MICRONICS JAPAN CO.,LTD.

A novel probe-card for 8 inch full wafer contact using MLS

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Outline

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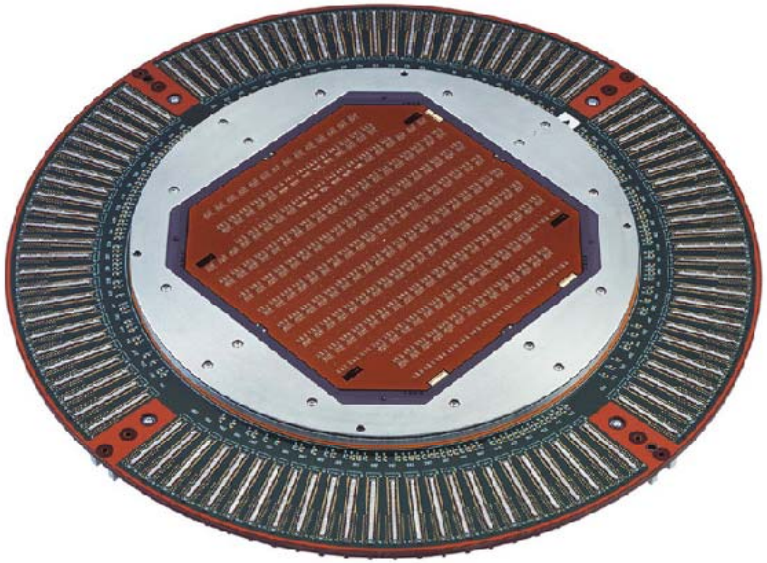
- Background
- FWC Probe Card Specifications
- Structure
- Micro Cantilever
- MLS
- Multilayer PWB
- Evaluation
- Future Work
- Conclusion
- Acknowledgements

Introduction

- In Dec. 2004 MJC announced a probe-card for 8 inch full wafer contact (FWC) (Nikkei Micro-devices News; 02-Dec.).
- The dominant structure of this probe-card consists of;



- **Micro-cantilevers;** which make contact with the LSI wafer bond pad
- **MLS (Multi-Layer ceramic/thin-film Substrate);** which is the interface between the micro cantilevers and the PWB
- **Multi-layer PWB**; the main body of the probe-card

Background

- **LSI memory** ➡ **Reducing TAT**

Tape out to silicon of 6 to 8 weeks shortening to 5 weeks

➘ **Increasing Density**

1~2 Gbits Memory

Quickly increasing to 8 Gbits

- **Product cycle dynamics;** require unscheduled production changes ~1x per quarter.
- **Advanced probe cards;** delivered in 8 to 16 weeks.

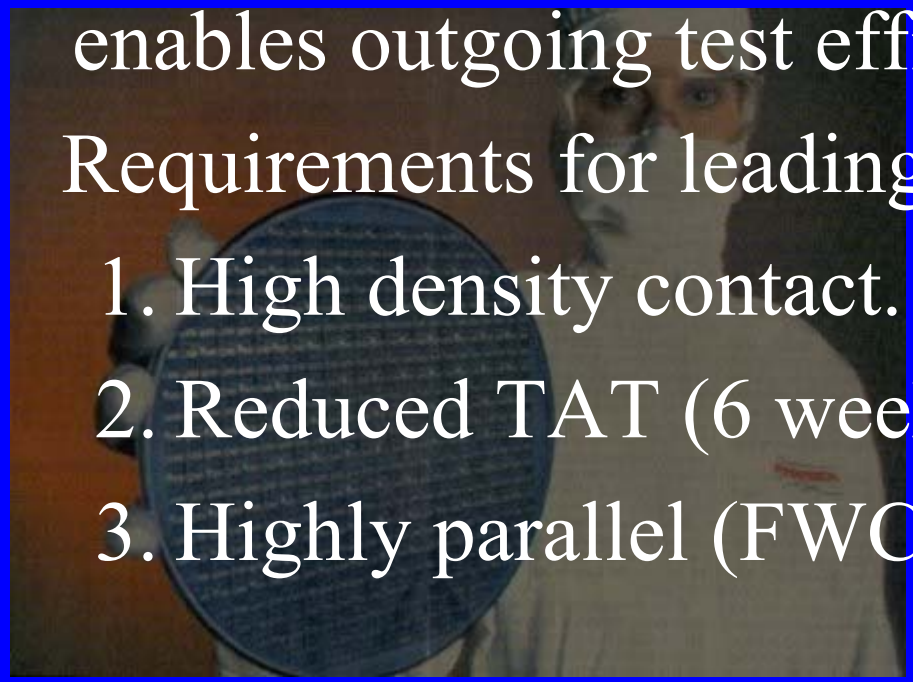
Tape out

First Silicon

Probe-card?!?!

Background

- **Highly parallel probe-card**
  ➡ FWC probe-card ;
  enables outgoing test efficiency
- Requirements for leading edge probe-cards;
  1. High density contact.
  2. Reduced TAT (6 weeks).
  3. Highly parallel (FWC is desirable).



•Specification for FWC Probe-card

Item	Specification
1.Pad pitch	>=100μm
2.Pad size	>60μm×65μm
3.Probe area	<□200mm
4.XY accuracy	<±15μm
5.Tip planarity	<30μm
6.Tip size	15μm□
7.Tip force	1.3g/25μm

* Specification may change without notice

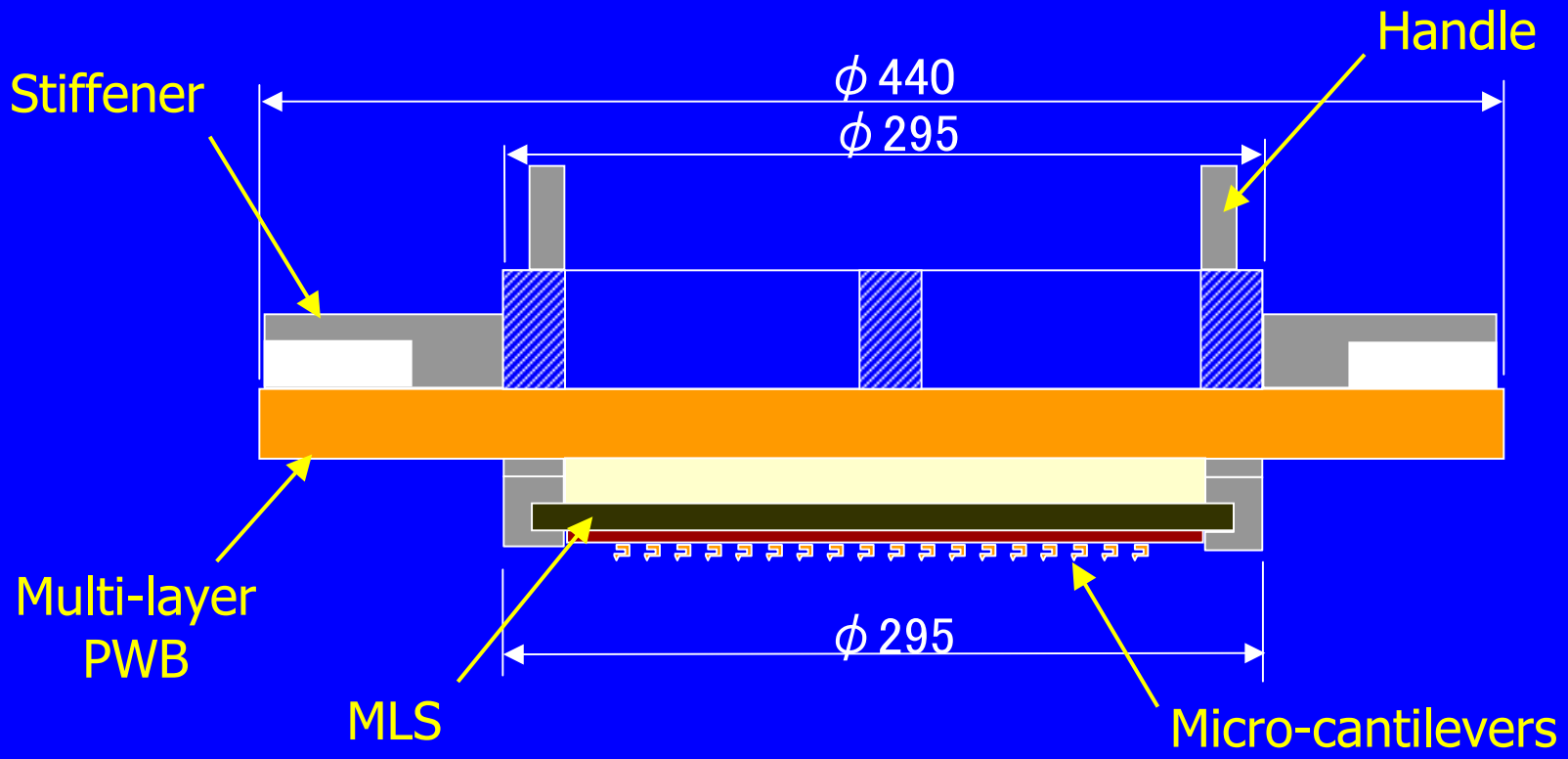
•Specification for FWC Probe-card

Item	Specification
8.Over drive	<=100μm (FC)
9.Scrub mark size	＜25μm
10.MLS to tip Height	270μm
11.Current per probe	<=400mA
12.Frequency	<=200MHz
13.Probe depth	8.3 or 12mm
14.Temperature range	RT～105℃
15.Contact Life	<=500K TDs

* Specification may change without notice

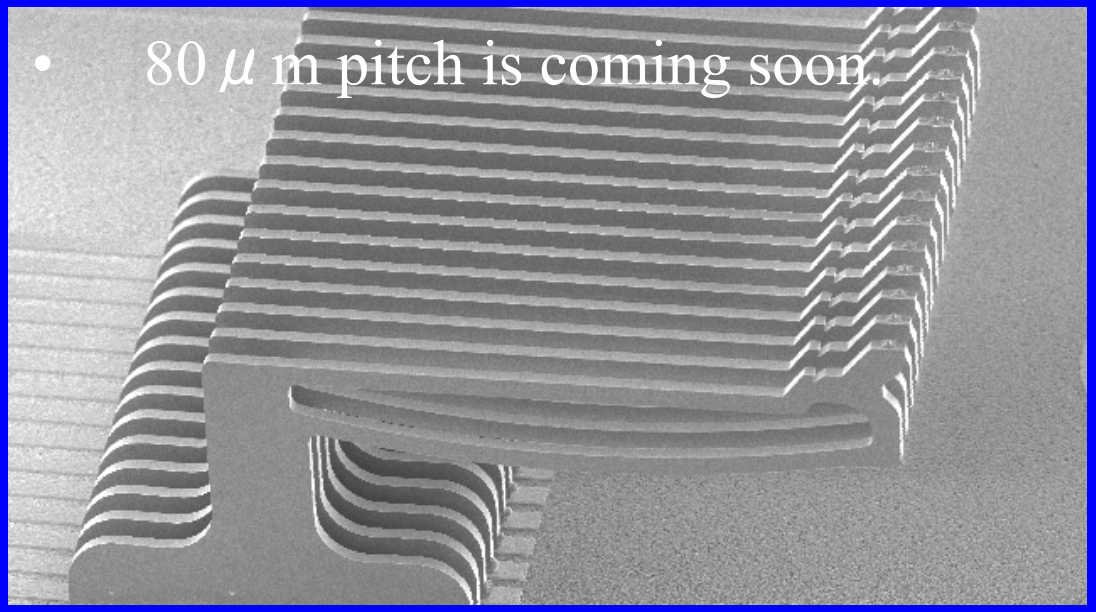
Structure

- Structure of the FWC probe-card consists of Micro-cantilevers, MLS and Multi-layer PWB



Micro Cantilever

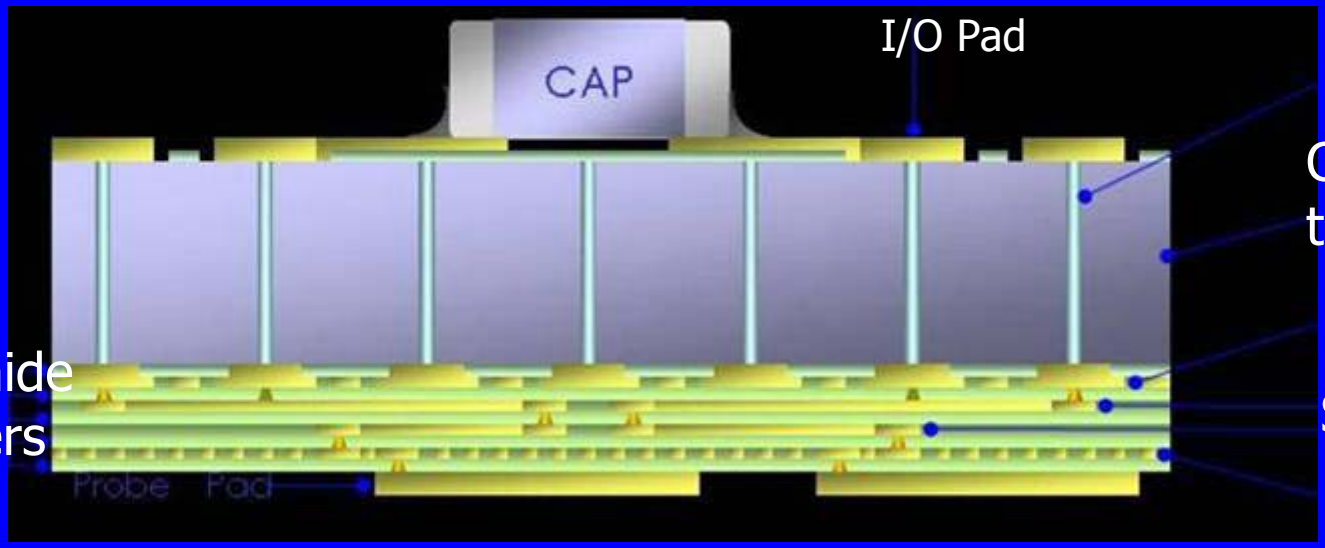
- MJC's micro-cantilever is fabricated by photolithography
  - Reduced size
  - Consistent, well-balanced performance
- A single row of micro-cantilevers with 100 μ m pitch is shown bellow



- 80 μ m pitch is coming soon.

MLS (Multi-Layer ceramic/thin-film Substrate)

- MLS; wiring substrate consists of thin-film metal layers and polyimide dielectric layers on a co-fired ceramic substrate.
- MLS technology was developed in 1985 by NEC for use in their supercomputers.
- NEC developed more than 20 MLS types based on one standard ceramic substrate.



Ceramic TH
ϕ =0.2mm
Pitch=1.5mm

Ceramic Substrate
t=3mm

Metal Pad & GND

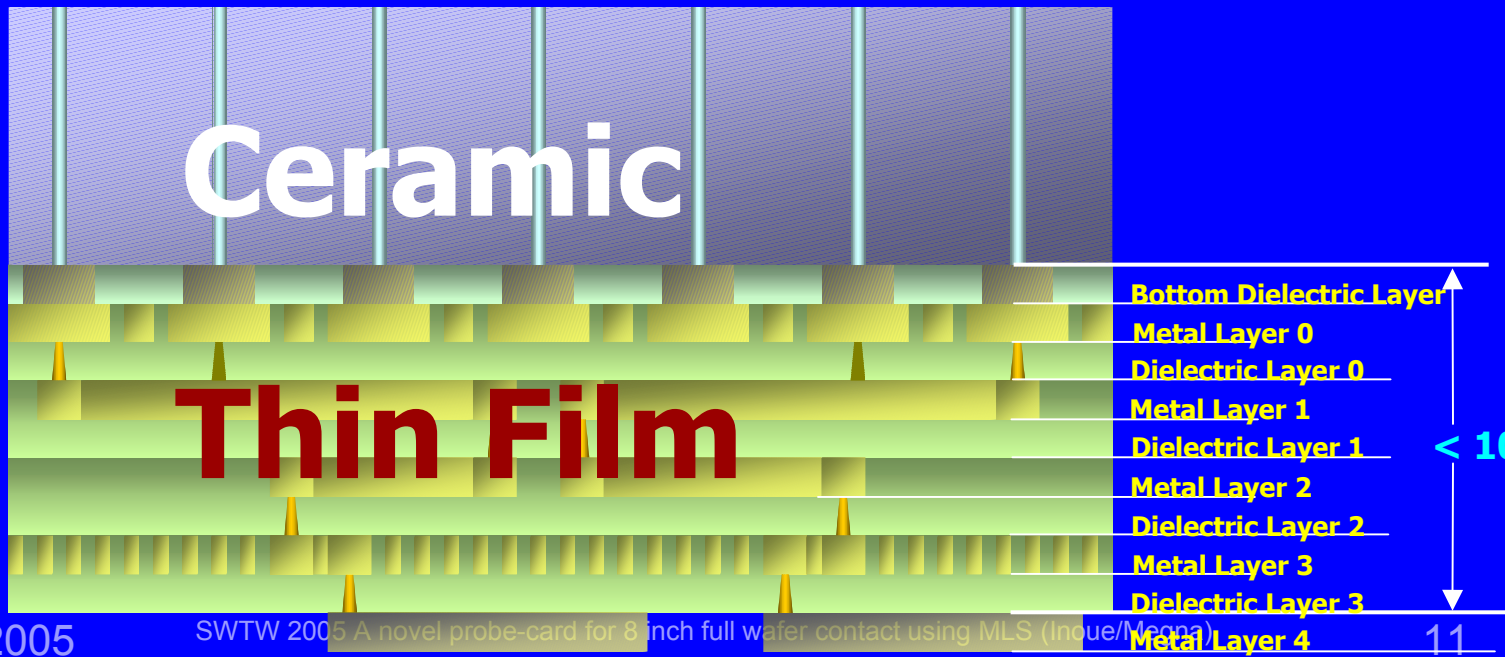
Signal & PS Layer

GND Layer

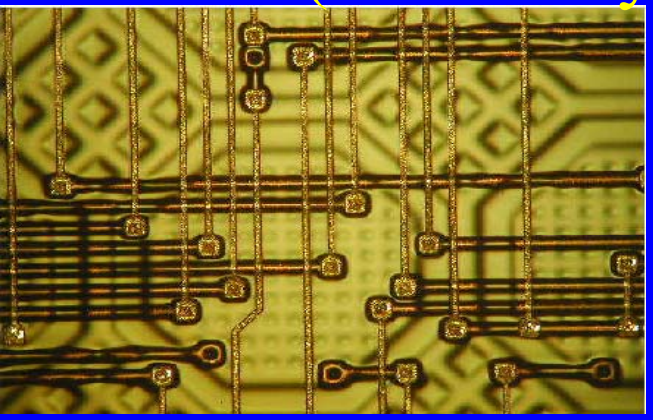
Polyimide Layers

MLS
(Multi-Layer ceramic/thin-film Substrate)

- MJC is now manufacturing MLS under license of NEC.
- Utilizing (5) standard ceramic substrate sizes, we are able to build probe cards from x16 up to 200mm FWC.
- Utilizing standard ceramic sizes results in zero TAT for the ceramic portion.



MLS (Multi-Layer ceramic/thin-film Substrate)



(a) Photograph of Signal Layer (Line width=25 μ m)

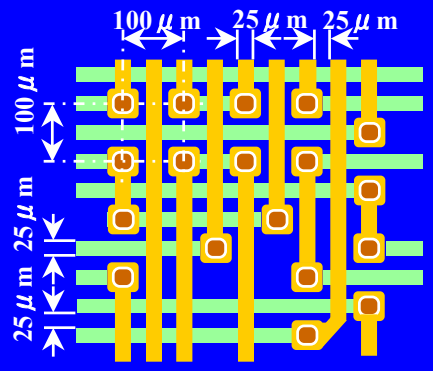
(b) Cross Section of Polyimide Thin-film Layers

- **Comparison with other technologies**

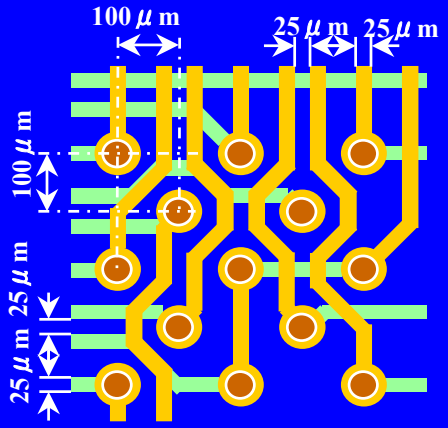
	Ceramic Substrate	**Multi-Layer Substrate**	Build-up PCB	Standard PCB
Via pitch	**0.635**	**0.1**	**0.141**	**0.5**
Via Pad Dia.	**0.381**	**0.052**	**0.075**	**0.35**
Via hole Dia.	**0.203**	**0.032**	**0.05**	**0.15**
Via Pad to line Clearance	**0.254**	**0.012**	**0.025**	**0.15**
Line Width	**0.127**	**0.025**	**0.025**	**0.07**
Space Width	**0.127**	**0.025**	**0.025**	**0.07**
1mm□ Via Count	**1.2**	**100**	**50**	**3**
Max Layer Count	22L	9L	8L	40L
Mask	metal	glass	film(glass)	film
size	220x220mm	225x225mm	250x250mm	500x500mm
thickness	max 5mm	100-200um	4.8mm	6.2mm

- MLS Comparison to other technologies

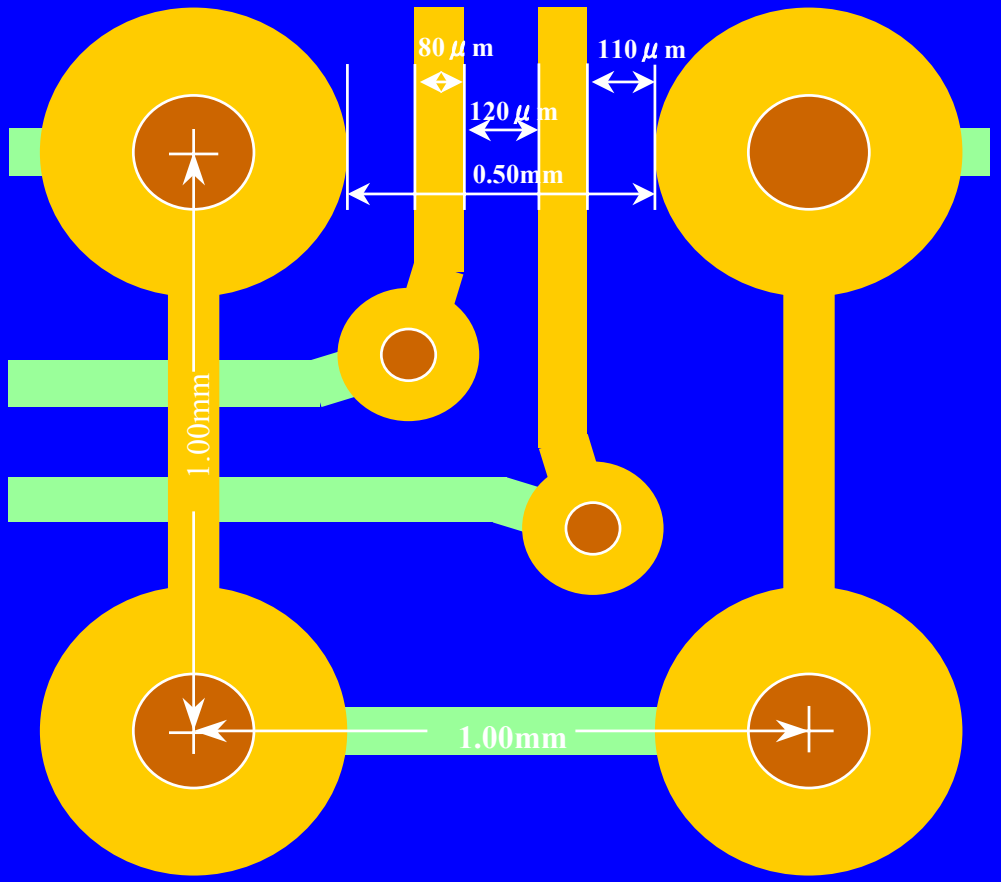
MLS 100 Via/mm²



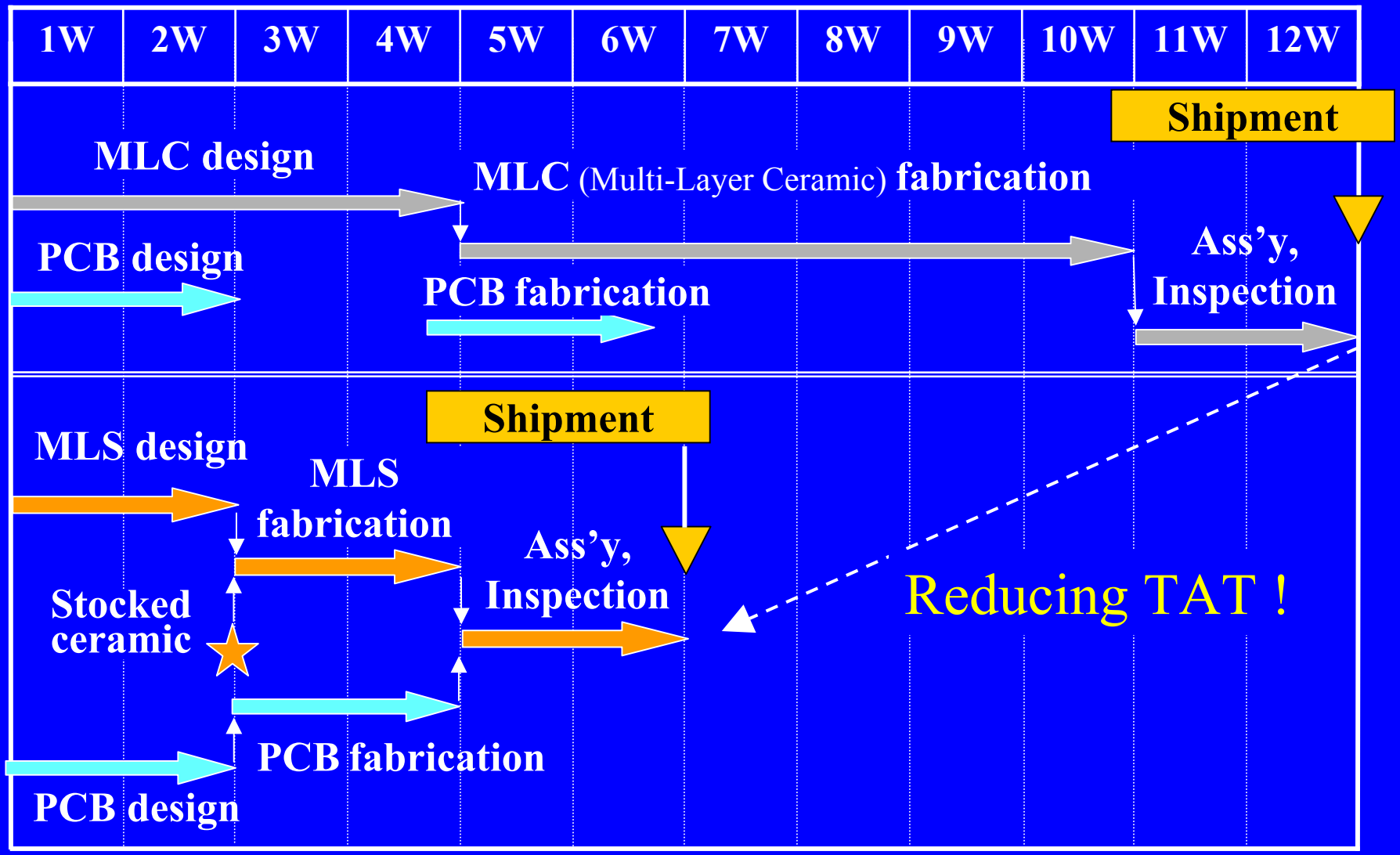
Build-Up PCB 50 Via/mm²



PCB with Buried Via-Holes
3 Via/mm²

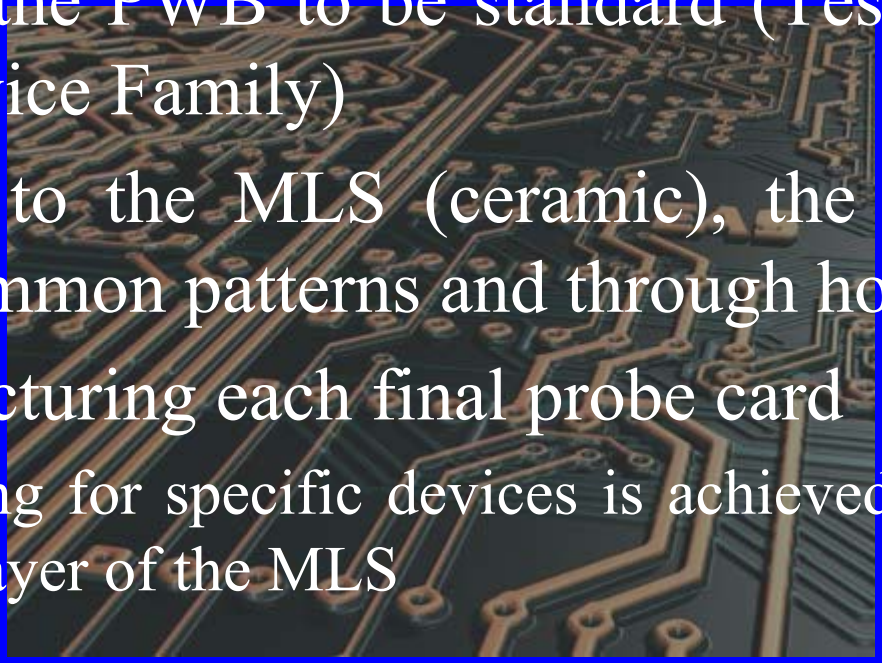


•MLS Reducing total TAT



Multi-layer PWB

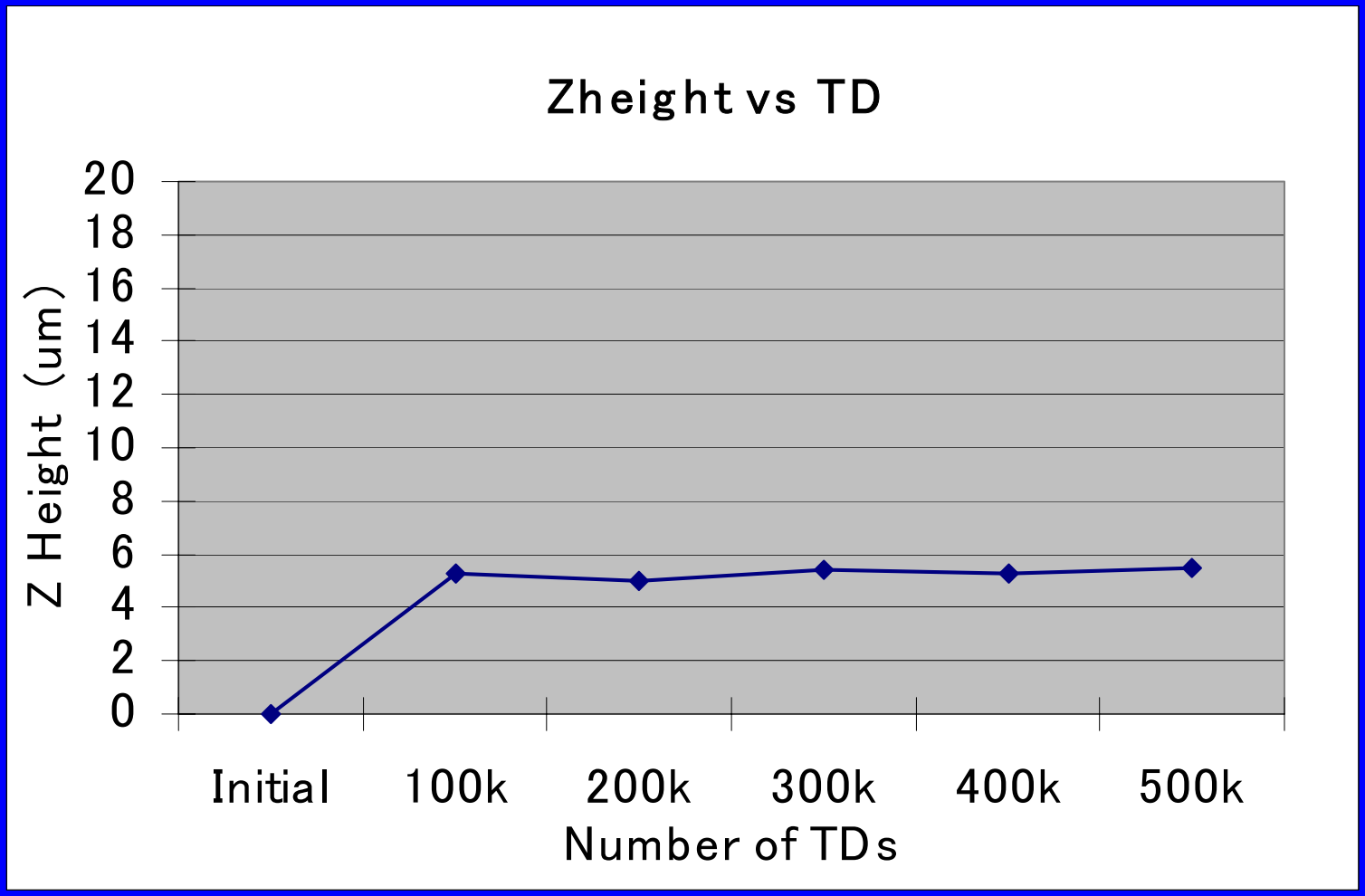
- Applying MLS techniques to the PWB
  - Evolve the PWB to be standard (Test Platform and Device Family)
  - Similar to the MLS (ceramic), the PWB has only common patterns and through holes
  - Manufacturing each final probe card
    - Routing for specific devices is achieved in the thin film layer of the MLS



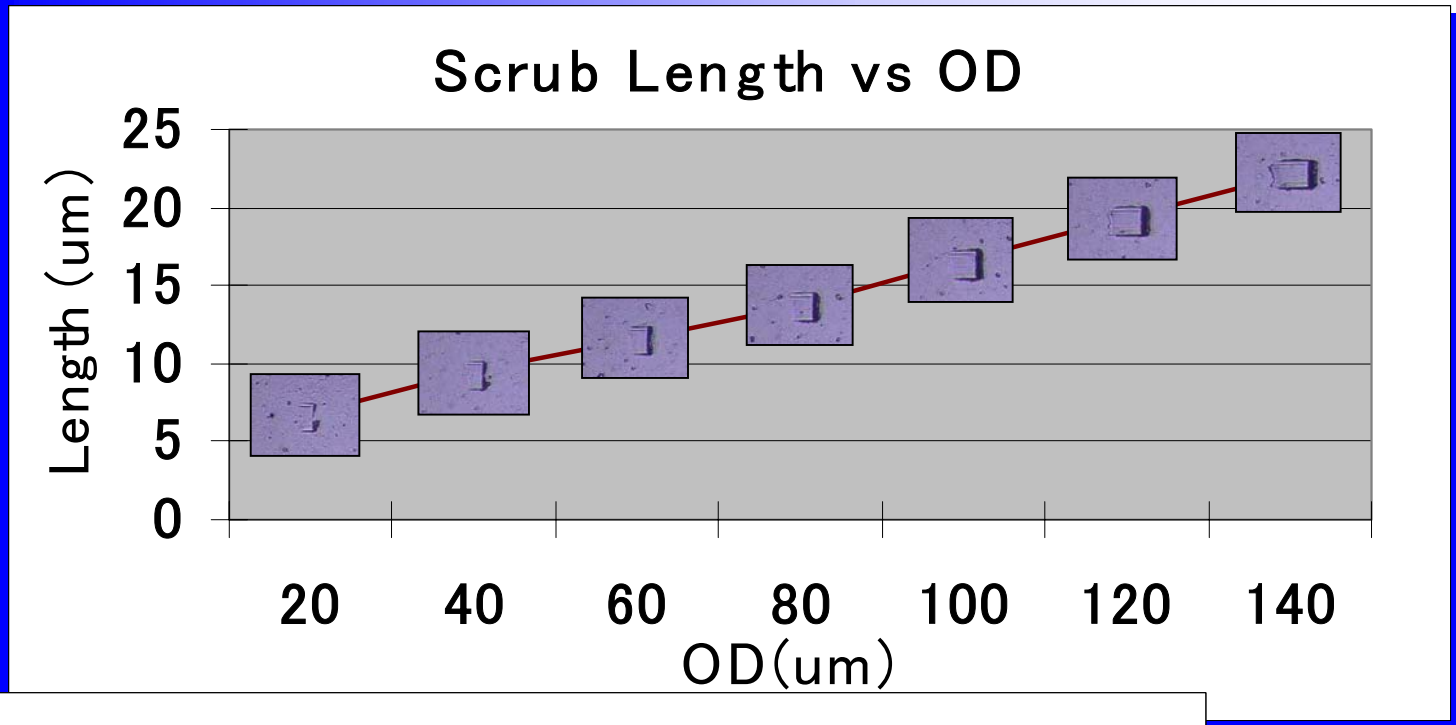
Evaluation

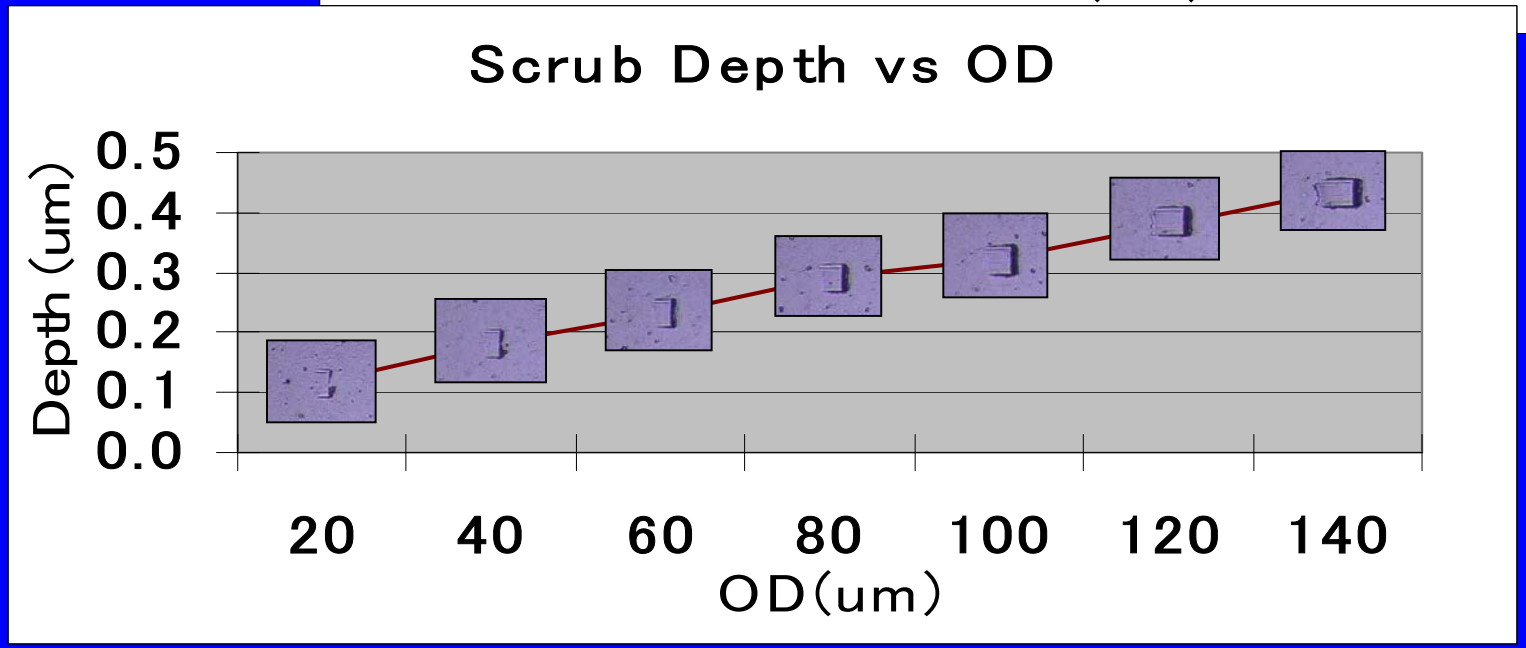
- Life Test
  - 0 to 500K TD
- Mechanical
  - Scrub
  - Contact force
  - Peel strength
  - Joint strength
- Electrical
  - TDR
  - Signal Propagation
  - Contact Resistance

- Z Height vs Touch Downs



Evaluation (Mechanical)





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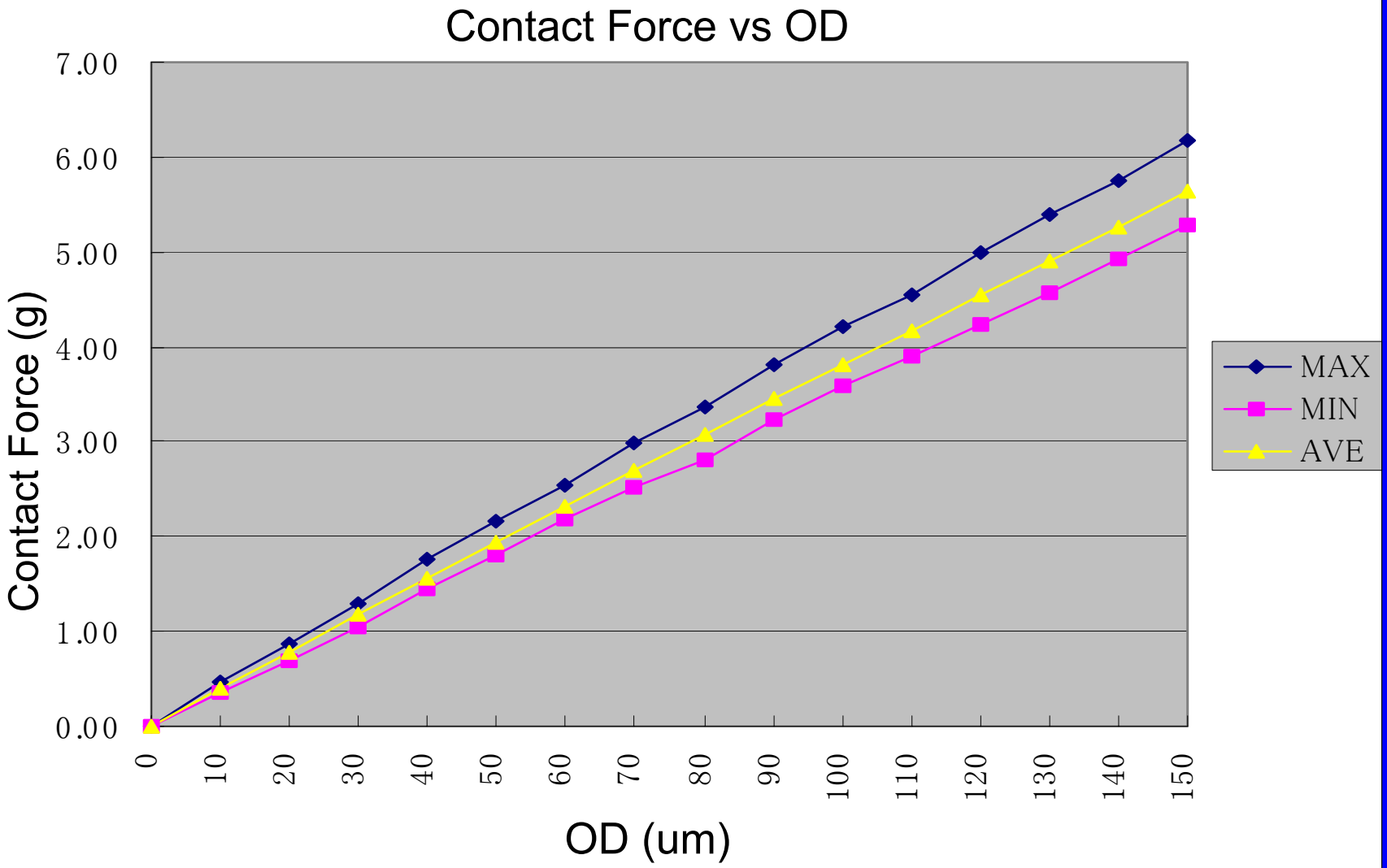


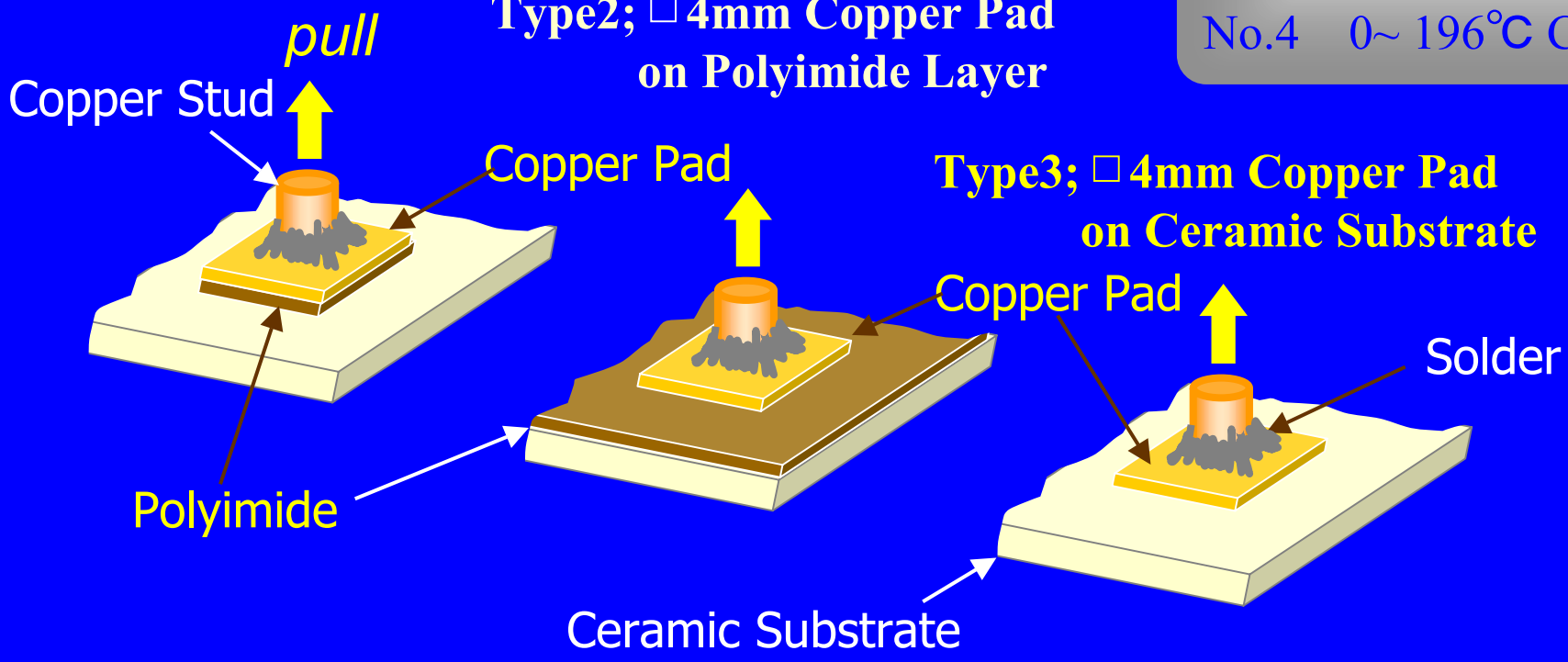
Evaluation (Mechanical)

- Peel Strength of MLS

Type1; □4mm Polyimide Pad on Ceramic Substrate

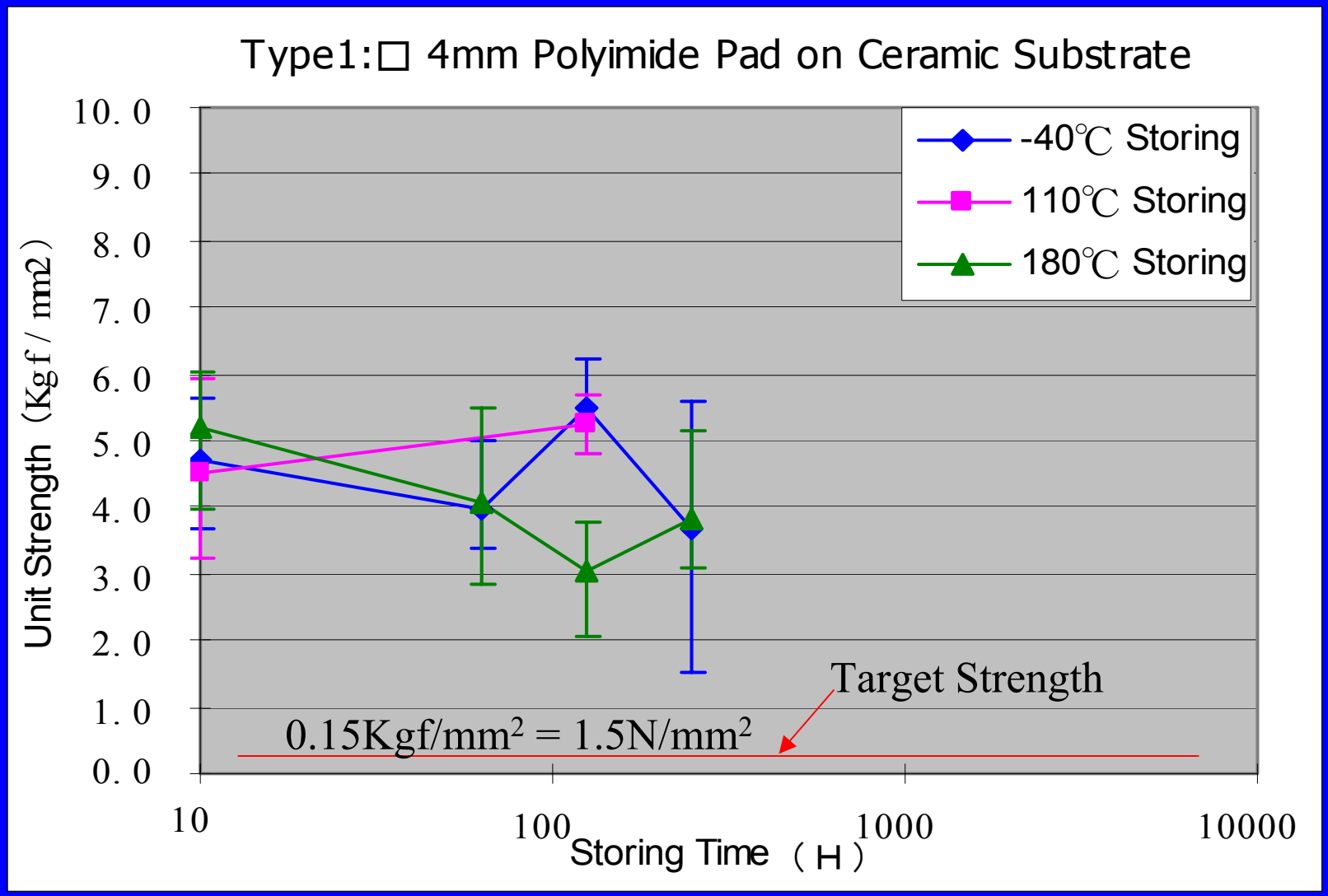
Type2; □4mm Copper Pad on Polyimide Layer

Type3; □4mm Copper Pad on Ceramic Substrate



Storage Conditions ;	
No.1	–40℃
No.2	110℃
No.3	180℃
No.4	0~ 196℃ Cycle

• Peel Strength of MLS



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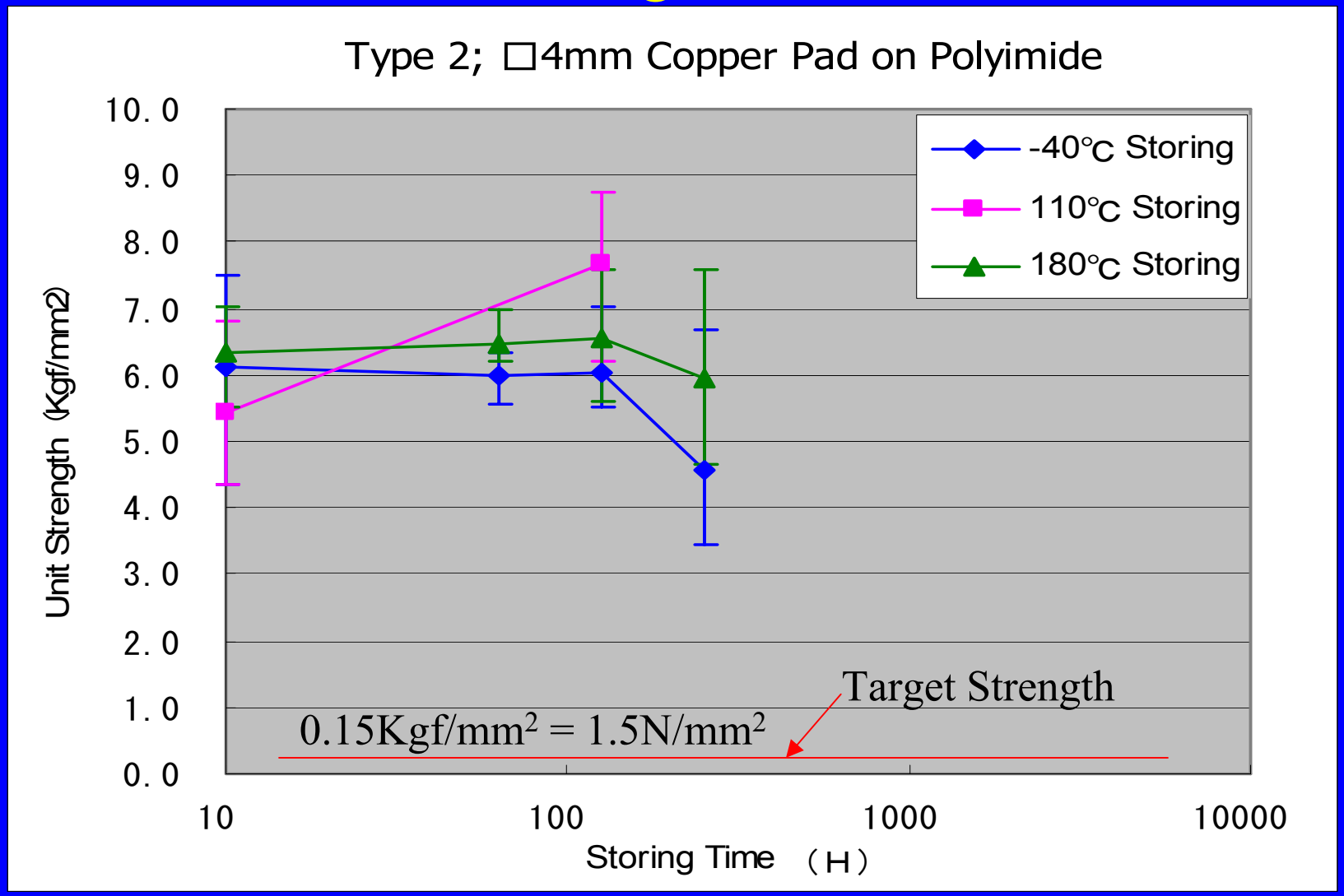

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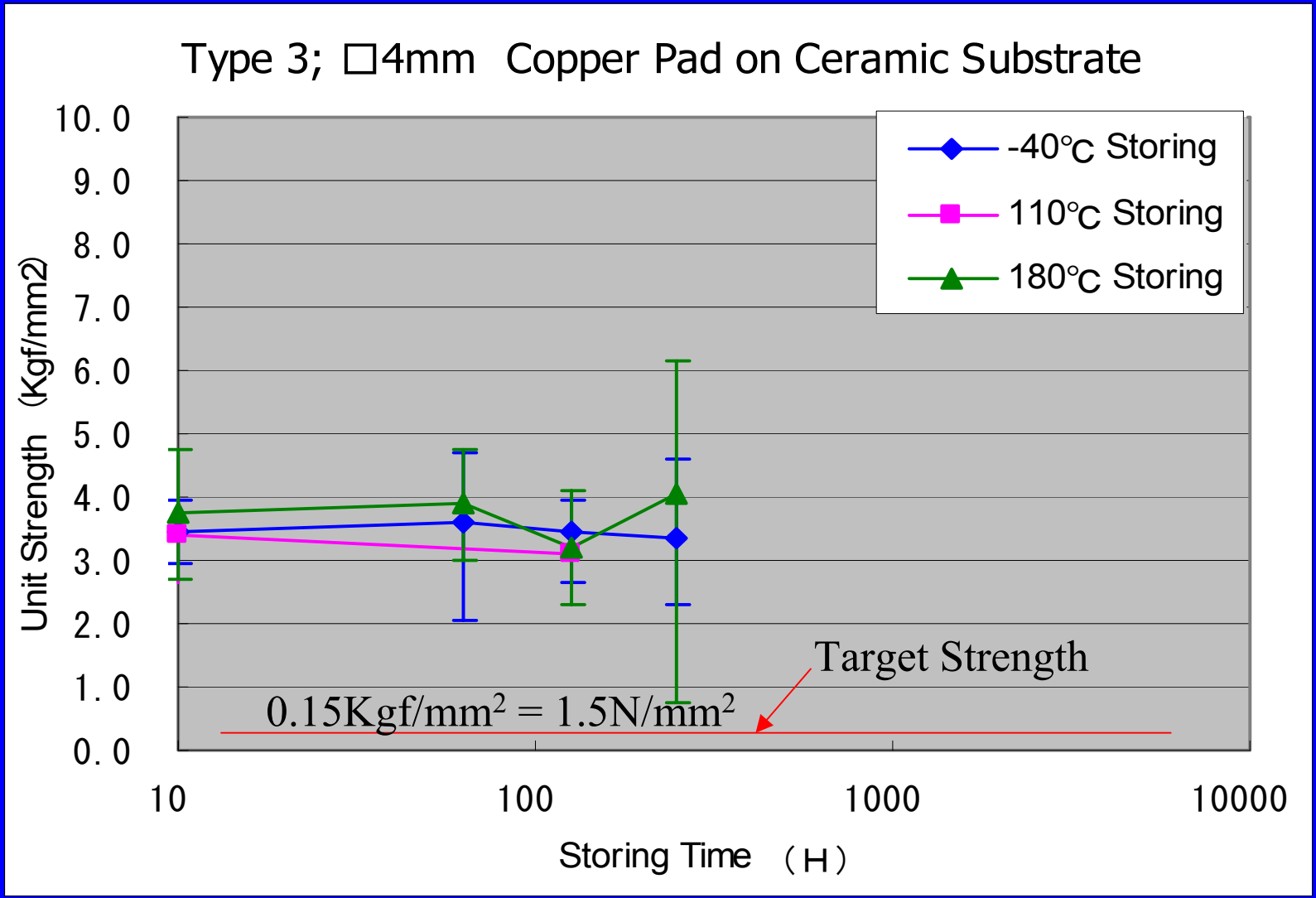

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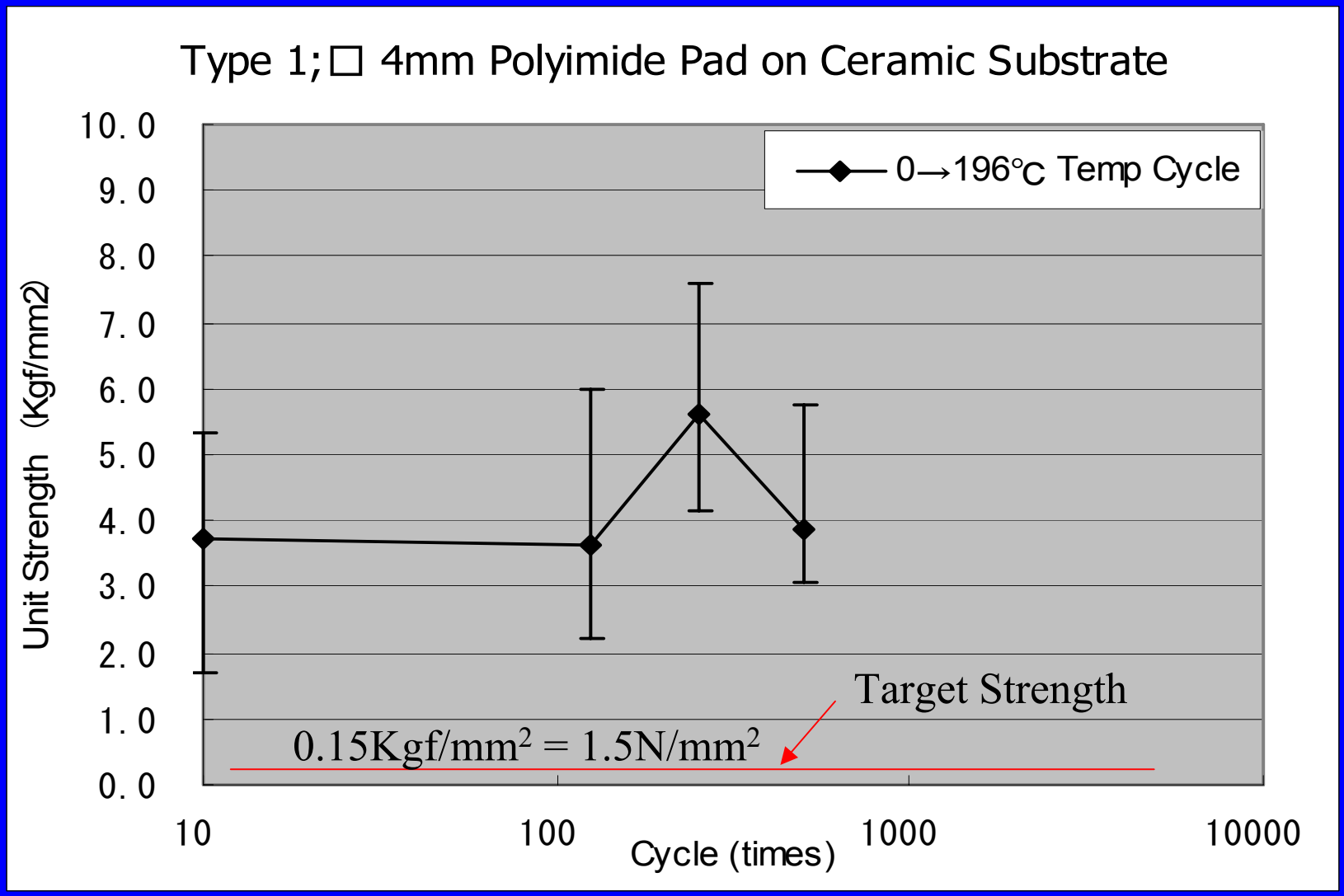

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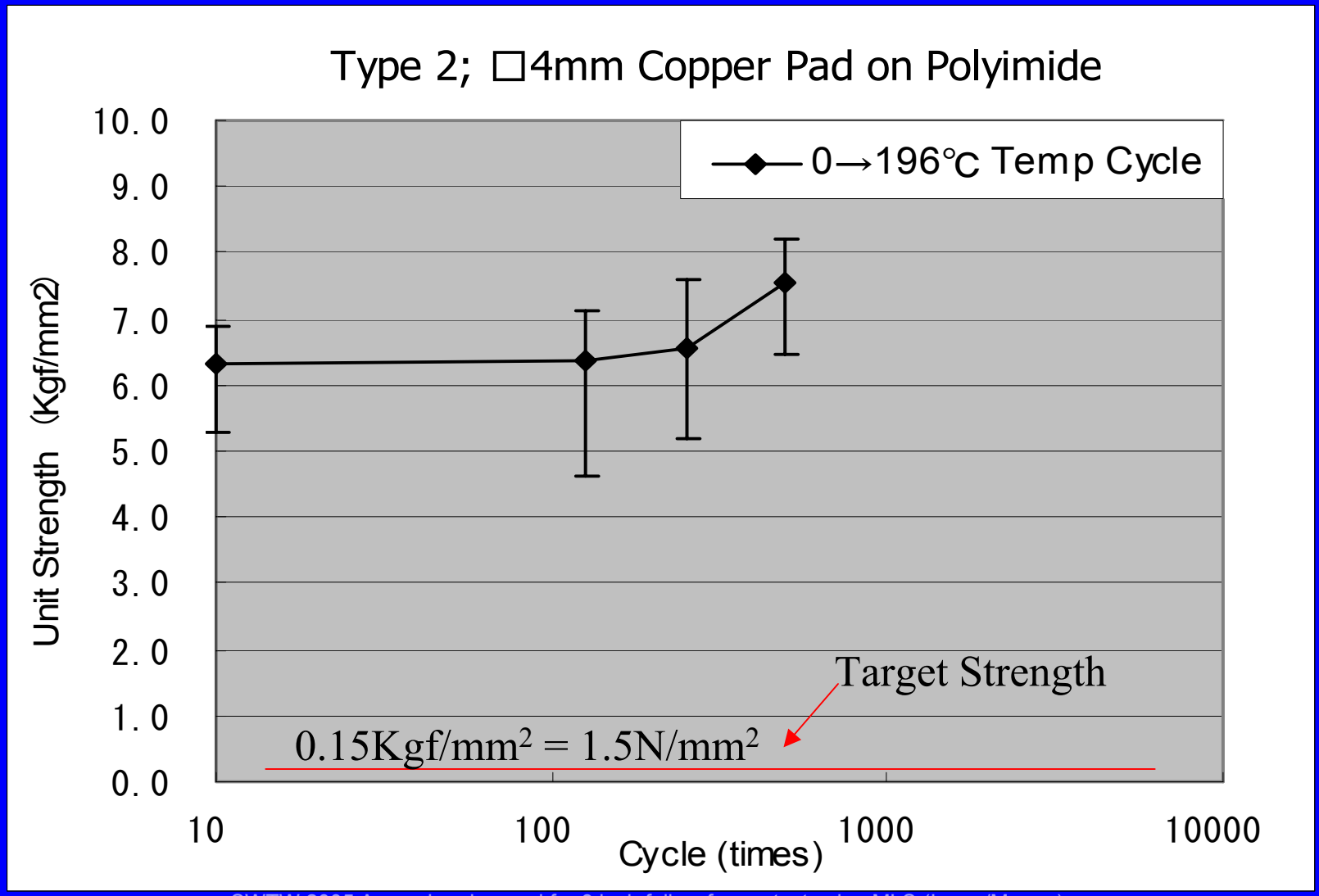
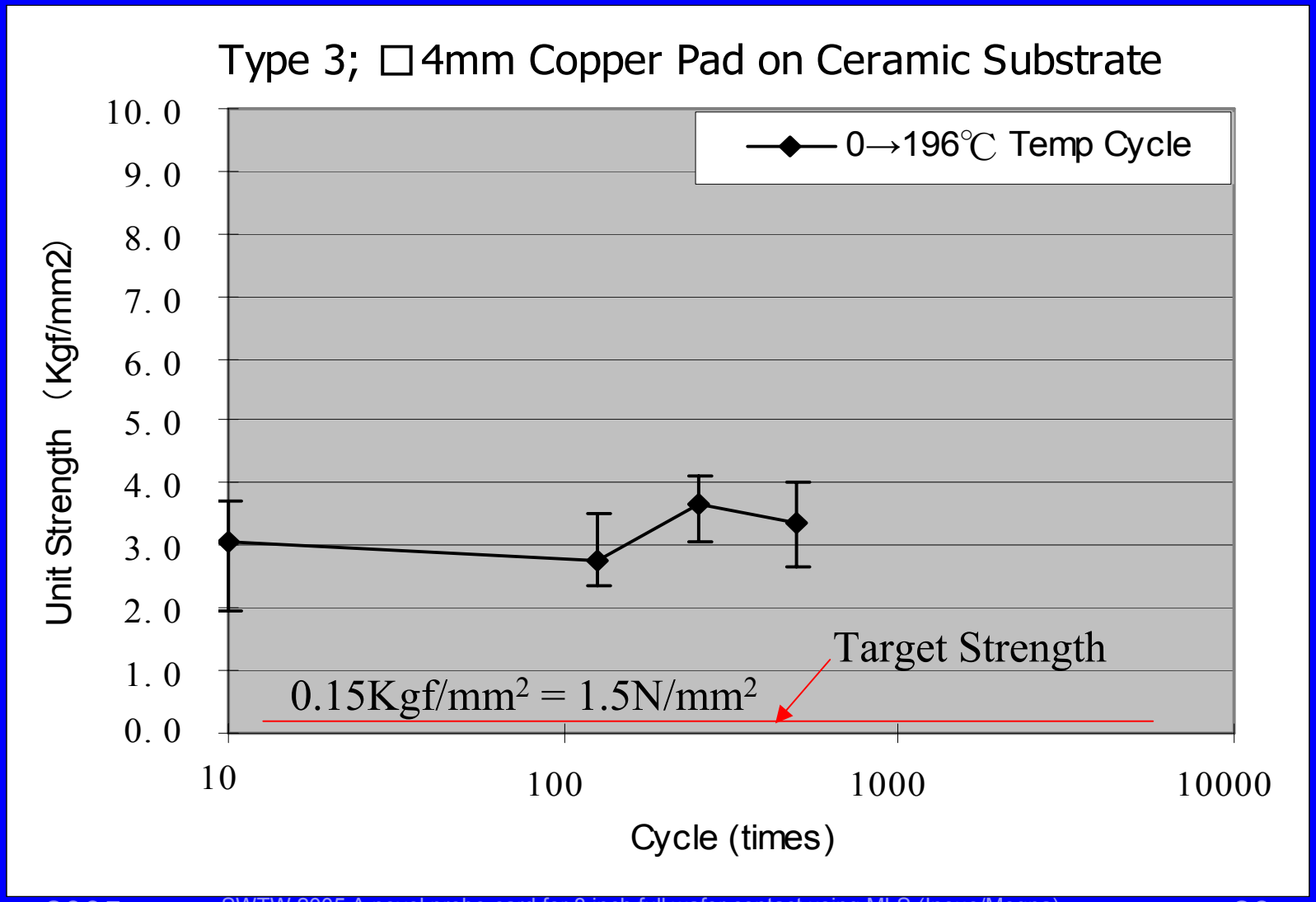
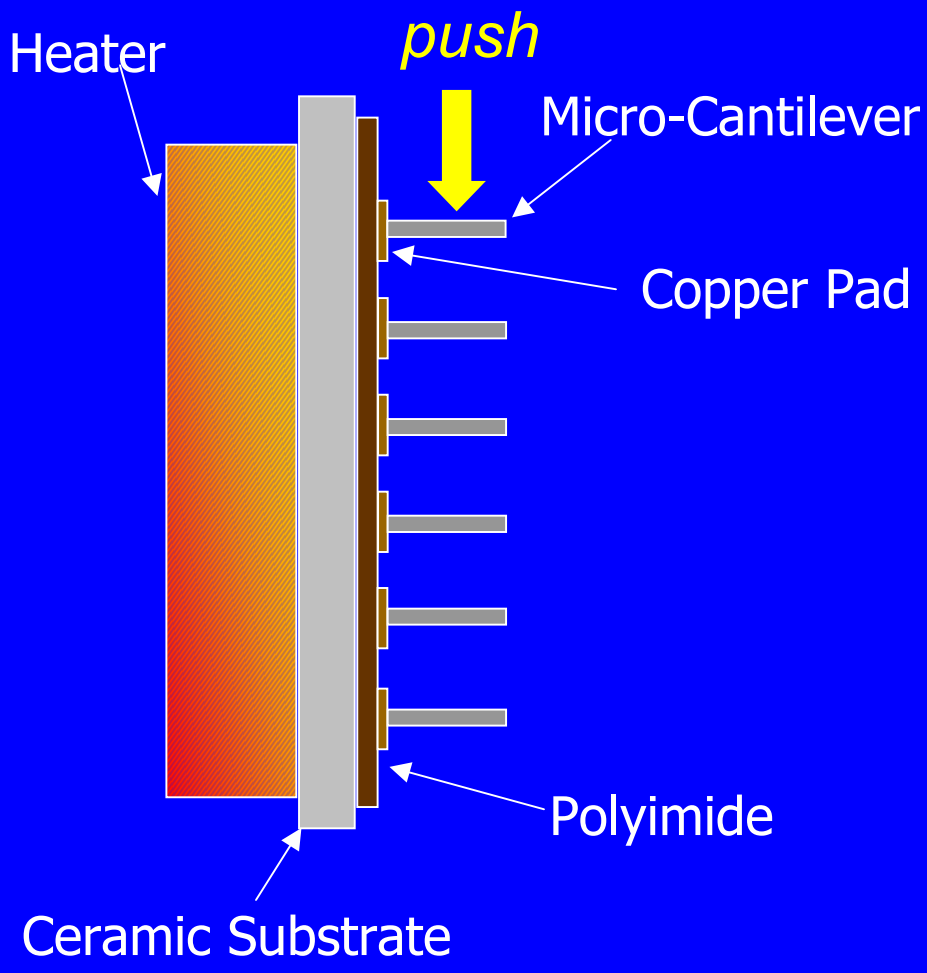
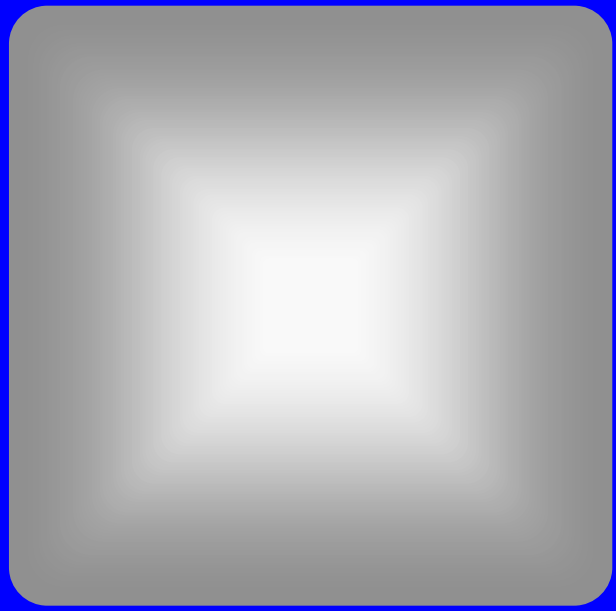


• Peel Strength of MLS



- Joint Strength of Micro-cantilever on Substrate

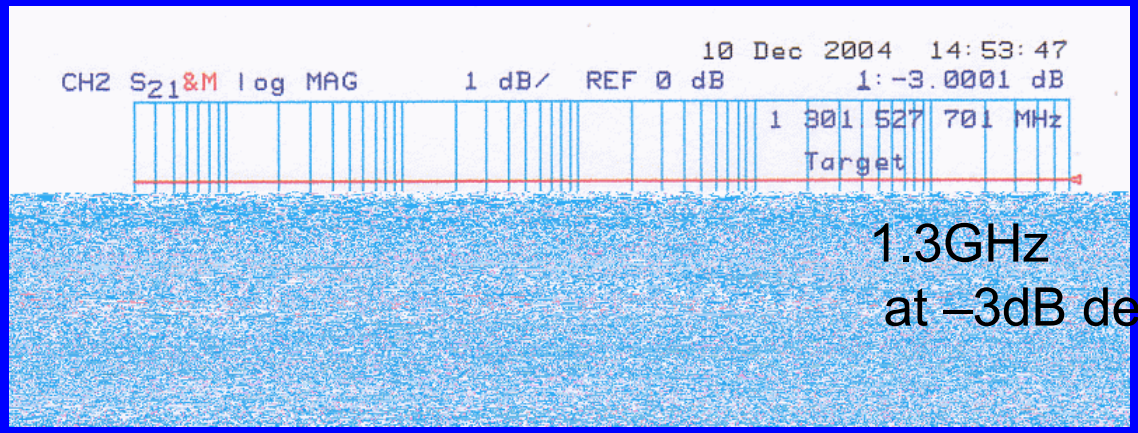


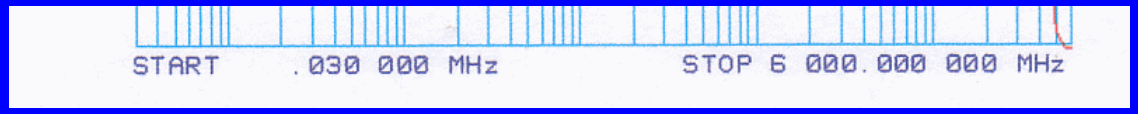


Evaluation (Electrical)

•Electrical Characteristic

Signal propagation characteristics through 100mm MLS signal line





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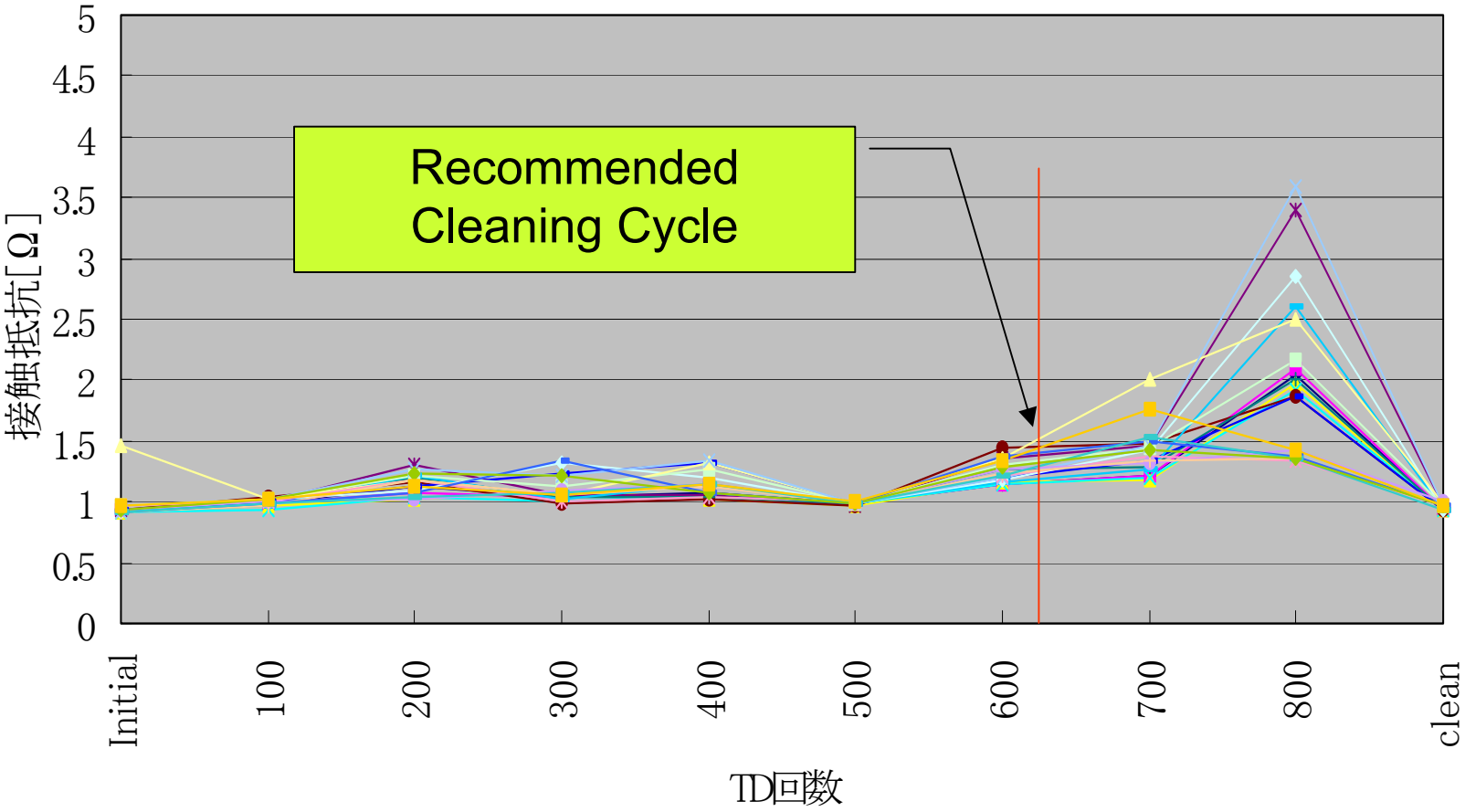

Future Work

- Development for high speed and high frequency signal propagation (>= 500MHz)
- Probe-cards for 12 inch full wafer contact testing

Conclusion

- A probe-card for 8 inch-wafer full contact has been completed and shipped with the structure consisting of; Micro-cantilevers, MLS and PWB.
- These are now being used in high volume manufacturing.
- Fine Micro-cantilevers and thin-film processed MLS have realized more than 6,000 contacts, with 100um pitch on a single probe-card.
- Design and manufacturing of a specialized MLS on a common ceramic substrate, and the combination of a common PWB realizes 6 weeks TAT for a completed probe-card.
- The evaluation results of several advanced probe-cards show excellent reliability and high frequency performance (up to 300MHz).

Acknowledgements

- Thanks to Yoshiei Hasegawa, the CEO of MJC for his outstanding guidance and support of 8inch FWC probe-card development.
- Thanks to Hisatoshi Shirasaka and Shizuo Tsuiki for their long term efforts to establish fundamentals of photolithograph technology.
- Thanks to the members of Aomori Plant, Mitaka Lab., Ibaraki Technology Lab. and U.S. team for their collaboration to develop 8inch FWC probe-card.