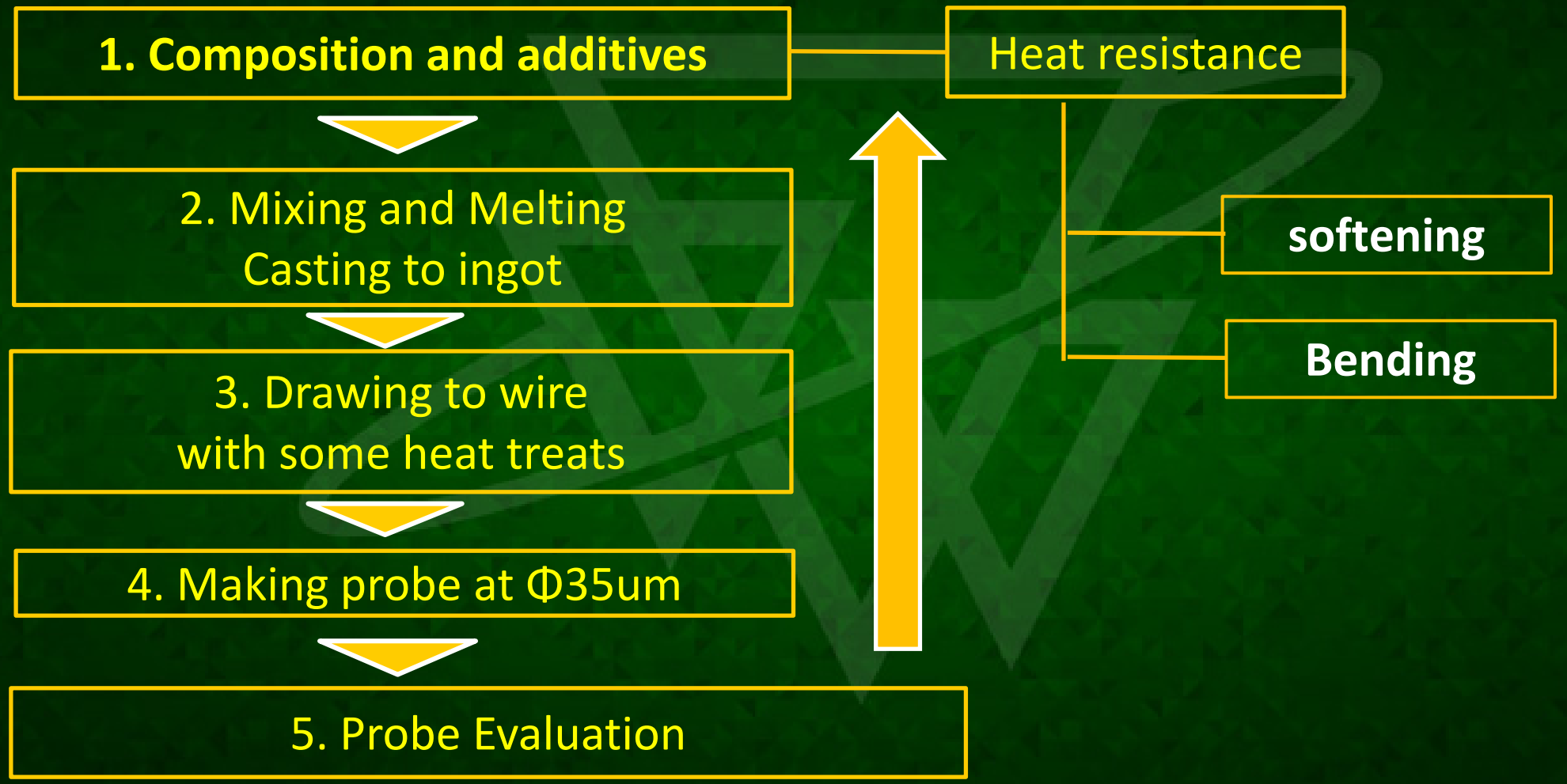
Wire drawing



Probe processing

After several attempts and process improvement breaking wire issues were solved

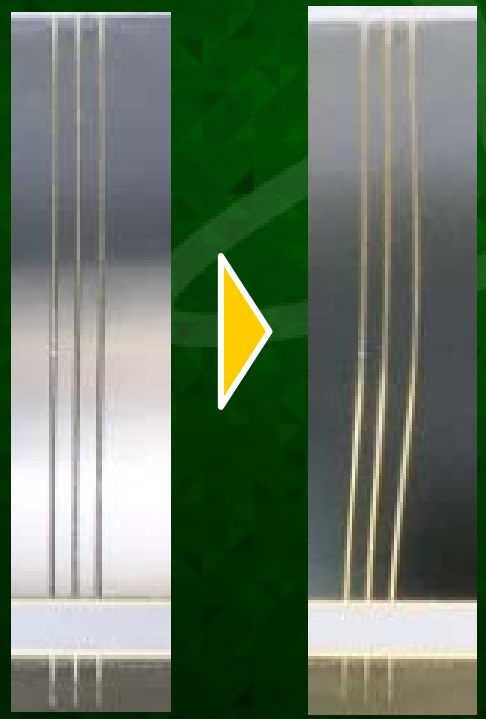
Process and effective factor

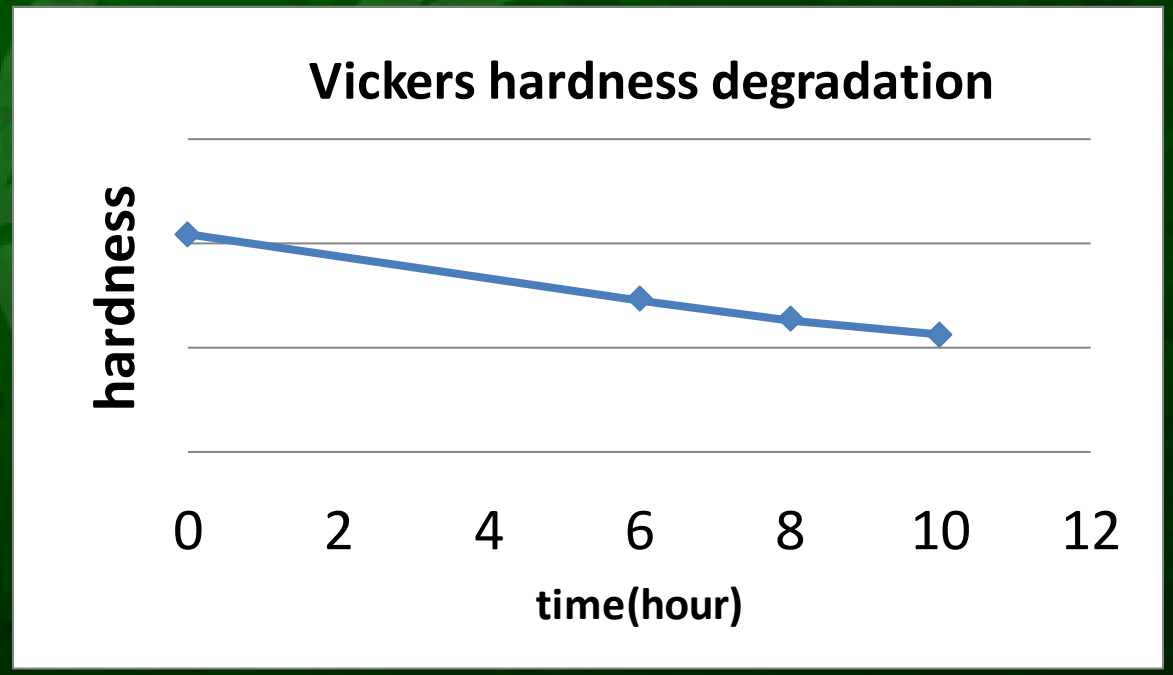


Softening and Bending under heat

- **Probed remained bent after OD and high temp.**
- **Hardness changed after prolonged exposure.**

Bending



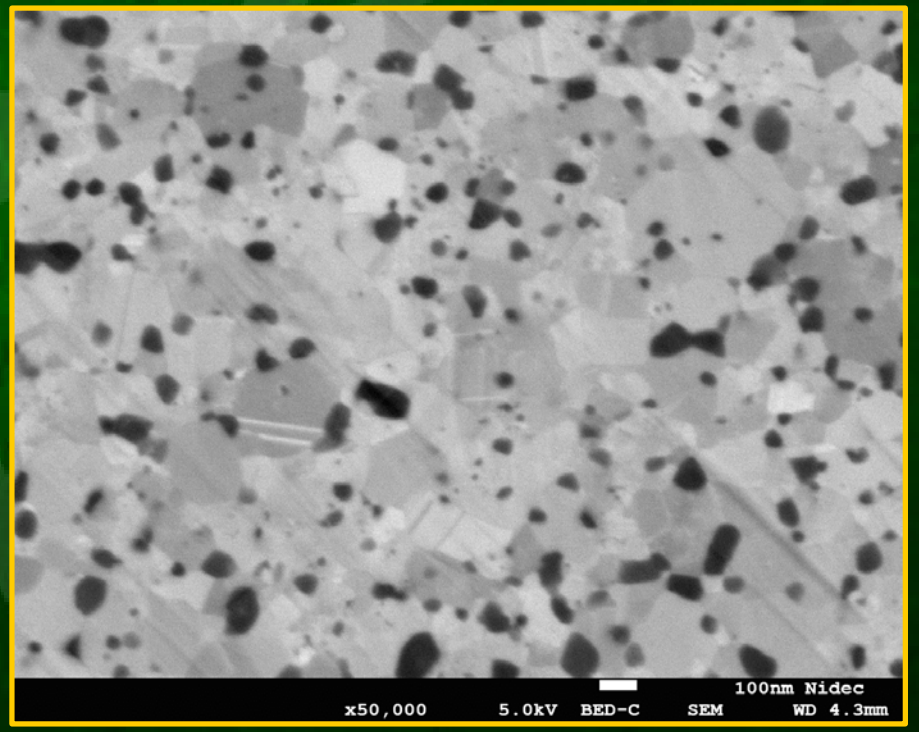


Recrystallization

- Recrystallization occurs way below the melting point, typically for pure metals at around 30 to 50% of the melting temperature.
- Coarsened crystals will results in a decrease of hardness and strength.

Before

After 0.5h at 300°C



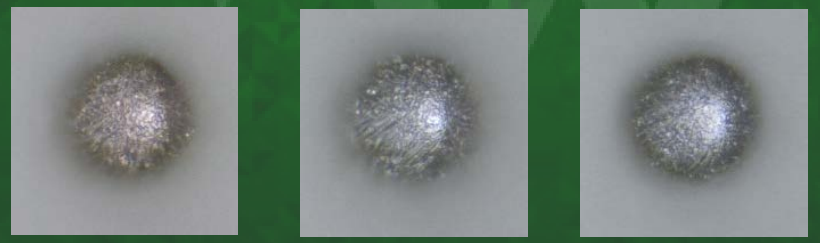
Summary the alloys tested

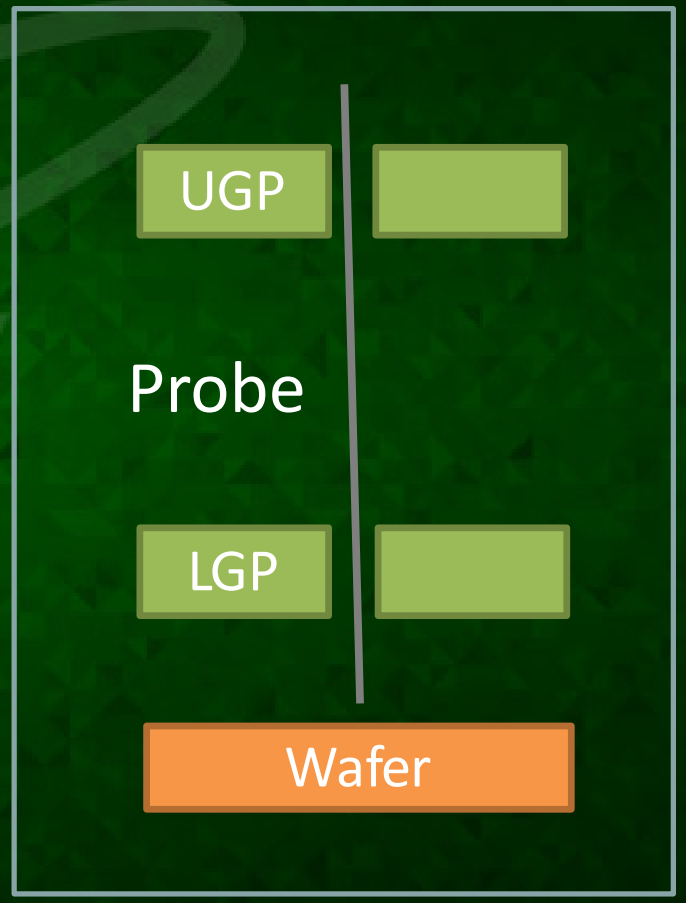
	Wire evaluation		Probe evaluation	
Alloy	Discolor	Broken in wire work	Softening under heat	Bending under heat
Test 1	NG	-	-	-
Test 2	NG	-	-	-
Test 3	OK	NG	-	-
Test 4	OK	OK	NG	NG
Test 5	OK	NG	-	-
EH	OK	OK	OK	OK

Finally we get results!

Evaluation of EH (Extremely High Temp) probe material

Specification of evaluation probe head

	unit	EH	STD	AgPdCu
Probe diameter	um	35	35	35
Wire length	mm	50	50	50
Probe force	gf	2.2	2.7	2.4
Tip shape	-	Round	Round	Round
Probe Tip				

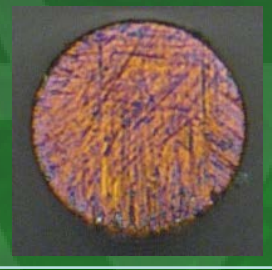
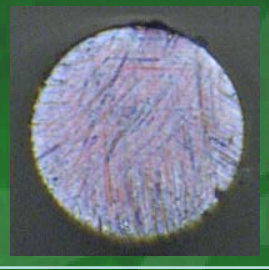
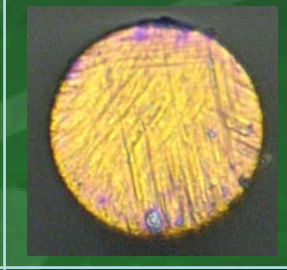
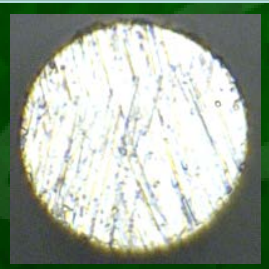
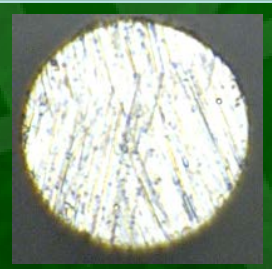
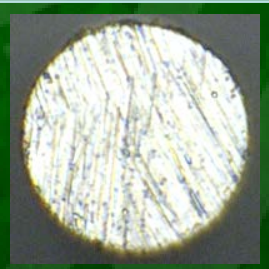
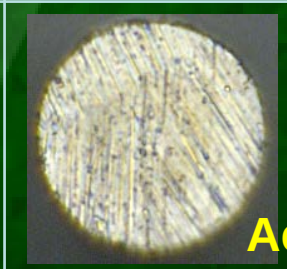
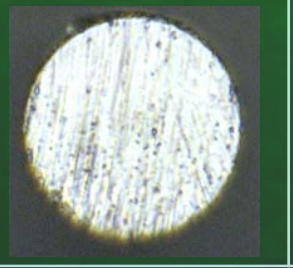
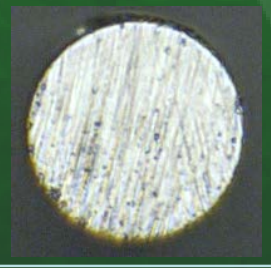
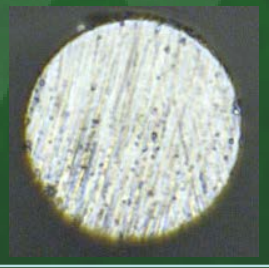
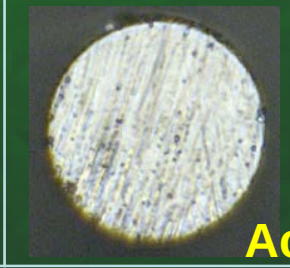


Evaluation items

- **Characterization:**
  - Discoloration (200℃)
  - Deformation with long contact (200℃)
  - Contact resistance (-40 ℃, RT, 200℃)
  - Probe marks (-40 ℃, RT, 200℃)
  - Current carrying capacity
- **Durability test**
  - 1 Million TD (200℃)

Discoloration

EH color hardly changes, it does not cause alignment error

	initial	200℃ 5min	200℃ 10min	200℃ 60min
STD				
EH				
AgcuPd				

Acceptable

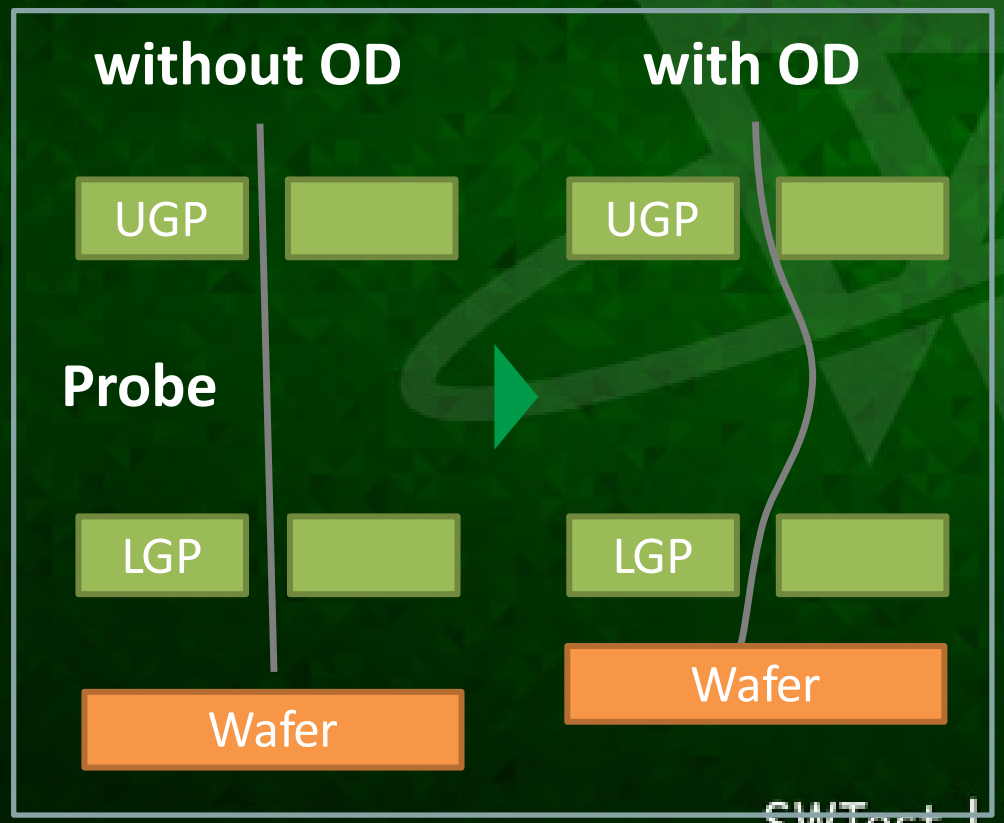
Acceptable

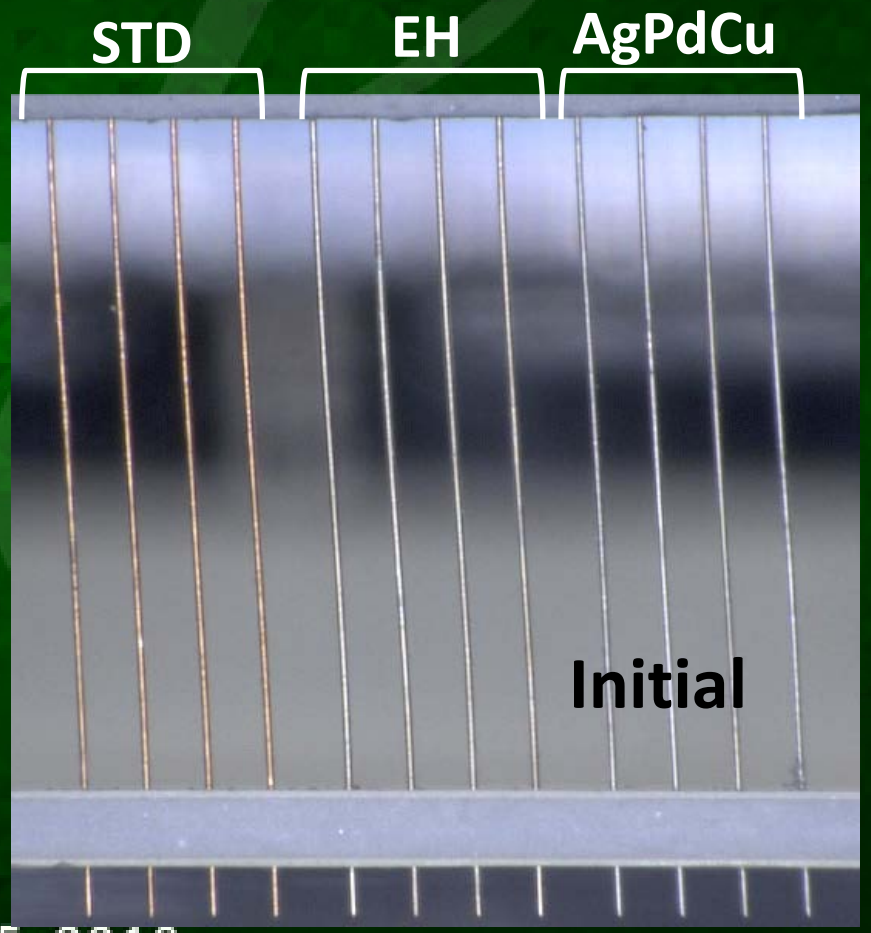
Deformation with long contact

Method

- **Apply OD for 20 minutes**
- **Check for probe deformation and measure probe force**

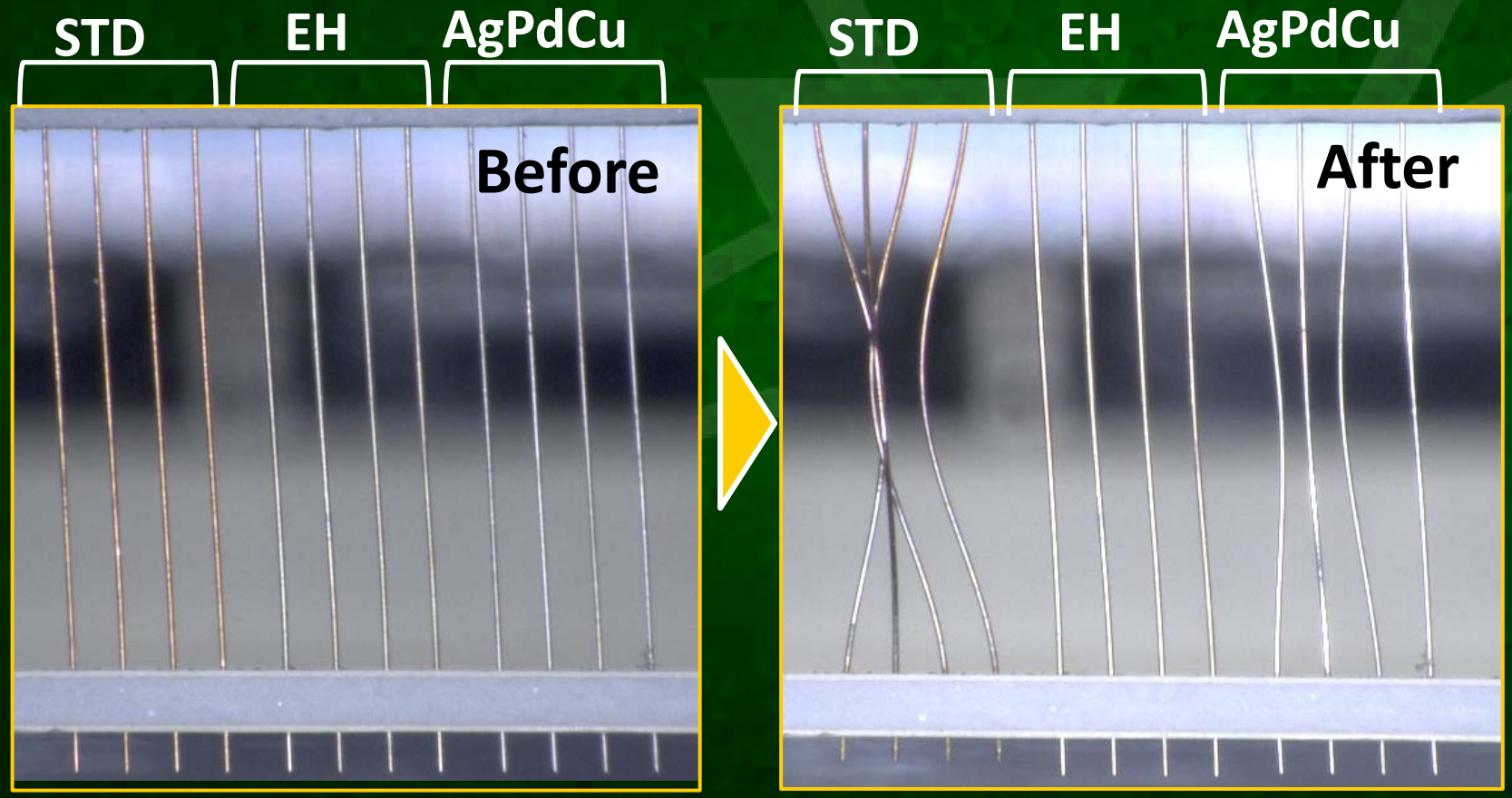
Conditions
Chuck Temp:200℃
Over drive : 100um
Contact time : 20min



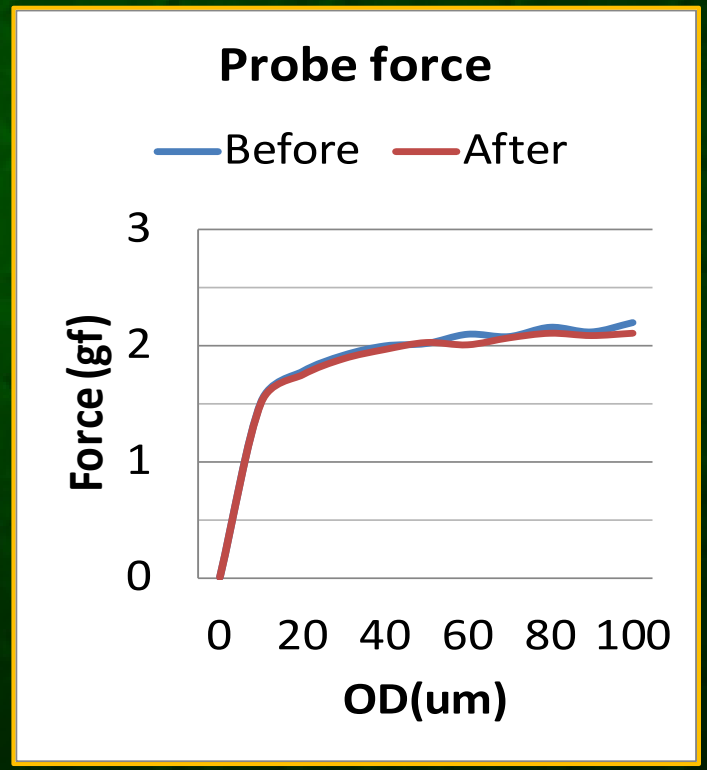


Deformation with long contact/Result

Contact at very high temperature results in deformed probe for the standard material and AgPdCu alloy.
EH probe material shows slight deformation only, it provides superior heat resistance to other materials.

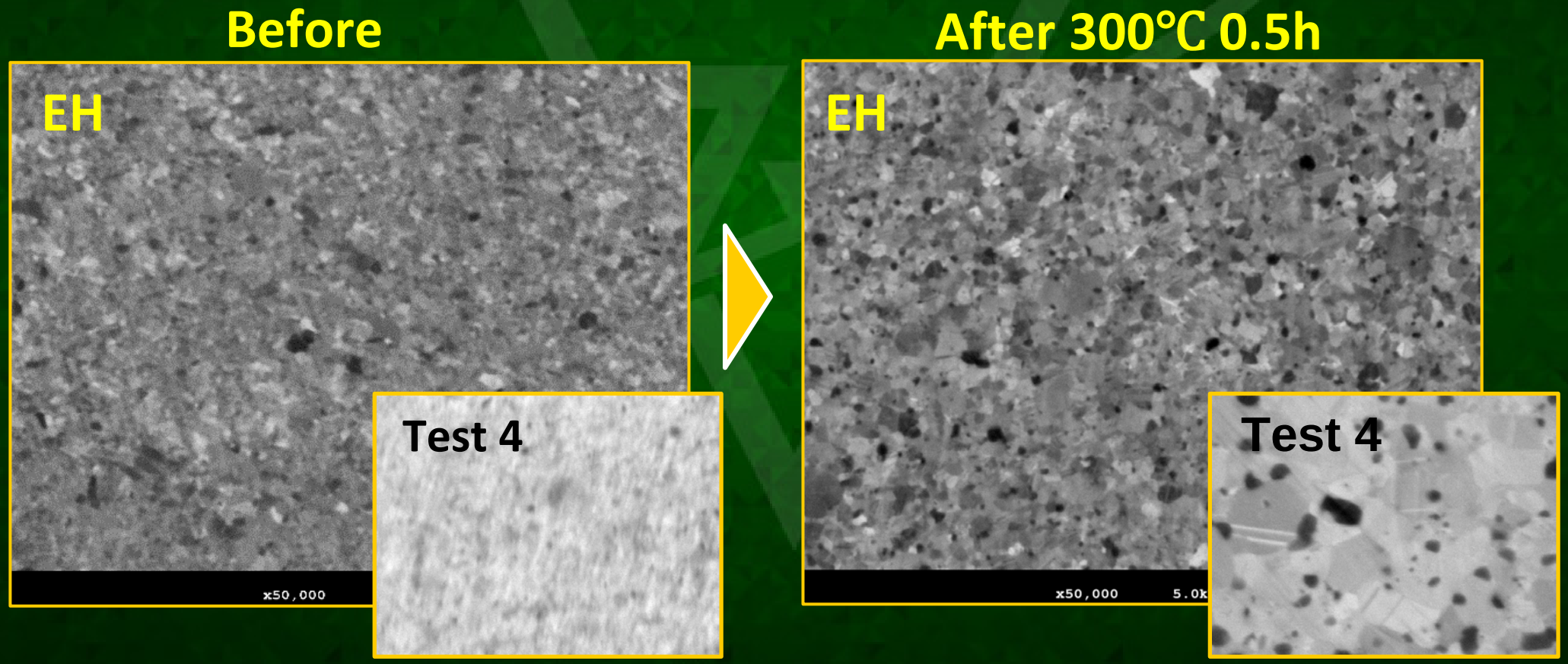


EH



Recrystallization

- EH probe material composition results in fine crystals even when exposed to high temperatures.

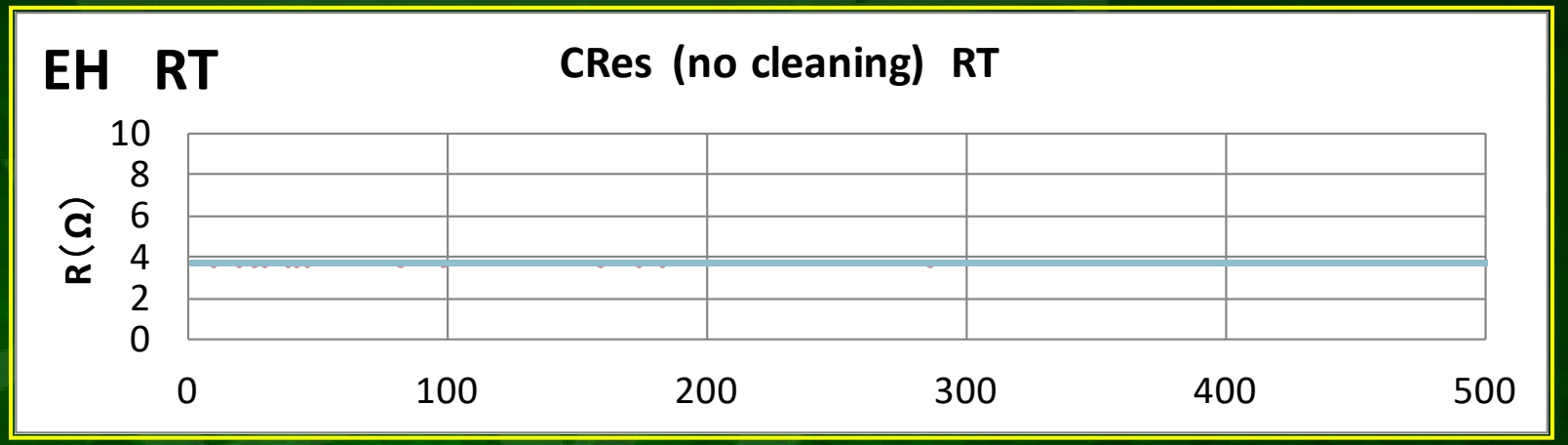


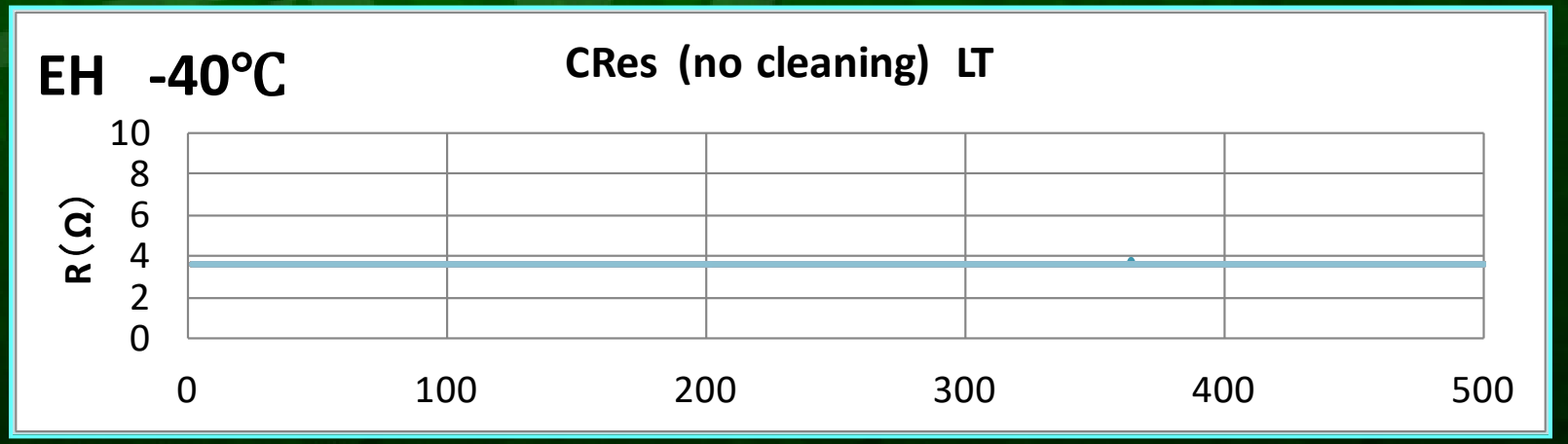
Contact resistance at room and low temperature

The contact resistance is stable at room temperature and low temperature.

Conditions

UF3000EX
Blank AL Wafer 8 Inch
(Thickness: 1µm)
Impressed Current: 10mA
Temperature: RT/-40℃
OD: 50um
TD: 500
n=10
No cleaning





Contact resistance at 200℃

Conditions

UF3000EX

Blank AL Wafer 8 Inch
(Thickness: 1µm)

Impressed Current: 10mA

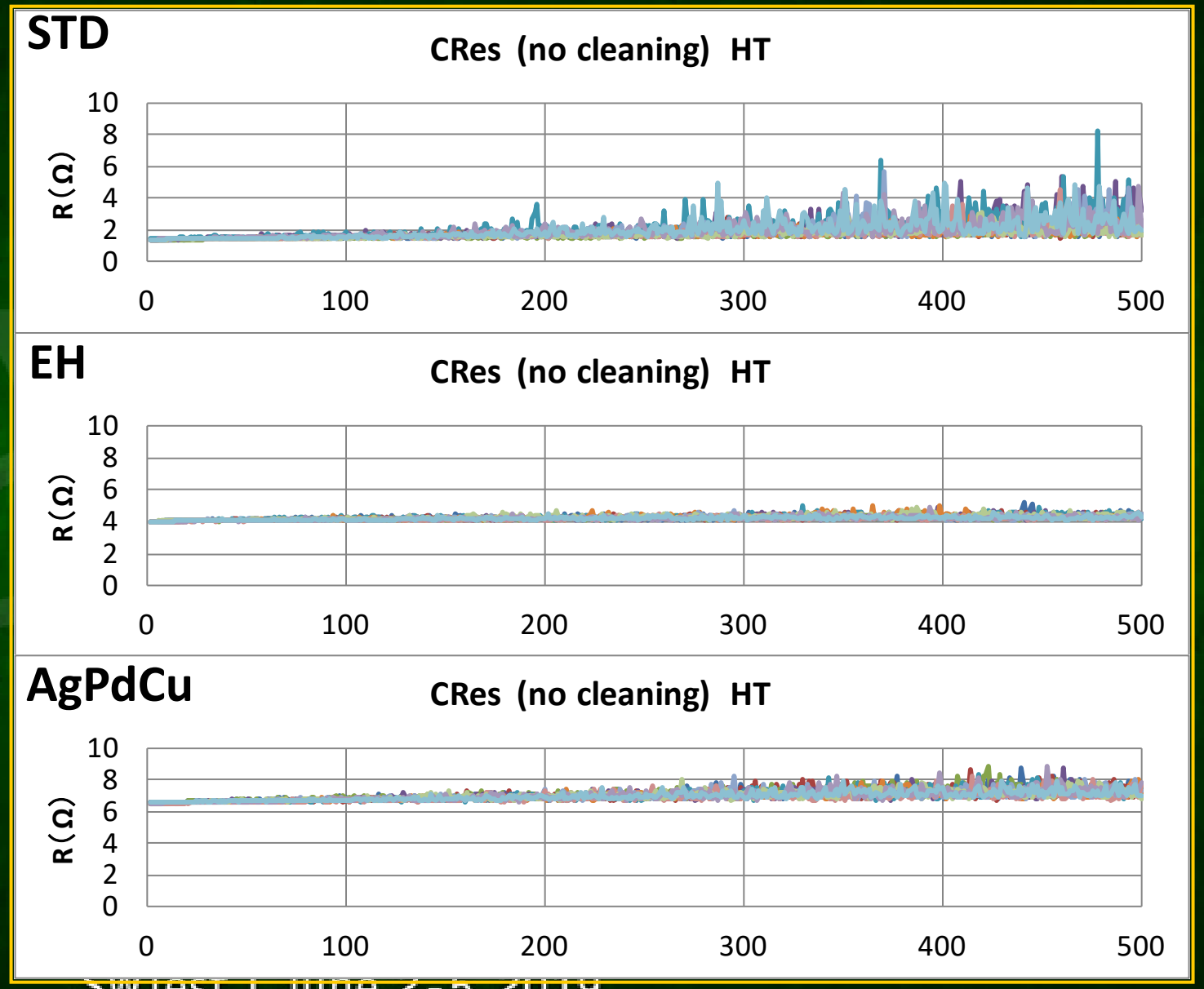
Temperature: 200℃

OD: 50um

TD: 500

n=10

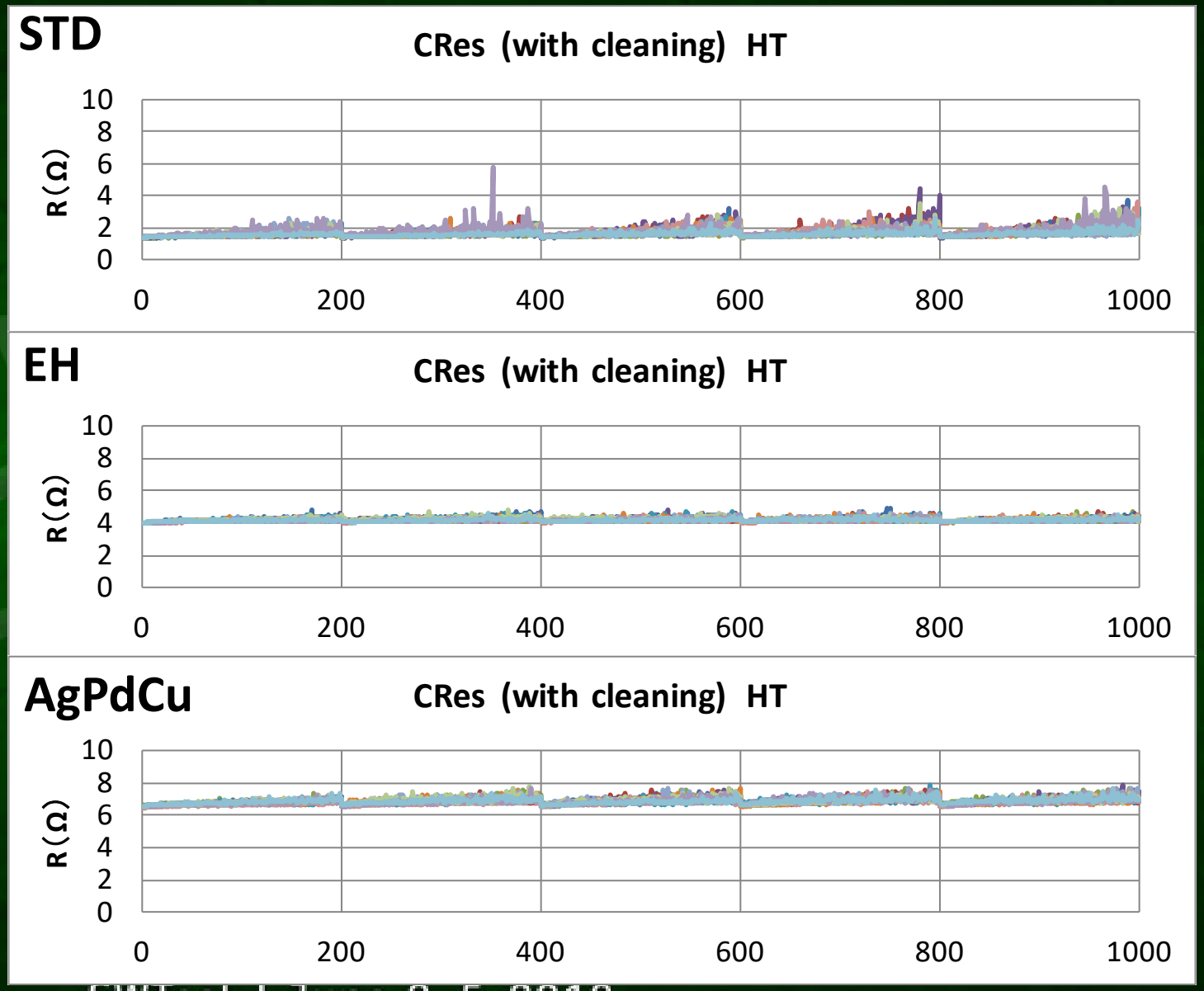
Cleaning: No cleaning



Contact resistance at 200℃

Conditions
UF3000EX
Blank AL Wafer 8 Inch
(Thickness: 1µm)
Impressed Current: 10mA
Temperature: 200℃
OD: 50um
TD: 1000
n=10

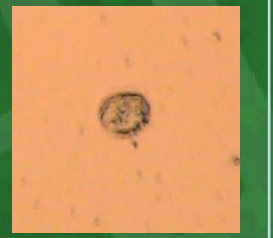
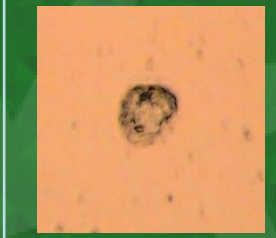
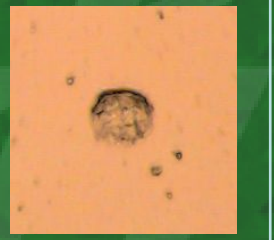
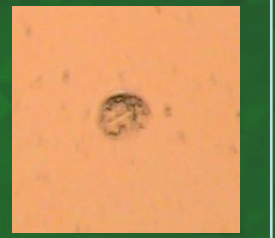
Cleaning: each 200TD
Sheet type: WA6000-SWE
OD: 60um
TD: 20



Probe mark

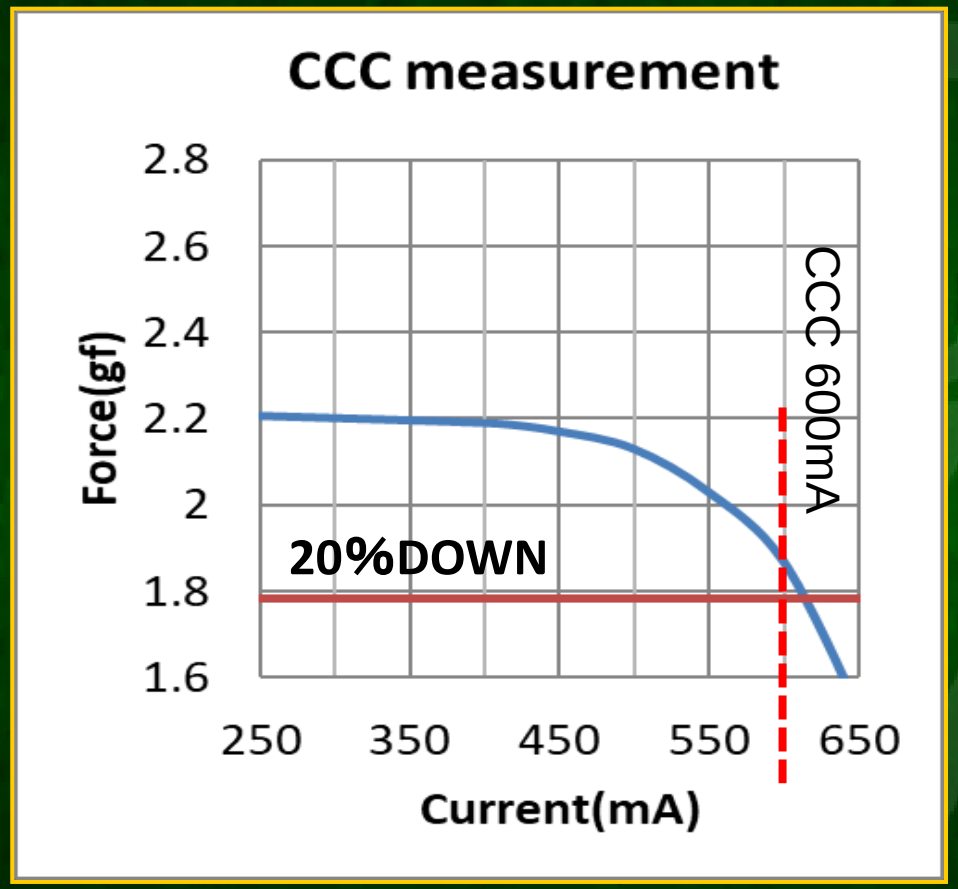
Blank AL Wafer 8 Inch (Thickness: 1µm)
OD: 50um

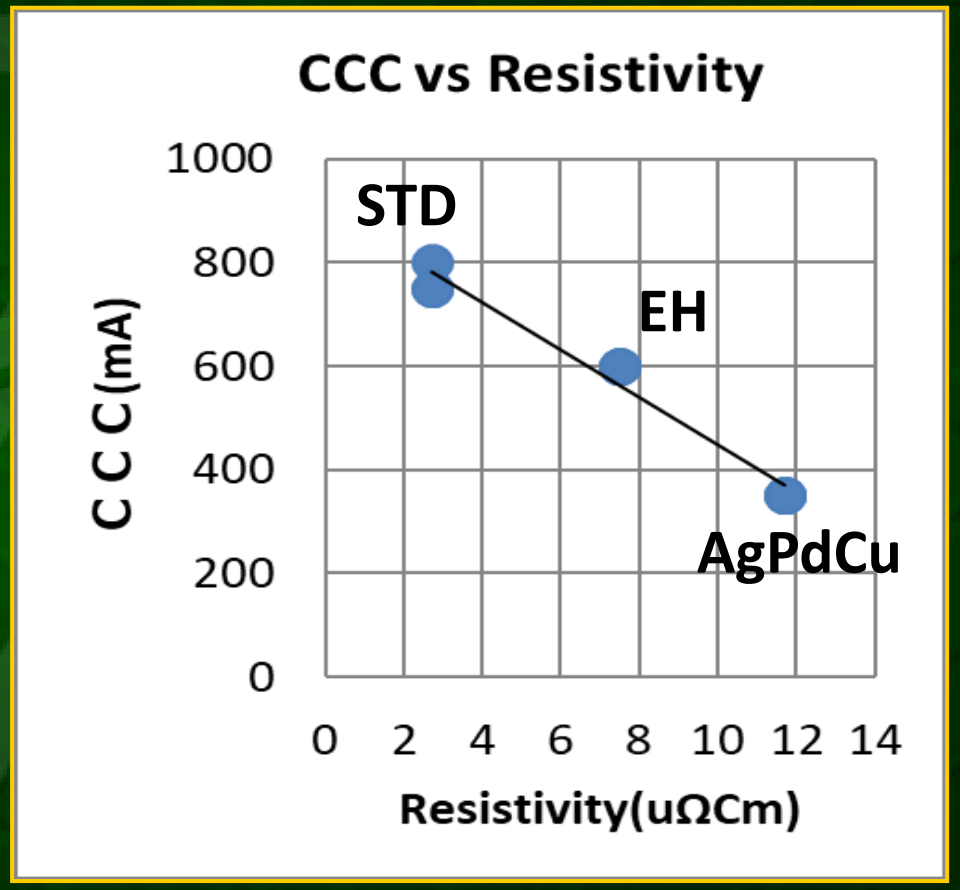
Small and shallow probe marks

	RT		200℃		-40℃	
Probe mark						
Width(um)	7.5	7.1	7.9	8.7	7.1	71
Length(um)	6.5	5.9	7.8	7.4	6.1	6.2
Depth(um)	0.37	0.49	0.46	0.41	0.28	0.35

Current Carrying Capacity (CCC)

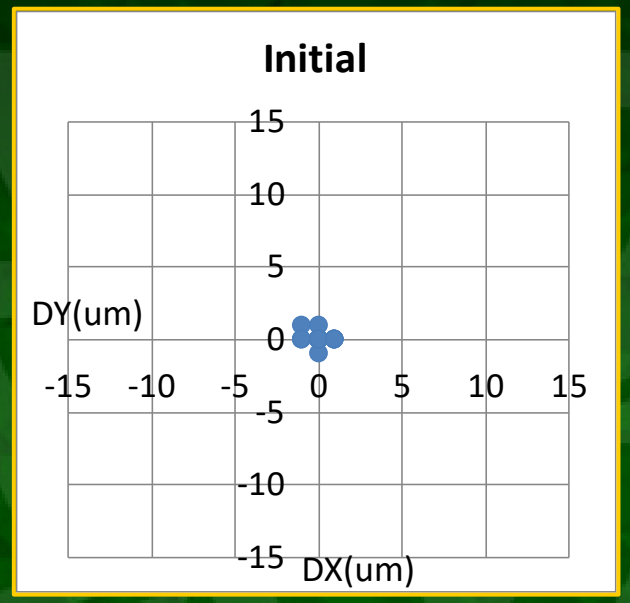
Conditions
Temperature: RT
OD : 80um
Time: 2min
n=3

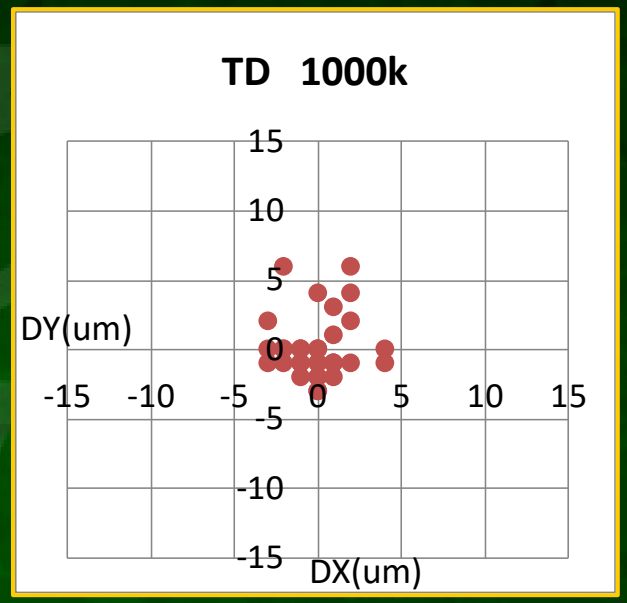




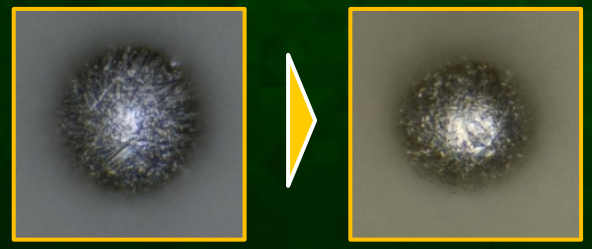
Durability (1000 kTD)

Conditions
UF3000EX
Blank AL Wafer 8 Inch
(Thickness: 1µm)
Temperature: 200℃
OD 80um
TD 1million
n=35
Cleaning: each 200TD

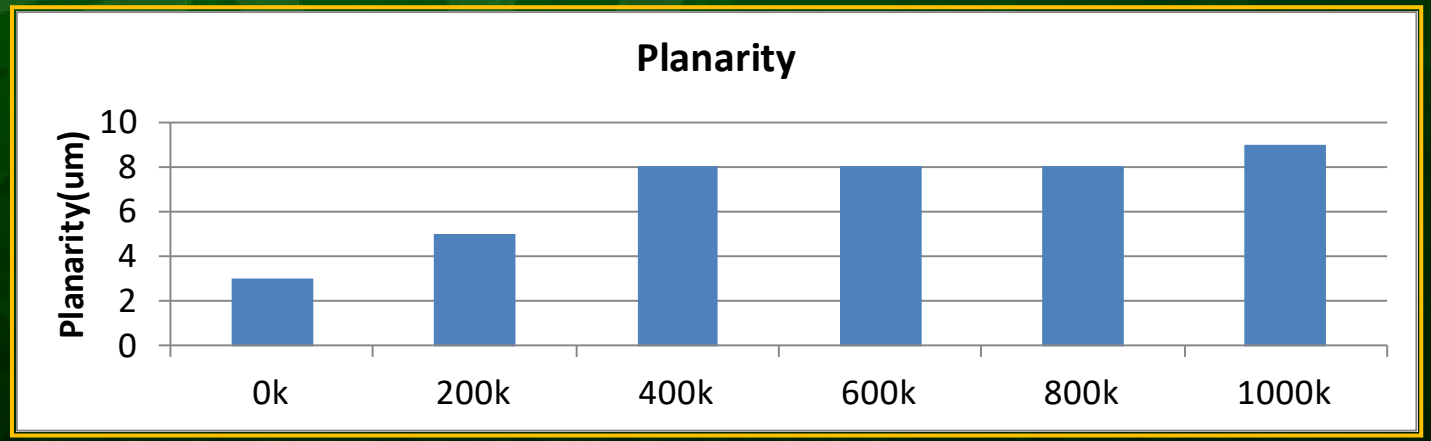




Probe Tip



Initial 1000 kTD

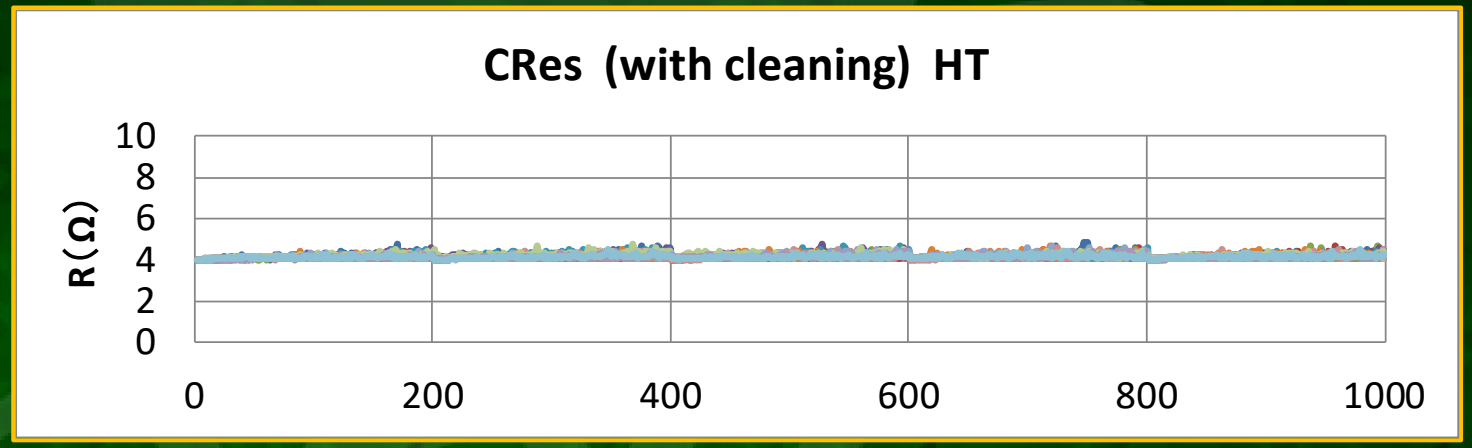


Durability (1000 kTD)

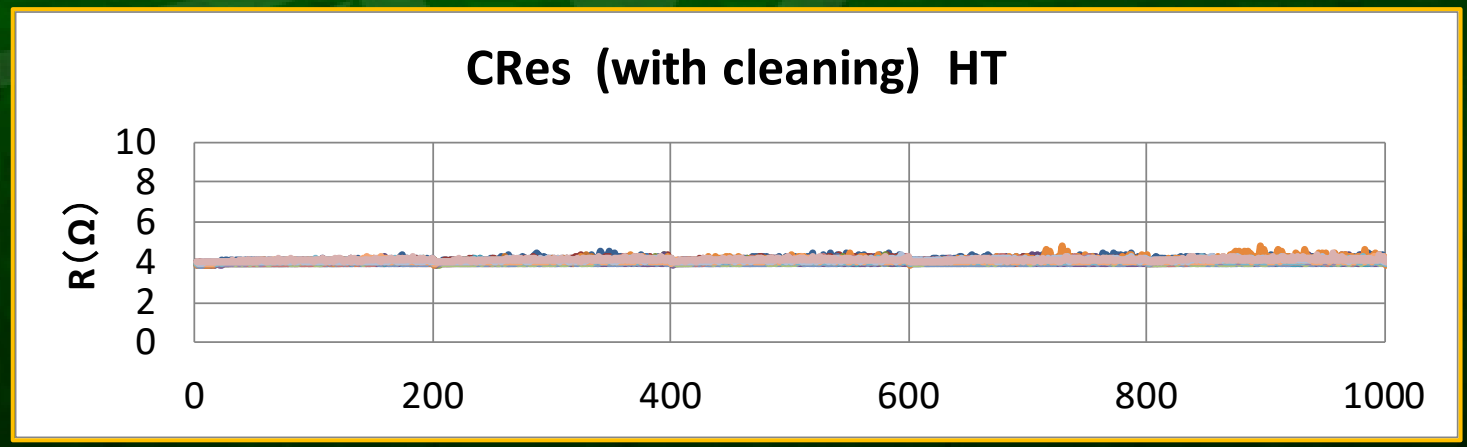
Conditions
UF3000EX
Blank AL Wafer 8 Inch
(Thickness: 1µm)
Impressed Current: 10mA
Temperature: 200℃
OD: 50um
TD: 1000
n=20

Cleaning: each 200TD
Sheet type: WA6000-SWE
OD: 60um
TD: 20

Initial



After 1000 k TD



EH probe performance summary

Item	Supporting temperature	Result
Discoloration	200℃	Good
Deformation	200℃	Superior
Contact resistance	-40℃～200℃	Superior
Probe mark	-40℃～200℃	Good
CCC	RT	600mA
Durability test	200℃	1000 kTD

Conclusion

EH probe material is a solution for test up to 200℃

- **EH probes provide superior mechanical stability at high temperature.**
- **EH probe is not subject to discoloration, this prevents prober set-up issue.**
- **EH provides superior contact resistance stability.**
- **EH probe low resistivity results in higher CCC than common AgPdCu alloys.**

Acknowledgements

- **Special thanks to our material and wire drawing suppliers for their partnership and relentless efforts and perseverance .**

- **Special thanks to the high temperature probe project team at Nidec SV TCL for their hard work & dedication in preparing data used in this paper:**

  – Engineering team

  – MFG team

- **Special thanks to management at Nidec SV TCL for their invaluable inputs regarding topic selection & review of this paper:**

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  – Daisuke Miyamoto

Thank you