# Silicon Whiskers Probe Card

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- Outline of silicon whiskers probe card
- Technology of 30 microns pitch
- For area array pad IC
- For Al pad IC

TOHO ELECTRONICS INC.

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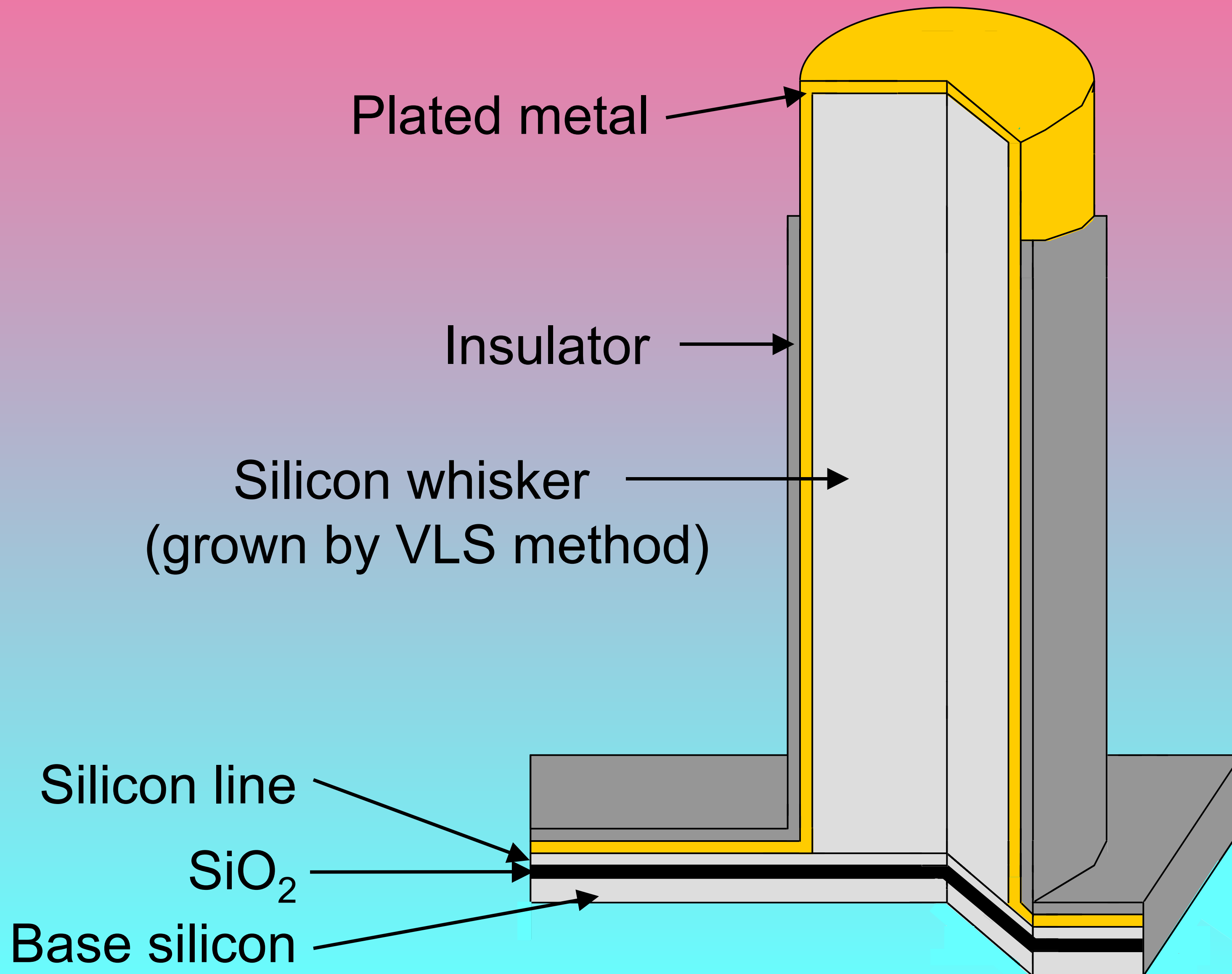
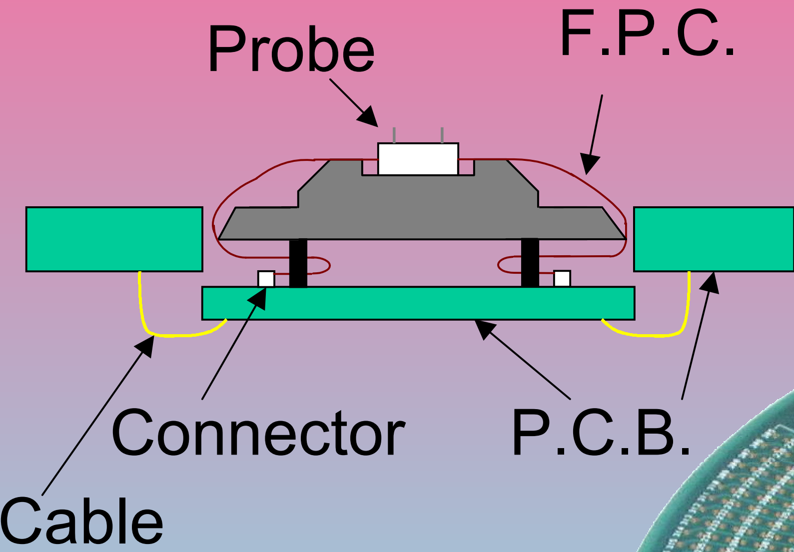
# TOHO's silicon whisker probe card

1. Basic technology
   - Vapor-Liquid-Solid growth method
2. Present application
   - L.C.D. Dr. IC
3. Product status
   - Using in mass production : 1 customer
   - Evaluating : 5 customers
4. Future application
   - For area array pad IC
   - For Al pad IC

# Structure of silicon whisker probe

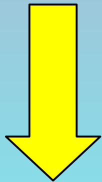


# Assembly



# Features

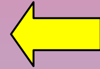
1. Vertical probe
2. Contact with buckling deformation
3. Microscrub
4. Low contact force



★Application is limited to gold electrode.

# Benefits (1)

1. Fine pitch
2. High pin counts



★ Not handmade production

★ Manufactured with photolithography, VLS growth method and plating

3. Maintenance free

★ Some customer used nonstop until 0.3 million contacts without cleaning.

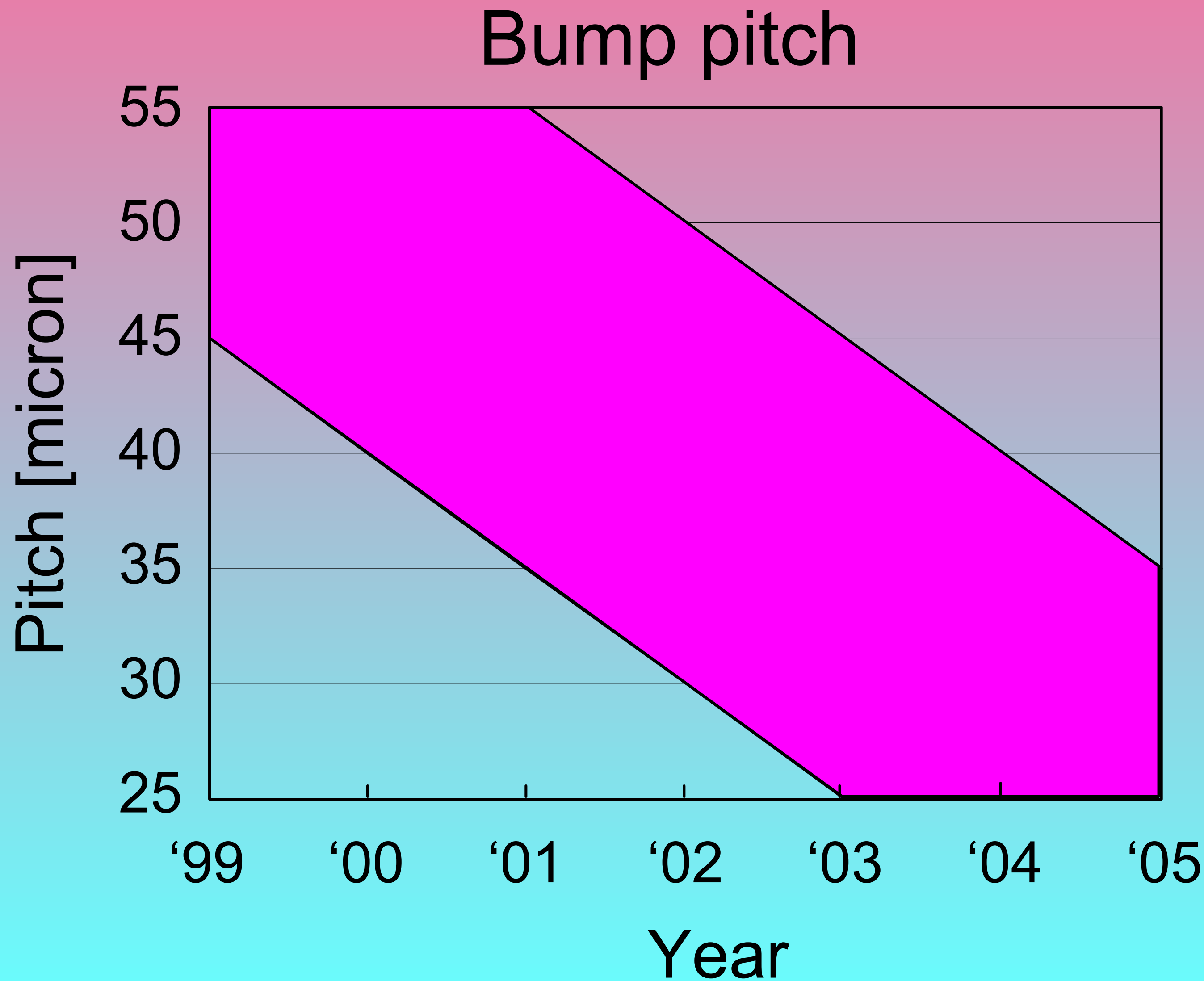
# Benefits (2)

4.Increasing yield of wafer test

| Wafer No. | IC Yield [%] | |
|---|---|---|
| | Cantilever | Silicon whiskers probe |
| 1 | 86.7 | 89.1 |
| 2 | 80.7 | 83.5 |
| 3 | 85.4 | 88.0 |
| 4 | 88.0 | 90.2 |
| 5 | 89.1 | 92.0 |
| Average | 86.0 | 88.6 |

5.Decreasing the total cost of wafer test

# Transition of bump pitch for L.C.D. Dr. IC.



# Key technology of 30 microns pitch (1)

1.XY Accuracy

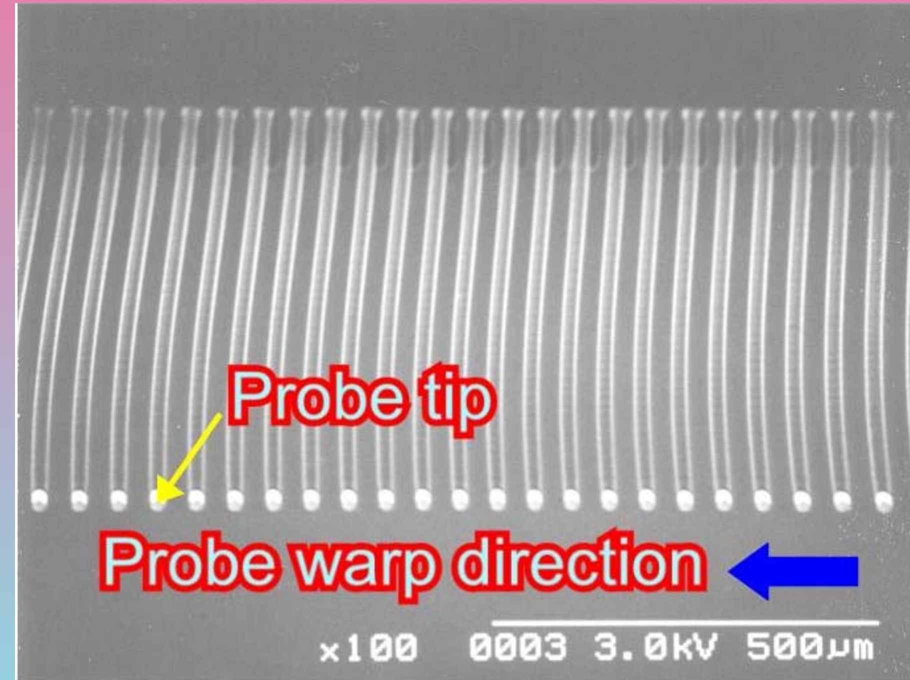
- More precise control of probe tip position

★Usual XY accuracy :

Max 10 microns

2.Stability of contact resistance

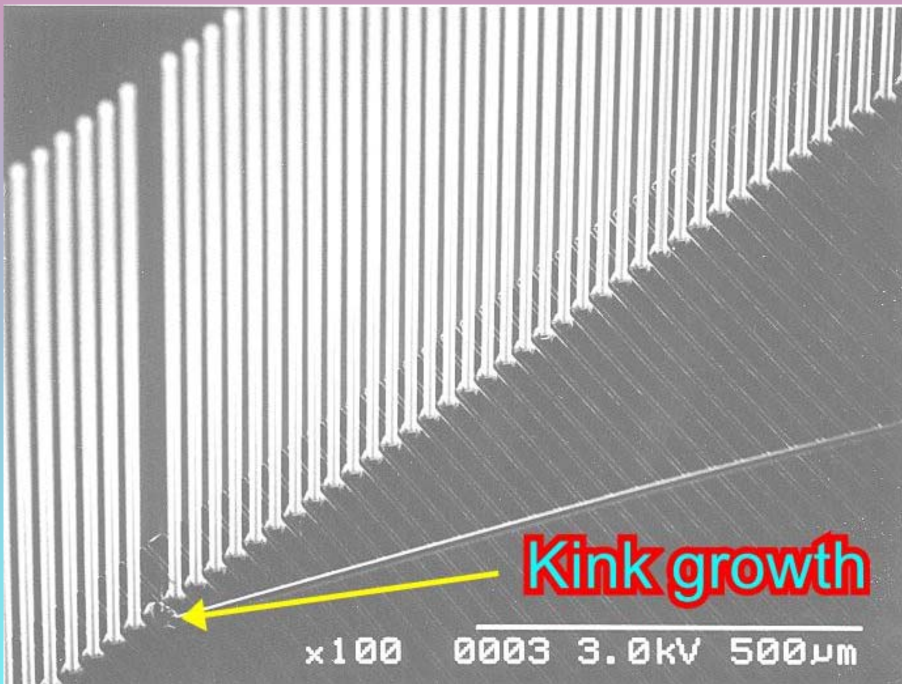
- Design pin diameter and pin length to get contact force more than 4 mN

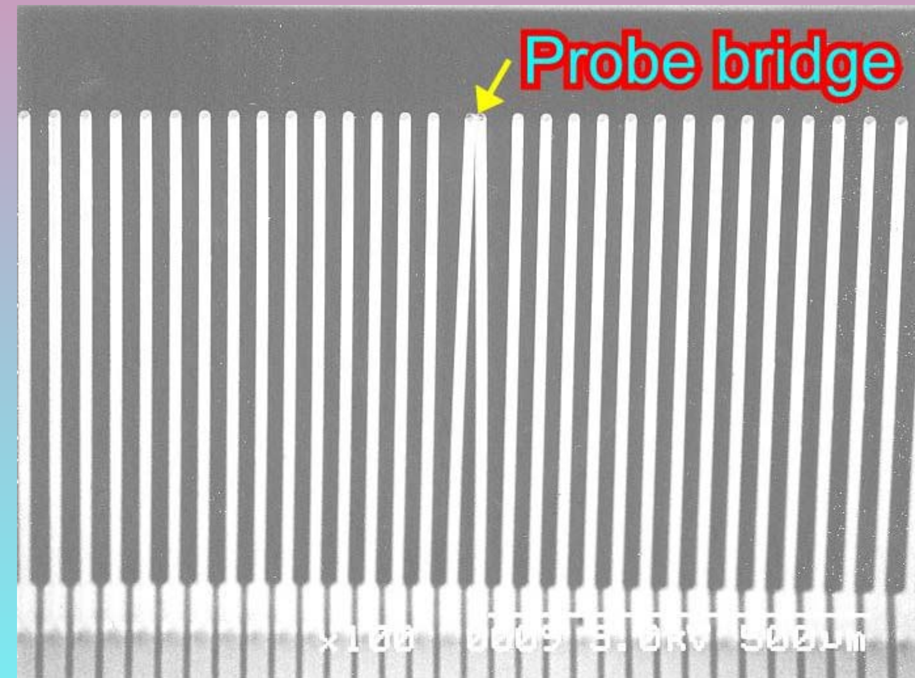


# Key technology of 30 microns pitch (2)

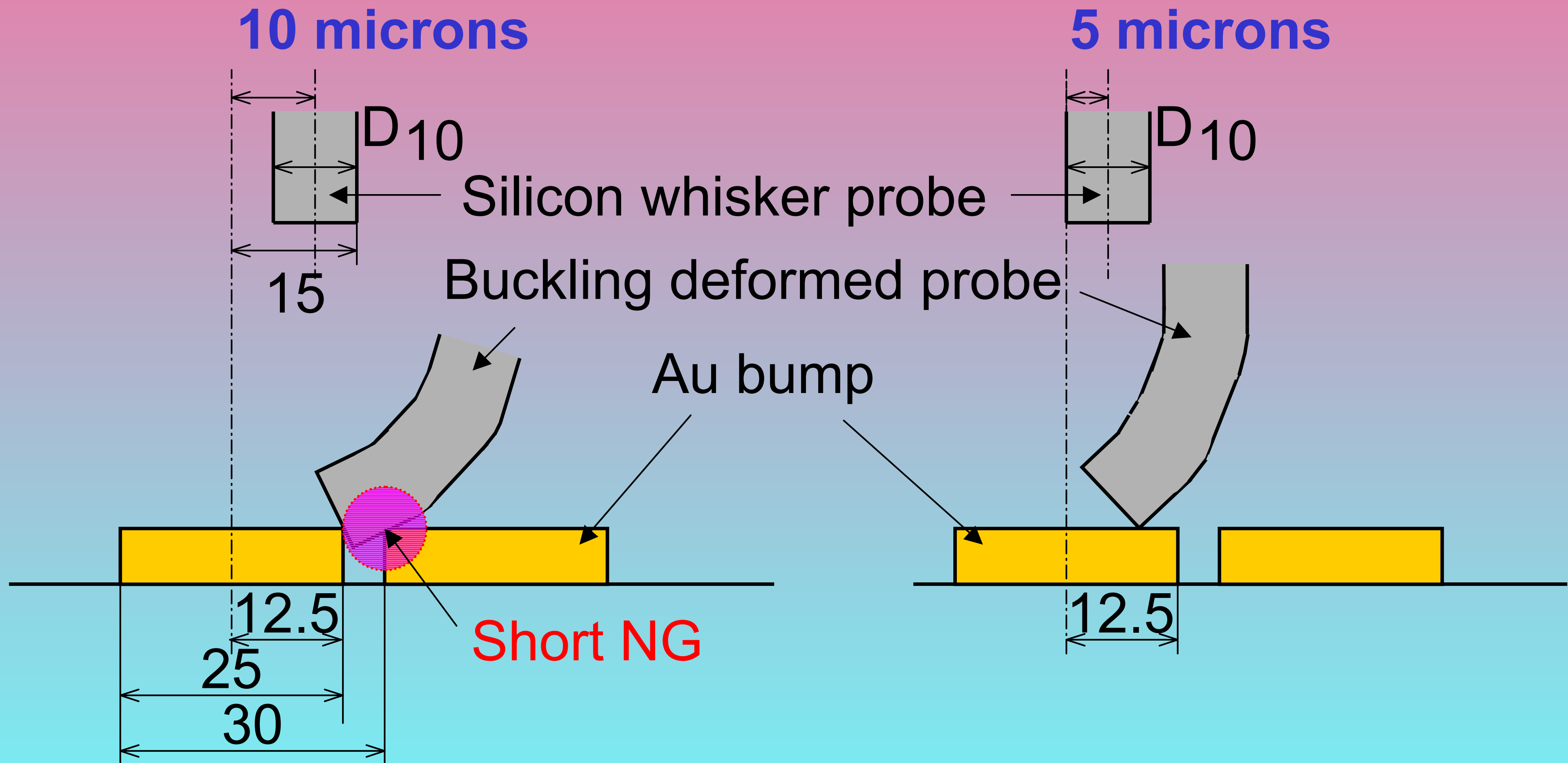
3.Manufacturing

- Extermination of bad growth
- Avoidance of probe bridge



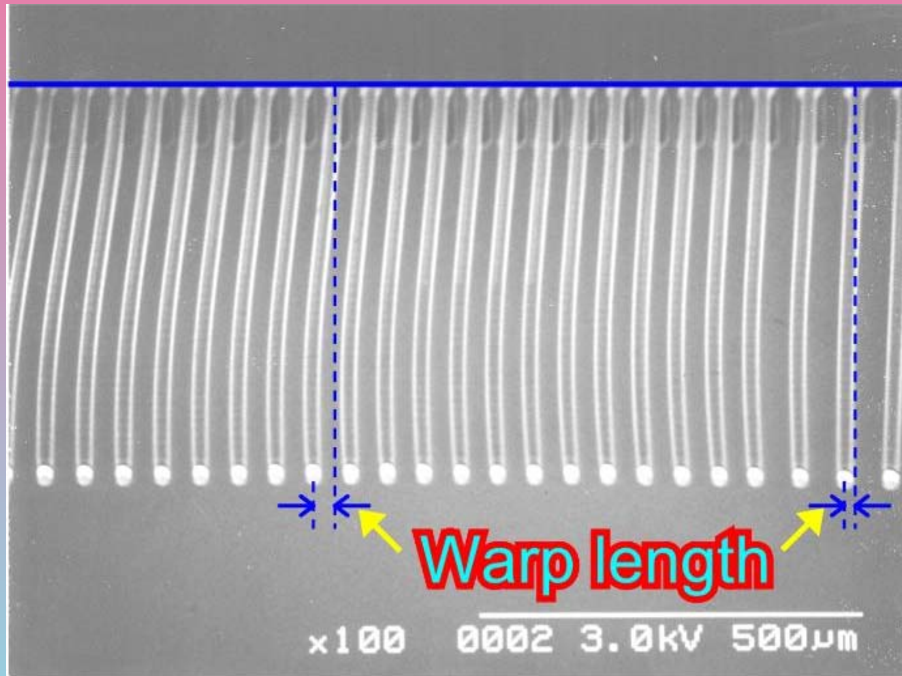



# XY Accuracy for 30 microns bump pitch




Provisional target XY accuracy : Less than 5 microns

# XY Accuracy of silicon whiskers probe

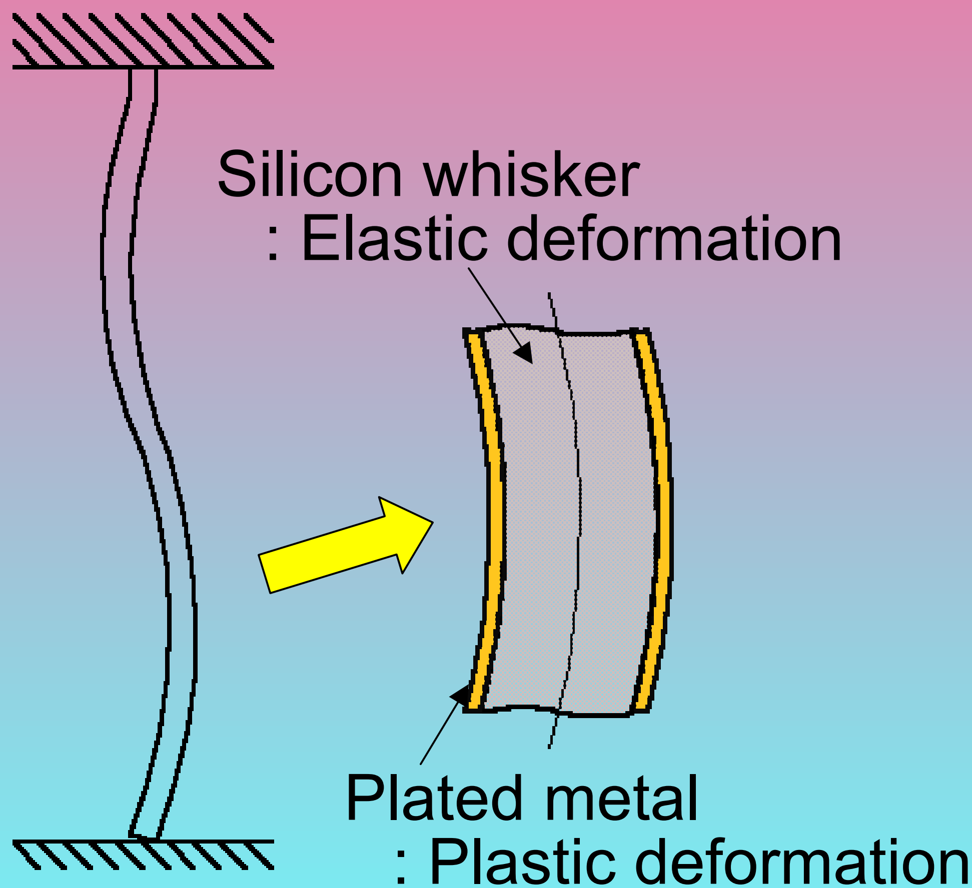


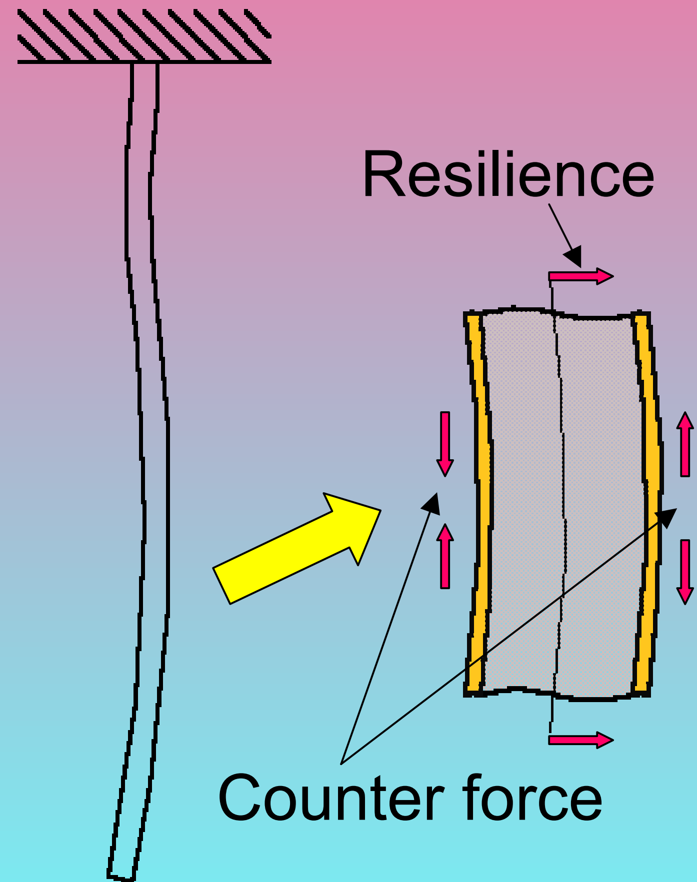

- Each probe tip XY accuracy is affected by the difference of warp length of the probe from average warp length.
- Decrease fluctuation of warp length to get more precise XY accuracy

★Tip XY position is shifted from bottom one by warp.

Warp length : Lateral distance from probe bottom position to tip position

# Mechanism of probe warp formation




Over drive :Exist

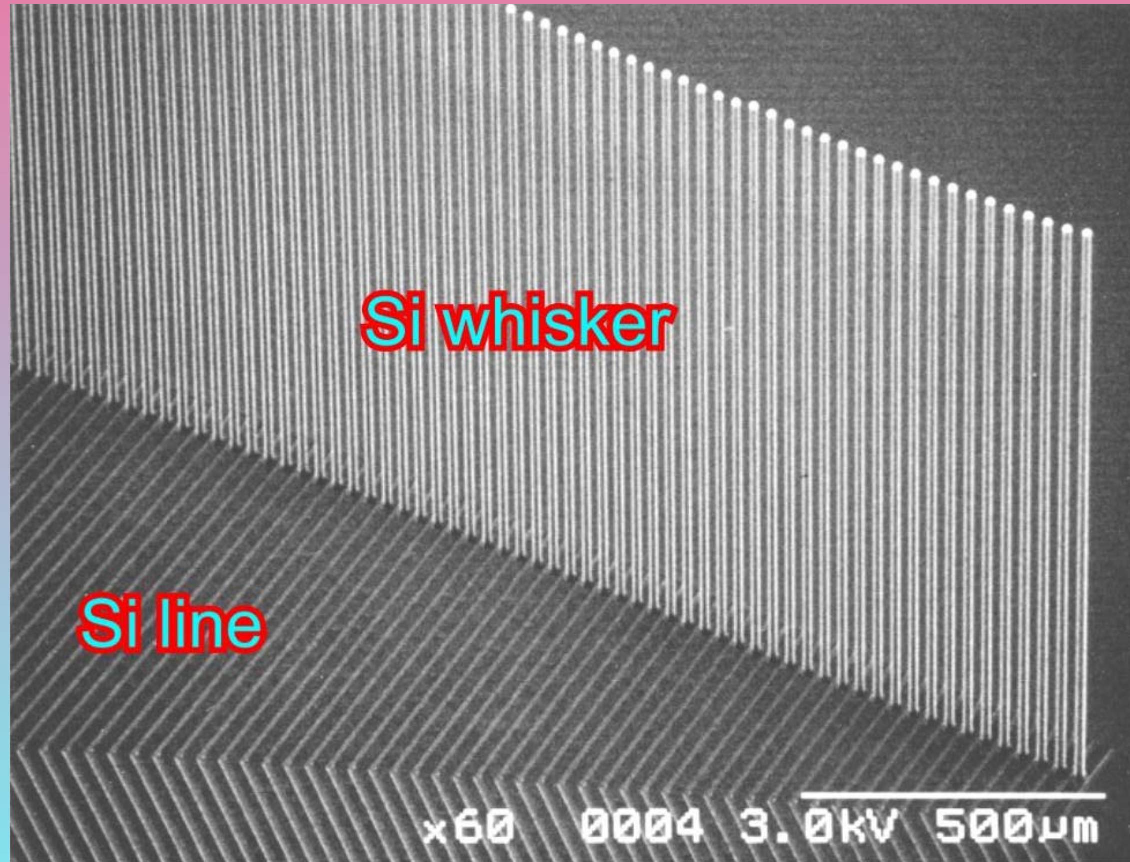
Over drive :Not exist

# Fluctuation of warp length

| Factor | | Control method |
|---|---|---|
| 1.Variation of plated metal properties for each probe<br>Ex.: Residual stress,<br>Ductility, Grain size | ⇐ | • Adjustment of plate condition<br>Temperature, pH,<br>Concentration of component |
| 2.Dispersion of plated metal thickness for each probe | ⇐ | • Improvement of instruments for plating apparatus |
| 3.Fluctuation of each silicon whisker diameter | ⇐ | • Readjustment of photolitho-graphy condition |

# Grown result

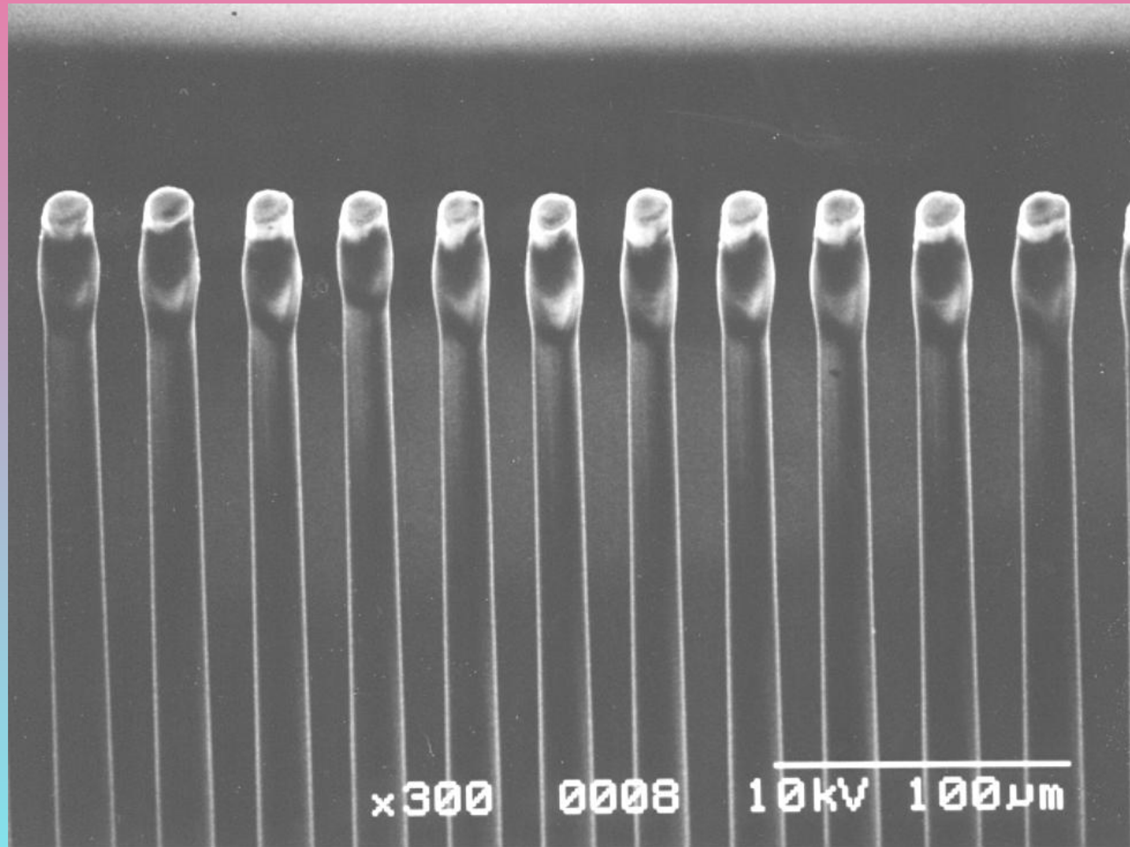
30 microns pitch
430 pins




As-grown

**Kink free**

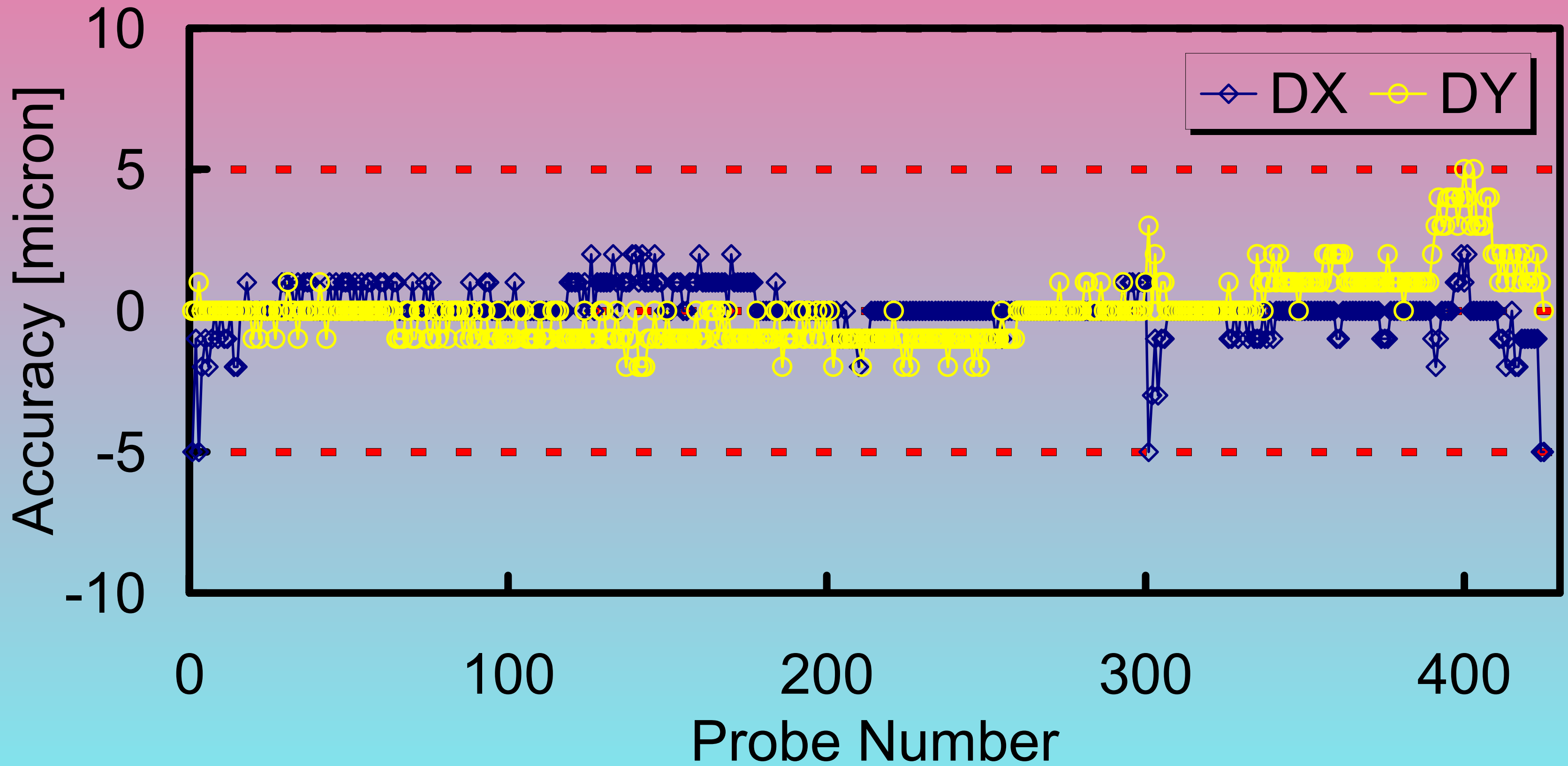
# Plated and insulated result




Plated and insulated

**Without probe bridge**

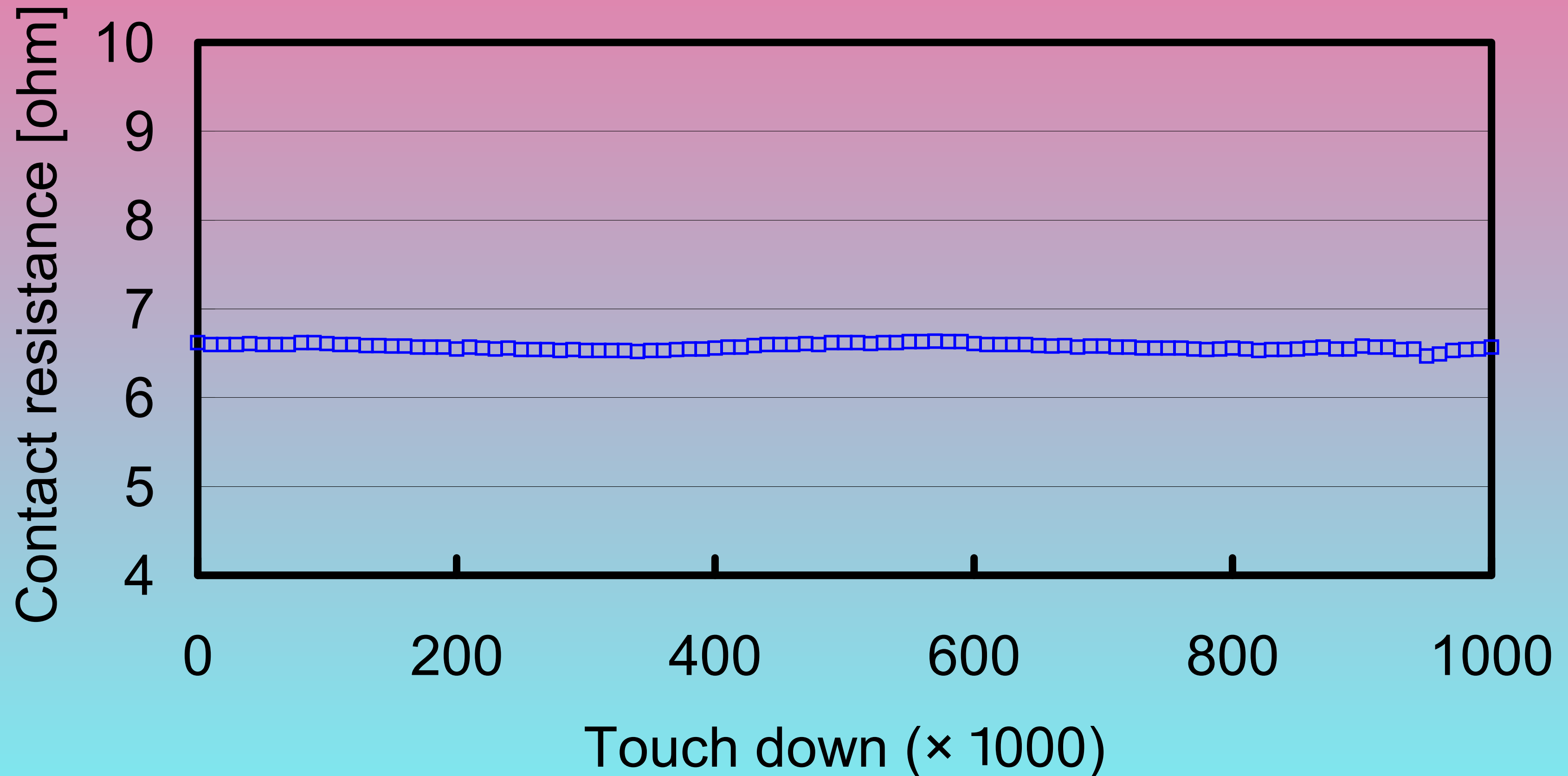
# Accuracy




After 1 million contacts with Au plated wafer

**Less than 5 microns**

# Variation of contact resistance




Contact with Au plated wafer without cleaning

**Stable contact resistance**

# Area array : Key technology

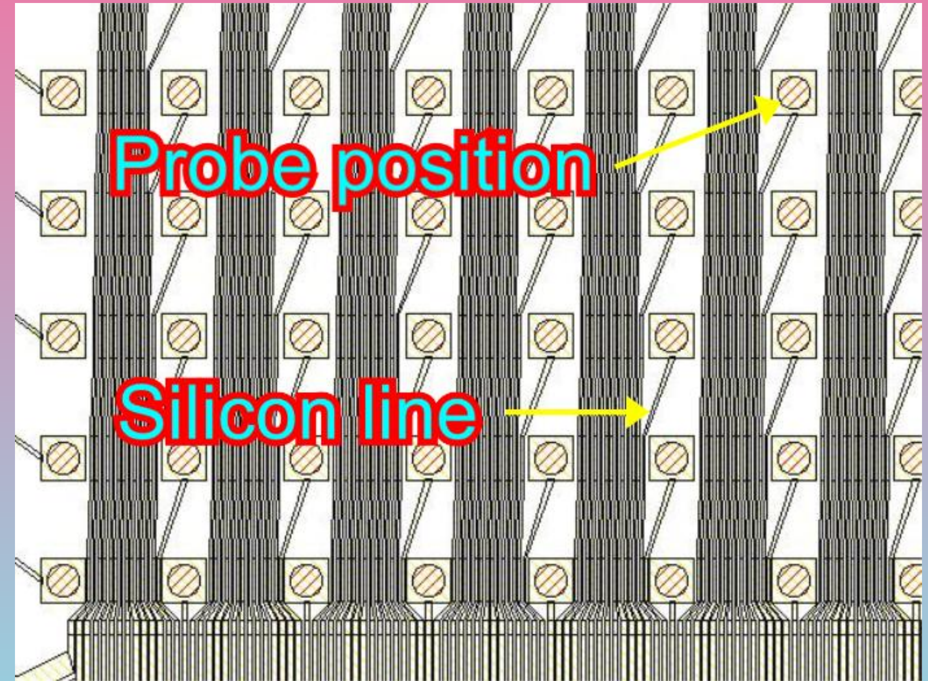
1.Design of line layout on SOI substrate

2.Process

- VLS crystal growth
  - ★Reduce rate of kink
- Photolithography
  - ★Countermeasure for line short and line cut

3.Assemble method to P.C.

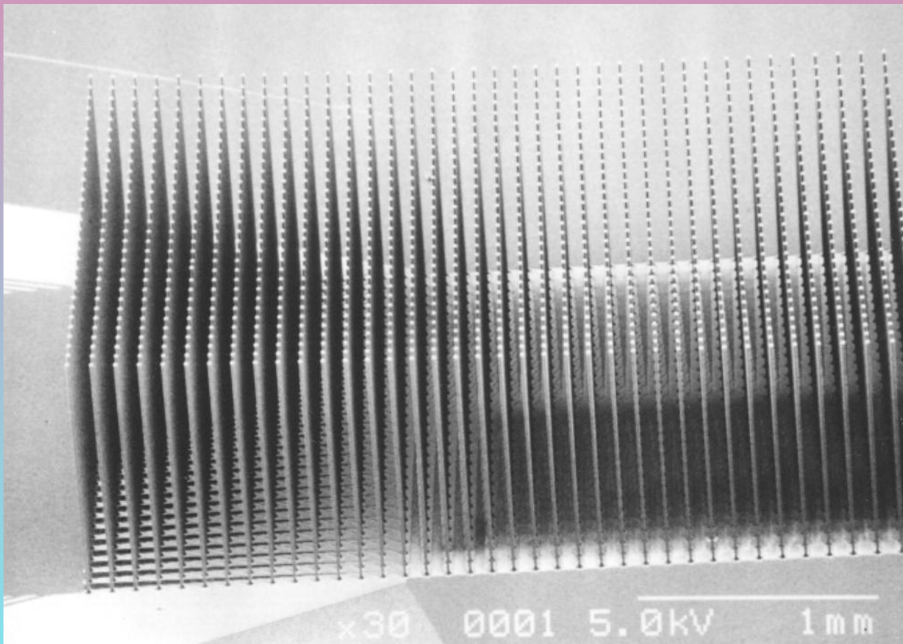
- Design assemble structure



# Area array : Result

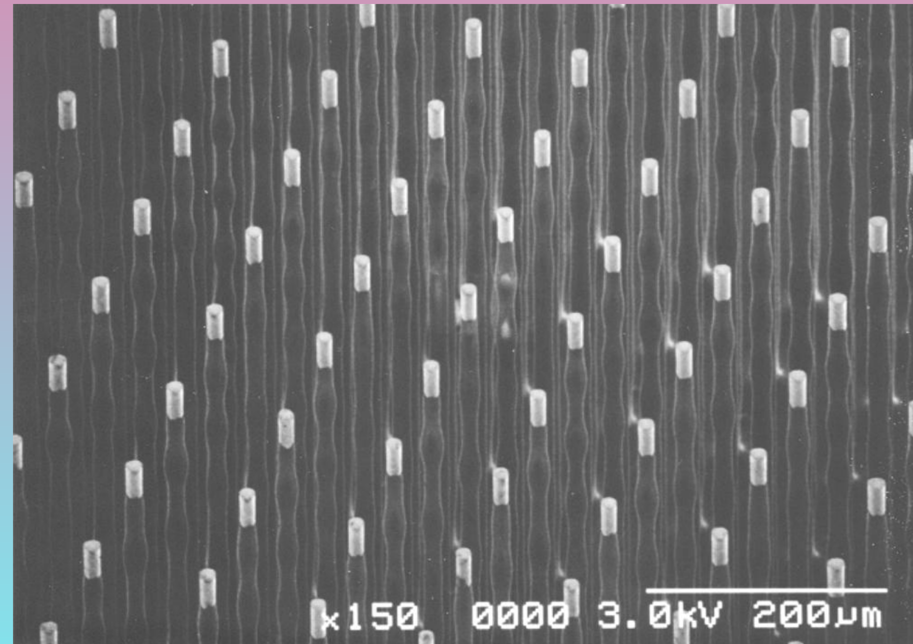
80 microns pitch

3000 pins




As-grown

**Kink free**




Plated and insulated

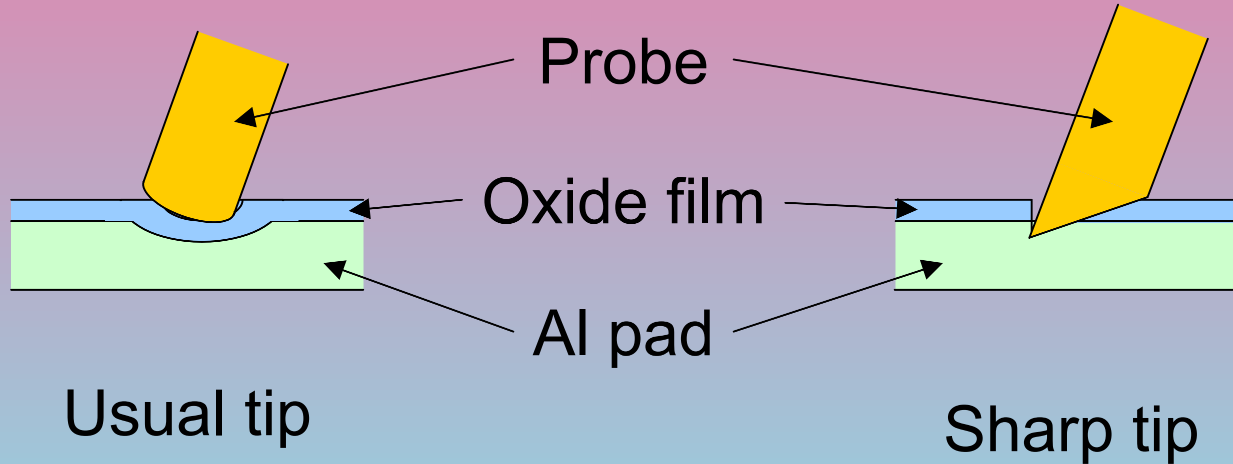
**No problem**

# Area array : Future work

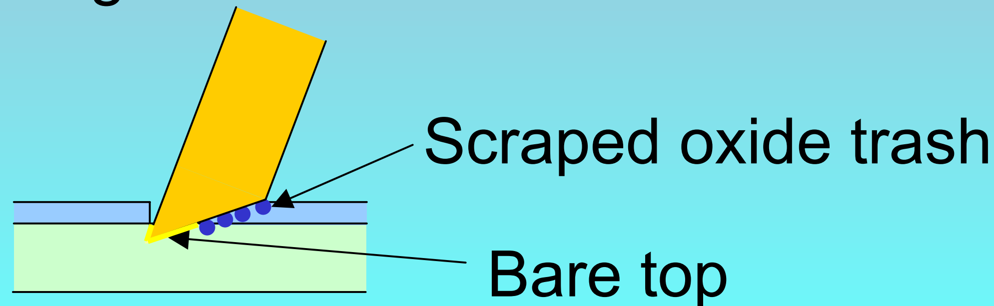
1. Assemble to P.C.
    - Select the assemble structure
2. Other method of line layout
    - Ex.: Draw out to the reverse side of silicon whiskers probe chip
3. Fine pitch
    - Investigate minimum pitch

# Al pad contact : Key technology

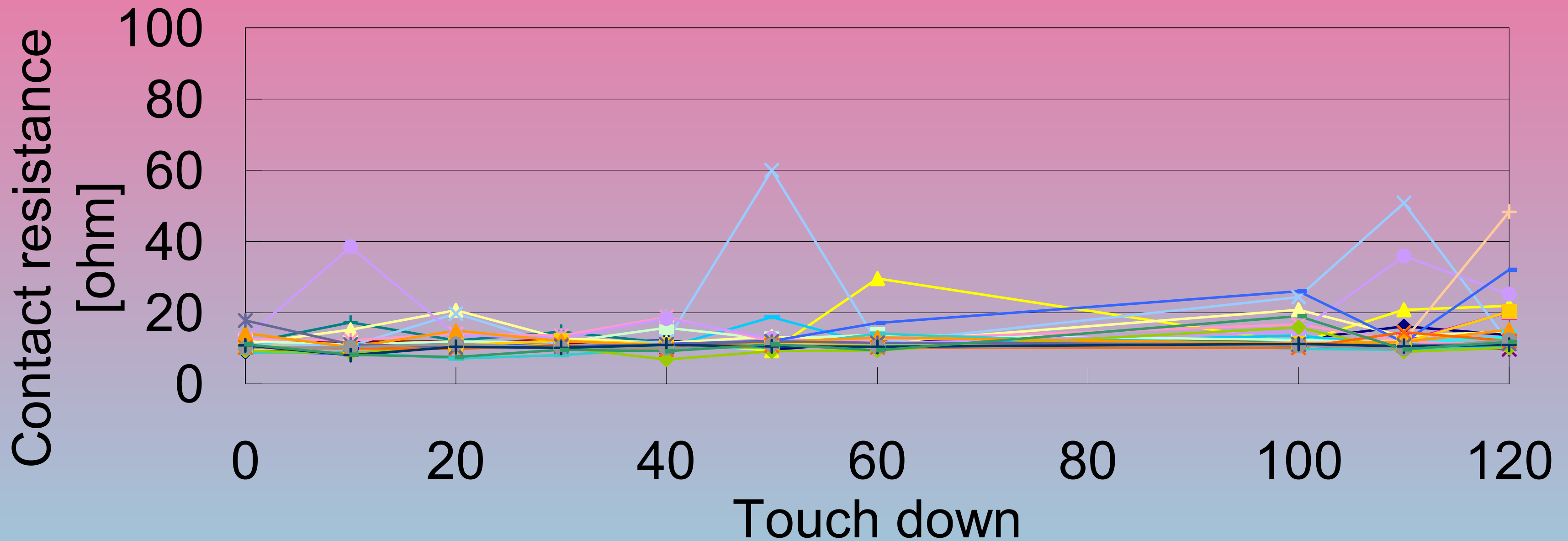
1.How to penetrate oxide film with low contact force




2.Self cleaning



# Al pad contact : Result




**<u>Unstable of contact resistance</u>**

# Feature work

- Select material and shape of probe tip
- Investigation of clearing method

# Conclusions

1. TOHO's silicon whiskers probe card
   - Some customer is using for L.C.D. Dr. IC.
2. 30 microns pitch
   - Performance and process issue was worked out.
3. For area array pad IC
   - Process of silicon whiskers probe is ok.
   - Remain to investigate assemble method.
4. For Al pad IC
   - Needed more examination to stabilize contact resistance.