SW Test Workshop
Semiconductor Wafer Test Workshop

Analysis of probe C.C.C. according to temperature and evaluation method

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Overview

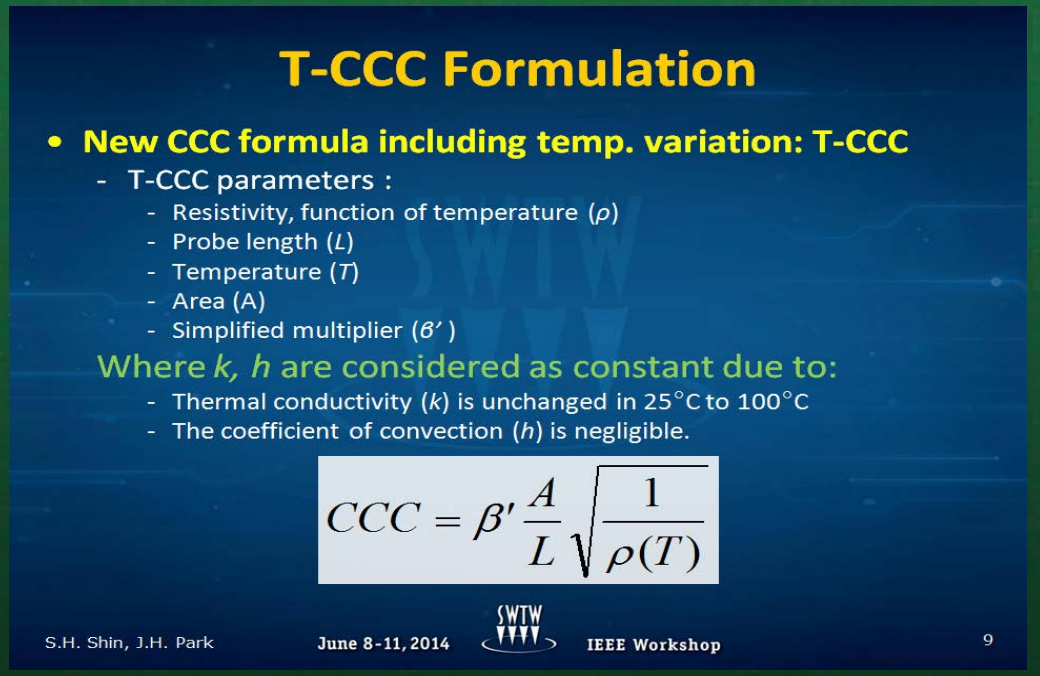
- Background
- Evaluation method
- Evaluation results
- Analysis of evaluation results
- Automated measurement system
- Conclusion
- Acknowledgements

Background

- **Diversification of application field of semiconductor chips**
  - Wafer test under harsh environmental condition is required
  - Probe card that ensures sufficient characteristics under high temperature is necessary
- **Analytical research on the probe characteristics are required**
  - Evaluation method (ISMI, MAC)
  - The temp. dependence of probe C.C.C

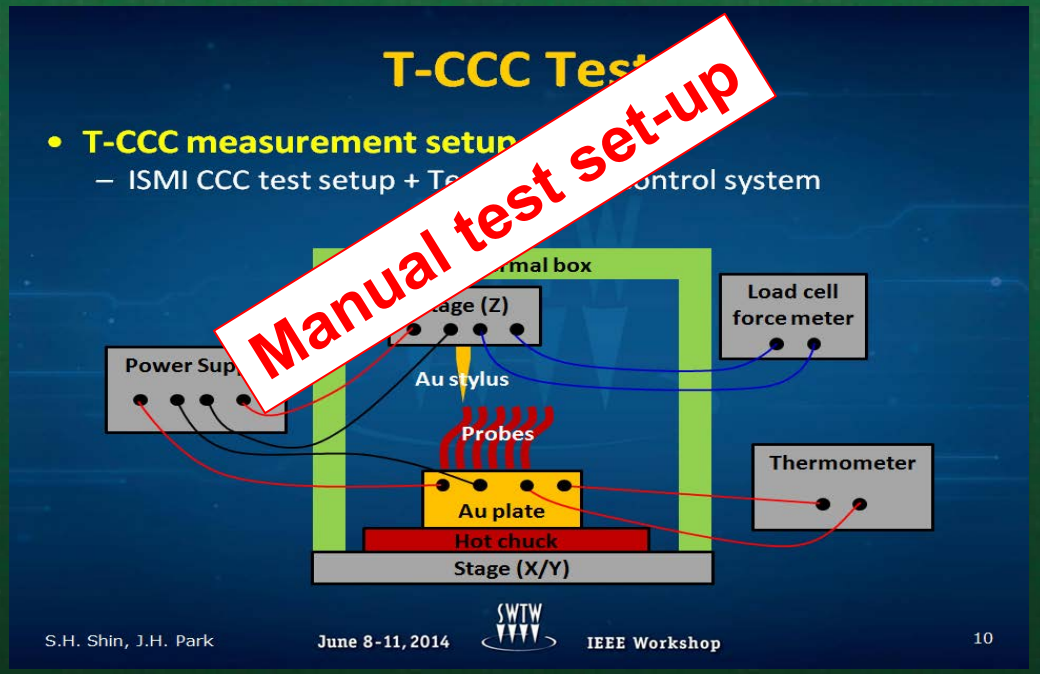
    → Verifying effect of materials & design

    → Guide to predicting high temp. C.C.C. and selecting probe



Background

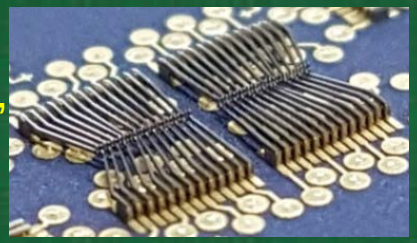
- **Development of precision probe analyzer**
  - Can evaluate various probe characteristics at elevated temperature
    → C.C.C., force, plastic deformation, Cres., durability, etc,.
  - High accuracy sensing
    → Temp., force, resistance, current
  - Fully automated equipment
    → Test time efficiency
    → Reliable testing and data acquisition



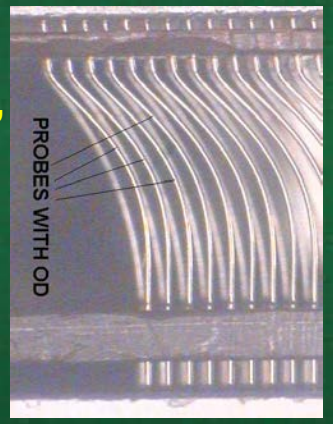
Evaluation method

- **Type of probes**
  - Type A: MEMS cantilever (Ni alloy)
  - Type B: ϕ50μm cobra (Pd alloy)

Type “A”



“Type “B”

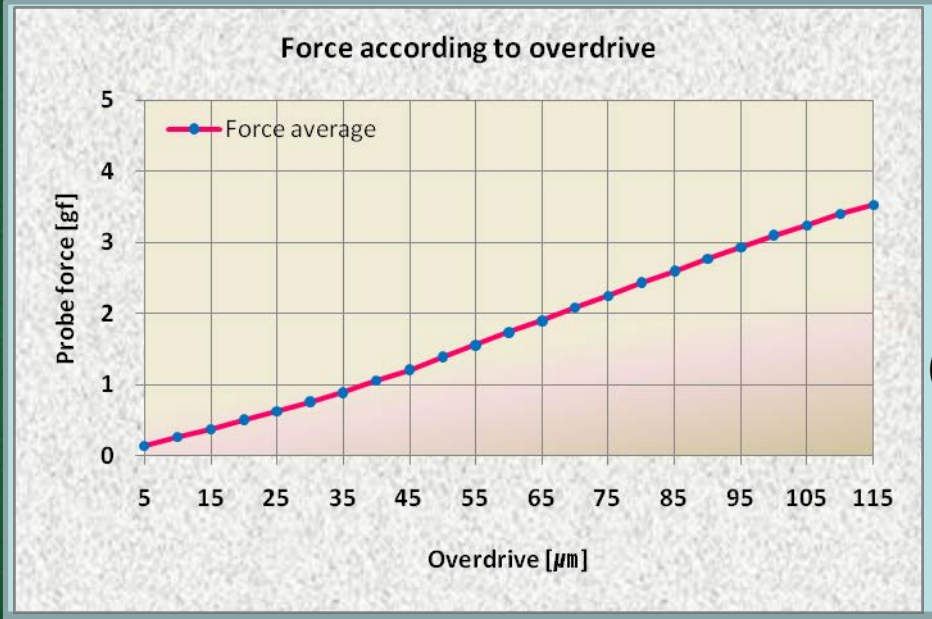


- **Evaluation parameters**
  - Probe force
  - ISMI C.C.C., MAC at various temp. (25°C ~ 150°C)
  - Equipment: newly developed probe analyzer

Precision probe analyzer

Evaluation results

“A” & “B” type probe evaluation results (probe force)



Type : “A”

Force : 2.25gf (@OD75)

Temp. : 25℃

- Type “A” : MEMS cantilever design
- The graph shows a linear trend.

Type : “B”

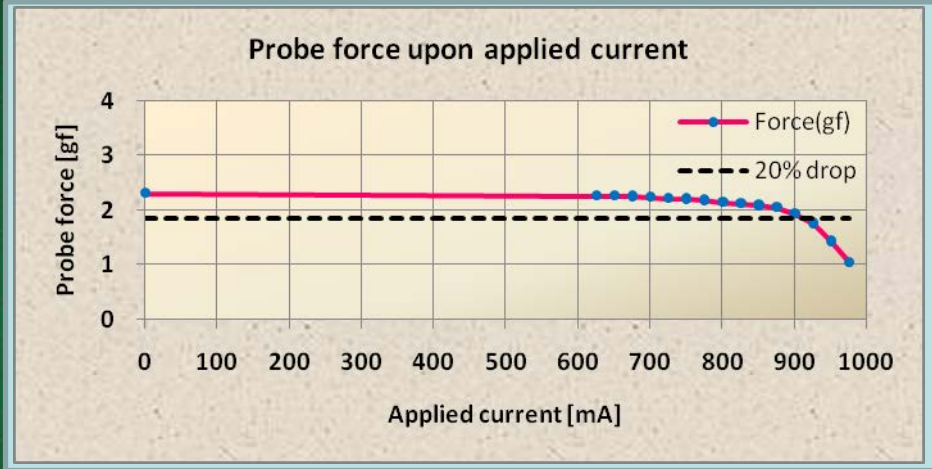
Force : 3.52gf (@OD75)

Temp. : 25℃

- Type “B” : Wire vertical (cobra)
- As O/D increase, slope of force curve is decreased
- The graph slope is smaller than “A” type

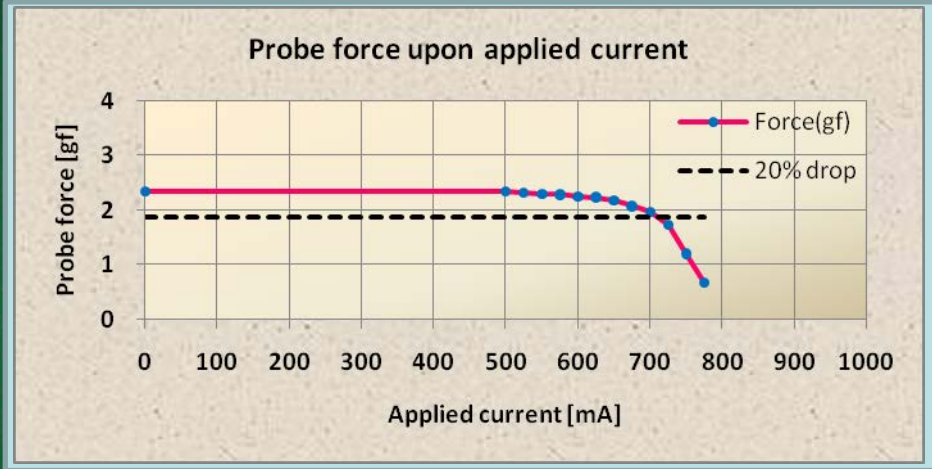
Evaluation results

“A” type probe evaluation results (ISMI C.C.C.)



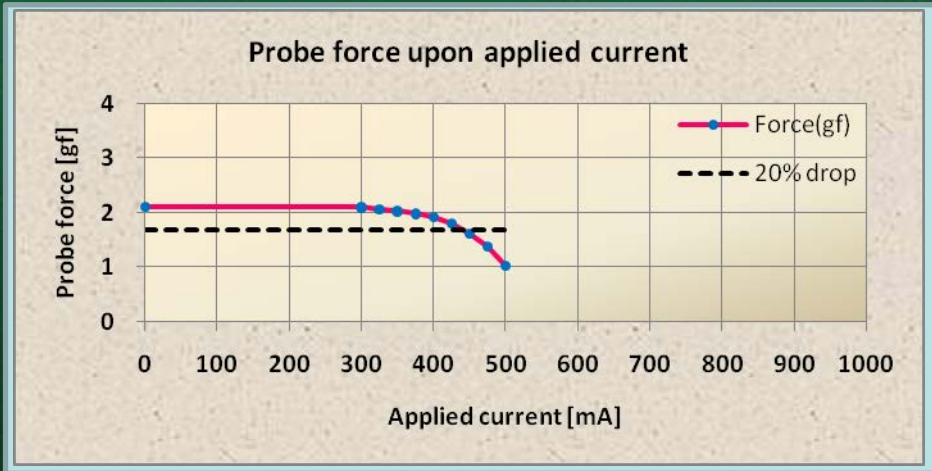
C.C.C. : 896mA

Temp. : 25℃



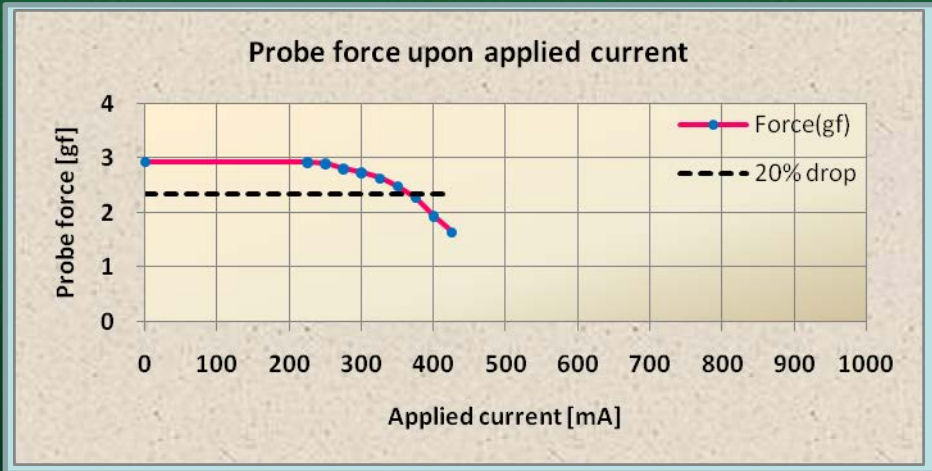
C.C.C. : 696mA

Temp. : 85℃



C.C.C. : 421mA

Temp. : 125℃

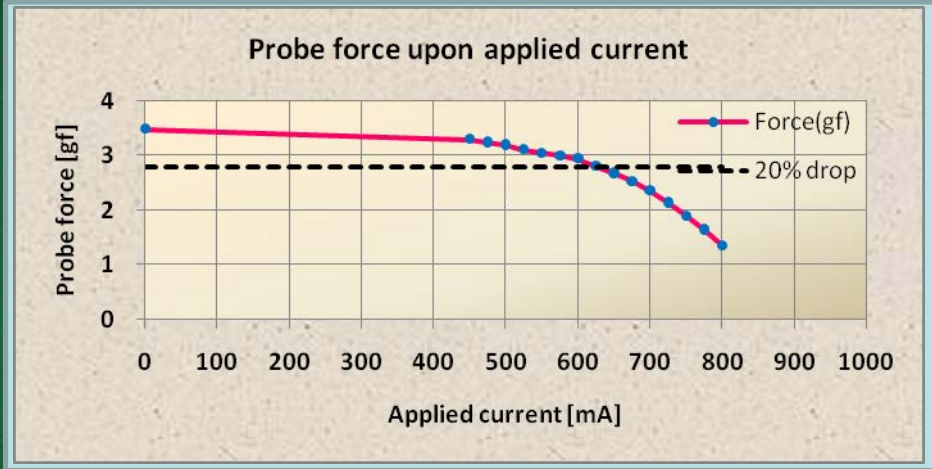


C.C.C. : 345mA

Temp. : 150℃

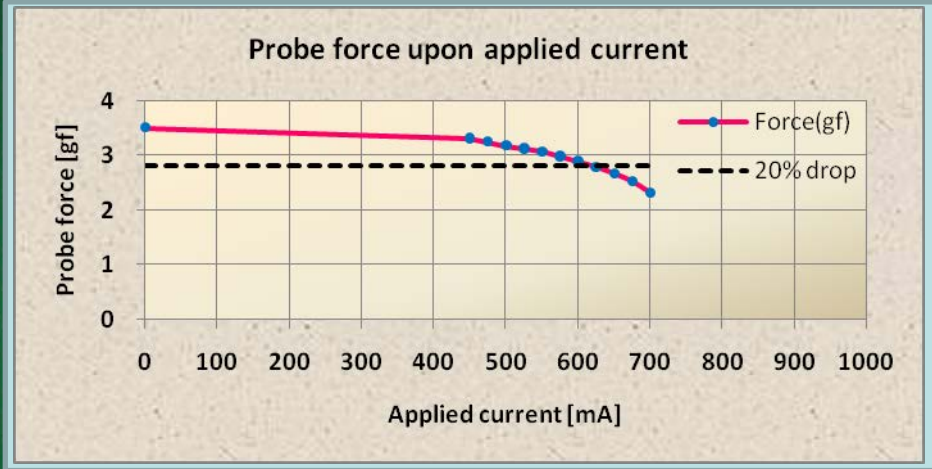
Evaluation results

“B” type probe evaluation results (ISMI C.C.C.)



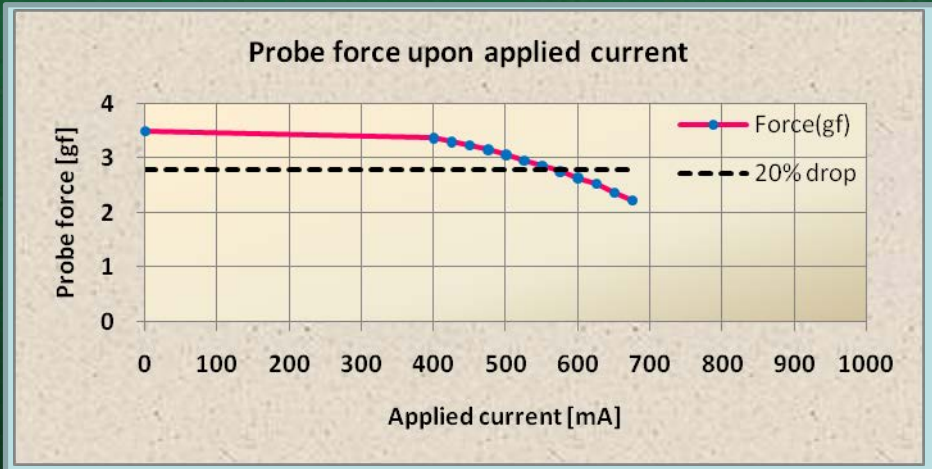
C.C.C. : 617mA

Temp. : 25℃



C.C.C. : 604mA

Temp. : 55℃

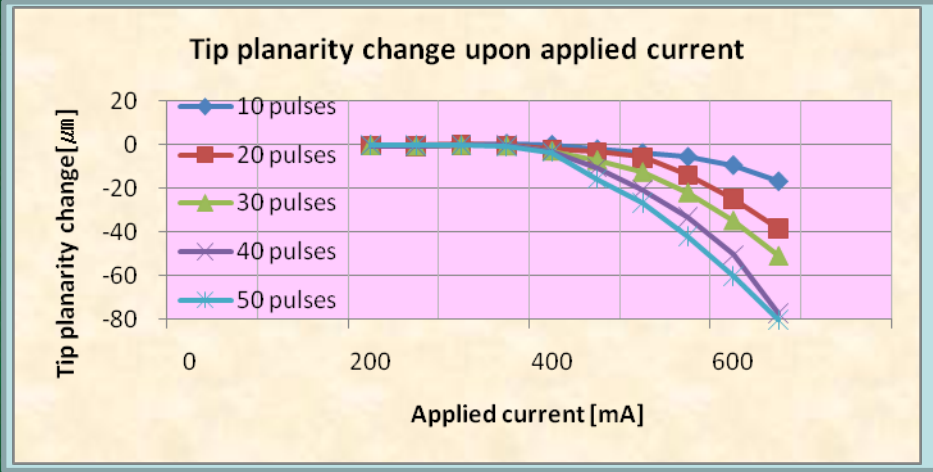


C.C.C. : 555mA

Temp. : 85℃

Evaluation results

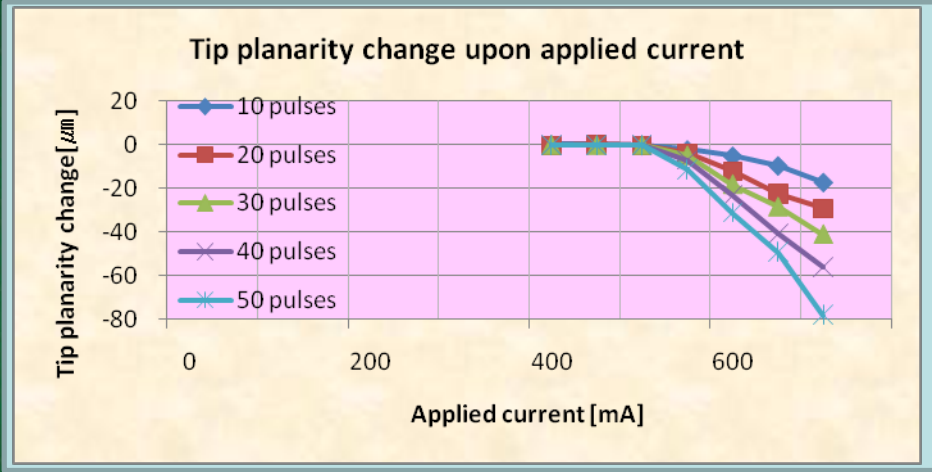
“A” & “B” type probe evaluation results (MAC)



Type : “A”

MAC: 281mA

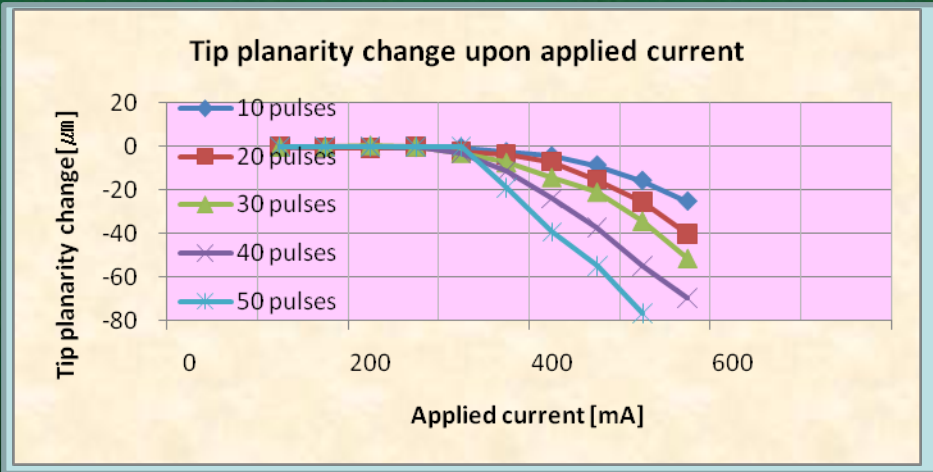
Temp. : 25℃



Type : “B”

MAC : 465mA

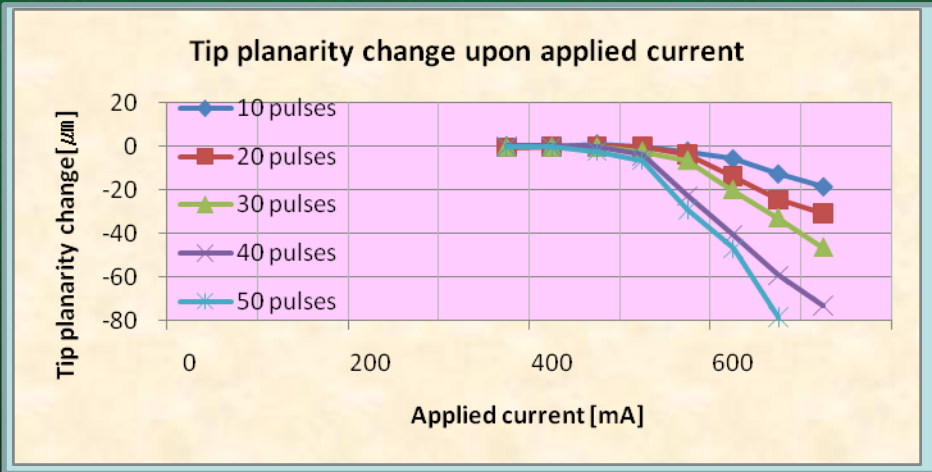
Temp. : 25℃



Type : “A”

MAC : 191mA

Temp. : 85℃



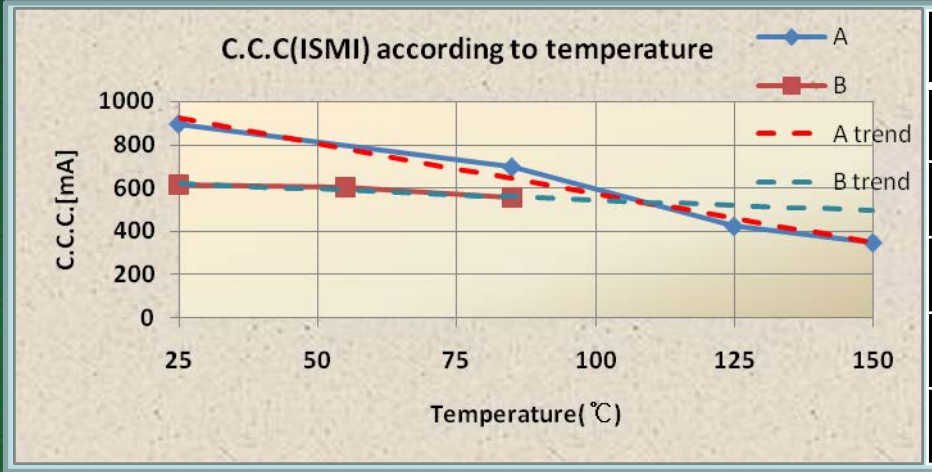
Type : “B”

MAC : 377mA

Temp. : 85℃

Analysis of evaluation results

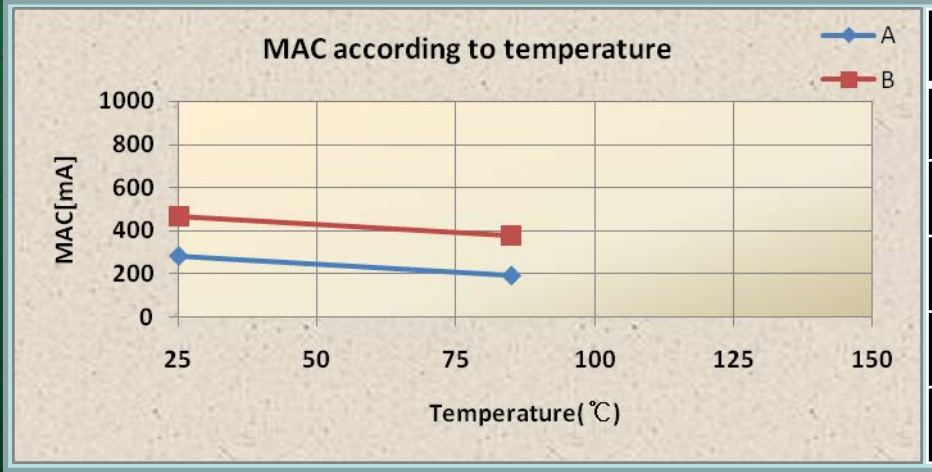
ISMI C.C.C. & MAC according to temperature



Temp.	"A" type	"B" type
25	896	617
55	(780)	604
85	696	555
125	421	(522)
150	345	(489)

$$C.C.C.(ISMI) = \beta' \frac{A}{L} \sqrt{\frac{1}{\rho(T)}}$$

- Evaluation result is correlated with above formula (error ≤ 5%)
- (data) is calculated value by the formula
- C.C.C. depends on probe material & design and decreases with the increase in temperature.

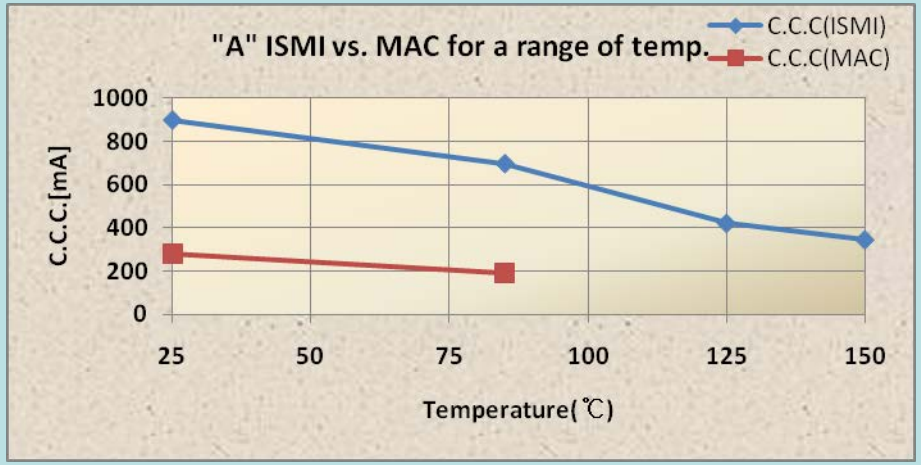


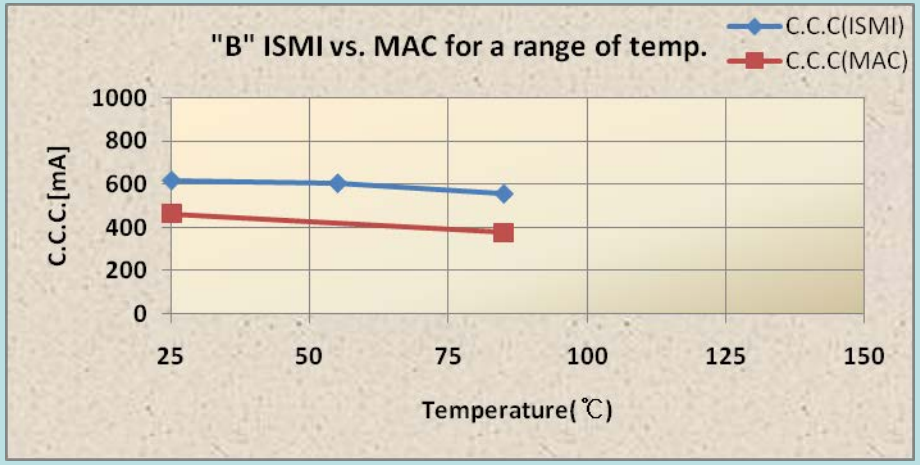
Temp.	"A" type	"B" type
25	281	465
55	-	-
85	191	377
125	-	-
150	-	-

- No correlation with the ISMI C.C.C. result.
- MAC also decreases when the temperature rises
- MAC is insensitive to probe design compared with ISMI C.C.C.
  → MAC slope upon temp. of A and B are similar

Analysis of evaluation results

ISMI C.C.C. vs. MAC for a range of temp.





Type	Temp. [℃]	ISMI [mA]	MAC [mA]	MAC/ISMI x100 [%]
"A"	25	896	281	32
	85	696	191	29
"B"	25	617	465	75
	85	555	377	68

- In case of "A" type, MAC value dropped sharply compared with "B" type.
- Probe design & fixation methods are more dominant factor than material.
- Vertical structure is more advantageous in evaluation than horizontal (cantilever) structure.
  → Vertical probe is easy to release heat by guide plate

Automated measurement system

Precision probe test solution

- **Precise force measurement**

  Resolution : 0.01g

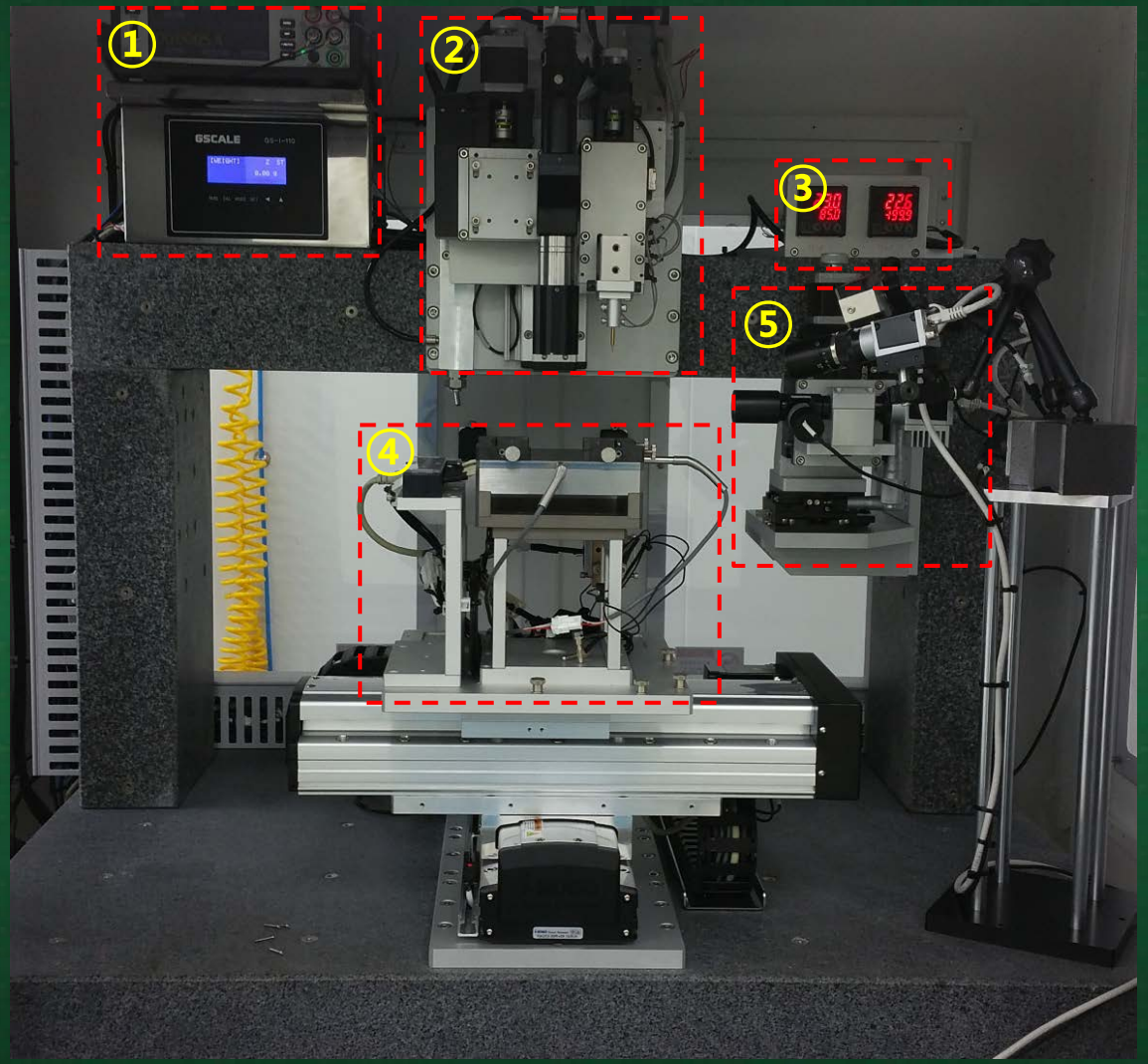
- **PID temperature control**

  RT, HT test available (Max. 180℃, target Temp. ±0.3℃)

- **4-wire resistance measurement**
- **X, Y, Z stage control**
- **Vision Alignment**

  3 camera system(Top, Side , CCTV)

Automated measurement system



① Source meter & load cell control

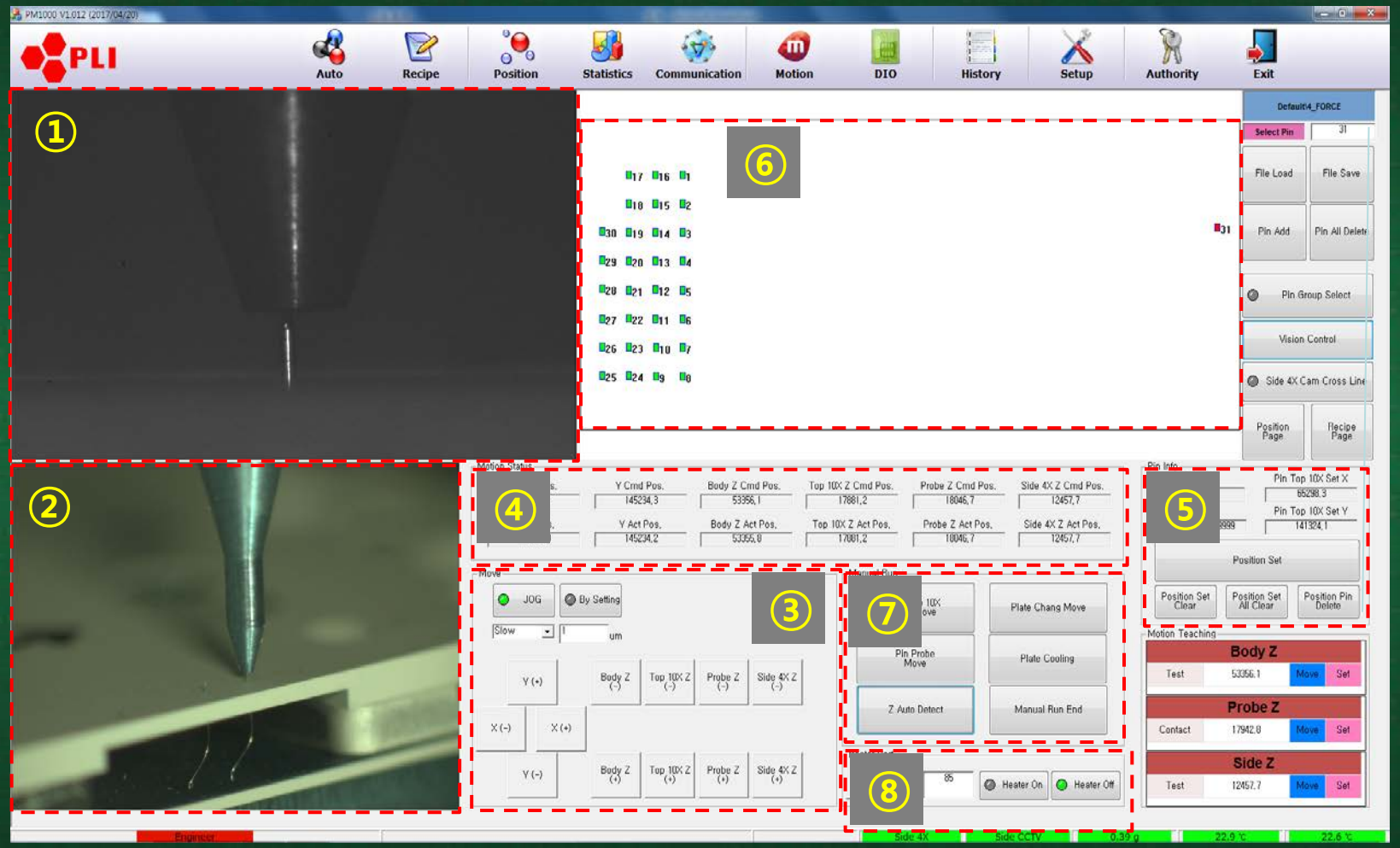
② Top camera & load cell

③ Temperature control

④ Stage, heater, temperature sensor

⑤ Side camera, CCTV camera

Automated measurement system



① Objective lens window

② CCTV window

③ Stage control window

④ Stage state window

⑤ Position/recipe set-up window

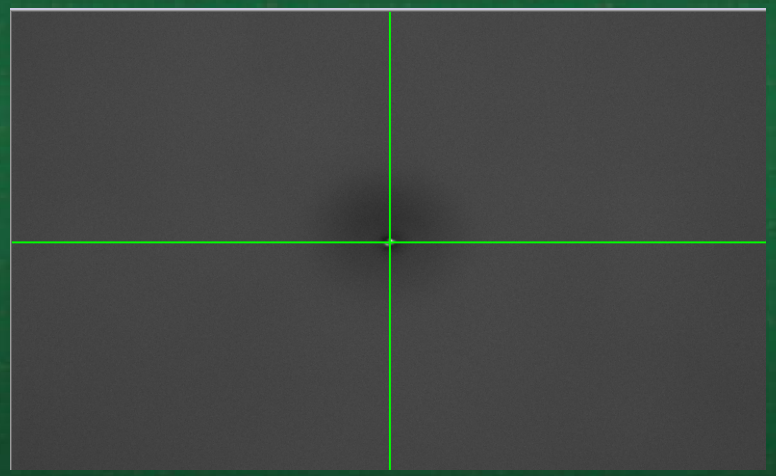
⑥ Pin map display window

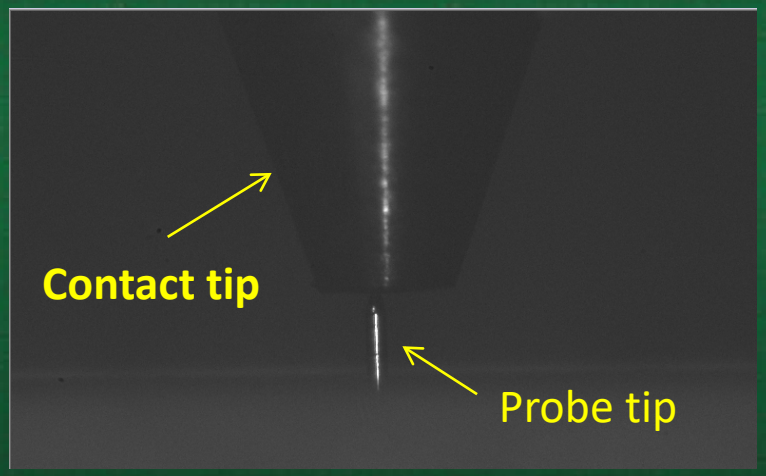
⑦ Manual run window

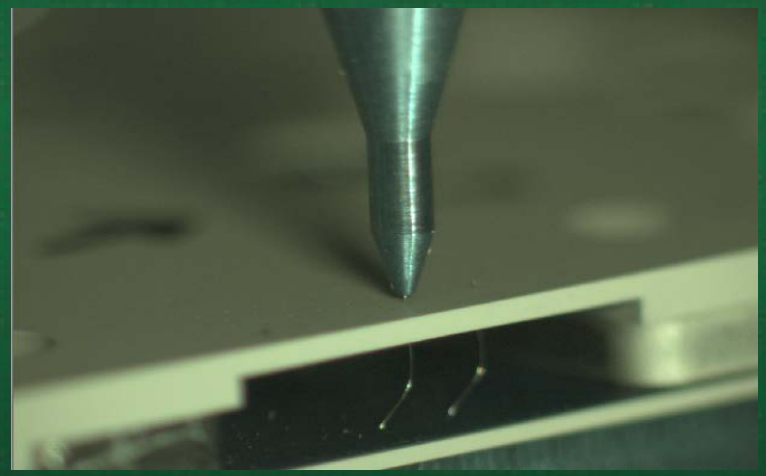
⑧ Stage heater control window

Automated measurement system

- **Objective lens(x10)**
  - X & Y-axis positioning
- **Objective lens(x4)**
  - Contact tip & probe first contact
- **CCTV**
  - Observation from various angle

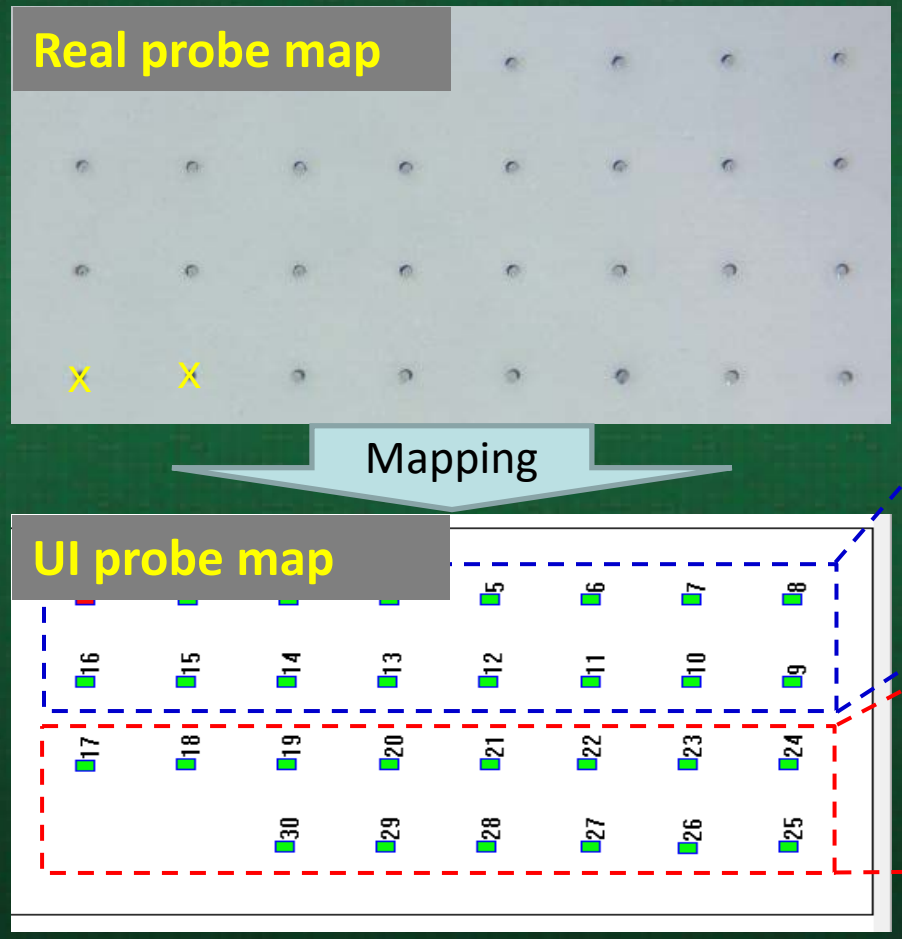




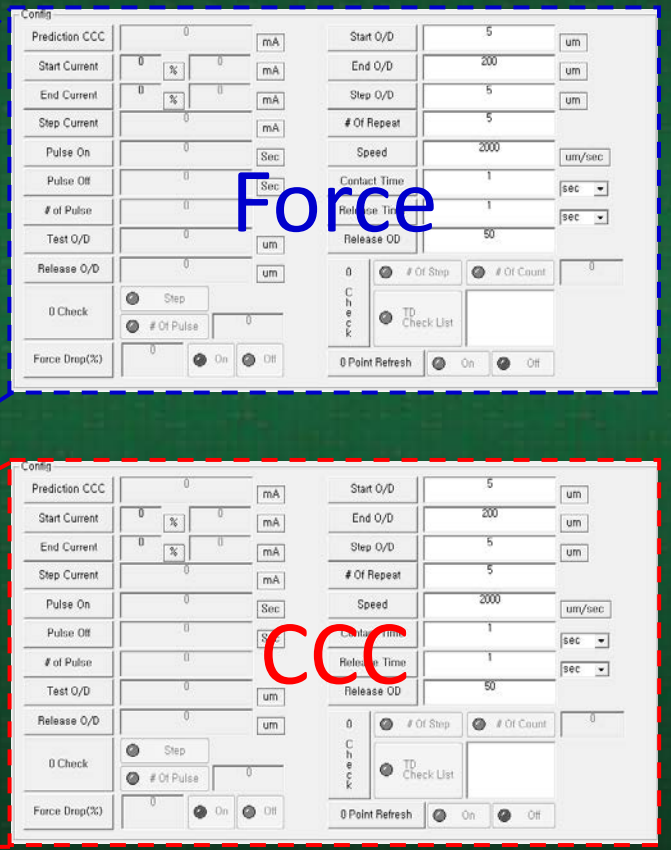


Automated measurement system

- **Probe position set-up**



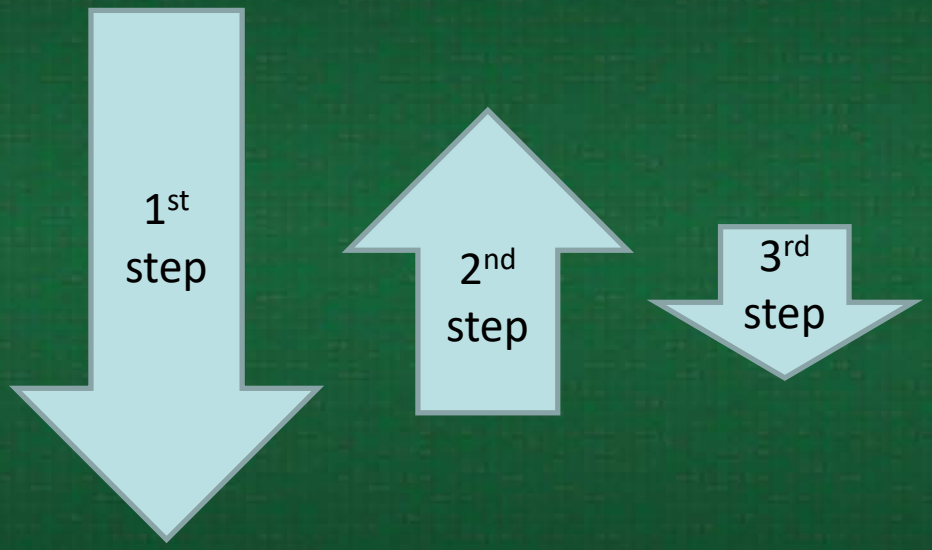
- **Probe recipe set-up**



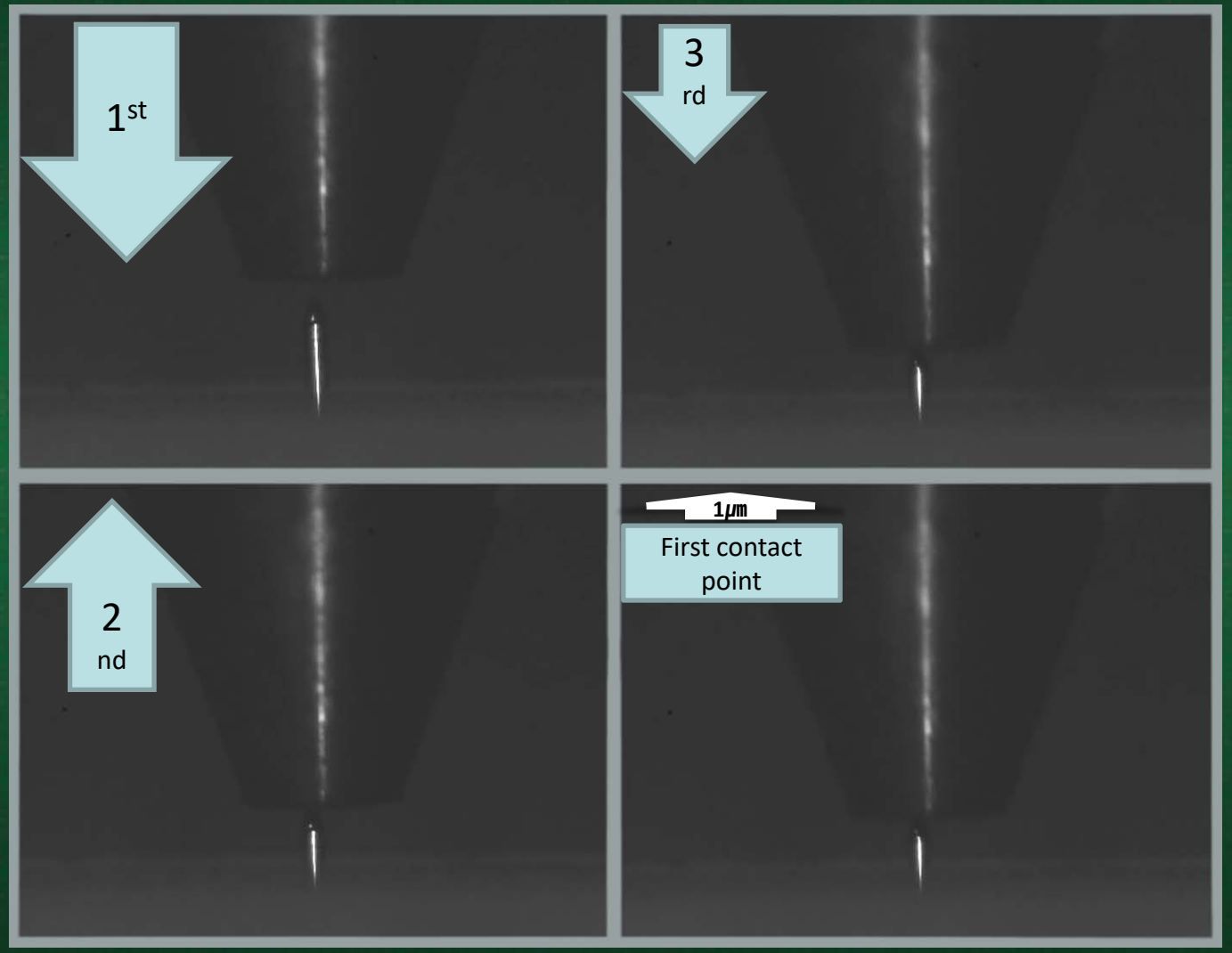
Automated measurement system

- **First contact (Z-axis auto detect)**

  Contact tip moving



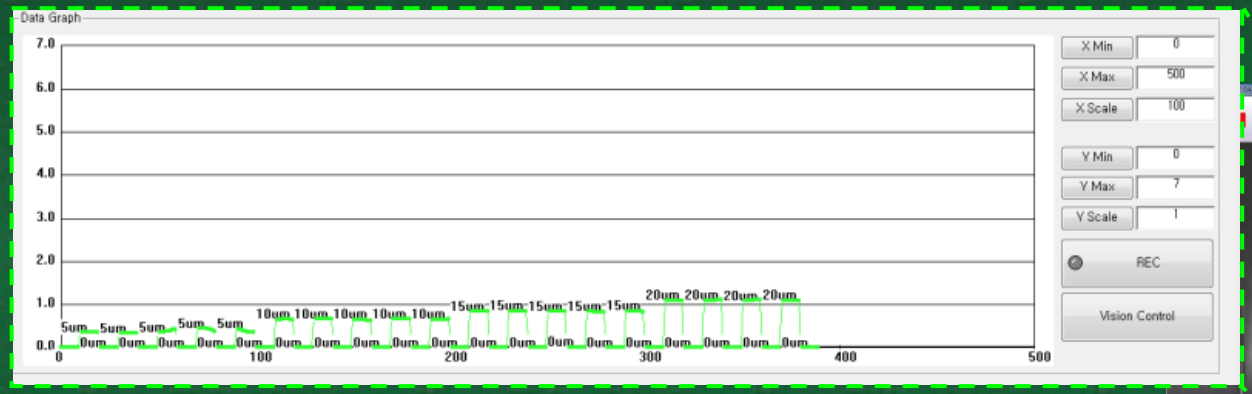
- Movement per step and the detection gram can be set depending on the probe type.
- After the 3rd step, 1µm retraction point is recognized as first contact point



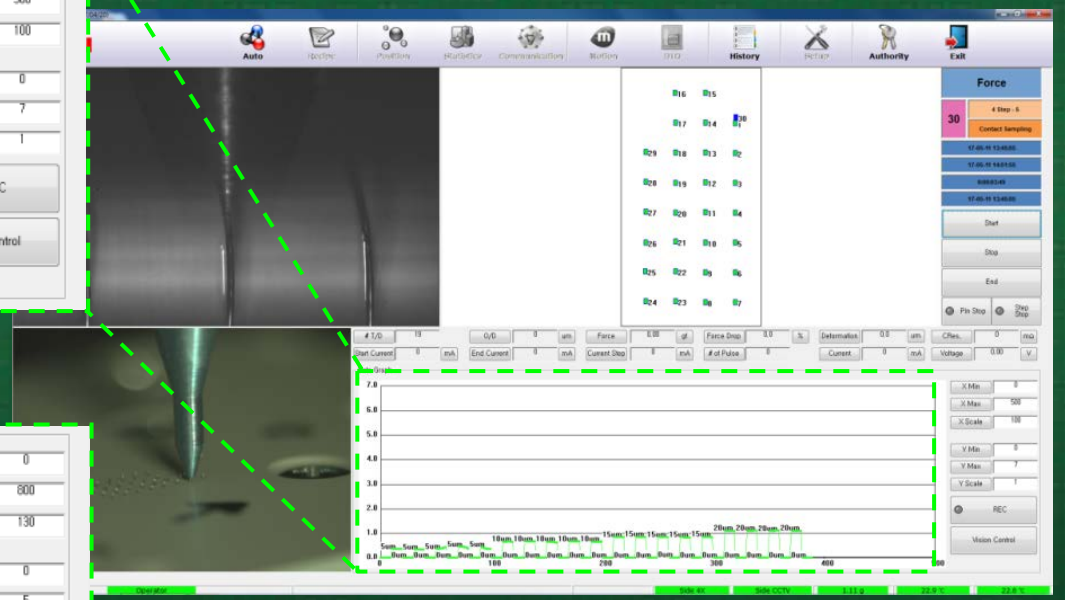
Automated measurement system

Data graph(example)

- Probe force



- C.C.C.(ISMI)



Conclusion

C.C.C. Evaluation & Analysis

- C.C.C. formula of previous presentation is well matched to the experimental result(ISMI).
- Temperature dependence of ISMI C.C.C. & MAC
  - Probe design & fixation methods are more dominant factor than material.
  - For the MAC method, the value is insensitive to probe geometry compared with ISMI C.C.C.

Automated measurement system

- Reliability of measurement result ↑
- Various measurement items can be set by each probe at one time

Acknowledgements

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