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Probe Card Cleaning by Laser

June 6 to 9, 2010

San Diego, CA USA

Contents

- PC cleaning Issues & Needs
- Conventional cleaning & problems
- IMT Laser cleaning technique
- Advantages of laser cleaning
- Results of laser cleaning
- Laser cleaning systems
- Summary & Conclusions
- Others: LCD Probe & Socket cleaning

Key Issues & Needs

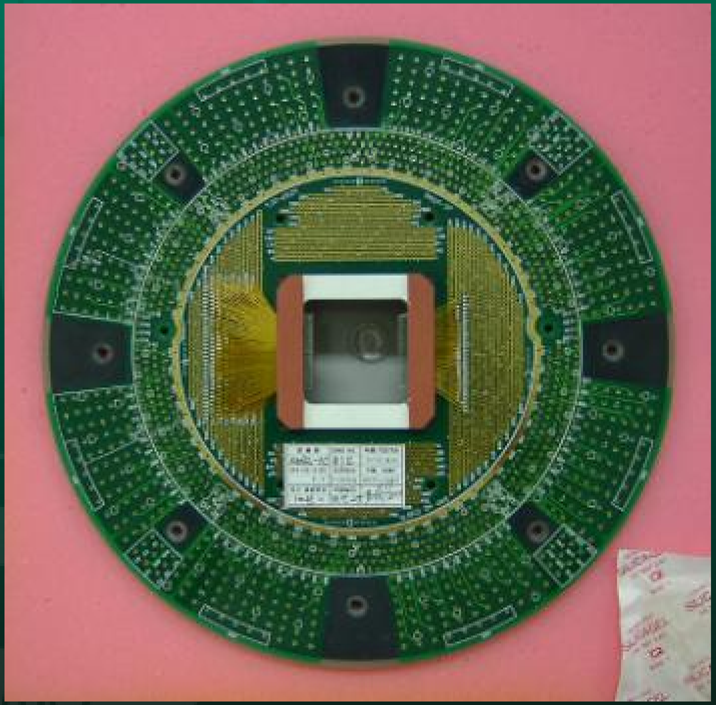
- **Issues**

: Tip Contamination in Fine pitch or MEMS probe

1. Rc increase > poor contact

2. Leakage occurrence

=> Yield drop



- Needs

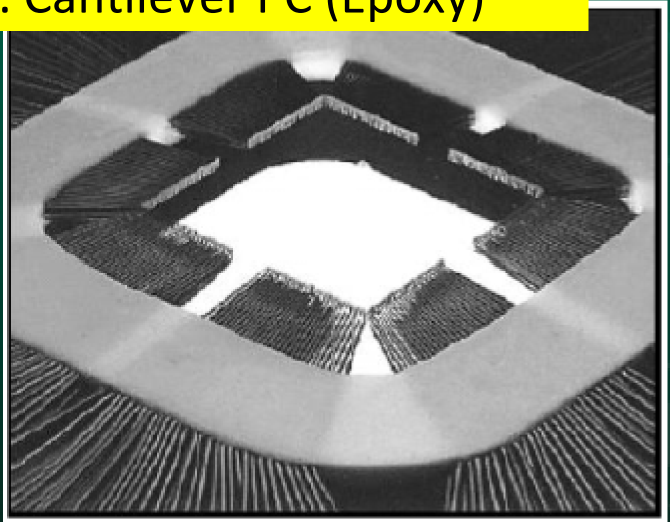
1. Precise cleaning tool

2. Damage free cleaning tool

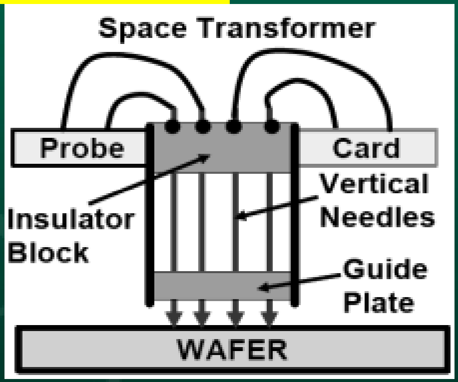
=> Solution : Laser Cleaning

Background - Probe Card Types

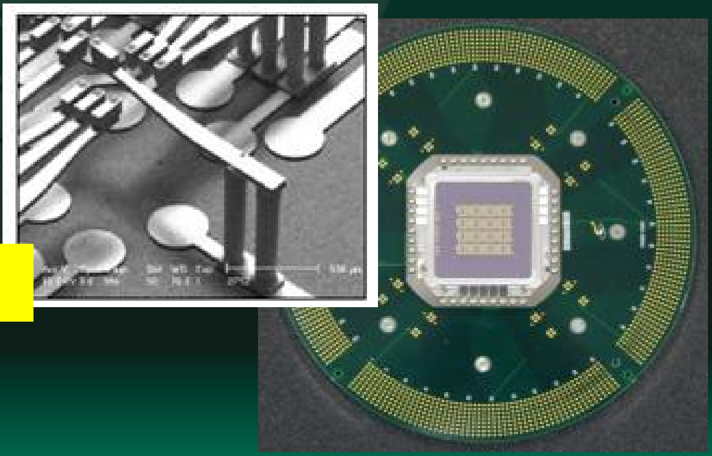
1. Cantilever PC (Epoxy)



2. Vertical PC

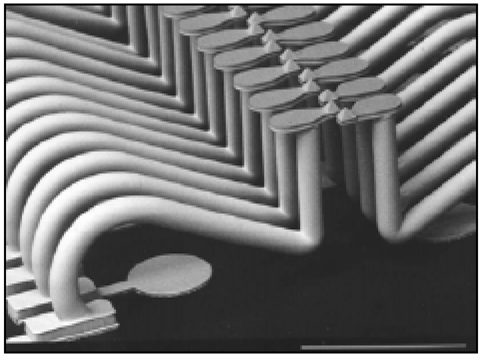


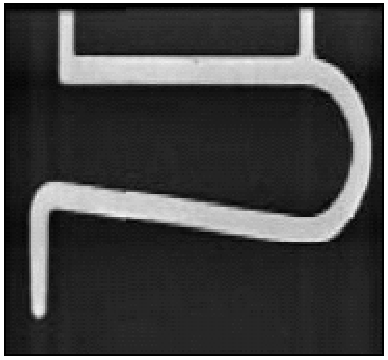
3. MEMS PC

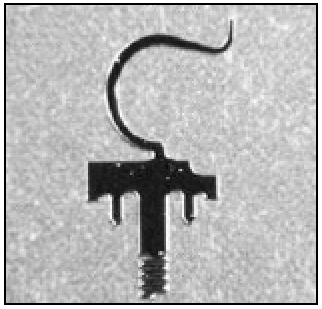


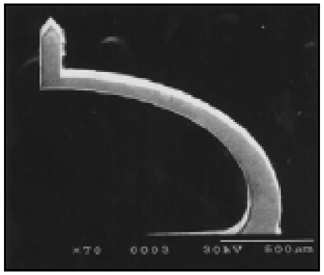
Background - Contactor Shape

Spring type

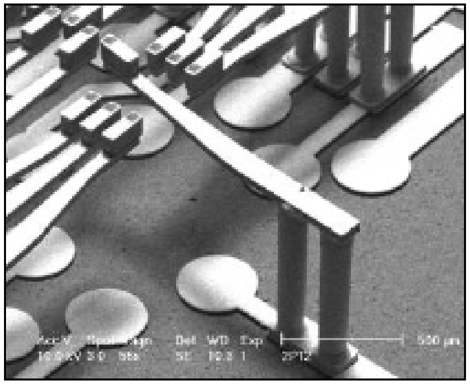

FormFactor


JEM HAWK


Advantest Labs


Sumitomo

MEMS type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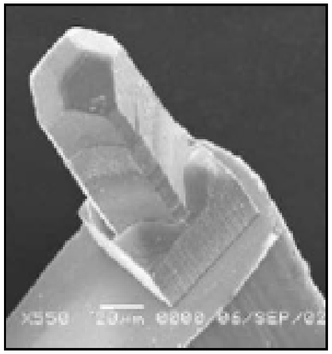
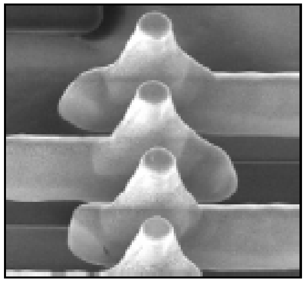

Phicom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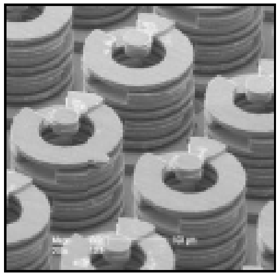

Microfabrica

Conventional Cleaning & Problems

Conventional PC cleaning

: Mechanical contact using abrasive pad at Prober

Problems

1. Difficult to clean the probe sides
2. Probe wear due to contact cleaning => PC Lifetime reduction
3. PC Alignment & planarity change due to contacts => Lifetime red.
4. Consumable Abrasive pads => Extra cost
5. No cleaning solutions for MEMS PC due to delicate structures

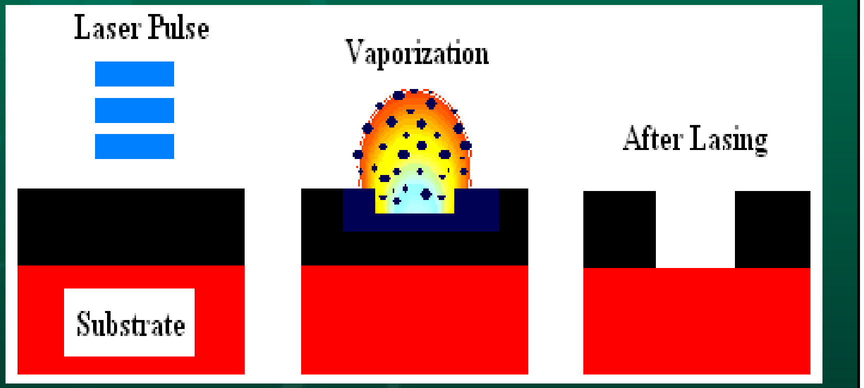
Probe Tip Inserted into Cleaning Polymer

***** Effective, No damage & wear, Fast cleaning method required**
=> Laser Cleaning

IMT Laser Cleaning

What is a laser cleaning

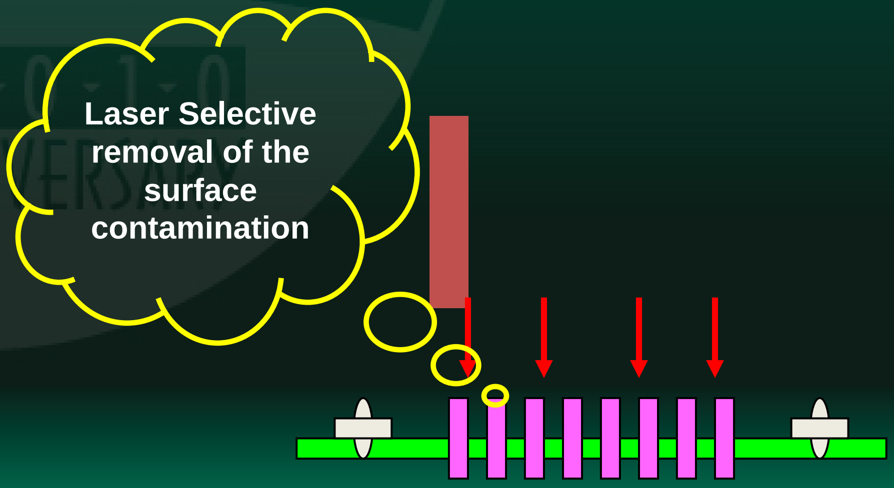
: Dry cleaning technique to remove the surface contamination selectively without inducing any substrate damages by using proper laser beam irradiation



Ref: “Lasers & Cleaning Process”, JMLee (2002)

Laser cleaning of probe card

: Various contamination removal process from the probe surface without inducing any substrate damage by using proper laser interactions between laser and contamination. Then enhance the test yield.

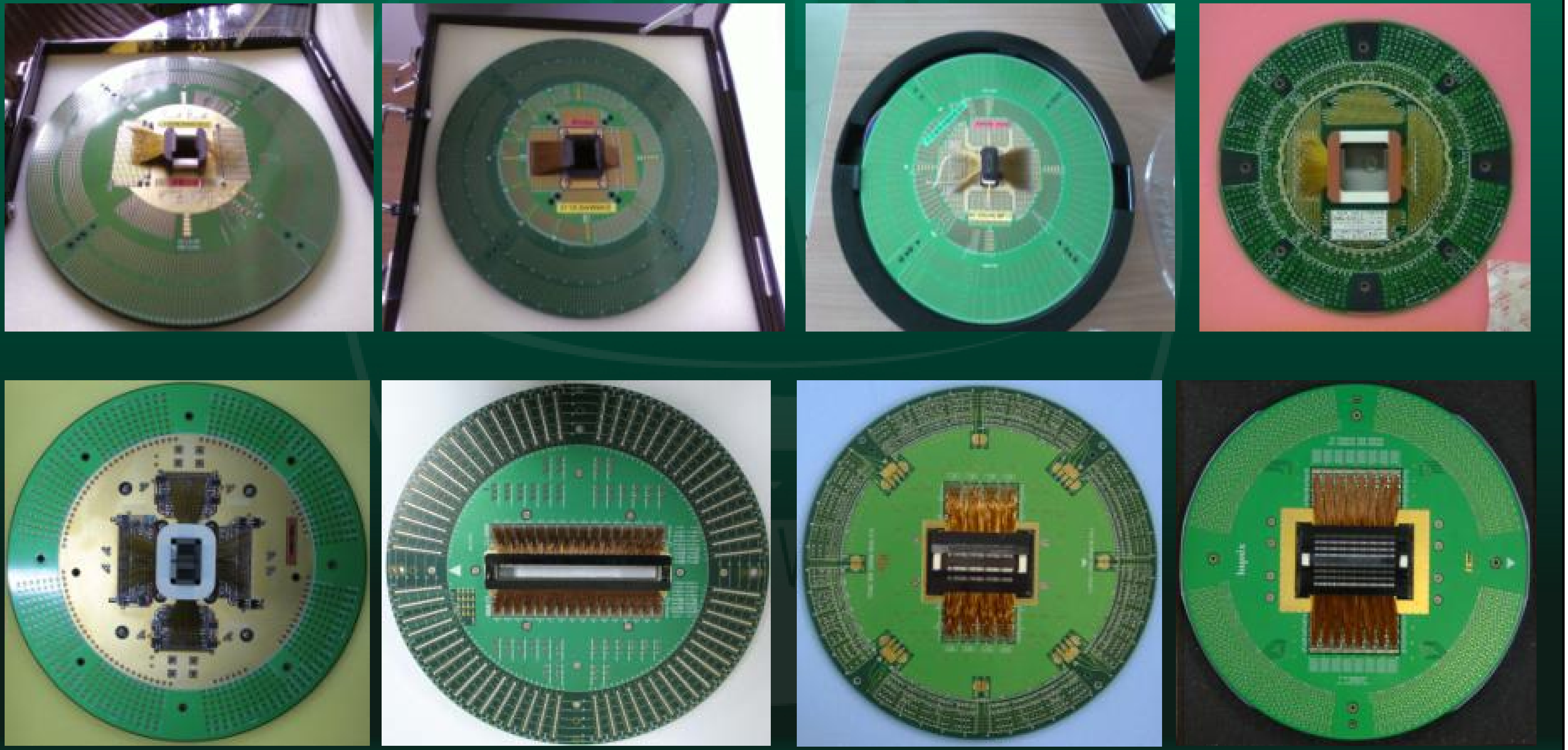


Laser Selective removal of the surface contamination

Advantages of Laser Cleaning

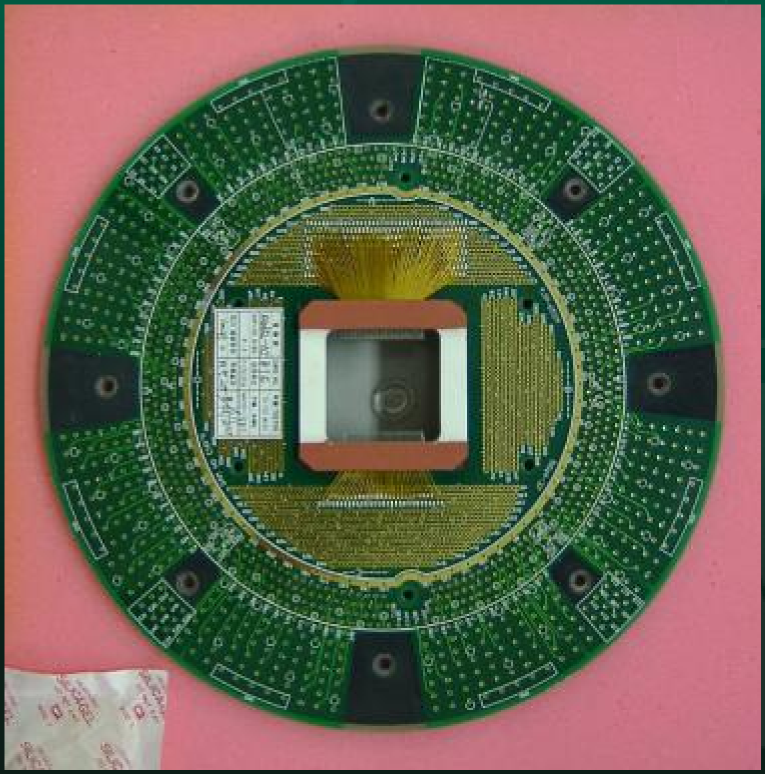
1. Excellent cleaning performance by selective removal of only contamination => top & side
2. No Probe wear due to non-contact process
3. Damage free process due to no physical touch & loads => No planarity & alignment change
4. Very fast cleaning process : <10min/300mm one touch PC
5. Very fast response process for emergency case
6. Safe process: no chemical use and automatic cleaning

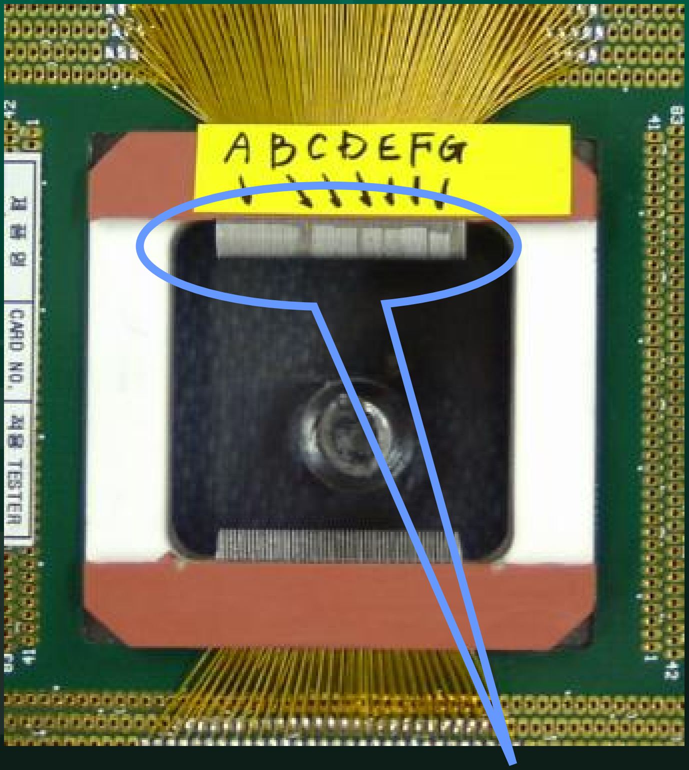
Cantilever PCs – W, ReW



Cantilever Type PC

- **The Samples before Laser Cleaning**

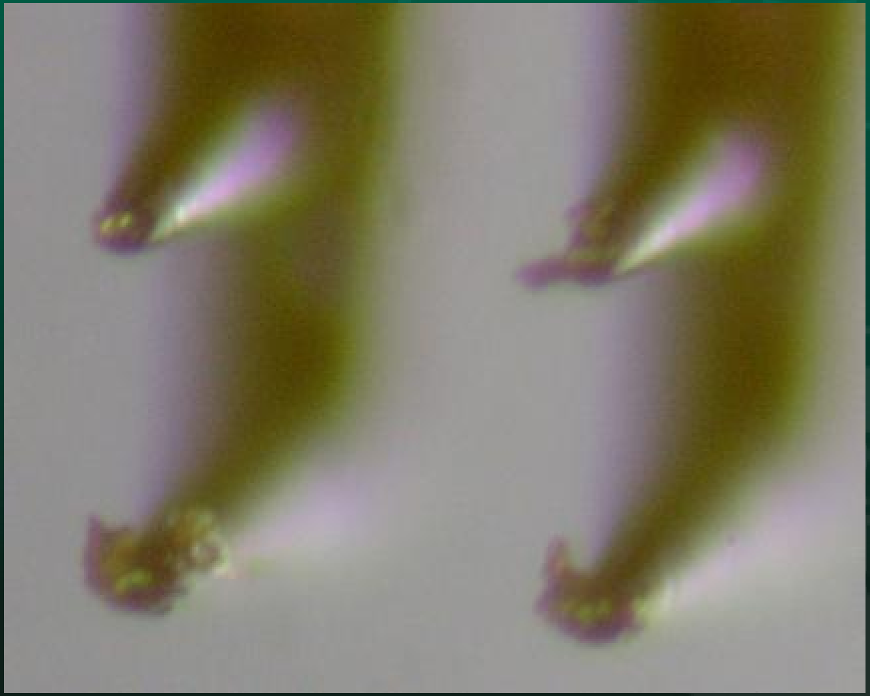




Laser Treated Area

Cleaning Test Result

- Probe Surfaces Before & After Cleaning (x50)

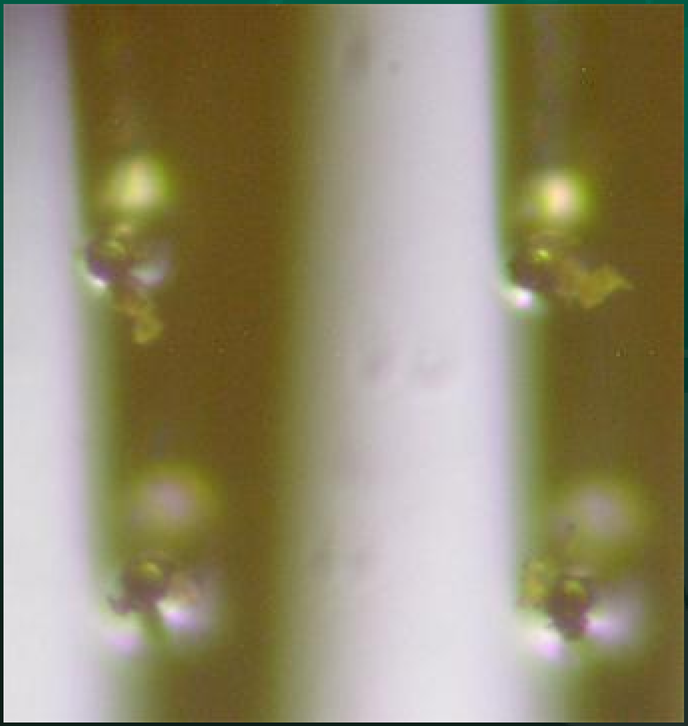


Before Cleaning

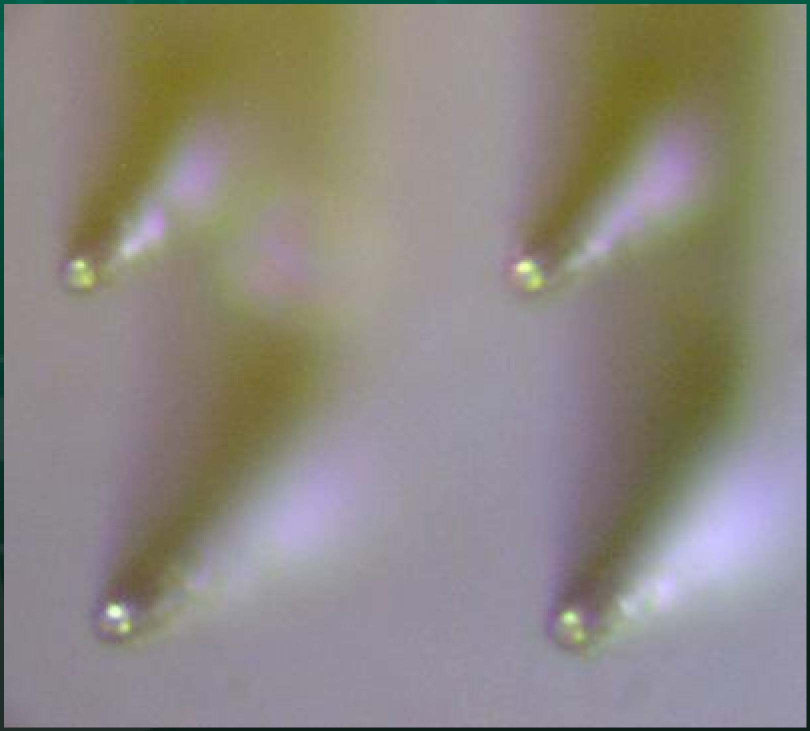
After Cleaning

Cleaning Test Result

- Probe Surfaces Before & After Cleaning (x50)



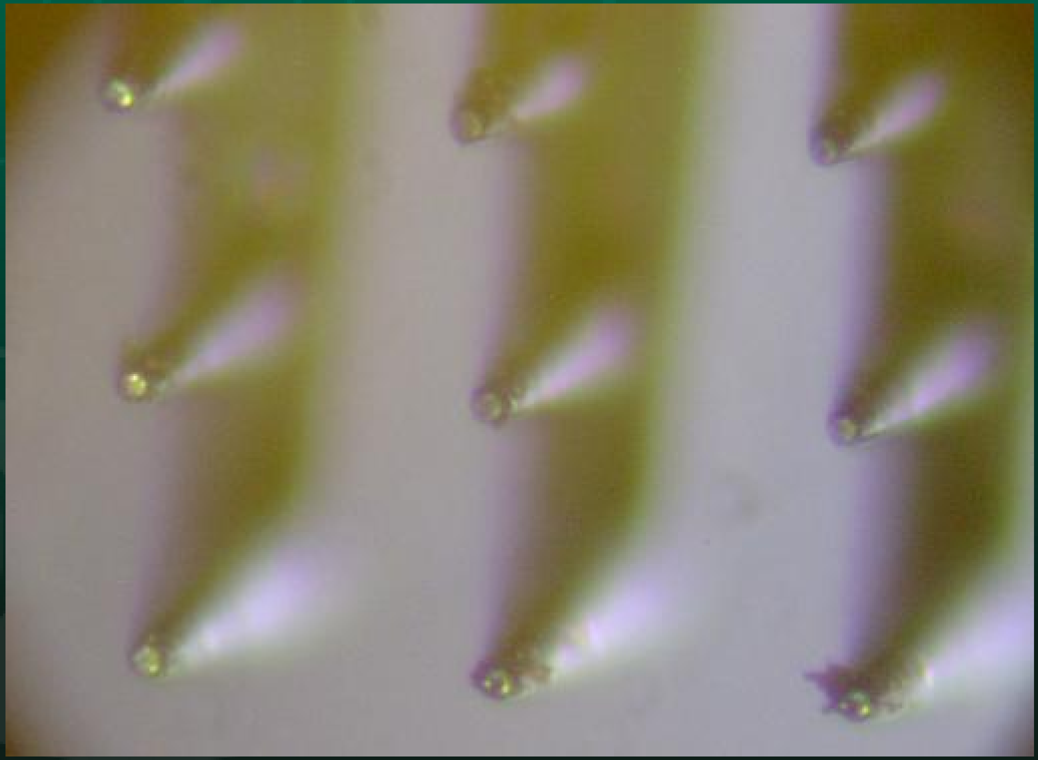
Before Cleaning



After Cleaning

Cleaning Test Result

- **Boundary Region (x50)**



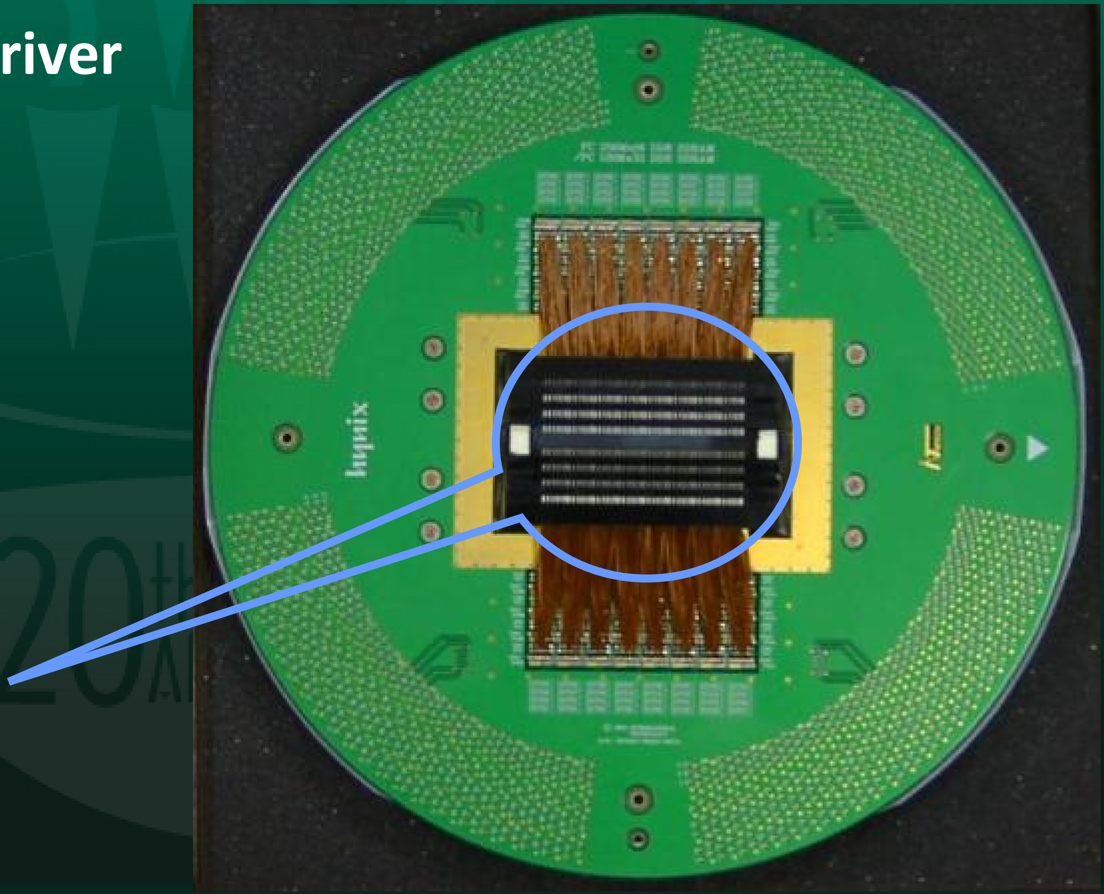
F-G boundary region

Cleaned Area
(F-region)

Uncleaned Area

4 Layer Cantilever PC

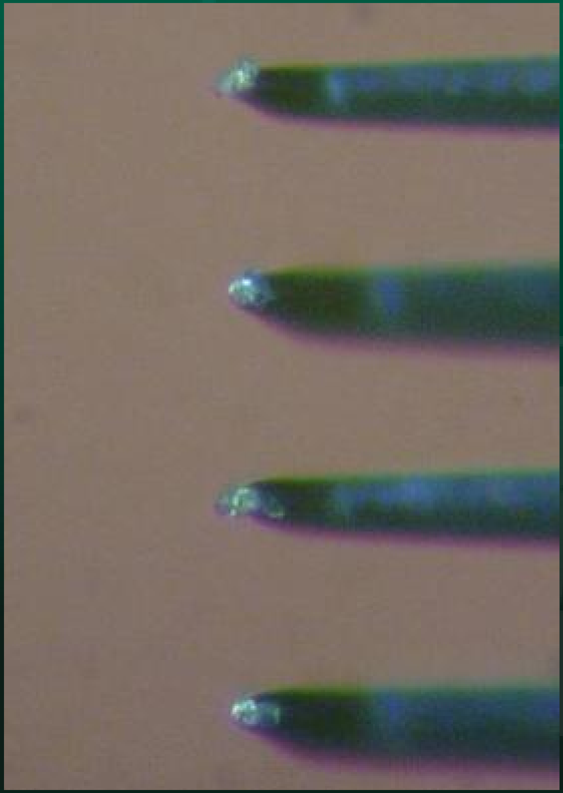
- **Probe Card for IC driver chip**



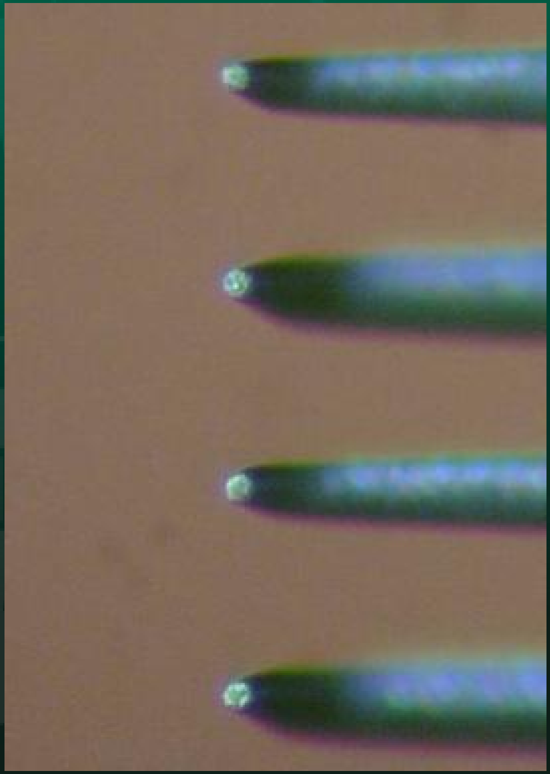
Cleaning Area

Cleaning Result (1)

- **Probe Surfaces Before & After Cleaning (x50)**



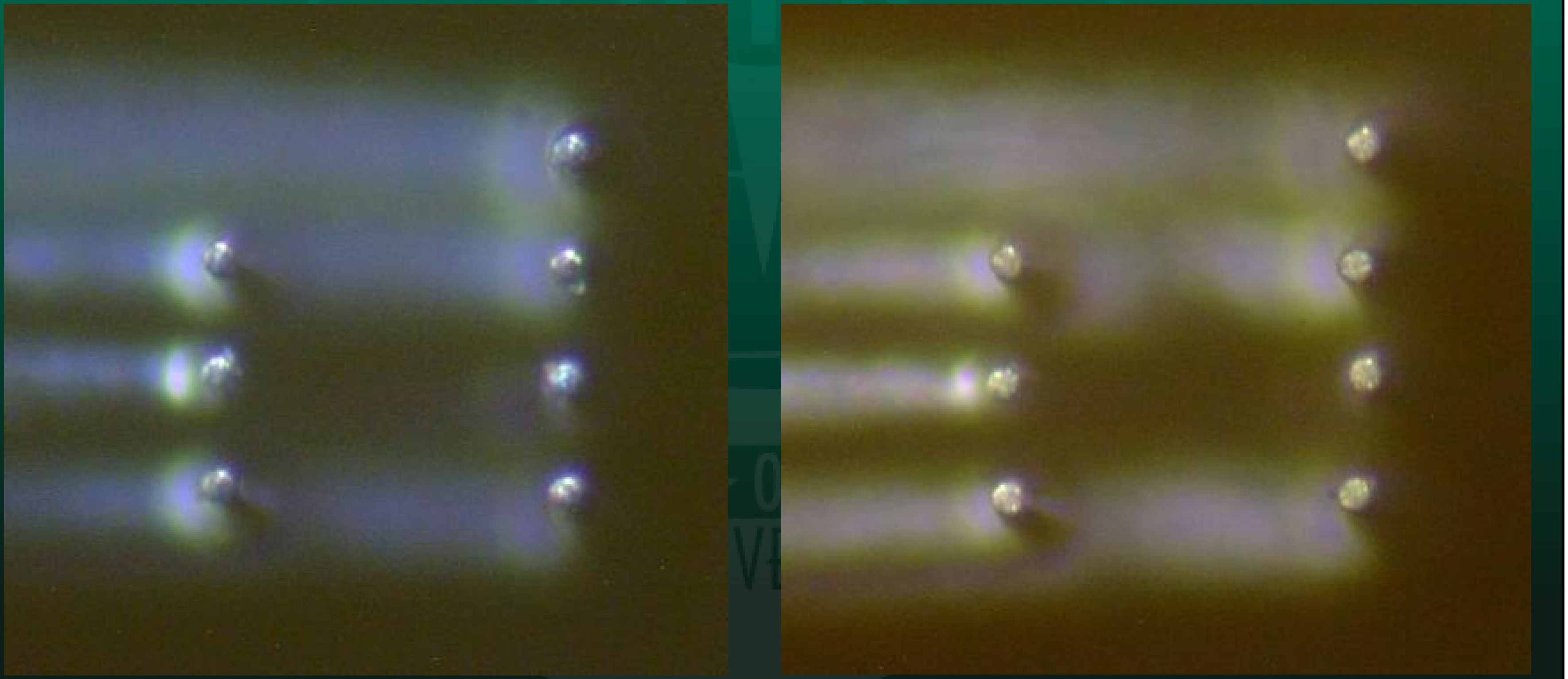
Before Cleaning



After Cleaning

Cleaning Result (2)

- **Probe Surfaces Before & After Cleaning (x50)**



Before Cleaning

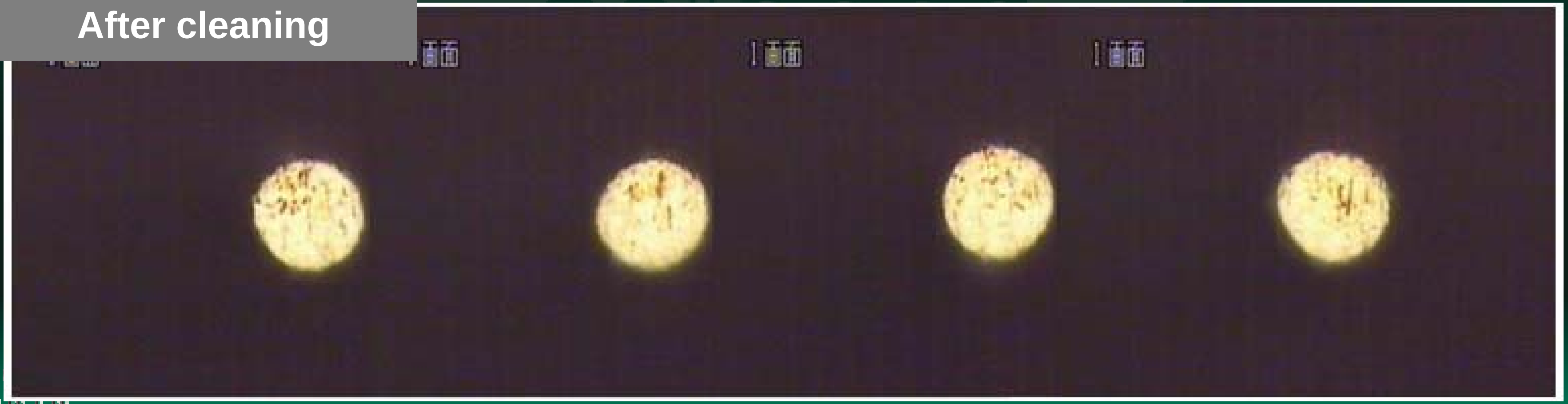
After Cleaning

Cleaning Result - details

- Magnified Tip Surface (x200)

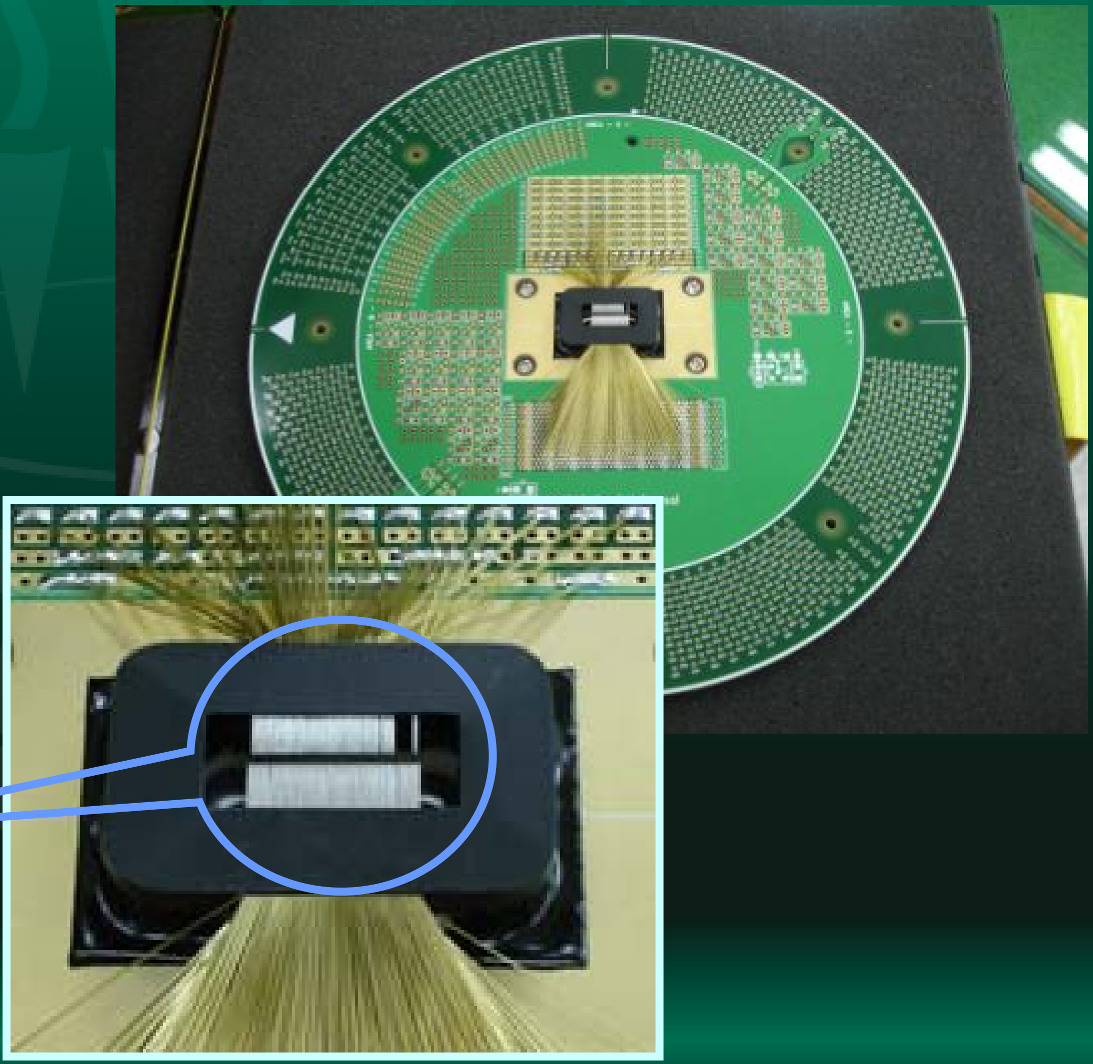
Before cleaning

After cleaning



Cantilever PC – W-Pt

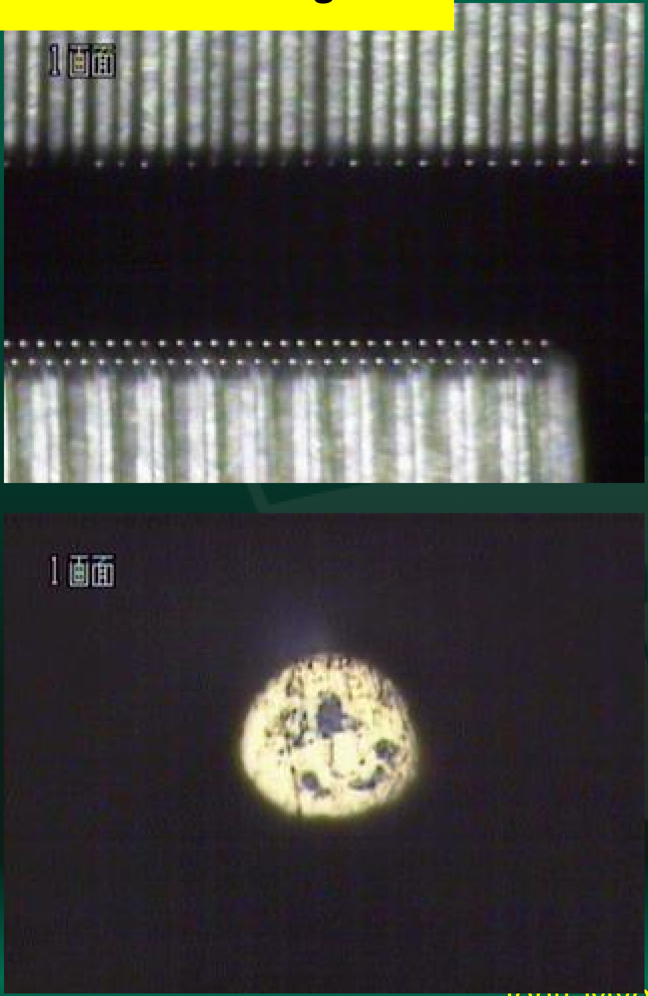
- W-Pt Probe Card for High speed performance



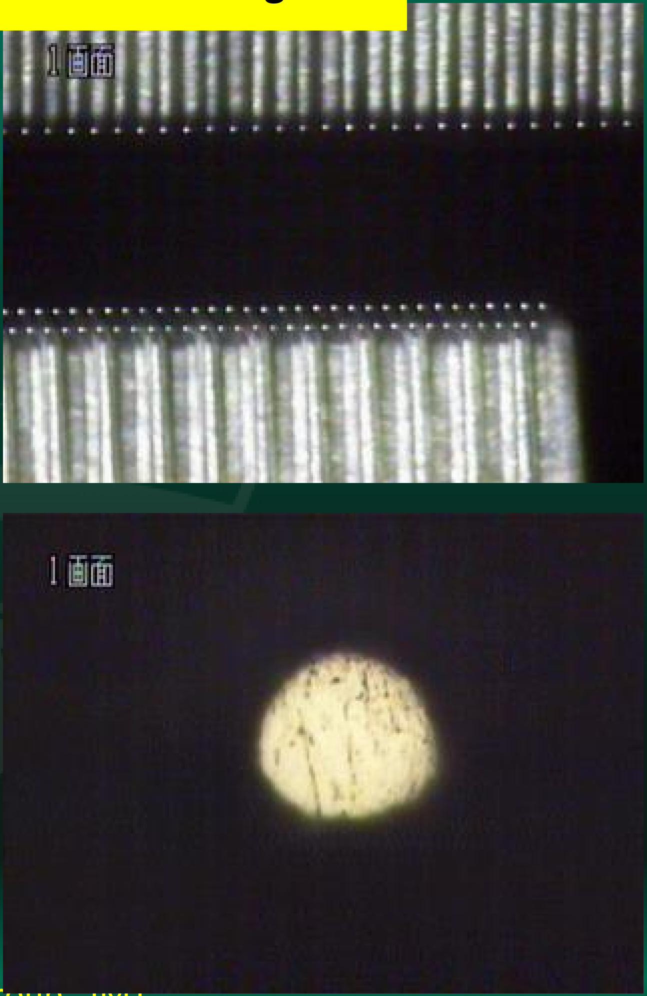
Cleaning Area

Cleaning Result

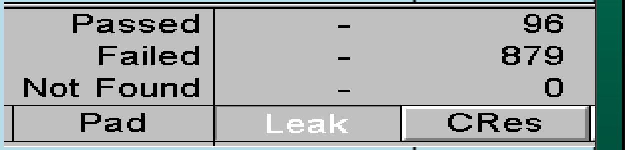
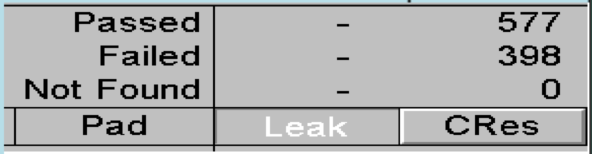
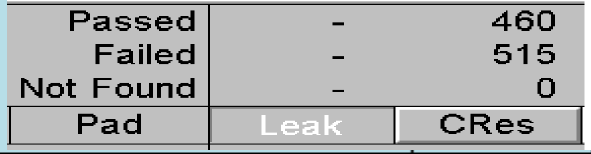
Before Cleaning



After Cleaning



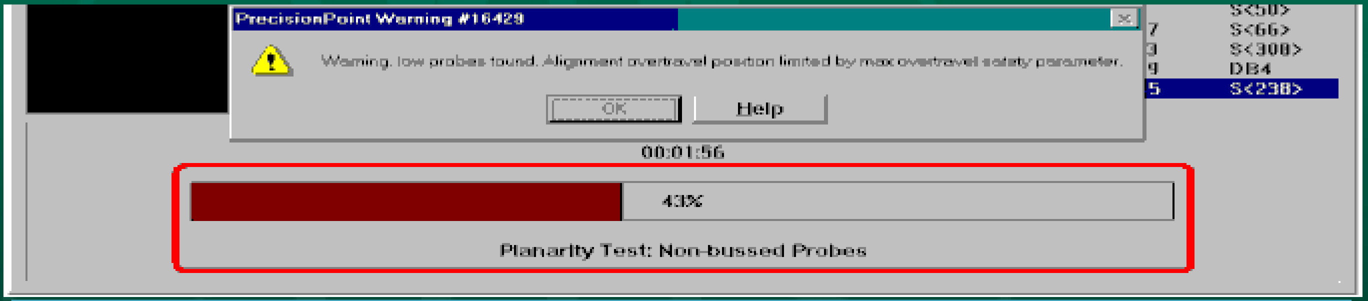
Electrical Test : Rc Measure

구 분 Item	단 면 상 태 Tip surface	PRVX3 Test [Contact Resistor]
Before Laser Cleaning		 Passed - 96 Failed - 879 Not Found - 0 Pad Leak CRes  Passed - 119 Failed - 856 Not Found - 0 Pad Leak CRes
After Laser Cleaning		 Passed - 577 Failed - 398 Not Found - 0 Pad Leak CRes  Passed - 460 Failed - 515 Not Found - 0 Pad Leak CRes

Needle Diameter	Ø80㎛	**Tip Diameter**	7±1㎛		**Needle material**	REW	
Laser 효과 effectiveness	Passed Channel 증가. increased C/R 저항 값 하락 Value decreased	**PRVX C/R (Before cleaning)**	1회	1.93~36.9Ω	**PRVX C/R (After cleaning)**	1회	0.10~10.2Ω
			2회	0.10~31.1Ω		2회	0.10~11.0Ω
			3회	0.10~49.2Ω		3회	0.10~11.7Ω
Laser	Power- 532nm Energy- 280mJ	**Overtravel**	Gold Plate - 20㎛		**PRVX C/R allowance**	5Ω	

Electrical Test : Planarity

Before Laser Cleaning [사진 1.]


PrecisionPoint Warning #16429

Warning, low probes found. Alignment overtravel position limited by max overtravel safety parameter.

00:01:56

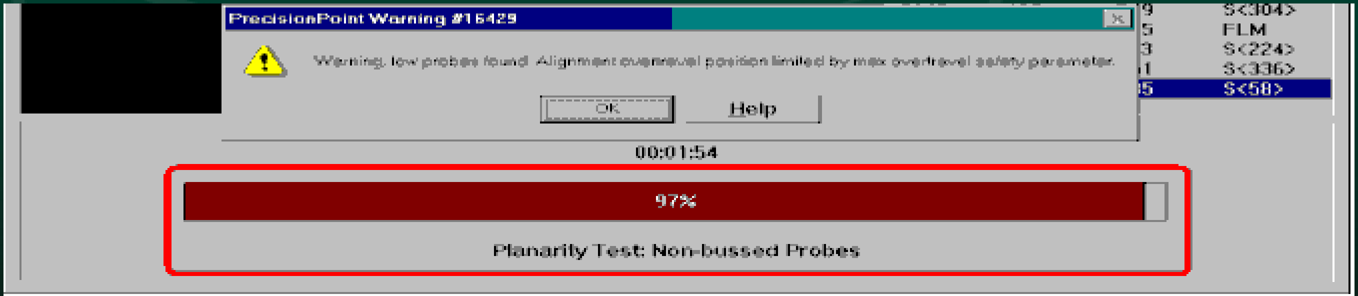
43%

Planarity Test: Non-bussed Probes

▪[사진 1.]과 같이 Tip의 산화 및 이물질 발생시 제품의 품질 저하 발

Poor planarity data due to foreign contamination and oxides

After Laser Cleaning [사진 2.]


PrecisionPoint Warning #16429

Warning, low probes found. Alignment overtravel position limited by max overtravel safety parameter.

00:01:54

97%

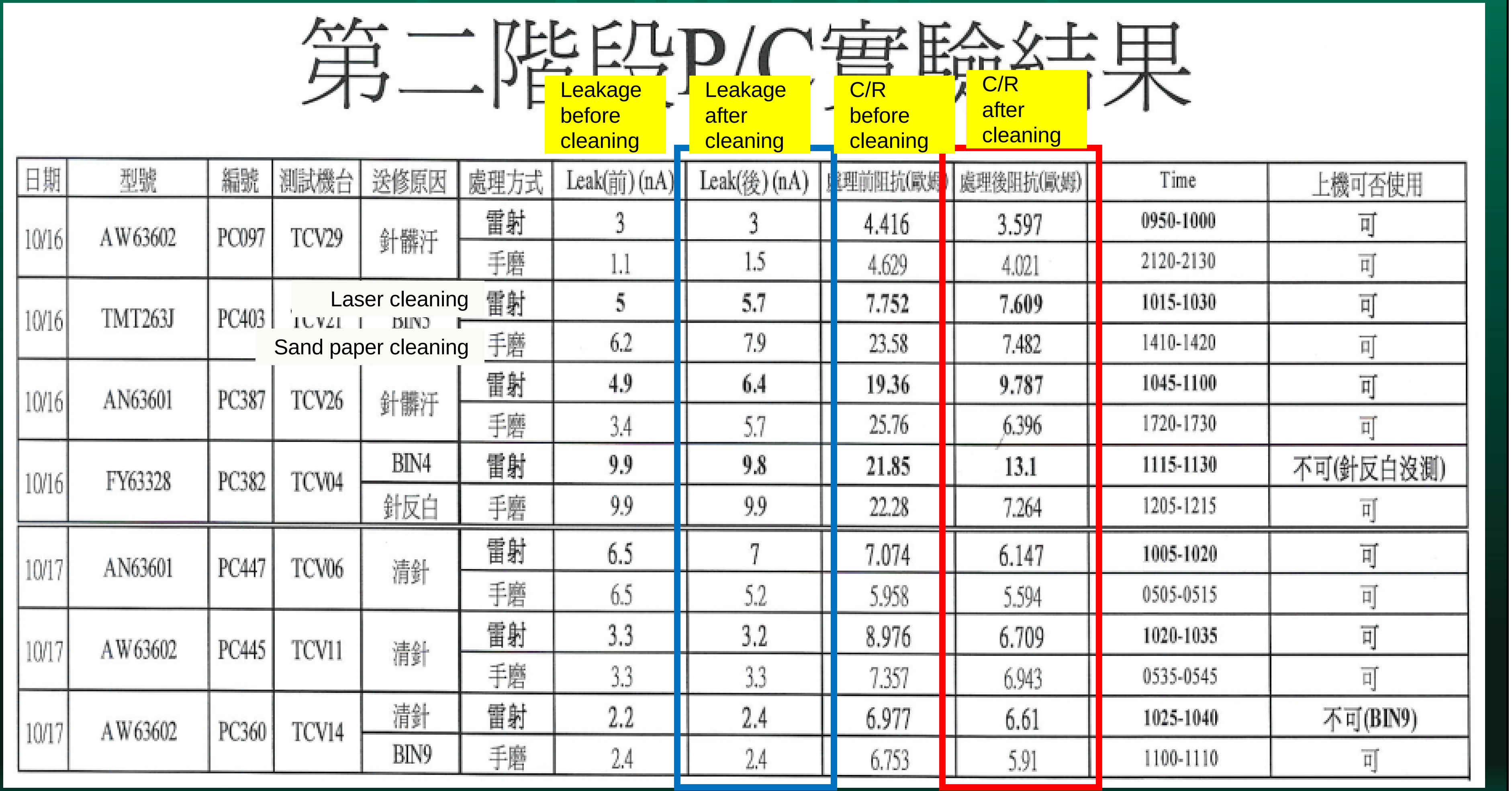
Planarity Test: Non-bussed Probes

▪Tip의 산화 및 이물질 제거로 인해 [사진 2.]와 같이 제품의 성능 향상 효과 확인.

Improved planarity data after cleaning

▪ Device	S6C Series [WillTech Co. Cantilever Probe Card]
▪ Results	Planarity Pass Increased Significantly [Before cleaning: 43%, After: 97%]

Laser vs Sand Paper cleaning



第二階段P/C實驗結果

Leakage before cleaning

Leakage after cleaning

C/R before cleaning

C/R after cleaning

Laser cleaning

Sand paper cleaning

日期	型號	編號	測試機台	送修原因	處理方式	Leak(前)(nA)	Leak(後)(nA)	處理前阻抗(歐姆)	處理後阻抗(歐姆)	Time	上機可否使用
10/16	AW63602	PC097	TCV29	針髒汙	雷射	3	3	4.416	3.597	0950-1000	可
					手磨	1.1	1.5	4.629	4.021	2120-2130	可
10/16	TMT263J	PC403	TCV21	[illegible]	雷射	5	5.7	7.752	7.609	1015-1030	可
					手磨	6.2	7.9	23.58	7.482	1410-1420	可
10/16	AN63601	PC387	TCV26	針髒汙	雷射	4.9	6.4	19.36	9.787	1045-1100	可
					手磨	3.4	5.7	25.76	6.396	1720-1730	可
10/16	FY63328	PC382	TCV04	BIN4	雷射	9.9	9.8	21.85	13.1	1115-1130	不可(針反白沒測)
				針反白	手磨	9.9	9.9	22.28	7.264	1205-1215	可
10/17	AN63601	PC447	TCV06	清針	雷射	6.5	7	7.074	6.147	1005-1020	可
					手磨	6.5	5.2	5.958	5.594	0505-0515	可
10/17	AW63602	PC445	TCV11	清針	雷射	3.3	3.2	8.976	6.709	1020-1035	可
					手磨	3.3	3.3	7.357	6.943	0535-0545	可
10/17	AW63602	PC360	TCV14	清針	雷射	2.2	2.4	6.977	6.61	1025-1040	不可(BIN9)
				BIN9	手磨	2.4	2.4	6.753	5.91	1100-1110	可

***** The CR improvement by laser cleaning is equivalent with the sand paper cleaning. Also there is no leakage problem after laser cleaning.**

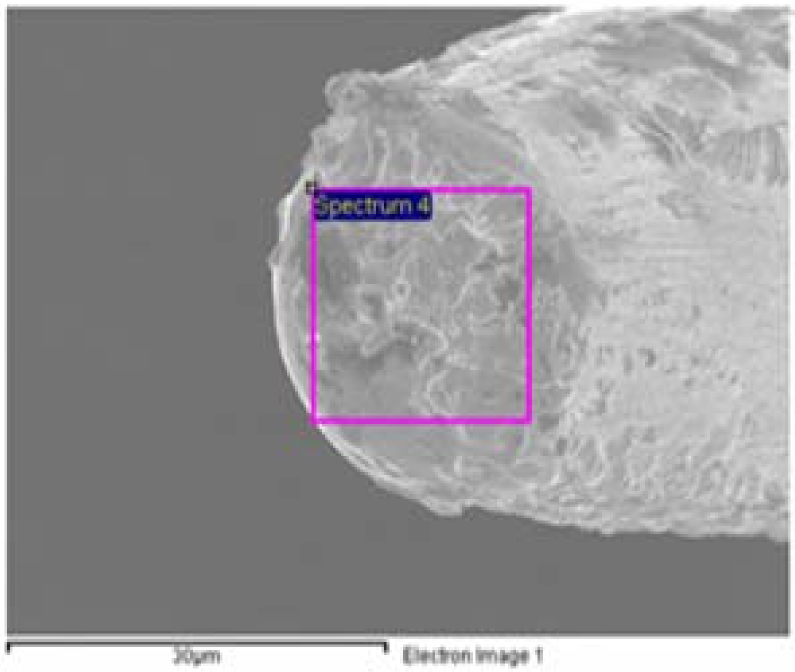
New PC Tip Cleaning -ReW

Before cleaning

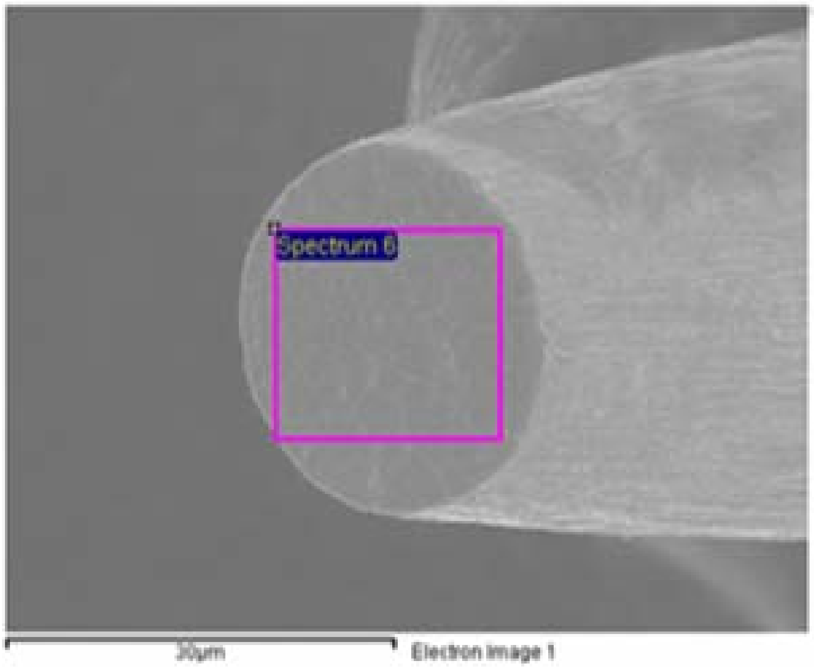
After cleaning

***** The original contamination on the tip such as organic and native oxide were successfully removed by laser cleaning.**

SEM Analysis – New PC



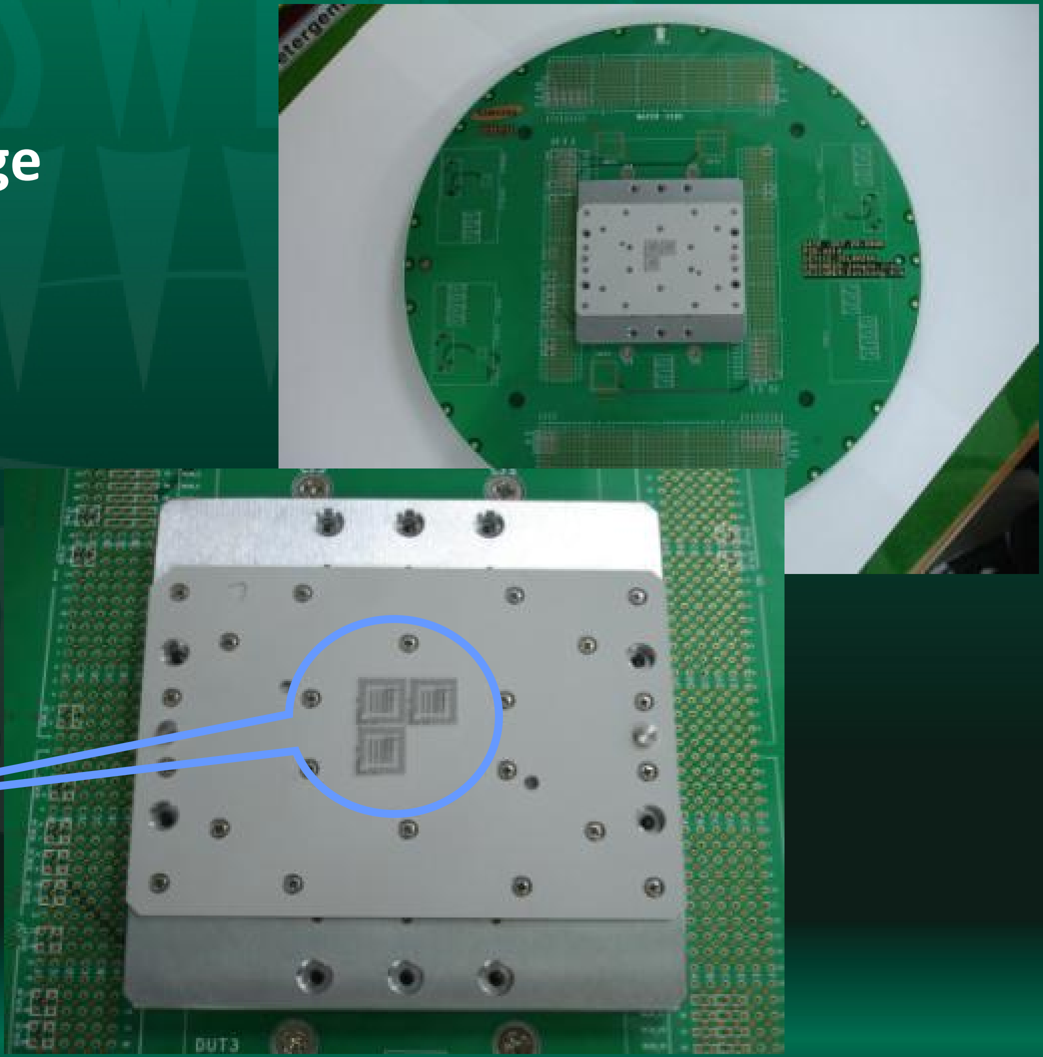
Before Laser Cleaning



After Laser Cleaning

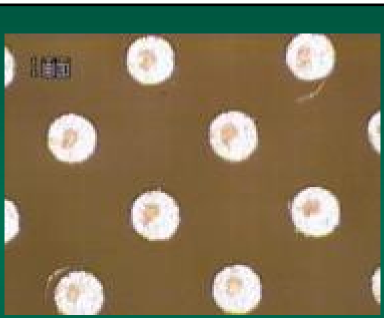
BGA Vertical PC

- E.Plastic Substrate & Vertical pins for Image Sensors
- Pin: Pd-Ag-Cu-Au-Pt



Cleaning Area

Test Result (1)



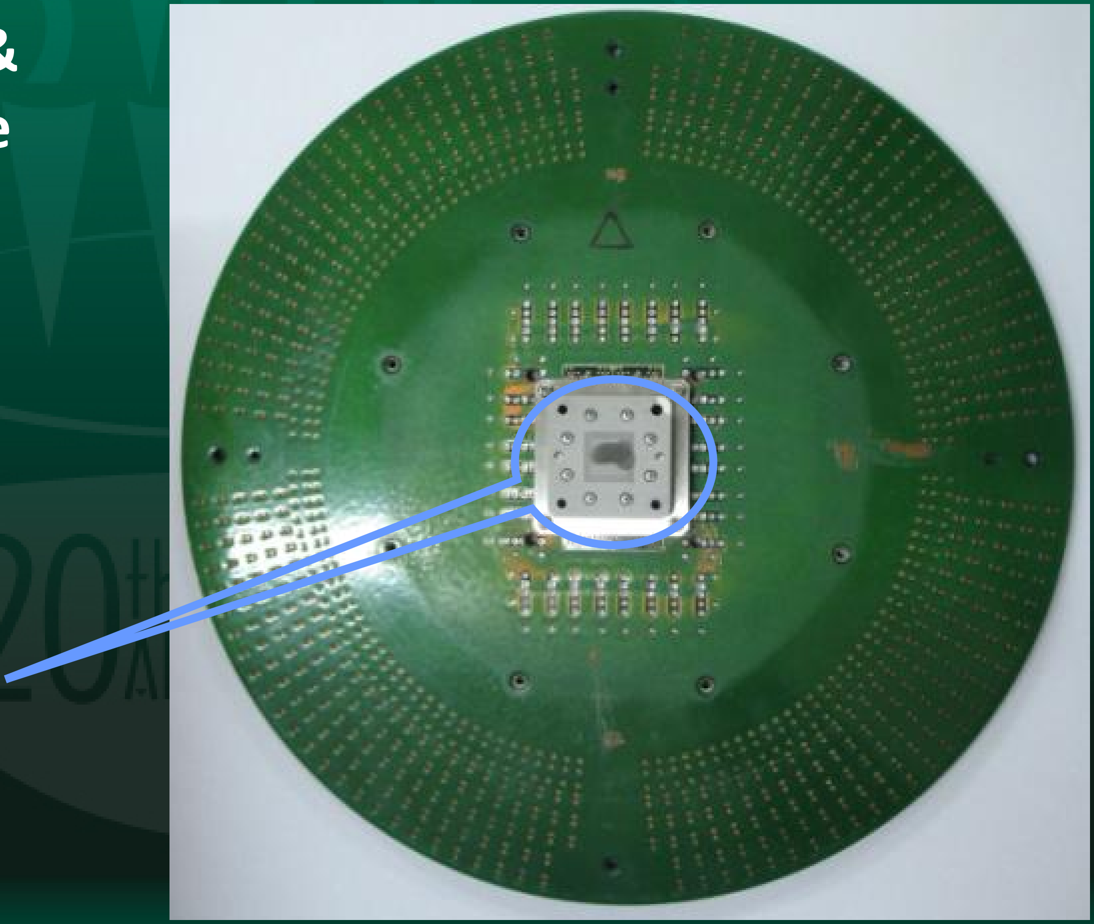
- Probe Surfaces Before & After Cleaning (x50)

Before Cleaning

After Cleaning
=> Well cleaned

Pogo Pin Vertical PC

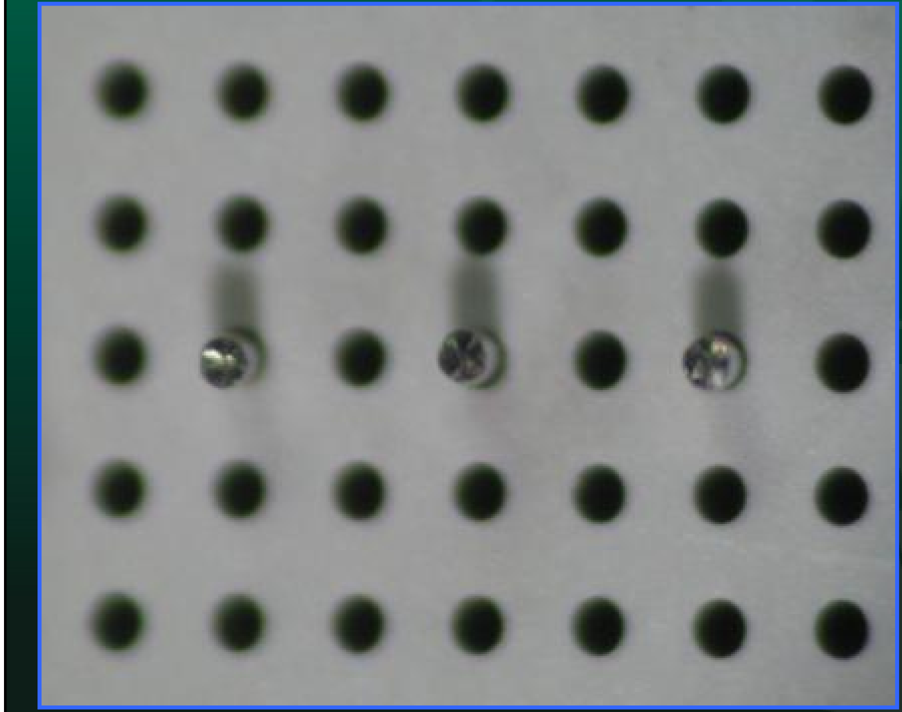
- **Ceramic Substrate & Pogo Pin type Probe Card**



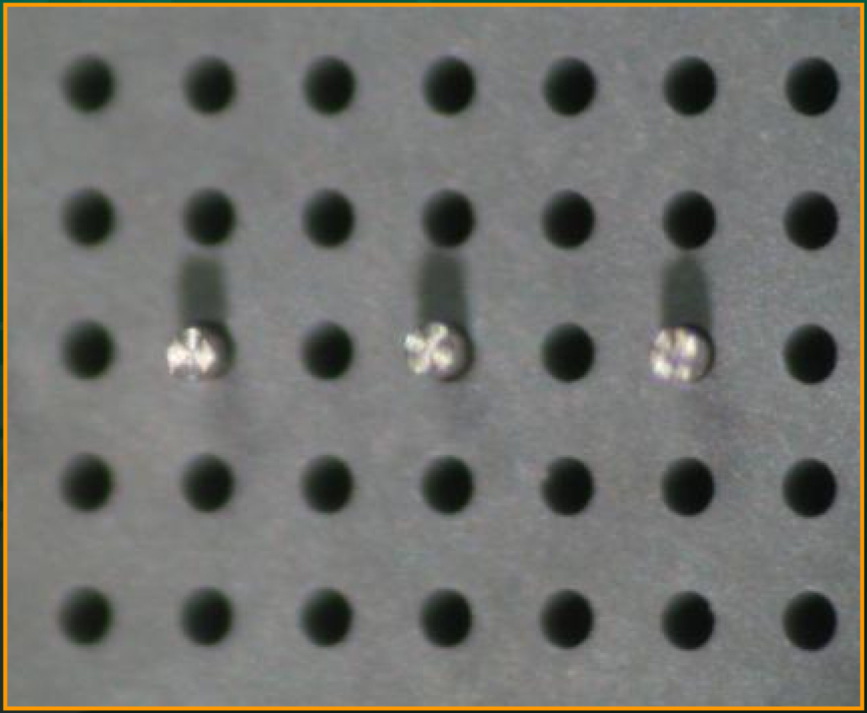
Cleaning Area

Test Result (1)

- **Probe Surfaces Before & After Cleaning (x50)**



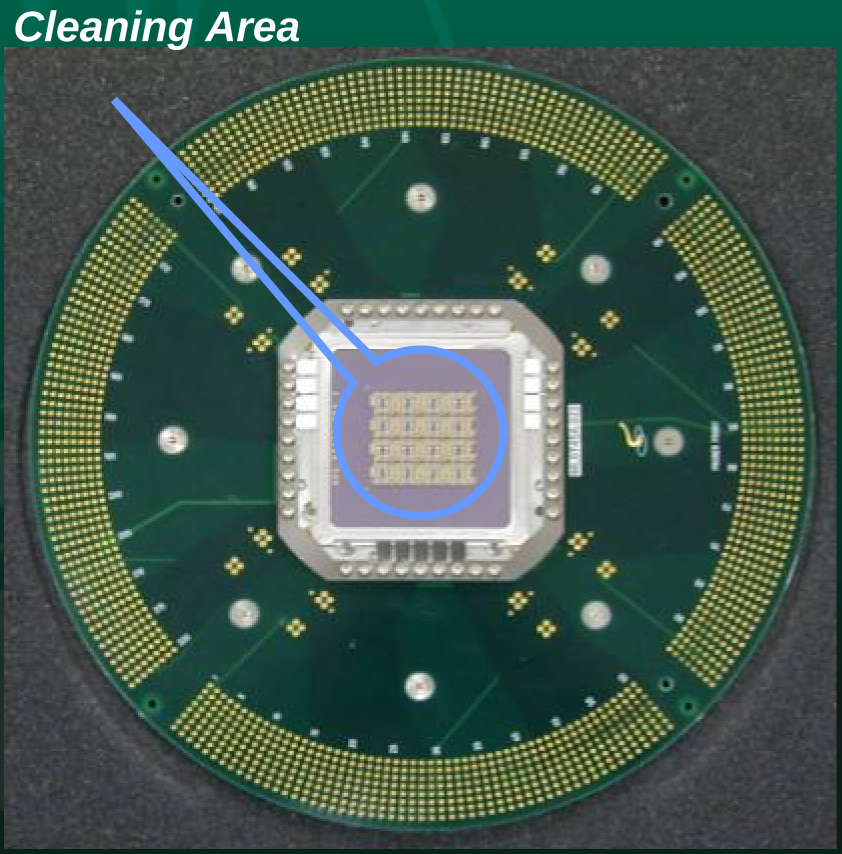
Before Cleaning

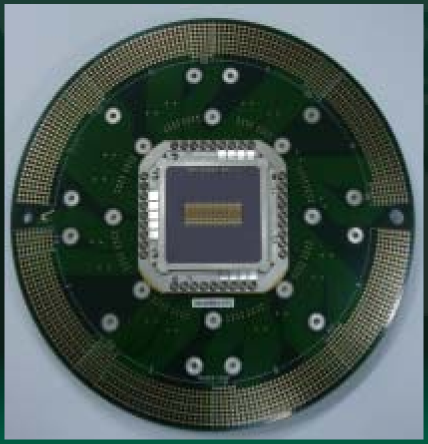


After Cleaning

MEMS P.C. – NiCo+Au

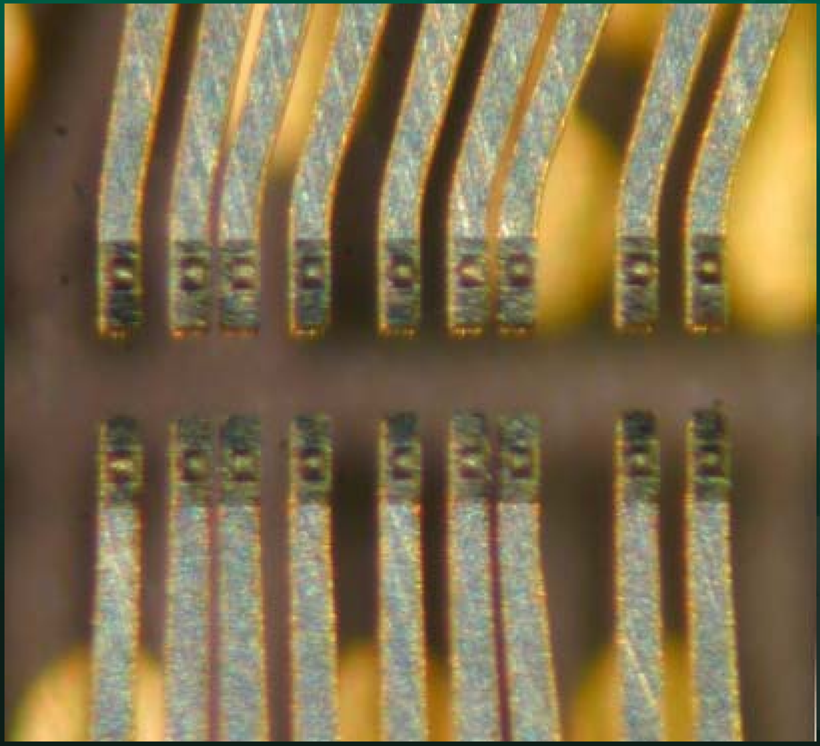
- **MEMS Probe Card for IC driver chip (Foamfactor PC)**



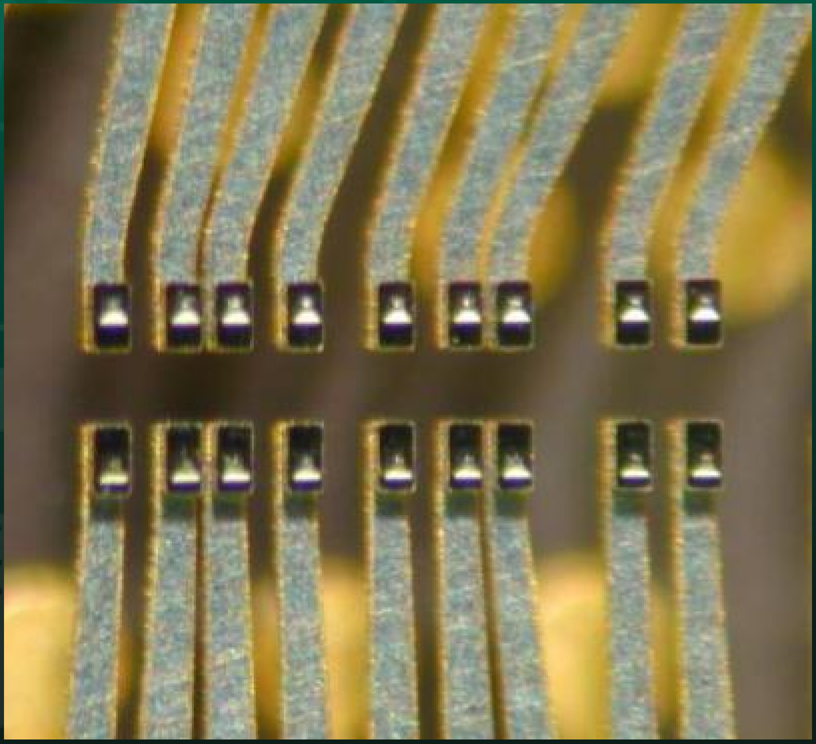


Test Result

- **Probe Surfaces Before & After Cleaning (x50)**



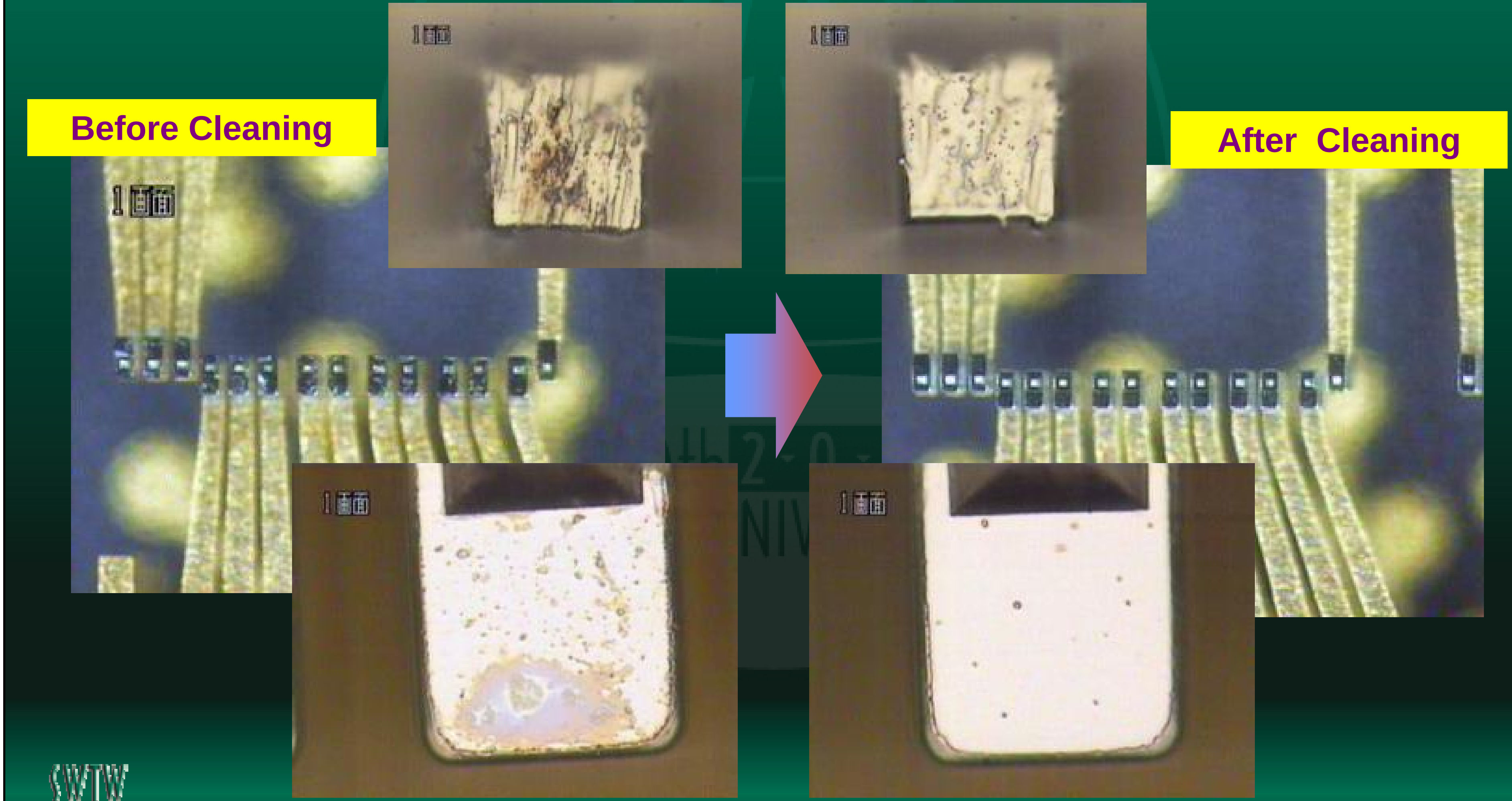
Before Laser Cleaning



After Laser Cleaning

Test Result

- Probe Surfaces Before & After Cleaning

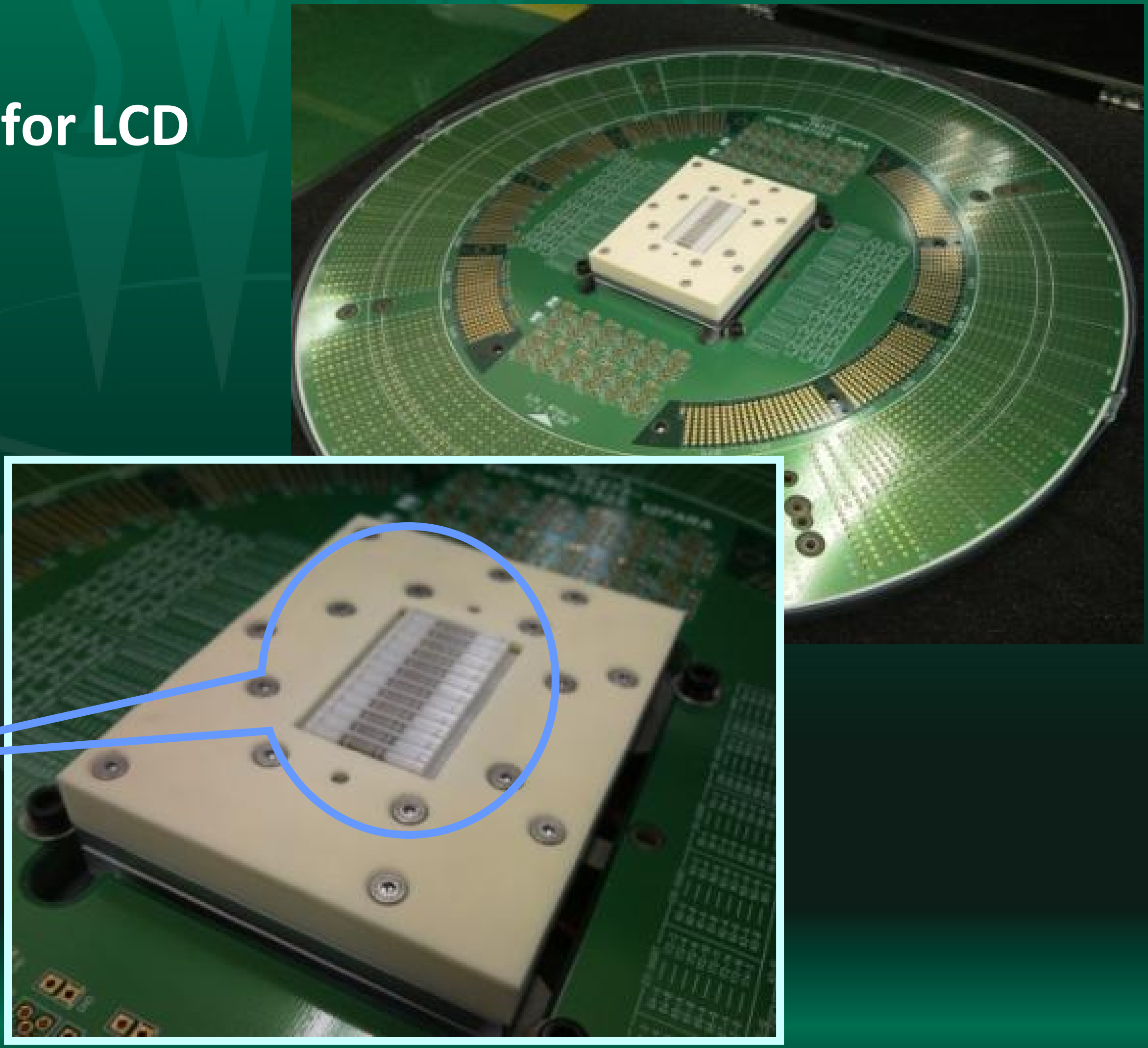


Before Cleaning

After Cleaning

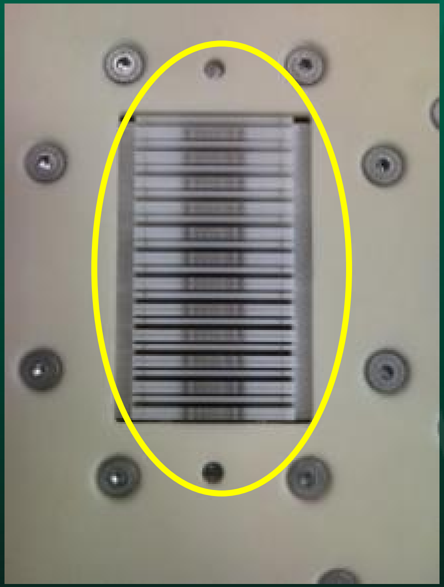
MEMS P.C. - NiCo

- **MEMS Probe Card for LCD Driver IC (LDI)**



Cleaning Area

Cleaning Result

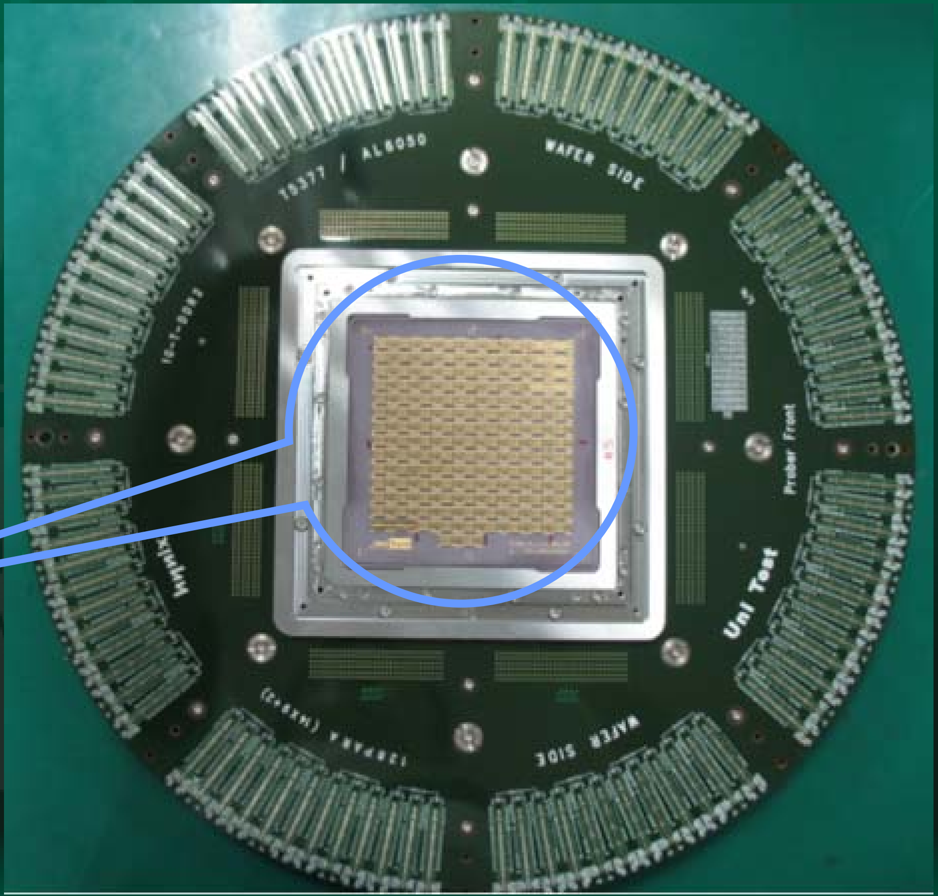


Before cleaning

After cleaning

MEMS P.C. - NiCo

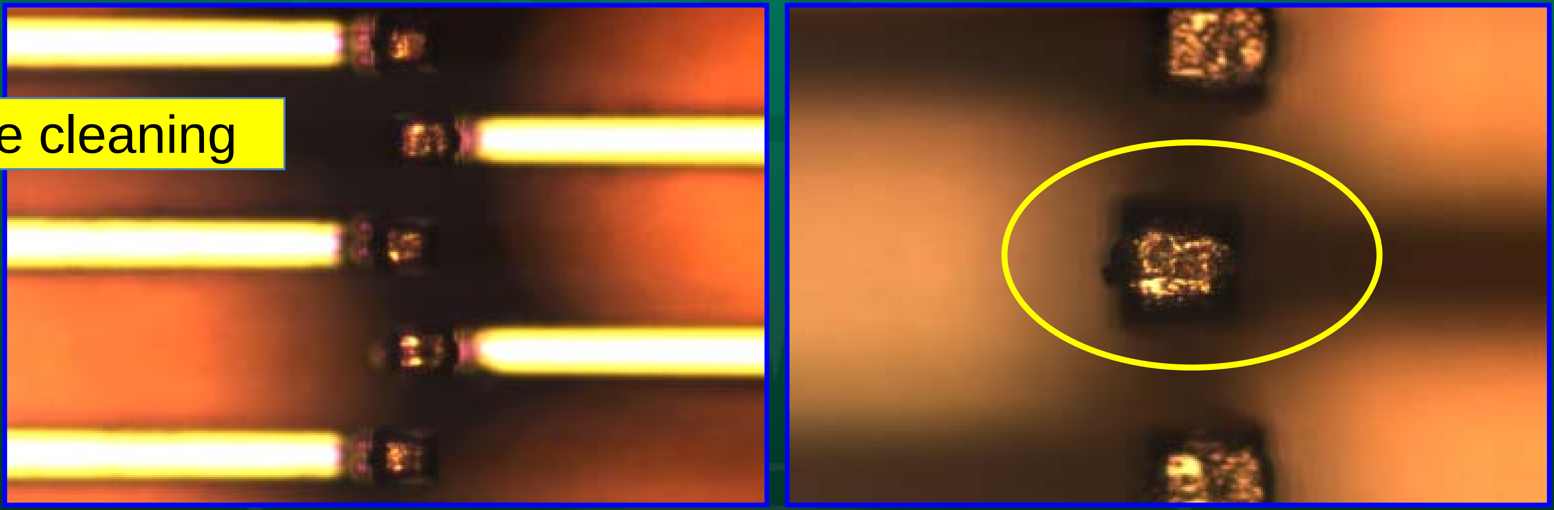
- MEMS Probe Card for 1G DDR2 Memory (U-com PC)



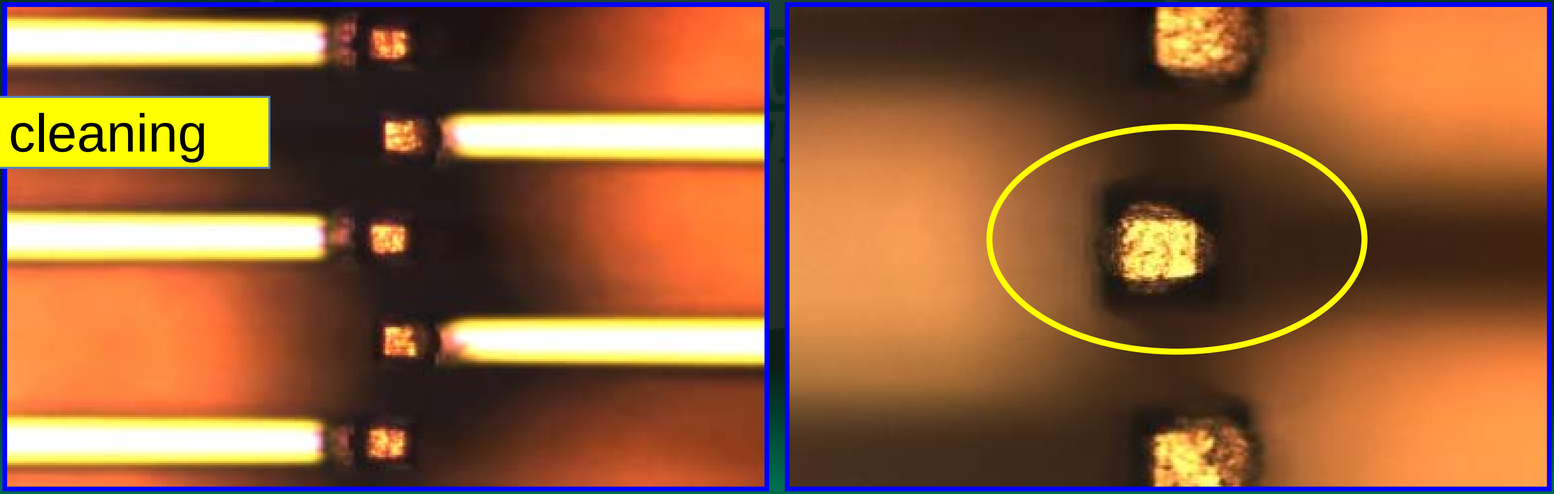
Cleaning Area

Cleaning Result

Before cleaning

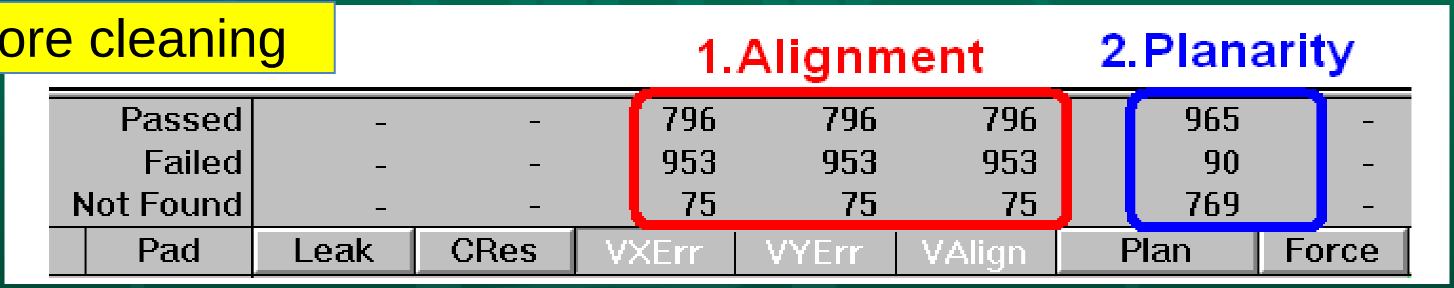


After cleaning



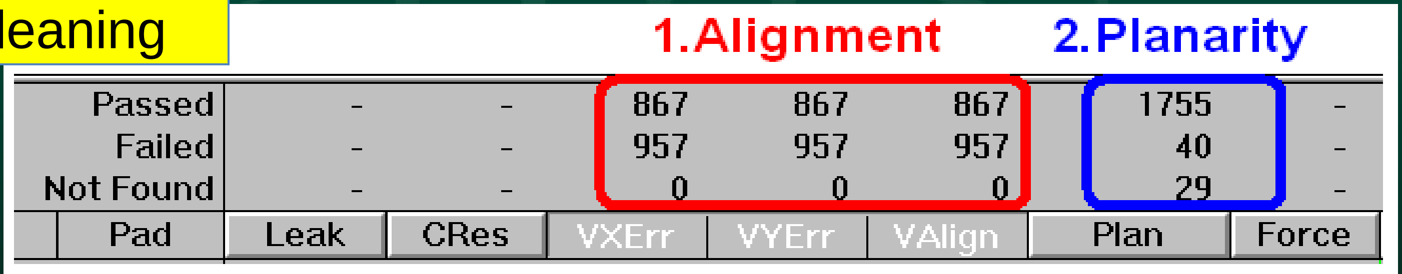
Functional Results after cleaning

Before cleaning



Pad	Leak	CRes	VXErr	VYErr	VAlign	Plan	Force
Passed	-	-	796	796	796	965	-
Failed	-	-	953	953	953	90	-
Not Found	-	-	75	75	75	769	-

After cleaning



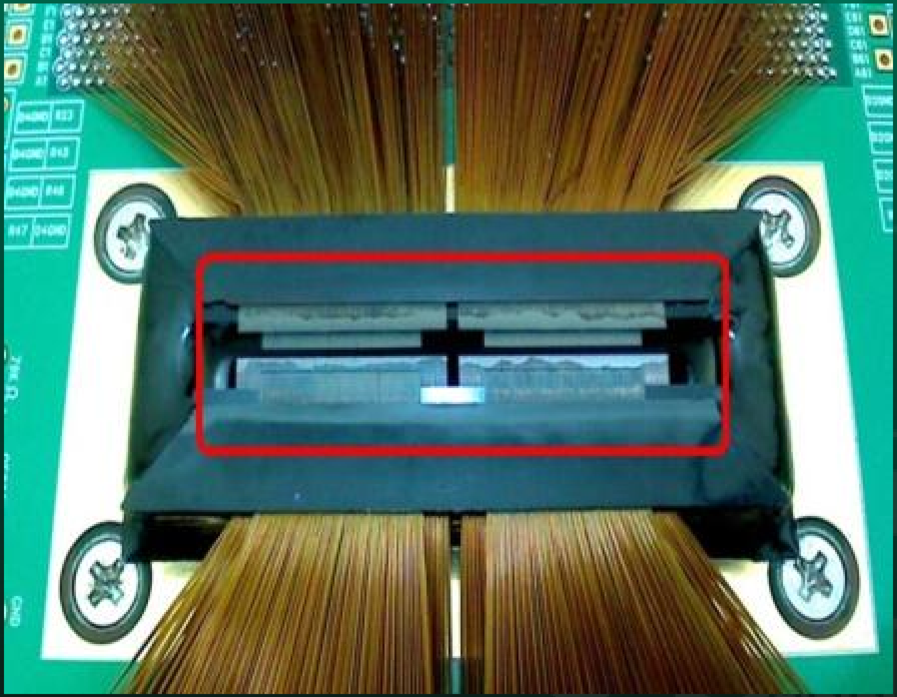
Pad	Leak	CRes	VXErr	VYErr	VAlign	Plan	Force
Passed	-	-	867	867	867	1755	-
Failed	-	-	957	957	957	40	-
Not Found	-	-	0	0	0	29	-

Alignment: "Not Found" 75 channels reduced and "Passed" increased by 70 channels

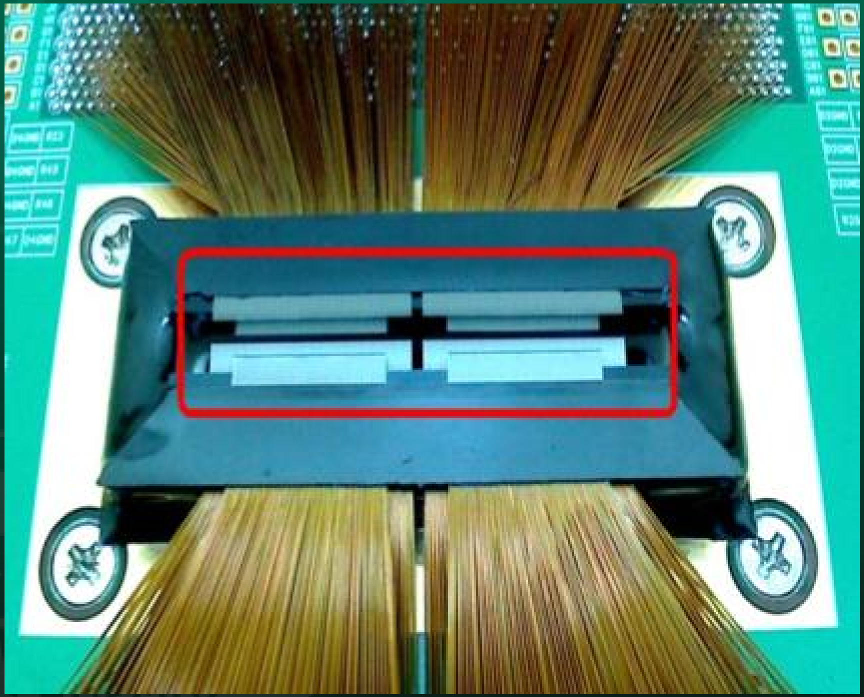
Planarity: "Not Found" 740 channels reduced and "Passed" increased by 790 channels.

>> Very effective of Laser cleaning for MEMS probe card

Needle Body Cleaning



Before Laser Cleaning



After Laser Cleaning

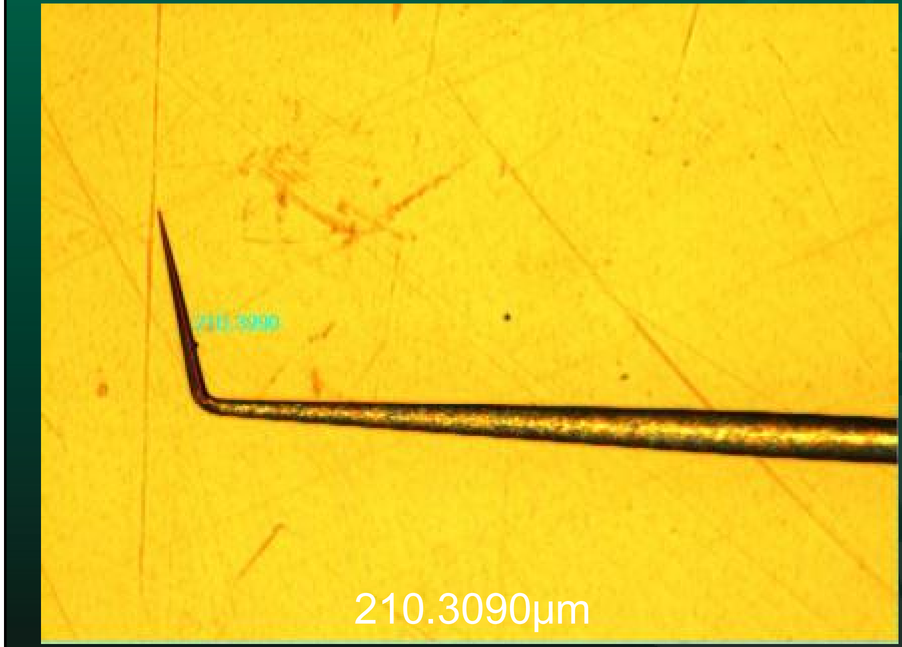
Cobra Needle Cleaning (Pt)

Before cleaning

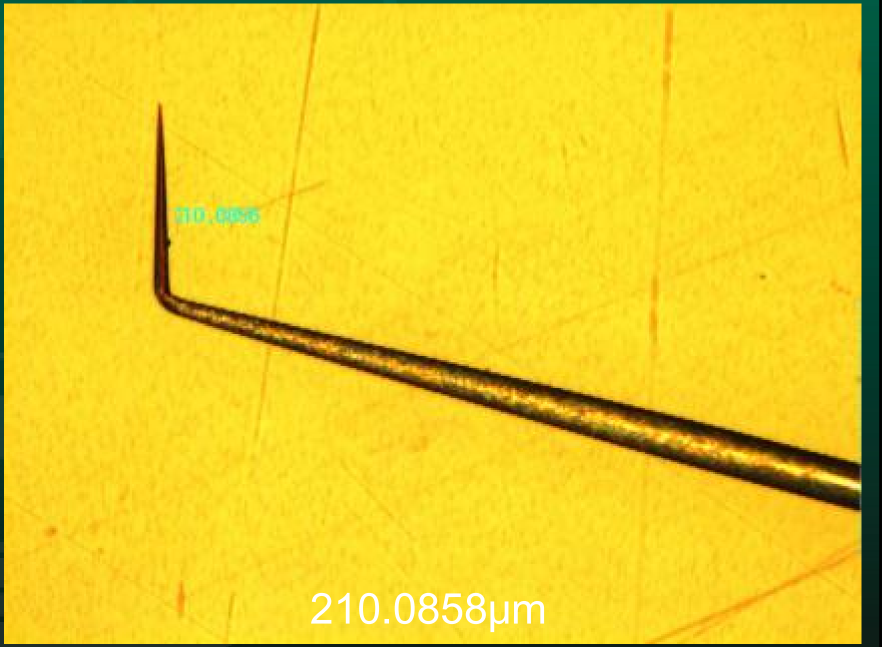
After cleaning

Damage Test - Dimension

- Probe dimension before & after 1000 laser shots at 350mJ



Before Laser Cleaning

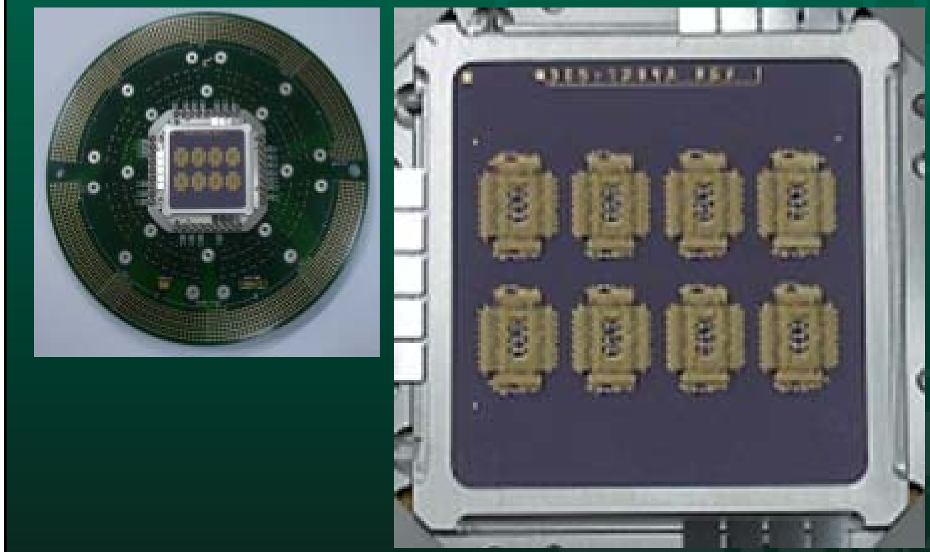


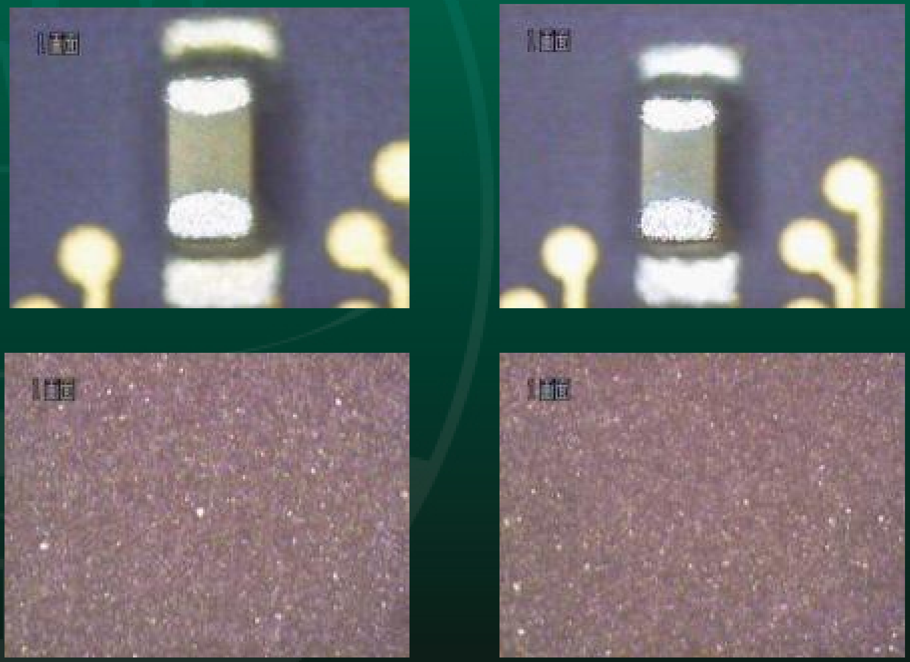
After Laser Cleaning

*** There was no any dimensional change after 1000 times of laser cleaning => No physical damage by laser

Damage Test - Substrate

- Substrate & Parts before & after 100 laser shots at 350mJ





Before treatment **After treatment**

*** There was no any surface changes after the harsh 100 laser treatment => No physical damages by laser cleaning

Commercial Tools – Laser Cleaner

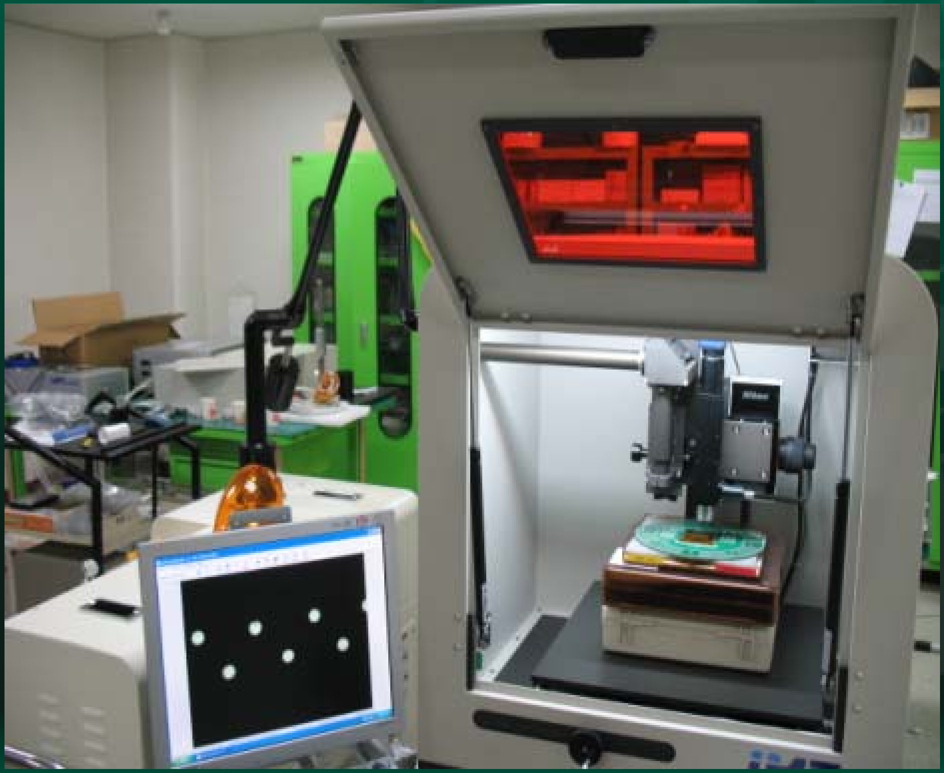
*** Mobile & Manual
For on-line cleaning

*** Fully Automatic
For off-line cleaning

Real Application – X-Y Cleaning Stage

* Off-line Cleaning Stage

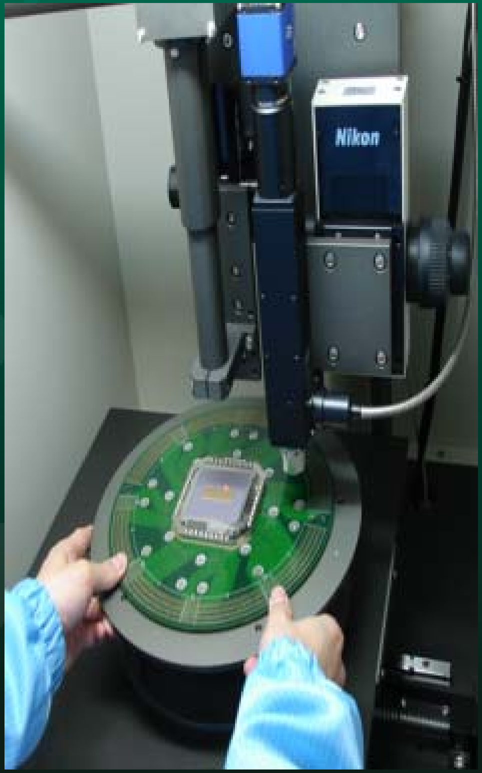
\- Manual operation



PC Cleaning Process (1)

Laser Cleaning Parameters Setting.

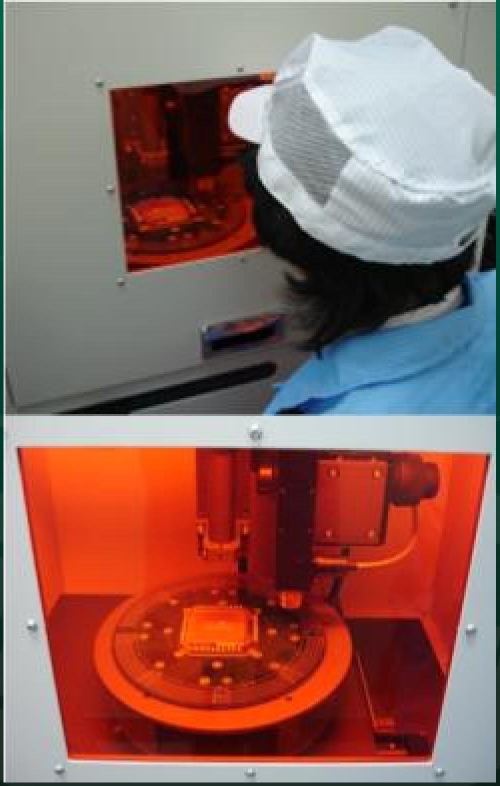
Install PC onto the cleaning stage



Positioning PC to the laser beam pointer

PC Cleaning Process (2)

Close the door and PC Cleaning start



X-Y Manual PC Laser Cleaning

Checking the cleaning quality by vision camera

Summary & Conclusions

Laser cleaning can be applied successfully for :

1. Canti: W, Re-W, W-Pt …
2. Vertical: Au in BeCu(pogo), Pd-Ag, Pd-Co …
3. MEMS: Au in Ni-Co, Ni-Co …

=> **Without any pin & substrate damages**

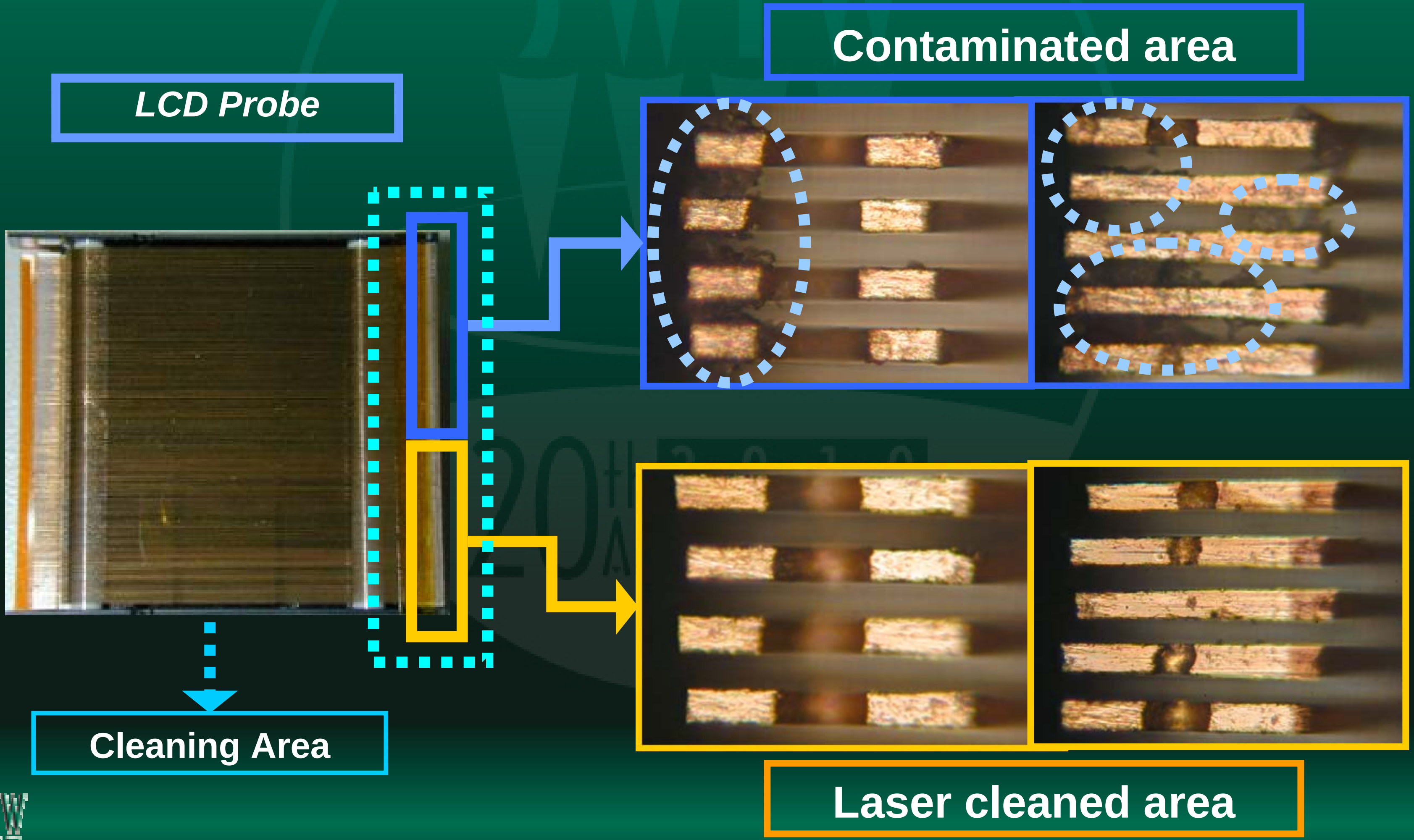
Laser cleaning can provides :

1. High speed cleaning even for 300mm PC
2. Safe cleaning even for MEMS PC
3. Quality assurance even for New PC

=> **Novel Probe Card cleaning solution**

LCD Probe Cleaning

- **Probe Surface Before & After Cleaning (x200)**



LCD Probe

Contaminated area

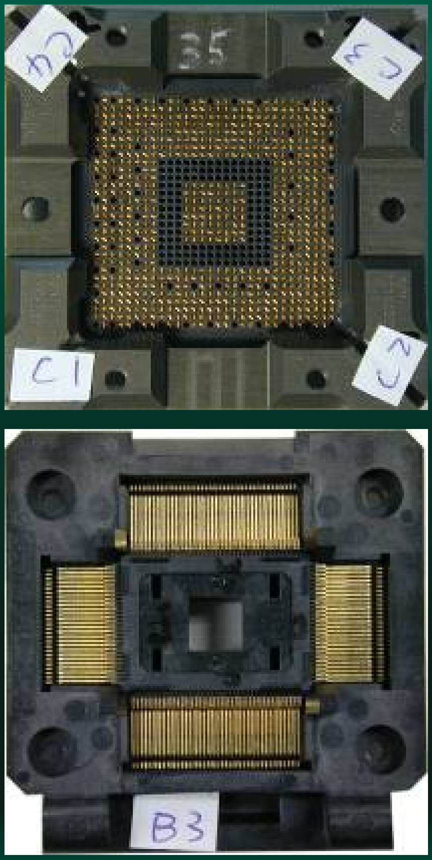
Cleaning Area

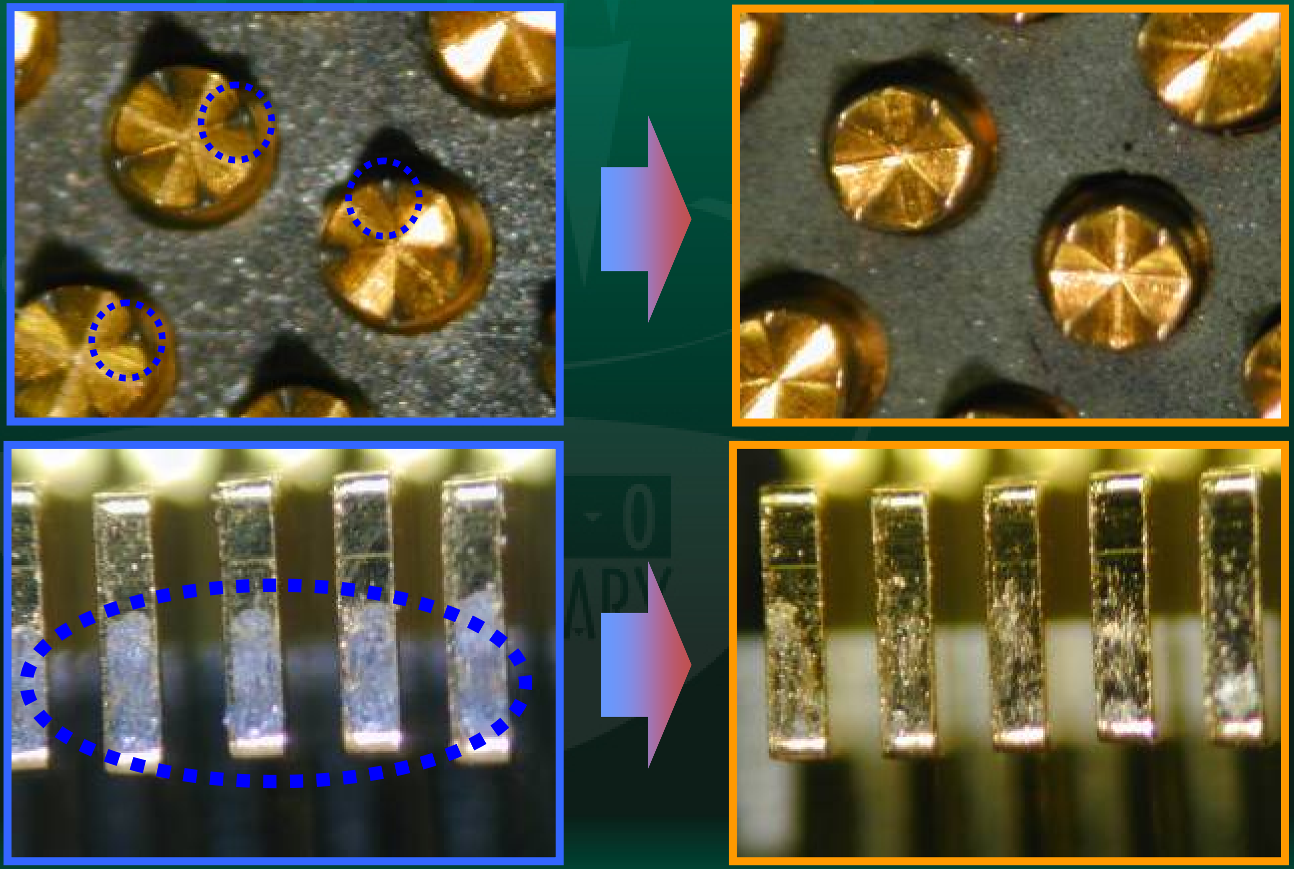
Laser cleaned area

Test Socket Cleaning

- **Target of Test Socket Cleaning**

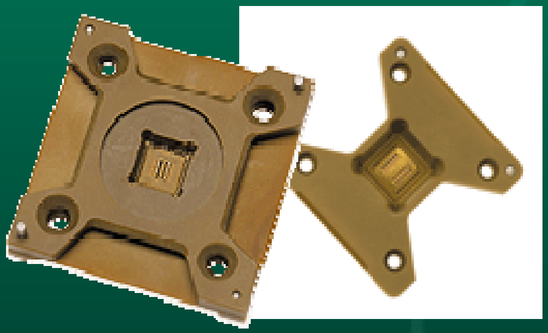
  : To remove Tin(Sn) based contamination from pogo-pin surface

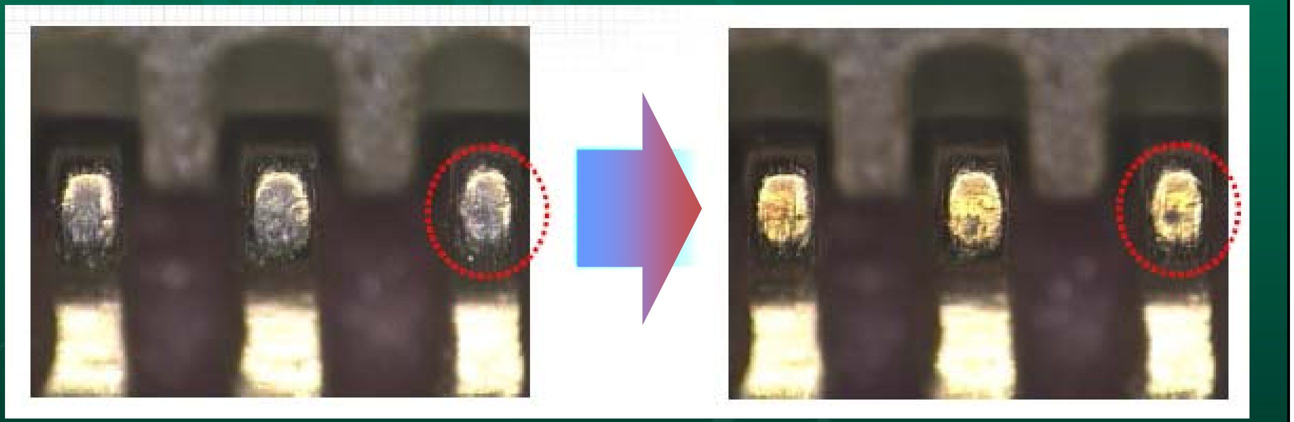


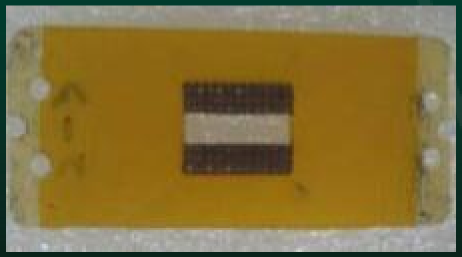


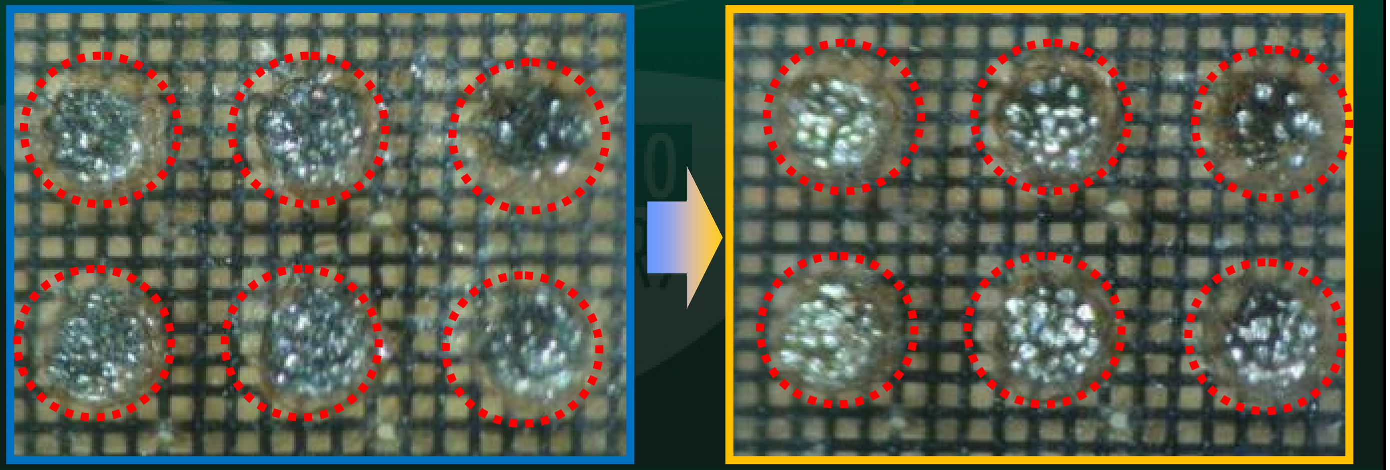
Before cleaning **After cleaning**

Test Socket Cleaning









Before cleaning **After cleaning**