

# Applied Precision

Productivity solutions for a small world

## Innovative Probe Tip Cleaning Techniques



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# Industry Survey

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- What are the suspected contaminants?
- What is thought to cause high Contact Resistance?
  - Aluminum Oxide
  - Anti-reflectives
  - Tungsten Oxide
  - Passivation
  - Silicon Nitride
  - Tri-nitrides
  - Polymers & Fluorocarbons (due to over etch)
  - Lapping media (adhesive)
  - Electrically activated buildup of dielectrics
  - Outgassing of packing materials

# *Industry Survey*

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- Compounds containing these elements were identified using SEM & Auger Analysis
  - Oxygen
  - Sulfur
  - Chlorine
  - Carbon
  - Nitrogen
  - Copper
  - Aluminum
  - Silicon

# Industry Survey

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- How do you determine when a card is “dirty”?
  - It exhibits high contact resistance
  - Yield fallout assumed to be a result of high Cres
  - Reprobe failure rate doesn't improve - assumed to be a result of high Cres
  - By visual inspection

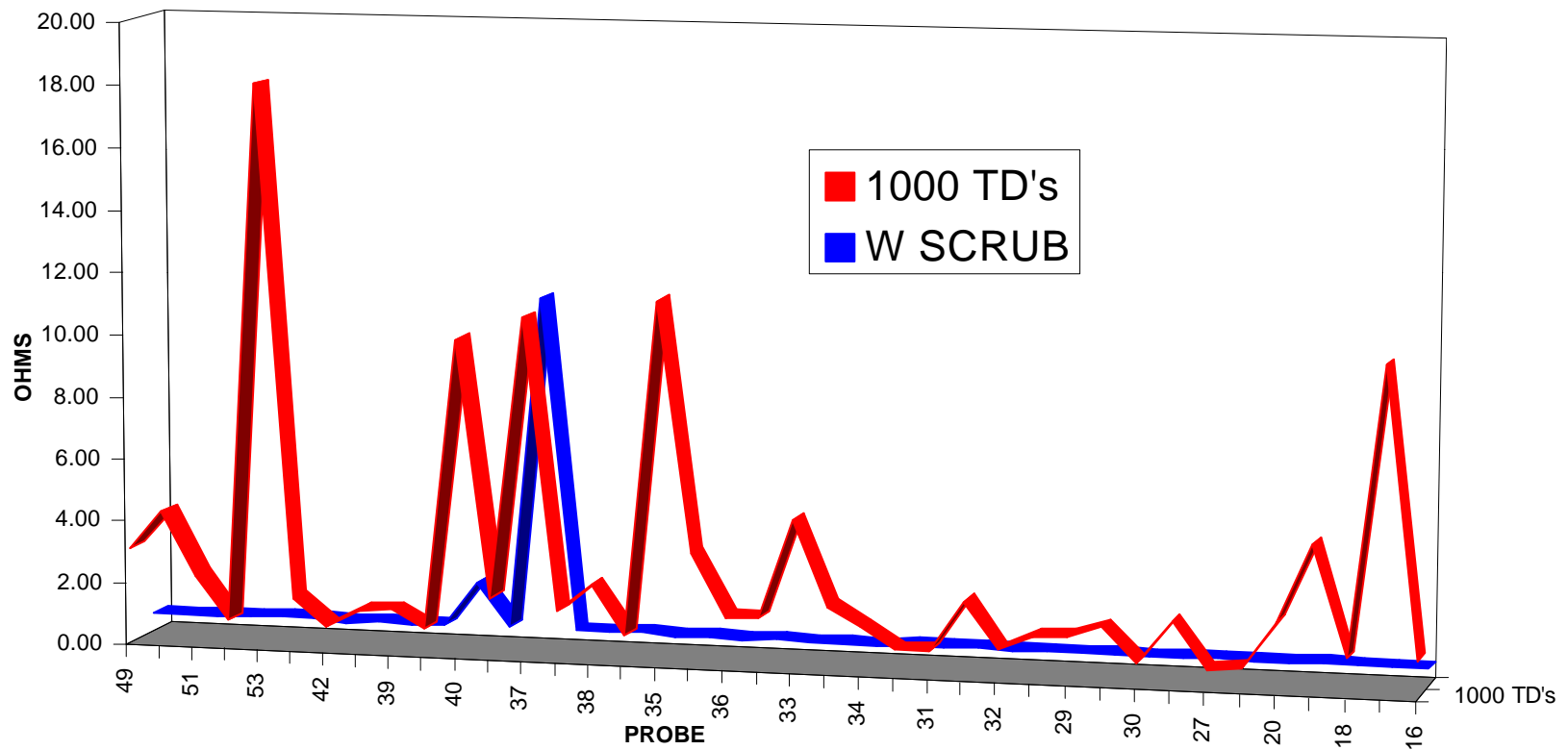
# Industry Survey

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- What methods do you use to “clean”?
  - Scrub on Tungsten Carbide
  - Scrub on Lapping films
  - Scrub on SandPaper
  - Camel Hair dry brushing - to remove particulates
  - IPA wet brushing
  - Scrub on Ceramic
  - Dish Soap followed by DI water
- What do you think reduces Cres??
  - Abrasion, physically removing the “contaminants”

# Scrubbing on Tungsten Carbide

Effectively reduces contact resistance



**BUT...**

# *Abrasive Cleaning*

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- Abrasive Cleaning...
  - Causes deformation of the tips
  - Reduces Probe Card Life
  - Produces additional contaminants
  - Is incompatible with some probe card technology

**A non-destructive  
cleaning alternative  
is needed!**

# *Chemicals and Solvents*

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- Sodium Hydroxide
- Potassium Hydroxide

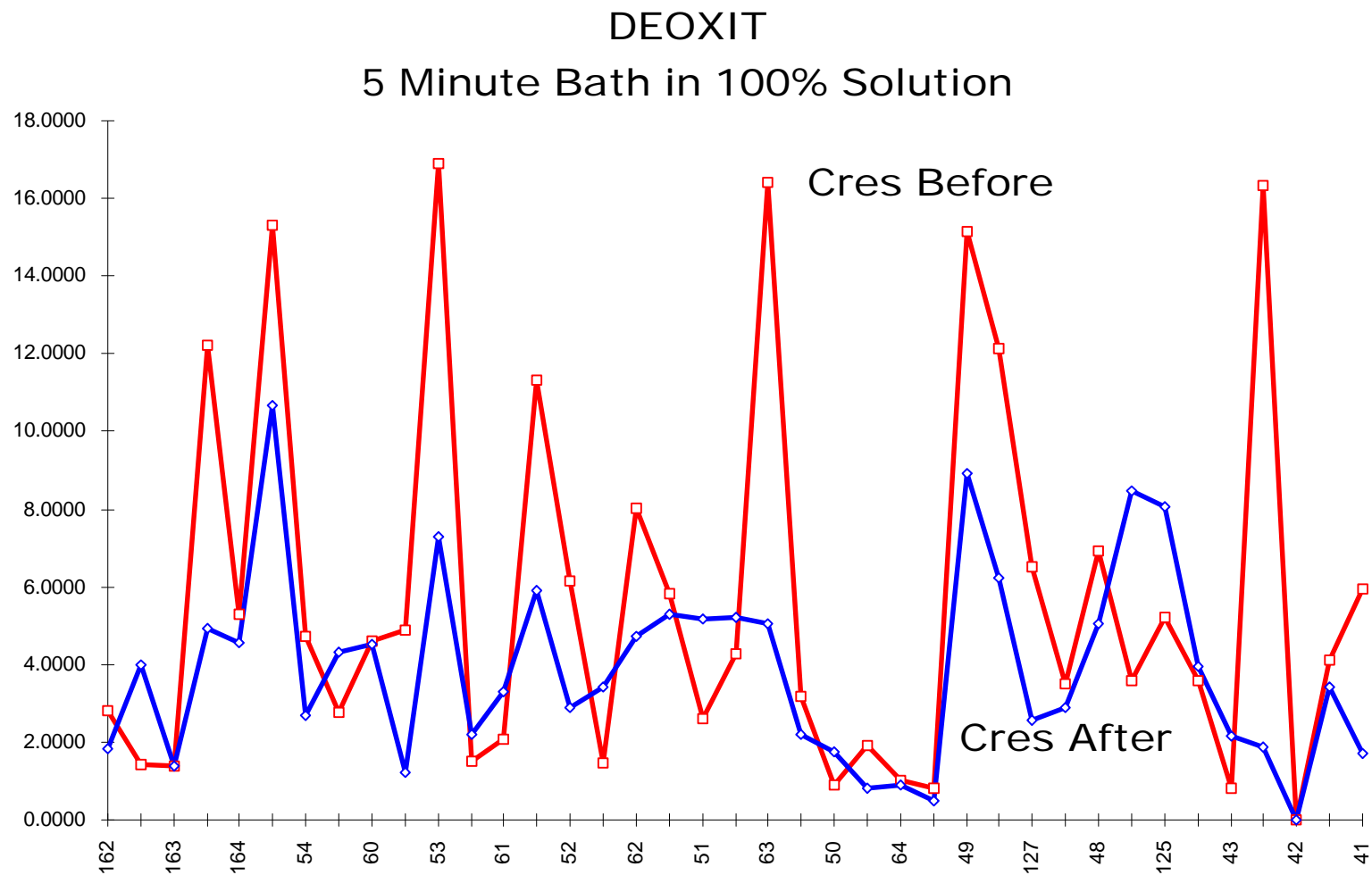
**Did not pursue evaluation of wet chemicals due to restricted usage in wafer fabrication environments**

- Solvents

**Process intensive usage and appear to have little or no effect on contact resistance.**



# Chemicals



# *Our Mission ...*

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To meet the industry requirement we need to find a cleaning method that is

Non-abrasive

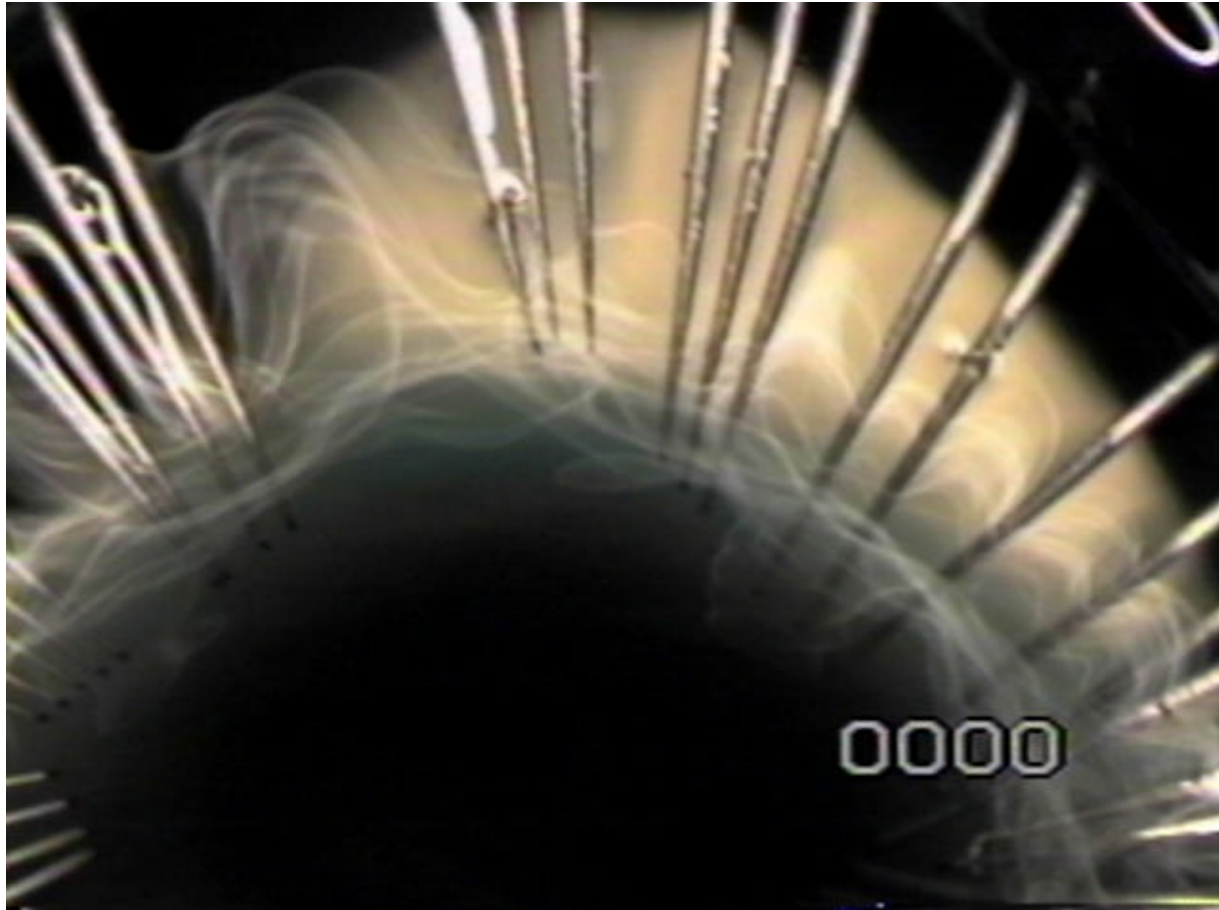
Non-destructive

Non-chemical

Material Independent

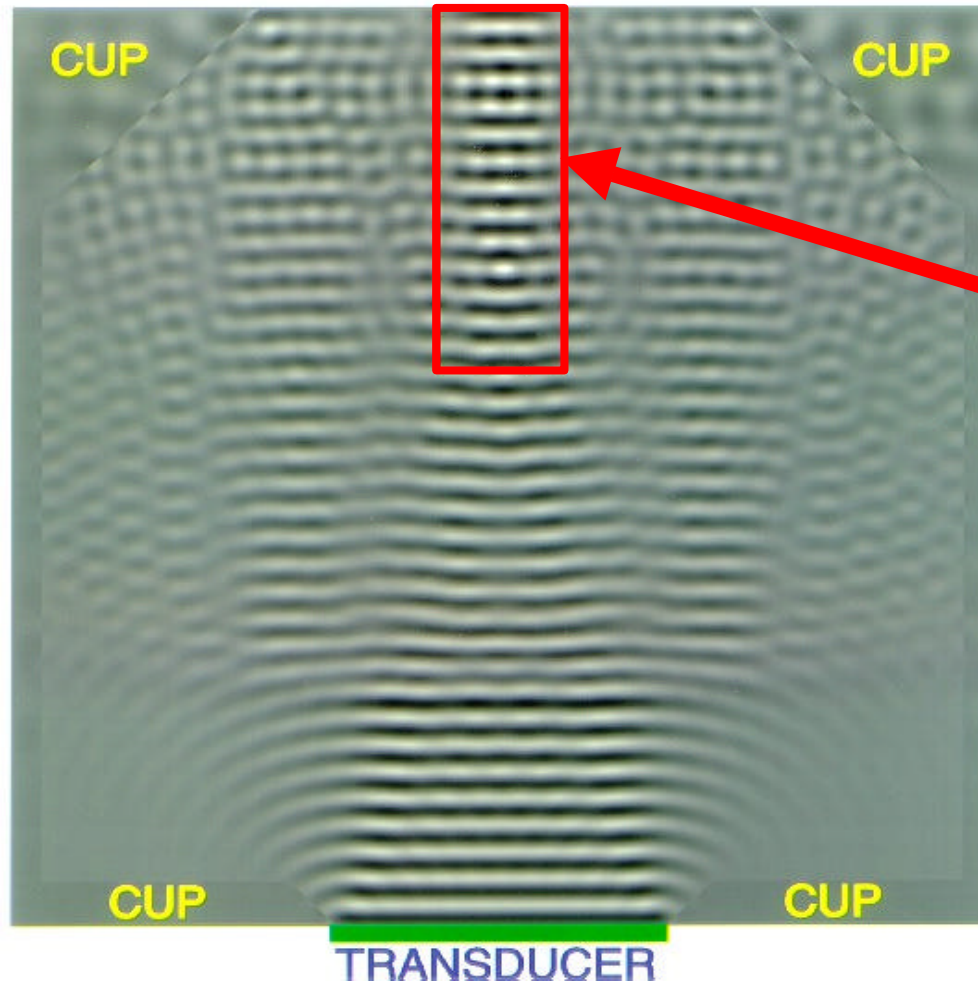
and EFFECTIVELY Reduces Contact Resistance

# *Acoustic Pressure Waves*



TIPS IN AN ACOUSTIC FOUNTAIN

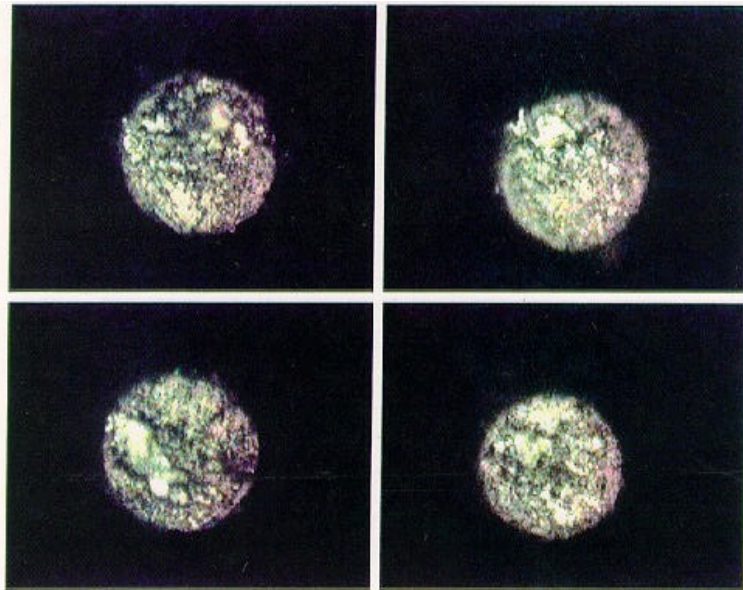
# Acoustic Energy



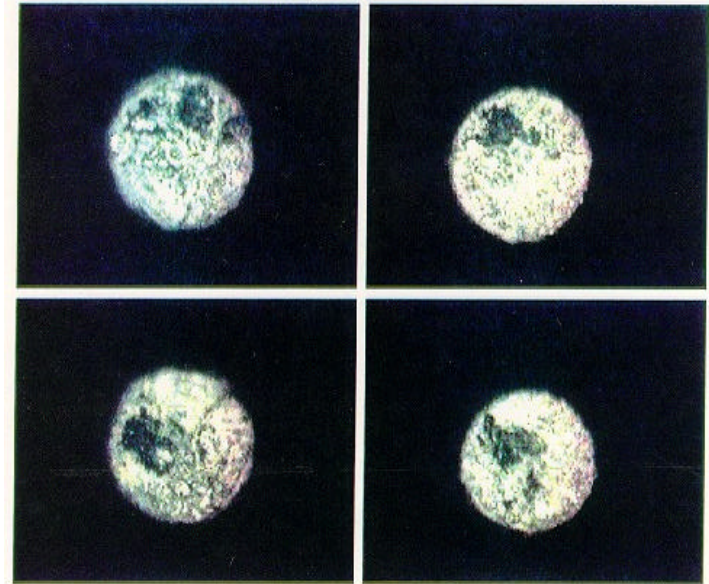
High  
Frequency  
Acoustics  
produce a  
spatially  
defined energy  
field

PRESSURE FIELD AS A STANDING WAVE

# MegaSonic Acoustics



BEFORE CLEANING



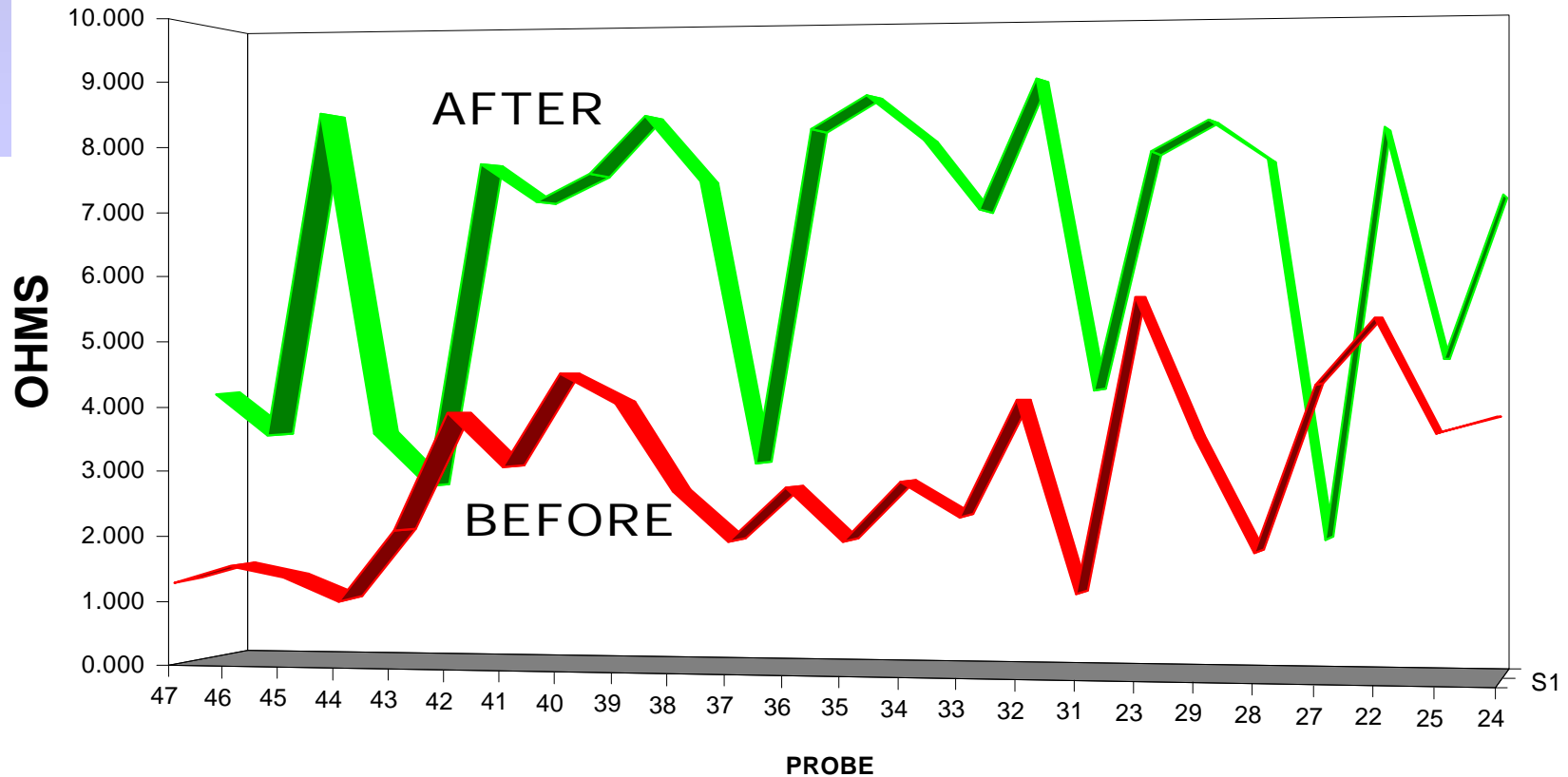
AFTER CLEANING

**Radiation Pressure Forces and Localized  
Microstreaming Effectively Remove  
Particulates**

**However...**

# MegaSonic Acoustics

...Contact Resistance Increases!

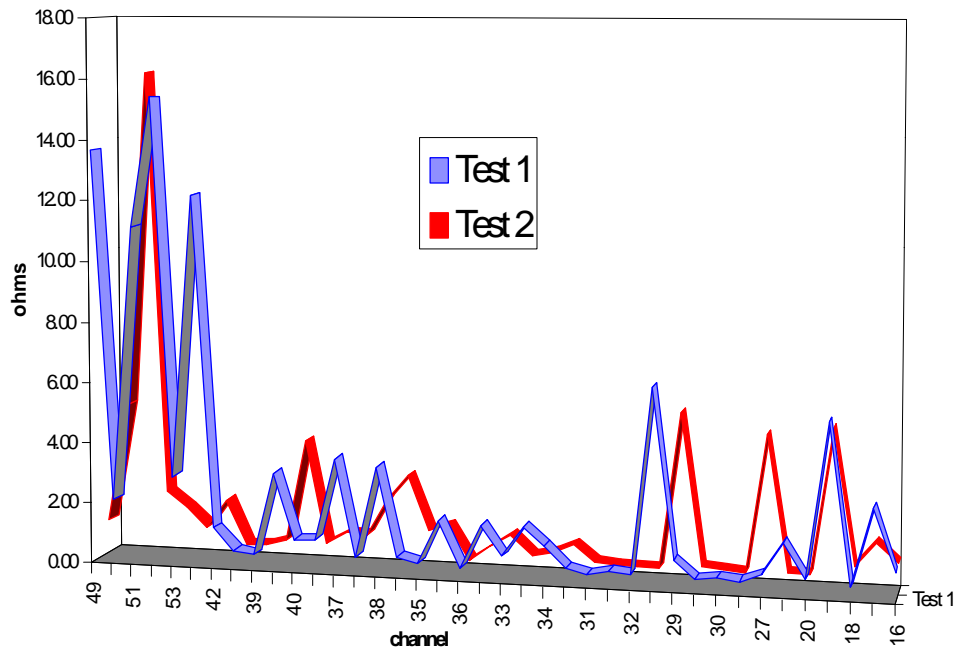




# Carbon Dioxide "Snow"

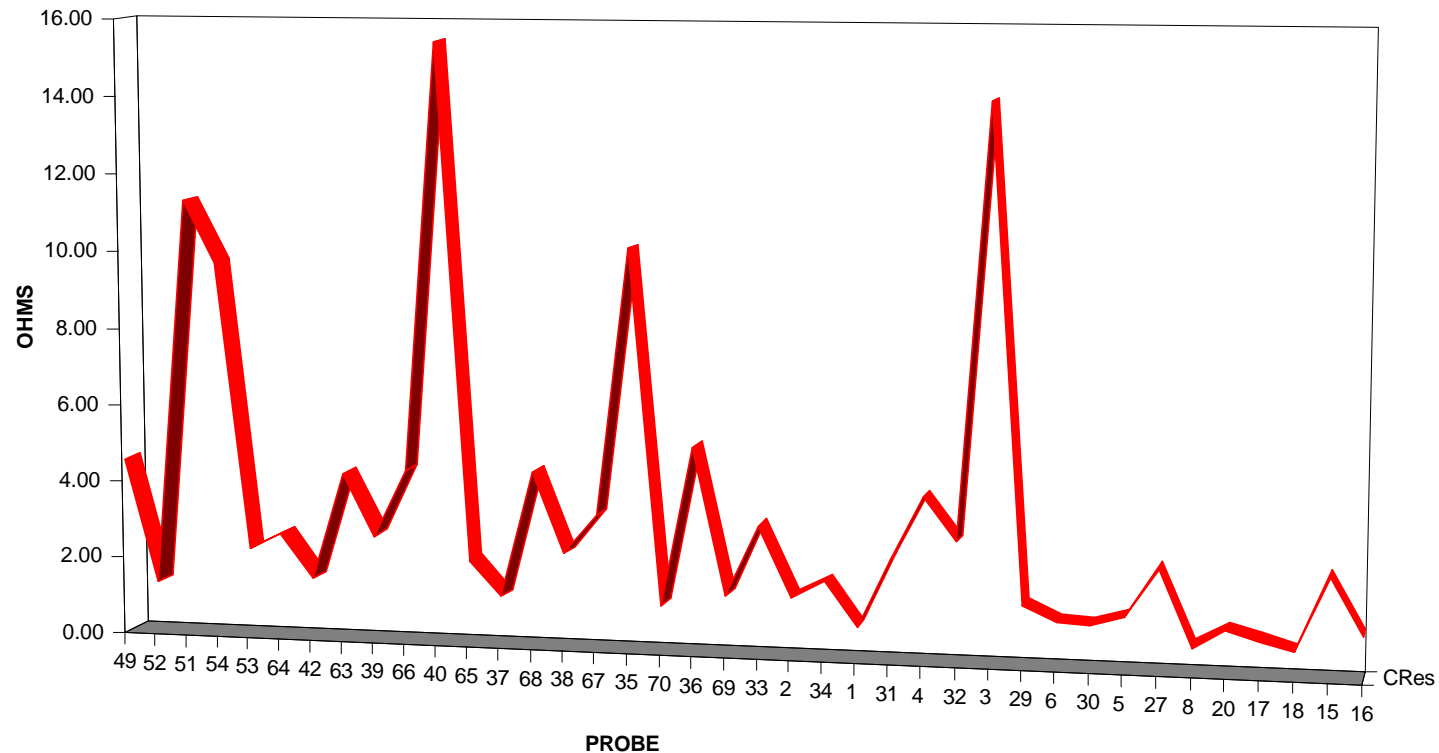
- Removes particles and organic contamination
  - High velocity gas
  - Momentum Transfer
  - Sublimation

**Provides Excellent  
Particle Removal  
but Minimal  
Contact Resistance  
Improvement**



# What Causes Contact Resistance?

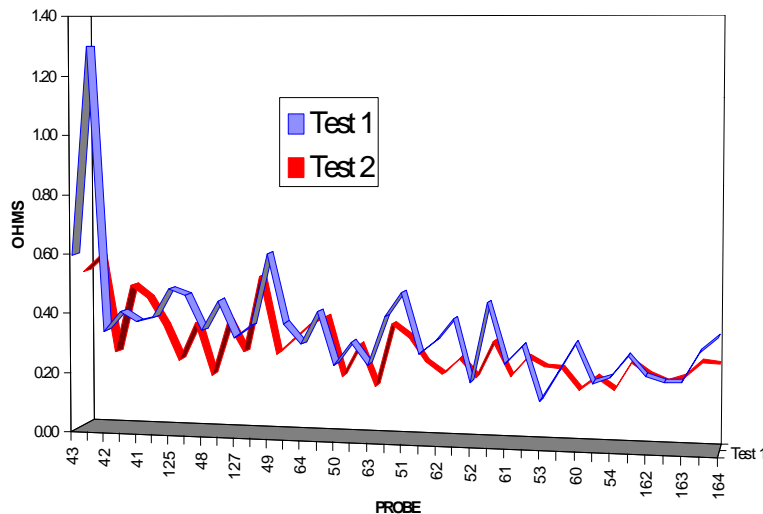
*This Card Has Never Touched a Wafer !*





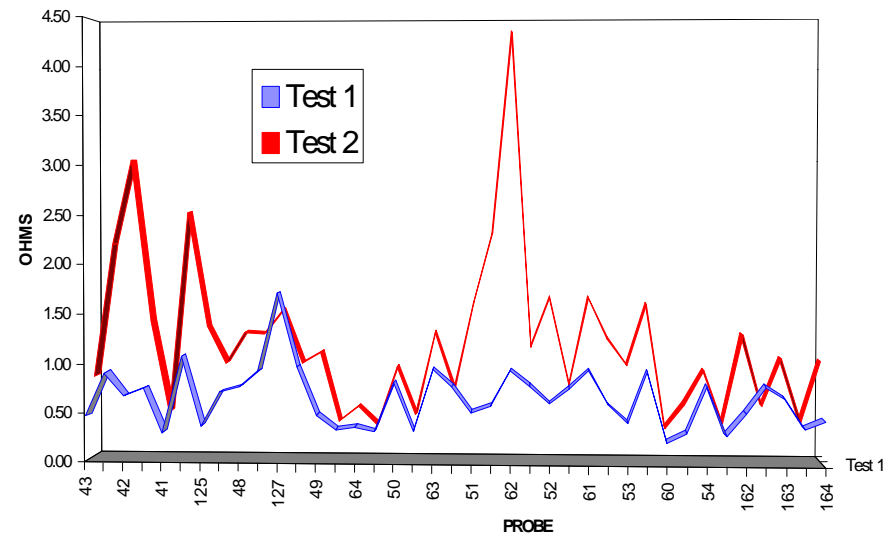
# Probe Card Storage

**Nitrogen  
Purging/Vacuum  
Sealing Controls  
Contact Resistance**



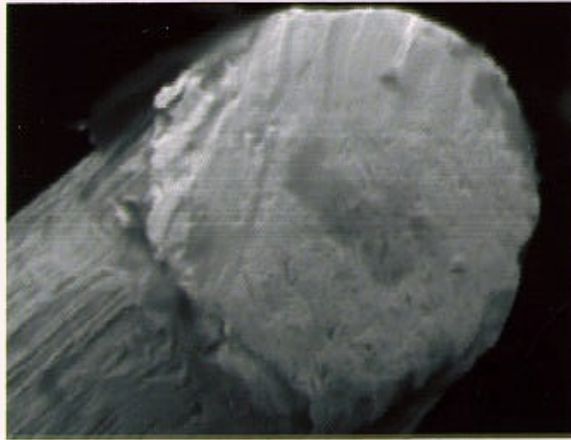
Vacuum Sealed

**Test Performed at  
one week intervals**



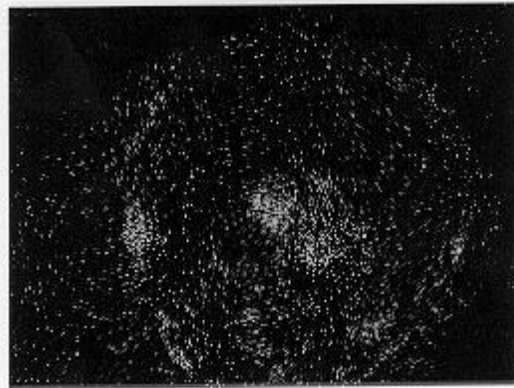
Stored in Air

# *What Causes Contact Resistance?*

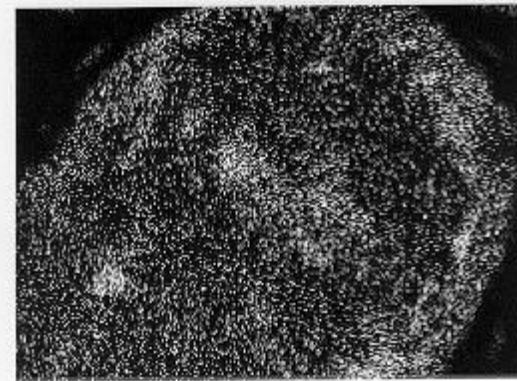


|-----| 10 um

**Presence of Oxygen  
Suggests Existence of  
an Oxide Layer**

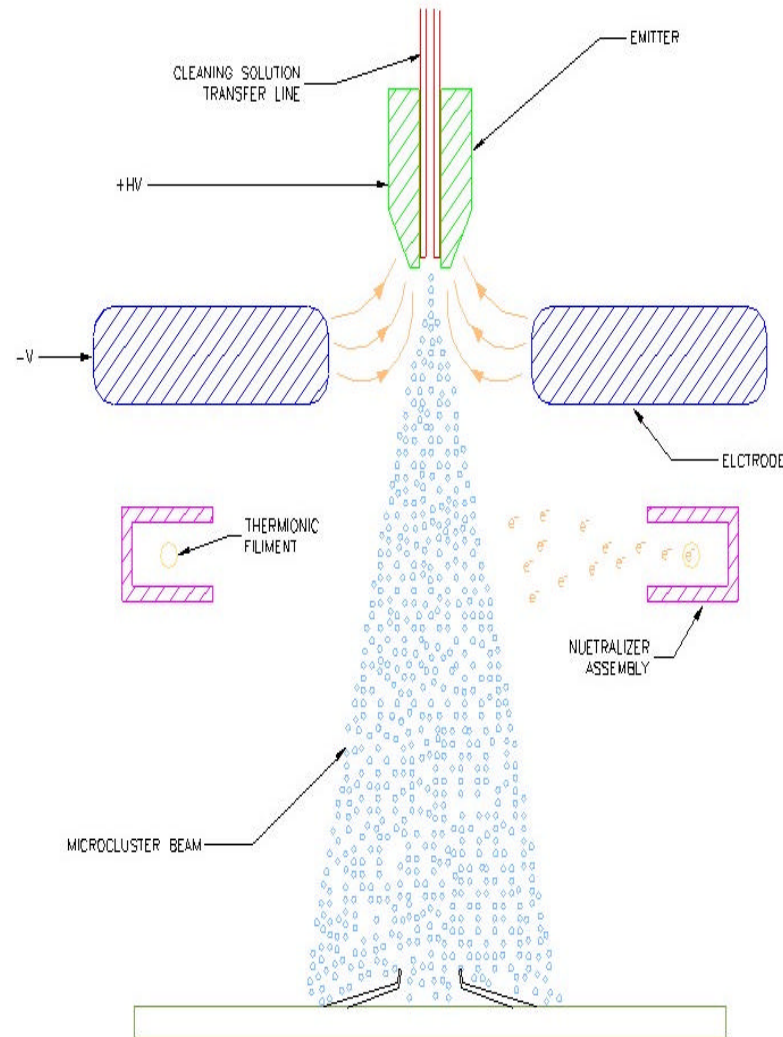


Aluminum



Oxygen

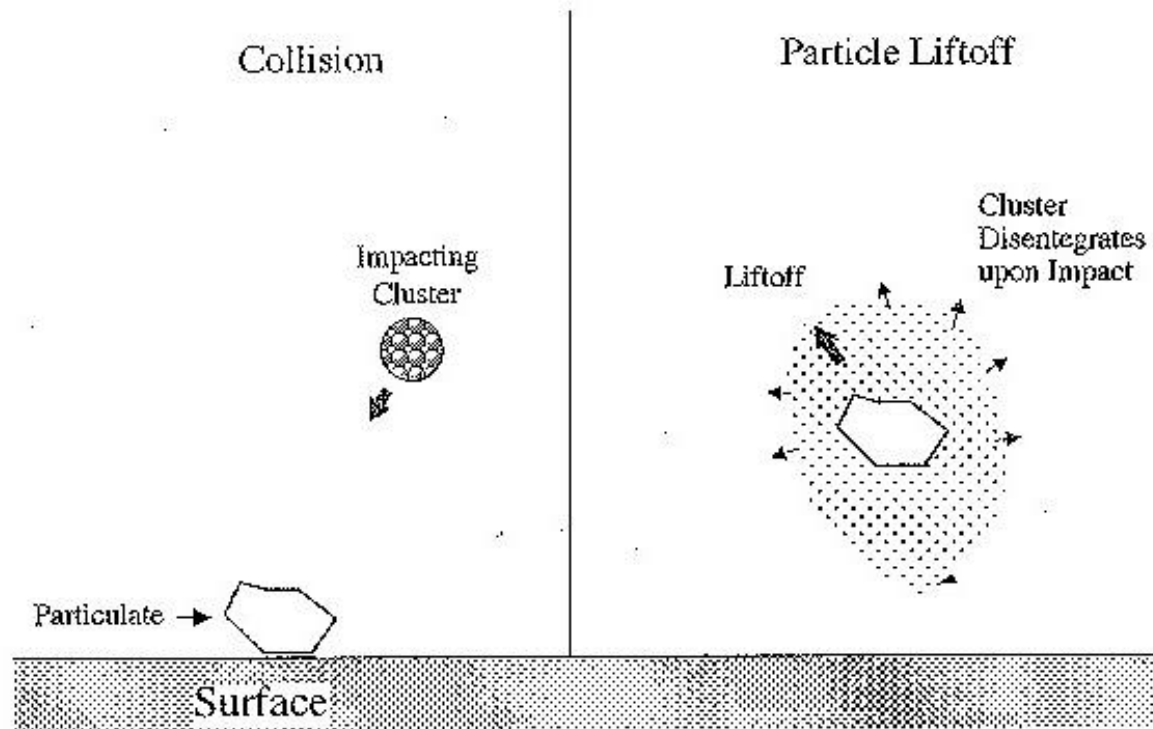
# MicroCluster Beam Technology



# MicroCluster Beam Technology

## Particulate Removal by Cluster Impact

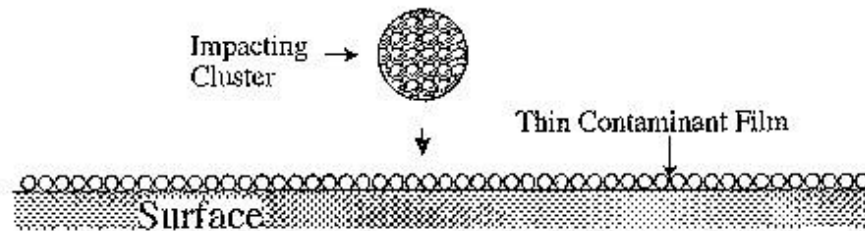
Impulsive Force Transmitted to Particle Upon Impact,  $F = mv/\Delta t$



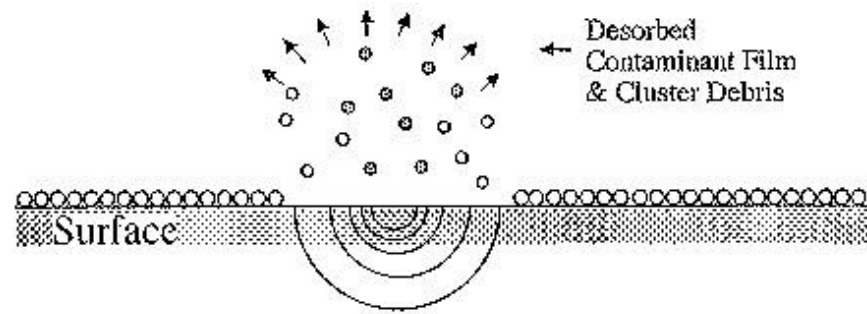
# MicroCluster Beam Technology

## Contaminant Film Removal By Shock Unloading

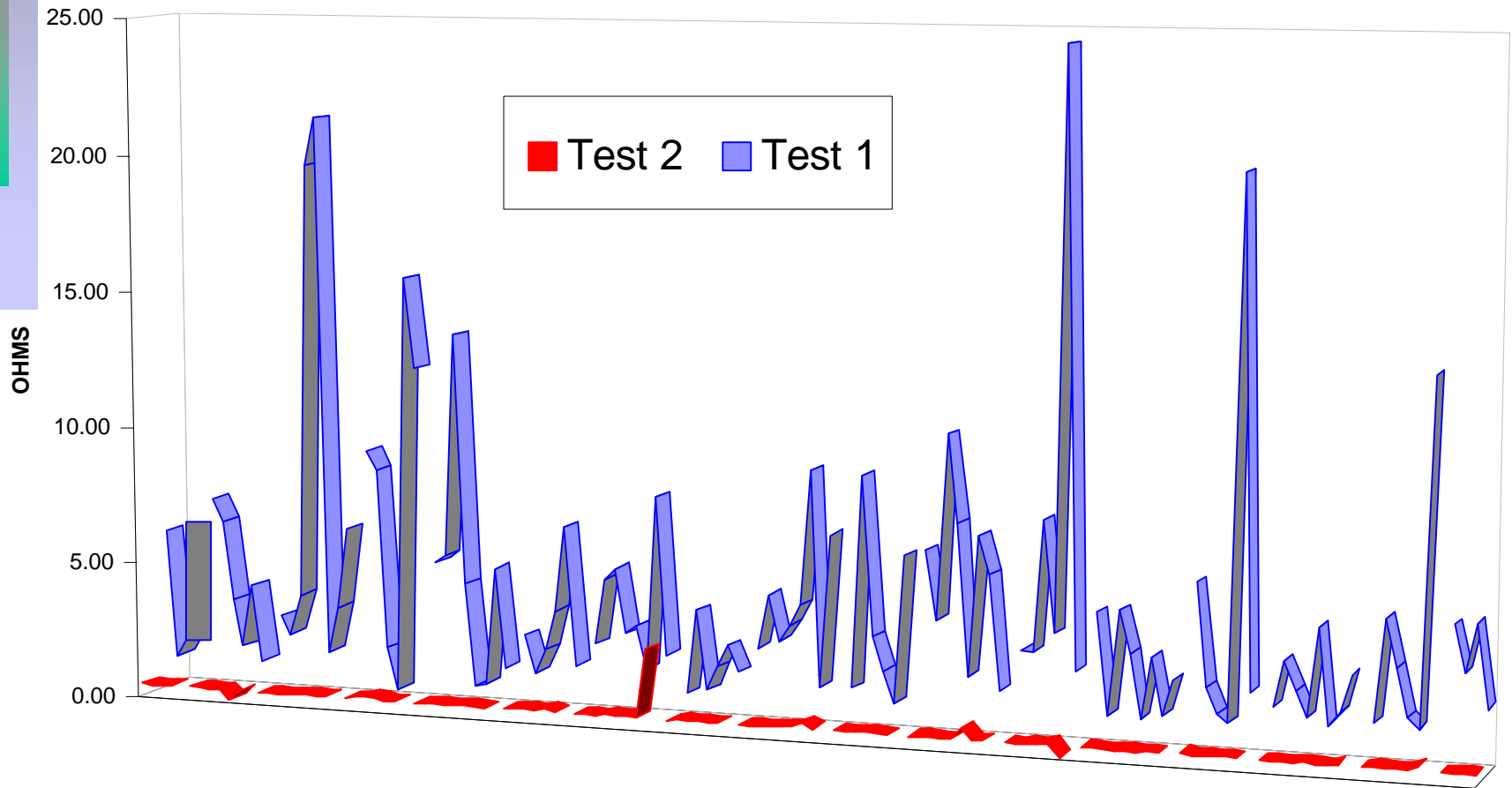
Hypervelocity Impact



Material Ejected By Rarefaction Wave Expansion

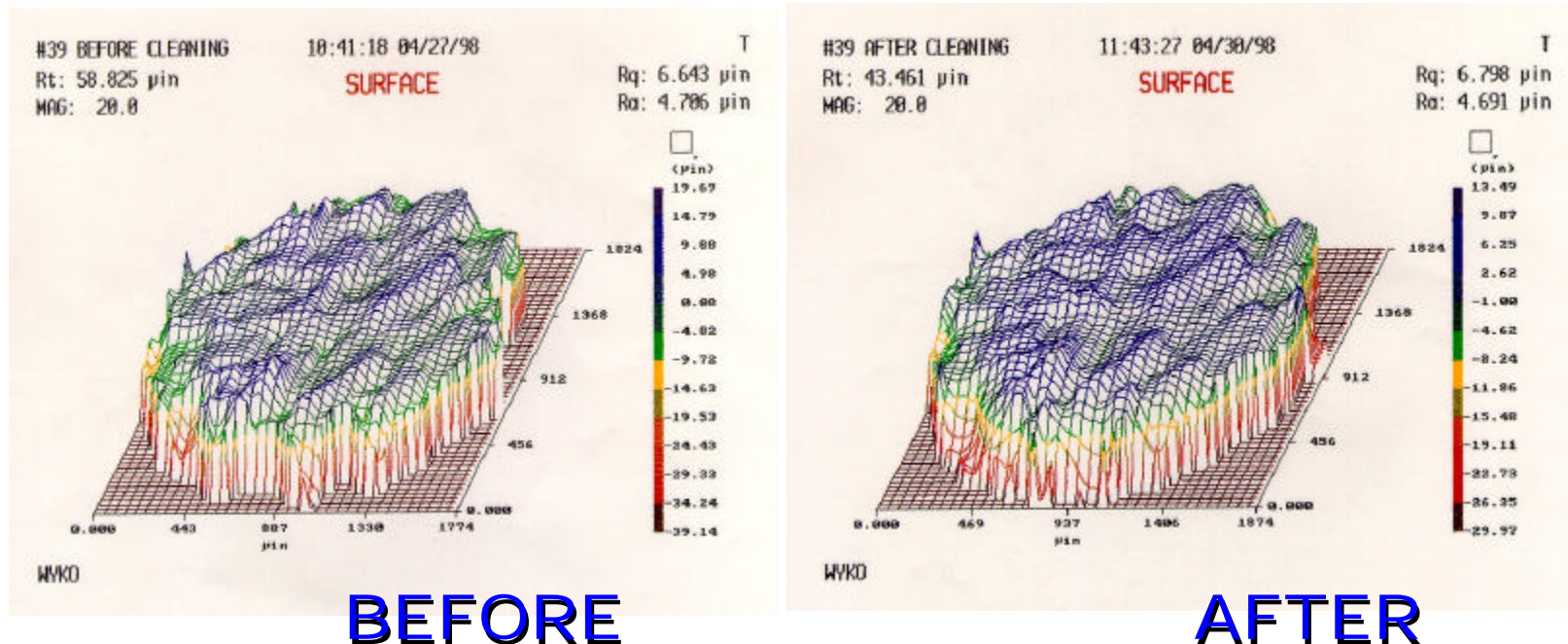


# *Rocket Science Reduces Resistance*





# MicroCluster Beam Technology



**MicroCluster Beam Cleaning Results in NO Measurable Changes to Probe Alignment, Planarity, or Tip Profile**

# Summary

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- Abrasive Scrubbing works, but is destructive.
- Chemicals can work, but are destructive and face restricted usage in Fab environments.
- Solvents are messy and ineffective.
- High Frequency Acoustic Cleaning removes particulates but increases contact resistance.
- CO<sub>2</sub> Snow removes particulates but did not reduce contact resistance.

**Is MicroCluster Beam Technology  
the Solution?**



# Conclusion

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## MicroCluster Beam Technology Exceeds Our Mission Objectives

- Non-abrasive Method
- No Measurable Probe Wear or Damage
- Non-chemical
- Dry process - No Bakeout Required
- Independent of probe material, pitch, topography, type.

**MicroCluster Beam Technology Effectively and Consistently Reduces Contact Resistance!**