Gel-PROBE™

PROBE CLEANING TECHNOLOGIES

MANUFACTURED BY Gel-Pak®

Gel-Pak®, a division of Delphon, has manufactured innovative device carrier products for over 40 years. Headquartered in Hayward, California.

Gel-Pak Innovative Material Solutions for Enhanced Semiconductor Testing:

Gel-Probe Products for High Performance Probe Card Cleaning

Agenda

- Gel-Pak | Company Snapshot
- Gel-Probe for Probe Card Cleaning
- Customer Case Studies and Qualifications
- Materials Selection Matrix

Gel-Pak | A History of Innovation

Gel-Pak® A DELPHON COMPANY

Delphon Companies
Gel-Pak TOUCHMARK UltraTape

95,000+ sq. ft.
Materials Manufacturing

3x
ISO 9001-2015 Certified Facilities

ISO
Class 10,000 & Class 7 Cleanrooms

Global
Sales & Support Network

1980s:
The Foundation
(Original Gel-Box)

Created to enable safe shipping and automated assembly of new beam lead diodes.

1990s:
Assembly Efficiency
(VR Technology)

Launched to improve assembly efficiency for emerging Multi-Chip Module (MCM) packaging.

2000s:
Handling Miniaturization

Introduced large VR carriers (up to 300mm) and WPX for devices >25µm.

Mid-2000s:
Advanced Integration

Gel-Probe materials developed to significantly improve wafer test yields.

Today:
Universal Handling
(Pocketless Carriers)

Universal textured trays provide versatile solution for in-process handling and singulated die testing.

Gel-Pak | Collaborative Customer Solutions

A 40-year legacy of collaboration with customers empowering innovation with a focus on improving operational efficiency.

Gel-Pak® A DELPHON COMPANY

CUSTOMER REQUIREMENTS & REVIEW

Critical Needs and Timeline Review

Chemists and engineers determine best path for development and manufacturing

RAW MATERIAL SOURCING

Ingredients for specific properties to meet unique needs

- Specialty polymer functionalities
- Novel additives
- Material purity
- Reliable supply chain

Customer Evaluation & Iteration as Needed

FORMULATION & PROCESS MODIFICATION

Combining unique raw materials and processing conditions

- Crosslink density
- Temperature profiles
- Cure kinetics
- Post conversion & purification
- Thickness
- Hardness
- Adhesion
- Thermal resistance
- Static dissipation
- Low outgassing
- Hysteresis

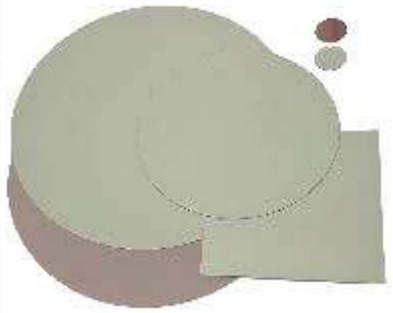
CUSTOMIZED SOLUTIONS

High-Volume Manufacturing and Technical Support

- Targeting high value/volume
- Operational excellence/automation
- Best-in-class customer service
- Best-in-class quality
- Technical support via world-renowned experts

Gel-Pak | Innovative Solutions that Drive OEE

ELASTOMER PROBE CARD CLEANING FILMS



Gel-Probe Card Cleaning

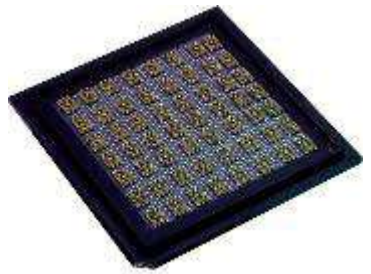
- Custom coating of highly engineered elastomer films for semiconductor applications.
- **Customizable probecard cleaning wafer and cleaning sheet applications.**

UNIVERSAL & POCKETLESS CARRIERS

Textured Device Carrier Products

- Pocketless \carriers and transport products for KGD and other devices
- **Universal Fixture for device handling in-process, singulated die testing, and shipping.**

SMALL DIE SHIPPING & HANDLING



Vacuum Release Carriers

- Automated pick & place applications for bare die and devices ranging from <250 micron to 75mm in size.
- Handling small components or large assembled modules.
- **Suitable for transport and handling MEMs Probes**

DIE WAFER & PANEL SHIPPING & HANDLING

Large Substrate Vacuum Release Carriers™

- Shipping and handling full or partial wafers, panels, and OTHER substrates from 75mm to 450mm.
- **Suitable for KGD, singulated die, and film frame loaded devices.**

Gel-Pak | A Global Footprint

Direct Sales

Manufacturing Facilities

2 US Based ISO 9001-2015 Certified Manufacturing Facilities:

Over 90,000 square feet

Over 150 Employees

Class 10,000 and 100,000 Cleanrooms

Asia Based ISO 9001-2015 Certified Manufacturing Facilities:

3,000 square feet cleanroom

13 injection molding machines

Cleanrooms

Delphon Business Unit	Clean Room Class	Certifications
Gel Pak	7	Annual ISO certification
Gel Probe	7	Annual ISO certification
Ultra Tape	7	Annual ISO certification
TouchMark	7	Annual ISO certification

International Distributors with Direct Sales Support

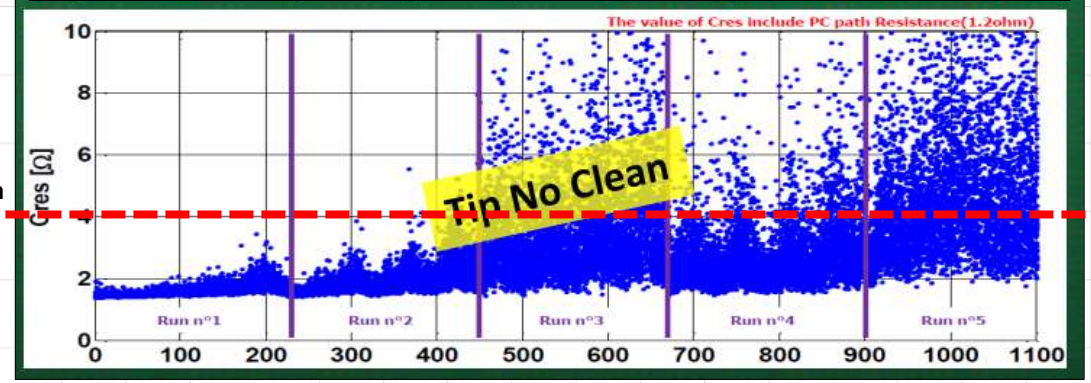
- Europe
- India
- China
- Israel
- Japan
- South Korea
- Taiwan
- Philippines
- Southeast Asia


Gel-PROBE™
PROBE CLEANING TECHNOLOGIES
MANUFACTURED BY
Gel-Pak®

Probe Cleaning is Mandatory

LOW FIRST PASS YIELD

(unchecked CRES growth)

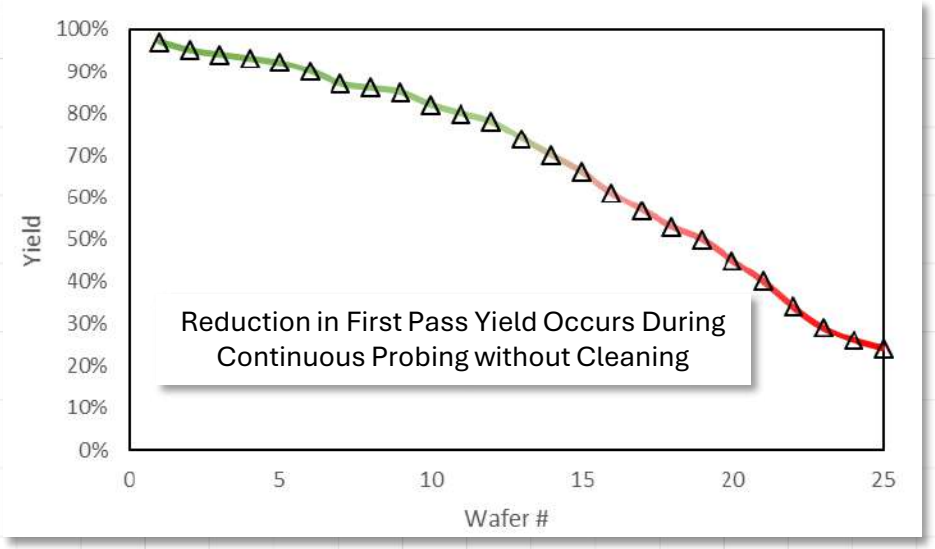


Specification Limit

Failed Die

Good Die

Reduction is first pass yield is attributable to “false fails” due to CRES instability and **NOT** bad die.



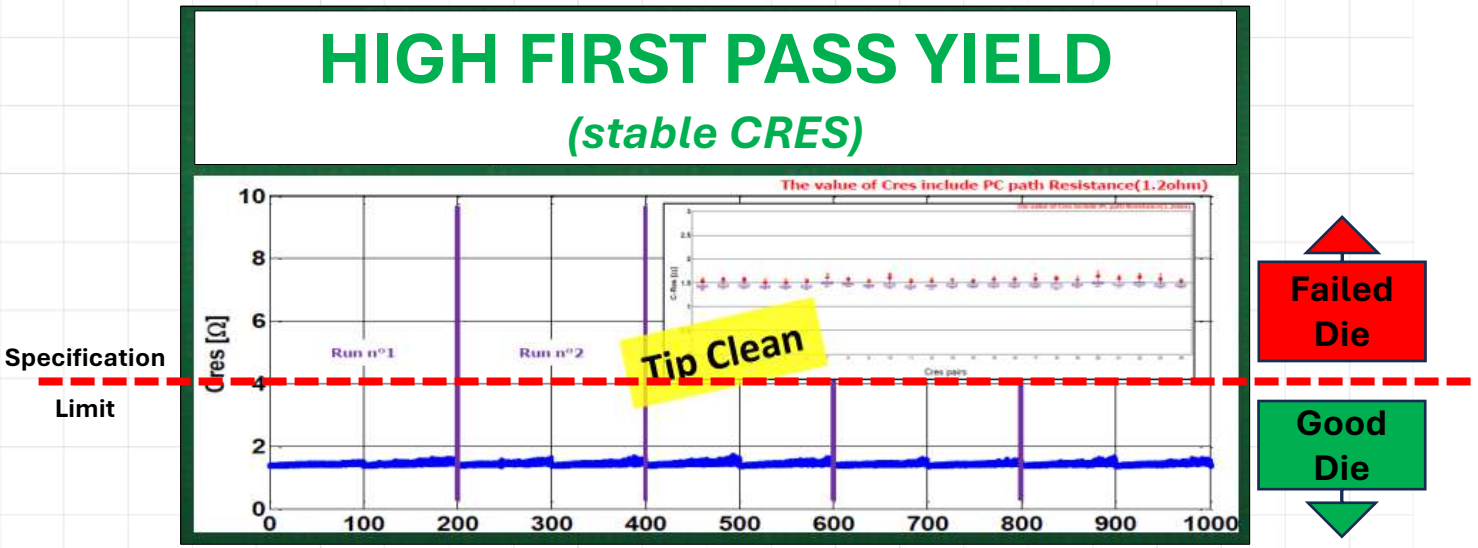
First Pass Yield Loss of ~1% can translate

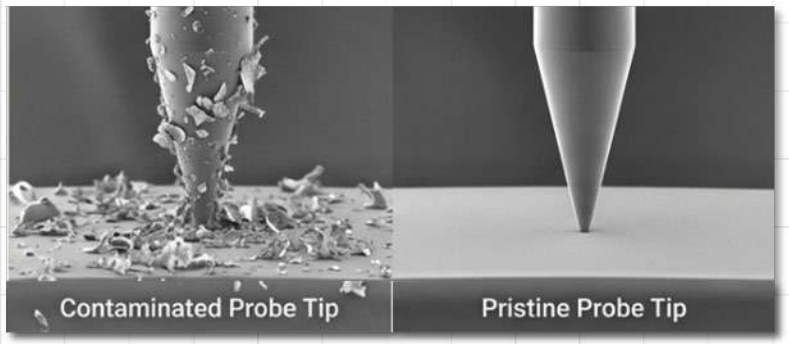
- >$150M/year net profit LOSS to a logic fab
- >$125M/year net profit LOSS at a NAND fab.

Probe Cleaning is Mandatory

Efficient Probe Cleaning

- **Improves test accuracy**: Removes debris, oxides, residuals, etc., that affect test program performance.
- **Prolongs probe card life**: Consistent cleaning maintains performance and reduces offline repair.
- **Reduces risk of contamination**: Prevents probe-related debris from dropping onto the wafer and affecting subsequent processing steps.
- **Increases prober availability**: Assures accurate probe-to-pad-alignment (PTPA) critical for small tips, small device I/Os, fine pitches, and large contactors.

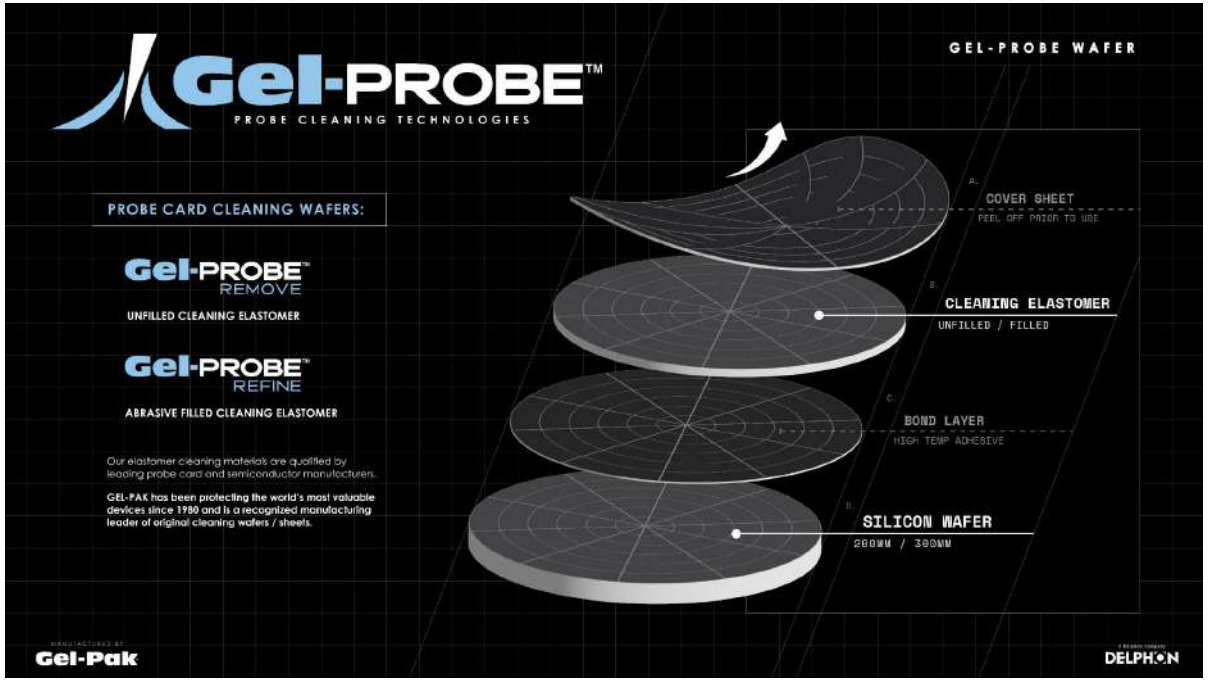


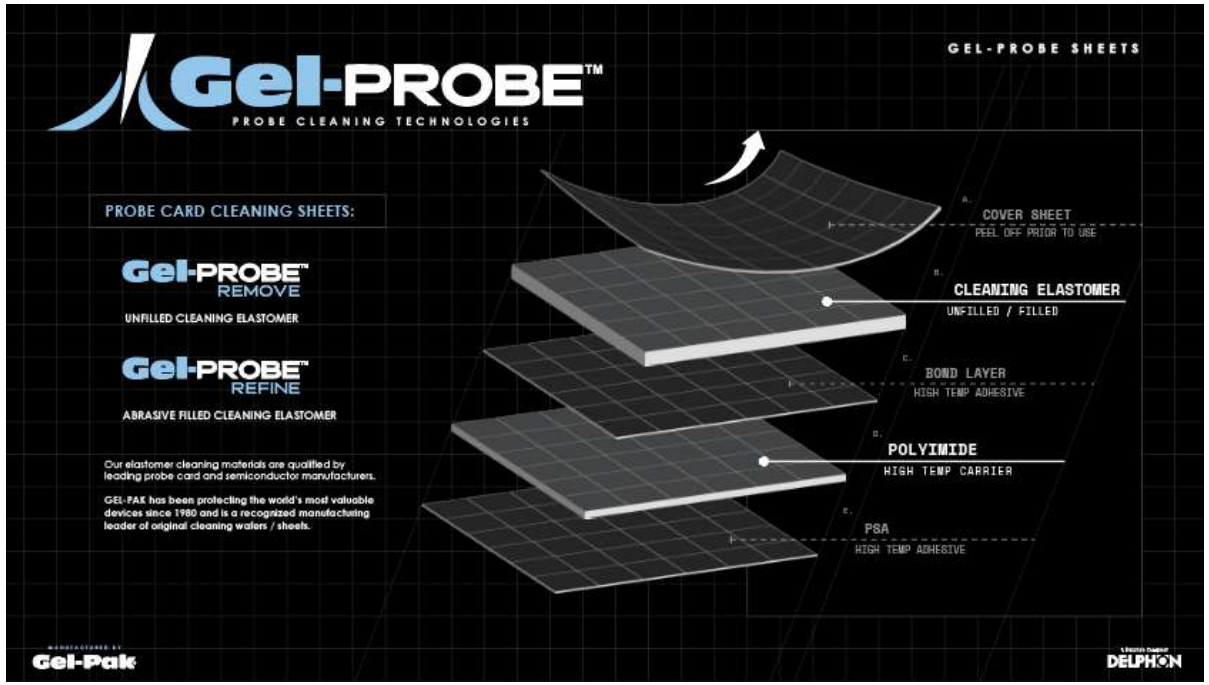


Gel-Pak Renters the Market with GEL-PROBE™

Gel-Probe Product Family is engineered with a variety of abrasive loadings

Increased loading → Increased material hardness → Increased Cleaning Efficiency





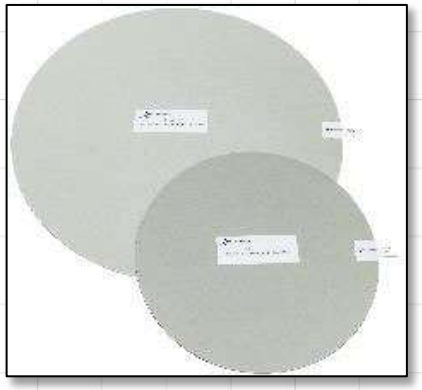
Operating Temperature Range = -60C to 200C

Efficient Cleaning | Elastomer Cleaning Materials

Property	GP Probe ReMove GP Probe ReFine
Chemistry	Gel Elastomer
Color	GPM - Opaque (unfilled) GPF - Green-Gray (filled)
Surface Texture	Proprietary "Dull Surface" for Optical Recognition
GPF - Abrasive Particle Filler	Silicon-Carbide (SiC) w/ Particle Size Distribution
Sheet Substrate	Polyimide (High and Low Temperature Capable)
Outgassing	Meets and Exceeds ASTM E595 TML ≤≤ 1.00% and CVCM ≤≤ 0.10%
TTV	Less than 25um
Sheet Film Tolerance	±20um
Operating Temperature	-60C to 200C

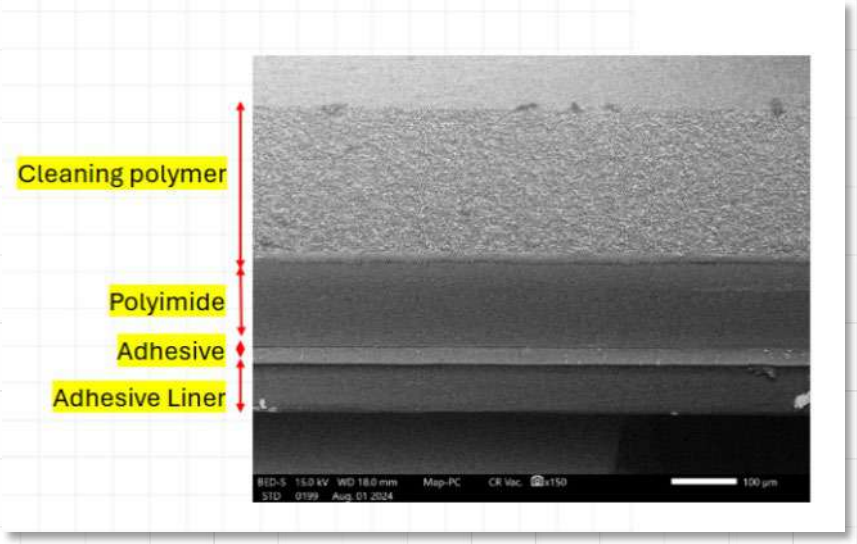
Standard Cleaning Wafers

SEMI 200mm and 300mm



Polyimide backed sheets

-60˚C to 200˚C performance

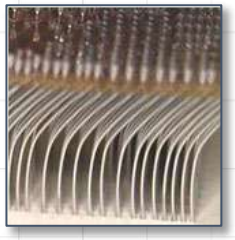


Gel-Probe Core Capabilities

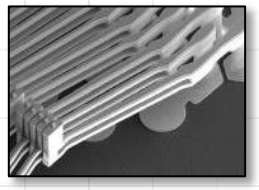
- **GP Does not fabricate lapping materials**
- **GP can provide various 3M lapping films from Ultra-Tape Division.**

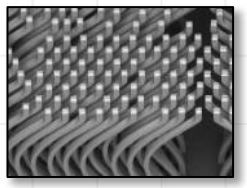
- **Cantilevered Wire Probe**
  - Cleaning materials validated for attaining long probe card lifetimes.
  - Critical data integrity for high value parametric applications.

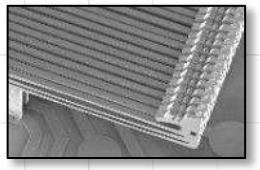
- **Vertical Probe**
  - Cleaning materials validated for maintaining tip shape
  - Highly effective for probe debris removal and collection.

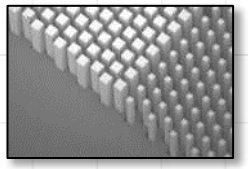


- **IC – Advanced Probe & MEMS Probe**
  - Best in Class performance the most advanced probe technologies.
    - 3D MEMS : litho / etch probes
    - 2D MEMS : litho / etch probes
  - Memory application with MEMS microcantilever.
  - Non-memory with vertical MEMS low-scrub and low-force probe technologies









Abrasive Materials

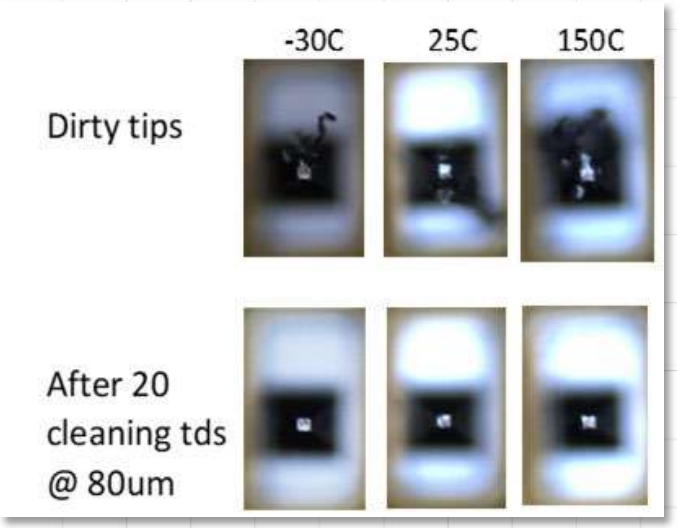
- **Lapping Films for Cantilever**
  - High Volume, Low Mix, Low Value
- **Abrasive Foams**
  - High Volume, Medium Mix, Low Value
- **High Loaded Elastomers**
  - Critical data reliability and quality
  - Low Volume, Low Mix, High Value

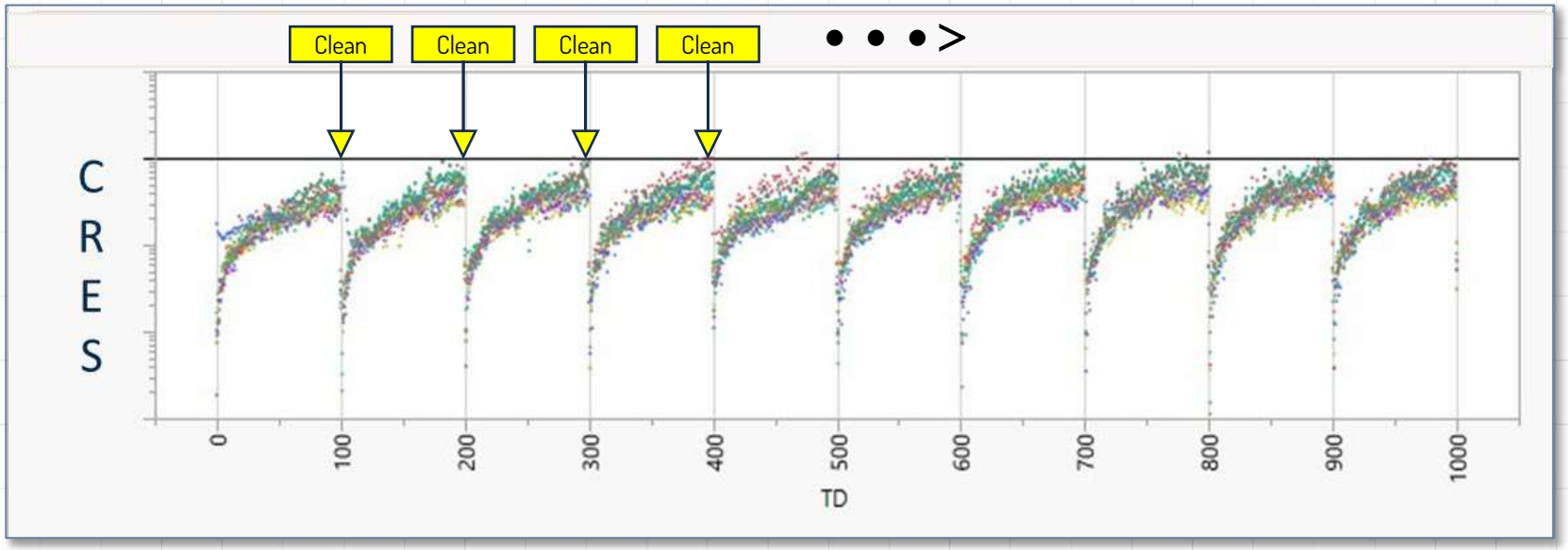
Elastomer Materials

- **Memory PC – Cleaning Wafers**
  - Massively parallel, high pinout, full-wafer contactor technologies
  - High Volume, High Value Cards and Devices
- **Non-Memory PC – Cleaning Sheets**
  - High volume, high pinout, advanced technologies
  - High Volume, High Value Cards and Devices

Case Study | HBM Memory Customer

- **GP-ReFine Elastomer Cleaning Implementation**
  - Rapid, Low and Stable CRES Recovery
  - Reduced Tip Wear (~15 to 20%)
  - Improved Cleaning Efficiency (~30%) at T ≤ -30C and T ≥ 150C
- **High first pass yield gains greater than ~1% to 3%**





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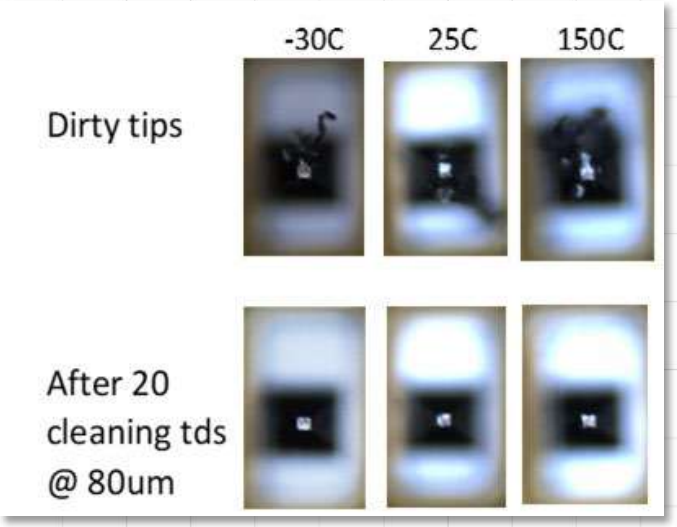
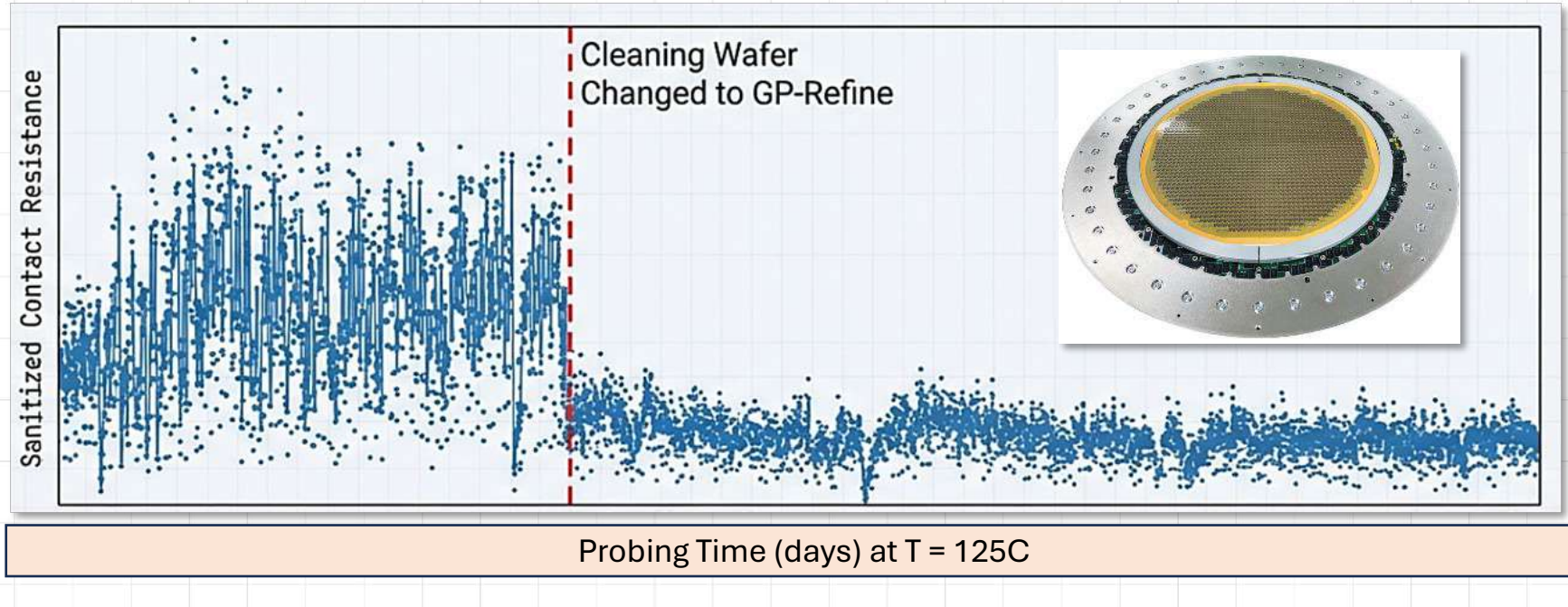
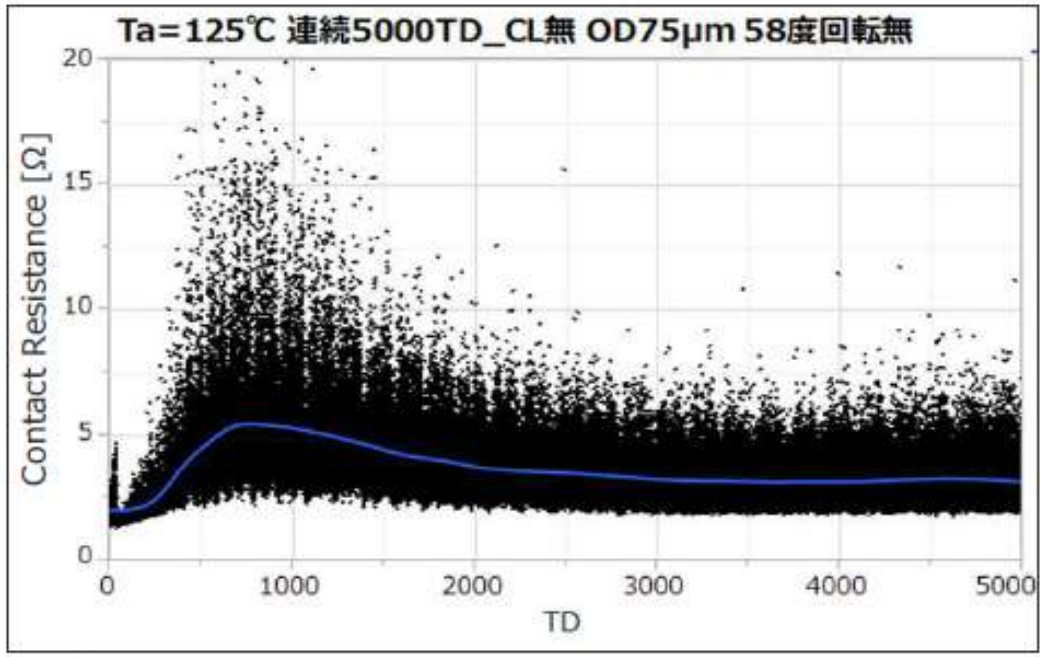




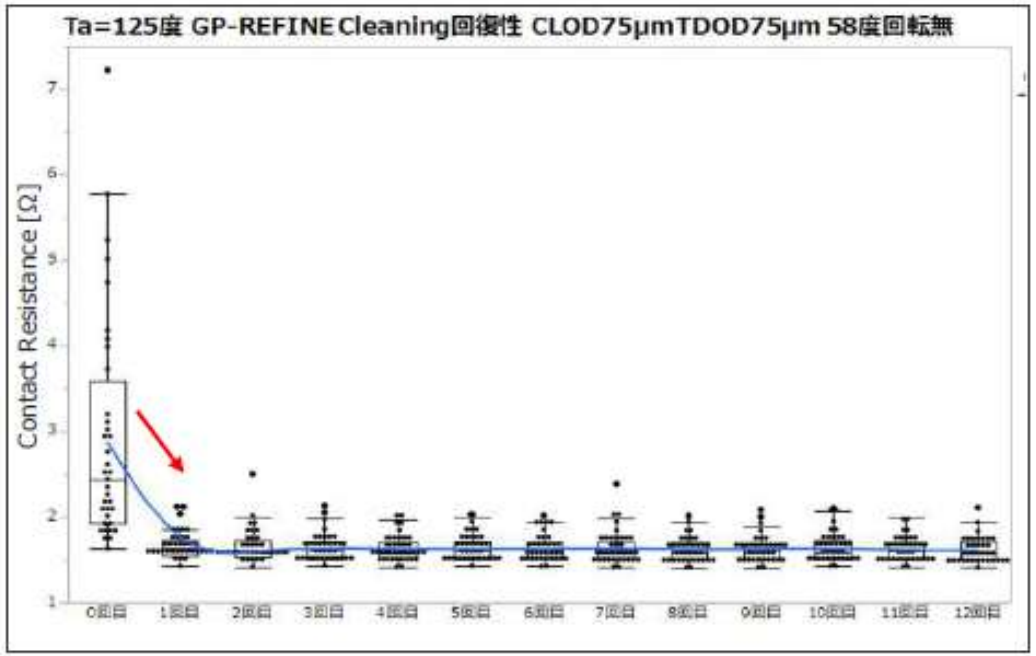
GP-ReFine Cleaning Materials | Vertical MEMS

- **GP-ReFine H3-Type Implementation**
  - Vertical probe w/ shaped probe tip CRES Recovery.

The contact resistance was intentionally worsened by making continuous contact with the Al wafer without cleaning the probe tip.



From a high contact resistance, cleaning with "Gel-Probe Refine" resulted in contact resistance recovery after 10 touchdowns.



GP-ReFine Cleaning Materials | Vertical MEMS

Evaluation Result: Maintain Tip Shape

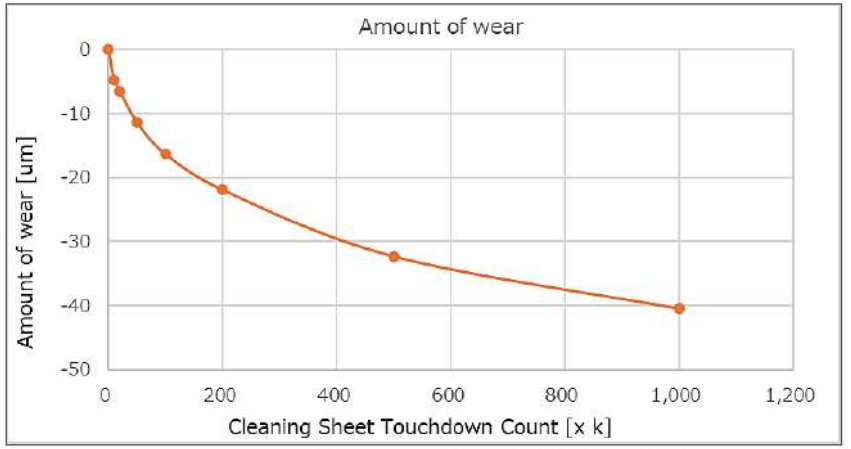
Update

➢ Evaluation Condition

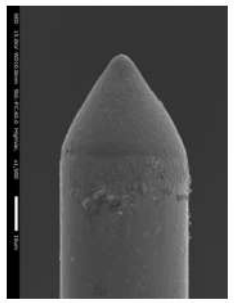
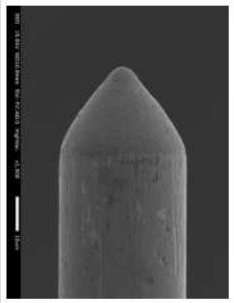
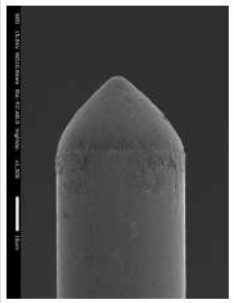
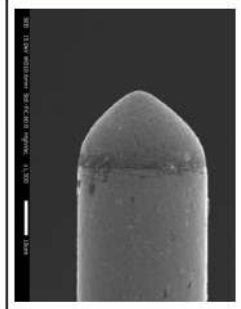
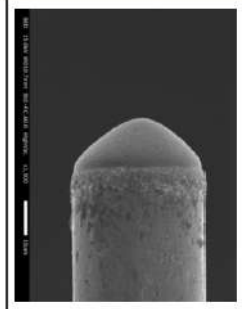
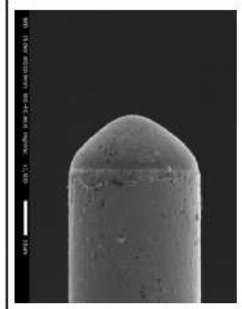
- Prober : ACCRETECH UF3000EX-e
- CL Sheet : Gel-Probe Refine
- CL Sheet OD : 75um
- Temperature : Room Temp.

➢ Maintain Tip Shape Evaluation Results

Wear rates tend to be non-linear.
Even at the initial stage, the wear rate is 0.00016um, which is about 1/10 of the wear rate of sponge-type sheets in general use.

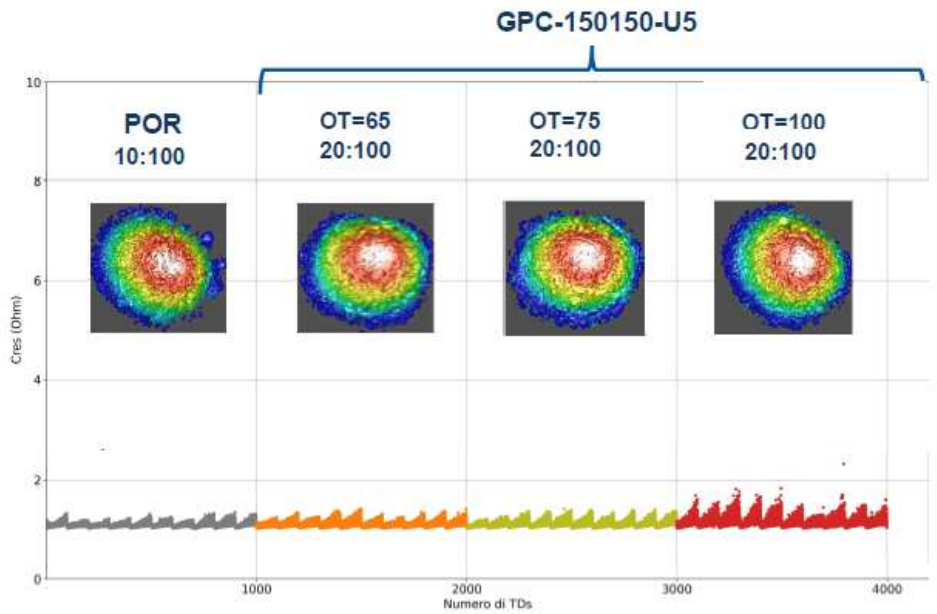


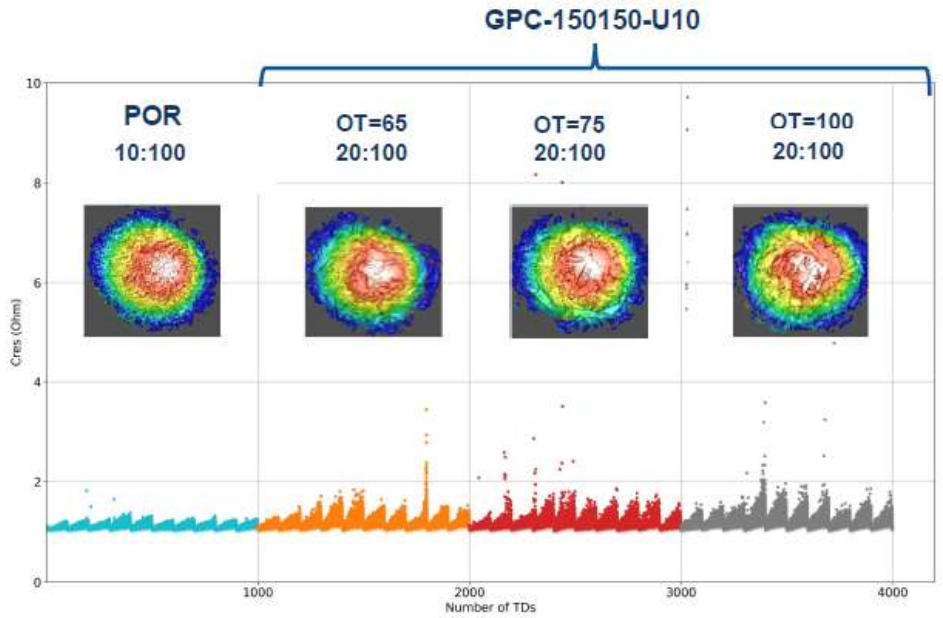
*Number of contacts to cleaning sheet

Initial	After 10k	After 20k	After 50k	After 100k	After 200k	After 500k	After 1M
–	⊿4.7um	⊿6.5um	⊿11.4um	⊿16.3um	⊿21.9um	⊿32.3um	⊿40.5um
							

GP-ReFine Cleaning Materials | Vertical MEMS

- **GP-ReFine Implementation**
  - Vertical probe w/ shaped probe tip CRES tracking.





	AVERAGE (Ohm)	ST.DEV. (Ohm)
POR OT65	1.10	0.03
GPC-U5 OT65	1.11	0.04
GPC-U5 OT75	1.12	0.04
GPC-U5 OT100	1.15	0.06

	AVERAGE (Ohm)	ST.DEV. (Ohm)
POR OT65	1.10	0.03
GPC-U10 OT65	1.15	0.07
GPC-U10 OT75	1.15	0.16
GPC-U10 OT100	1.23	0.4

• Probe Card Qualification Updates

each date indicates a different probe technology

• Qualification at Memory Probe Card Suppliers

MJC

- Jun 2024
- Feb 2025
- Sep 2025

FormFactor™

- Nov 2023
- Mar 2024
- Feb 2025
- Aug 2025

TSE

- April 2024
- July 2024

JEM

- Dec 2023
- Feb 2024

MPI

- Jan 2025
- Evaluations ongoing for HVM Probes

AMST Advanced Micro Silicon Technology

- Apr 2024

CELADON A Wholly Owned Subsidiary of MPI CORPORATION

- Mar 2025

• Qualification at non-Memory Probe Card Suppliers

FormFactor™

- Mar 2024
- Feb 2025

MJC

- Feb 2025

TECHNOPROBE

- Mar 2026
- Additional ongoing

• Pending Qualifications for Memory

(Ongoing Evaluation)

(Ongoing Evaluation)

✘ - Not Compatible
✓ - Compatible
✓✓✓ - Recommended

Gel-Probe Product Family

Operating Temperature Range -60 to +200C

Probe Needle Technology	Example Application	ReMove (opaque)	ReFine (3um, 5um, and 10um)				ReCover (5um, 10um)
		0	L	M	H	U	U
Wired Cantilevered	Parametric	Debris Collection Only	✓	✓✓✓	✓✓✓	✓✓	✓
Vertical (wired)	Flat	Debris Collection Only	Debris Collection Only	✓✓	✓✓	✓	✓
	Shaped, Pointed	Debris Collection Only	✓	✓✓	✓✓✓	✓	✓
	Crown	Debris Collection Only	✓	✓✓	✓✓✓	✓	✘
2D MEMS Microcantilever	Memory Non-Memory	Debris Collection Only	✓	✓✓✓	✓✓✓	✓	✘
3D MEMS Microcantilever	Memory Non-Memory	Debris Collection Only	✓	✓✓	✓✓✓	✓	✘
Vertical MEMS	Memory Non-Memory	Debris Collection Only	✘	✓	✓✓	✓✓	✓✓

Increased loading → Increased Cleaning Efficiency

Gel-PROBE

Available in a variety of abrasive loadings

Increased loading → Increased material hardness → Increased Cleaning Efficiency

Gel-Probe	Description	Silicon Carbide (SiC) Particle	Competition
ReMove-0 (GPM)	Opaque Elastomer	Unfilled	Probe Clean (PC)
ReFine-L3 (GPF)	70 filled Elastomer	3um, 70% Loaded	PP70 (70%, 3um)
ReFine-M3	99 filled Elastomer	3um, 99% Loaded	PP99 (99%, 3um)
ReFine-H3 ReFine-H5 ReFine-H10	150 filled Elastomer	3um, 150% Loaded 5um, 150% Loaded 10um, 150% Loaded	PP150 (150%, 3um) PP150-10 (150%, 10um)
ReFine-U3	300 filled Elastomer	3um, 300% Loaded	PP300 (300%, 3um)