Advances in Conventional Cantilever Probe Card

Mini DuraProbe

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Contents:

Why Mini DuraProbe?

- Proven DuraProbe Technology

- 50 um Pad Pitch (Inline)

- Two Tier Design

- Minimized Fan-Out Angles (Max. 3 degree)

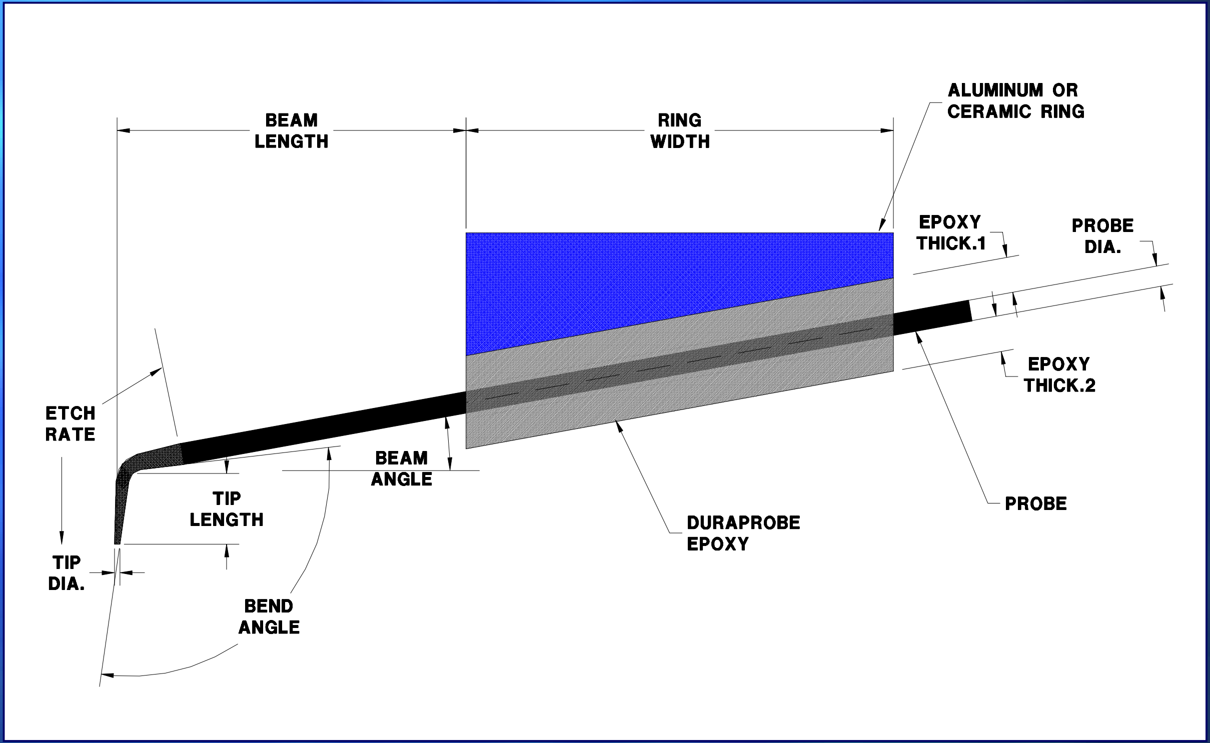
- Small and Uniform Scrub Marks

- Uniform Contact Force

- Uniform Contact Resistance

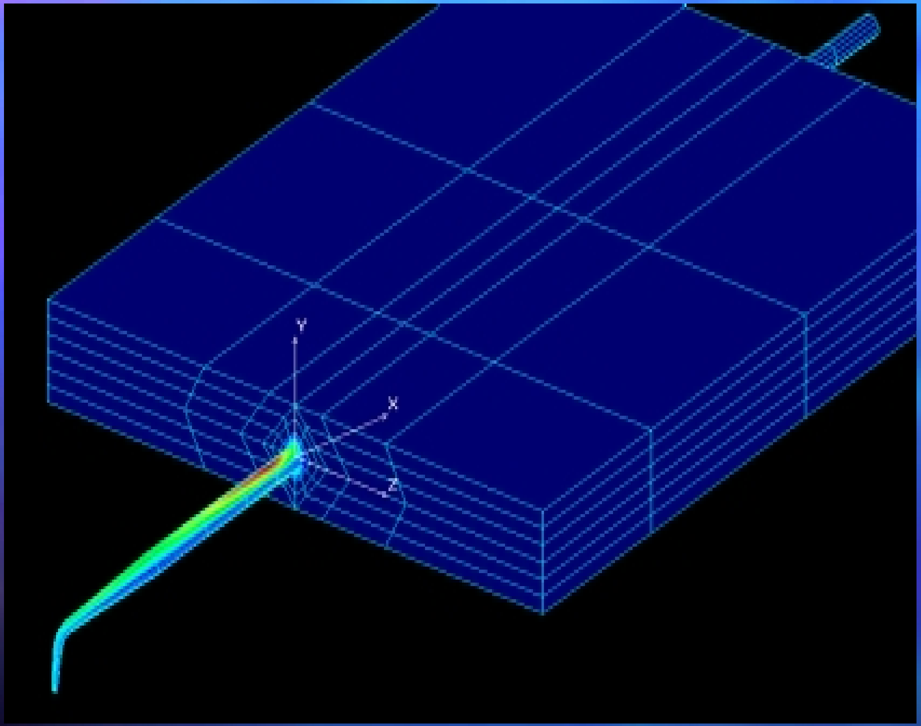
- Minimized Overdrive Required

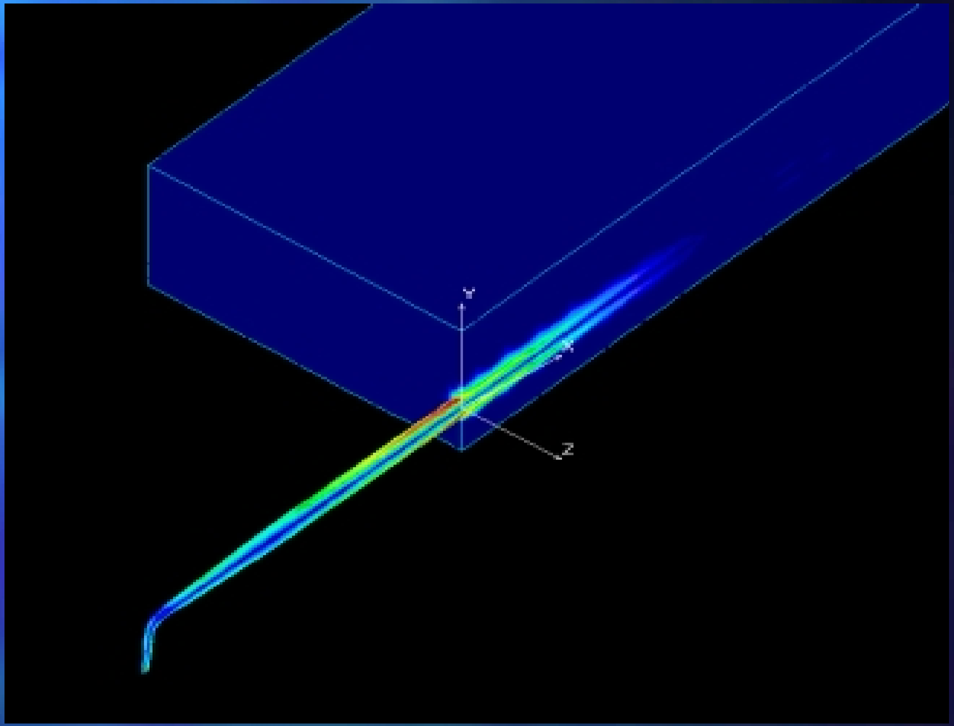
The Constituents of Mini DuraProbe for Parametric FE Model



Other probe parameters:	Young's Modulus
	Poisson's Ratio
	Friction Forces
	Operating Temperature

Parametric 3-D Probe Model



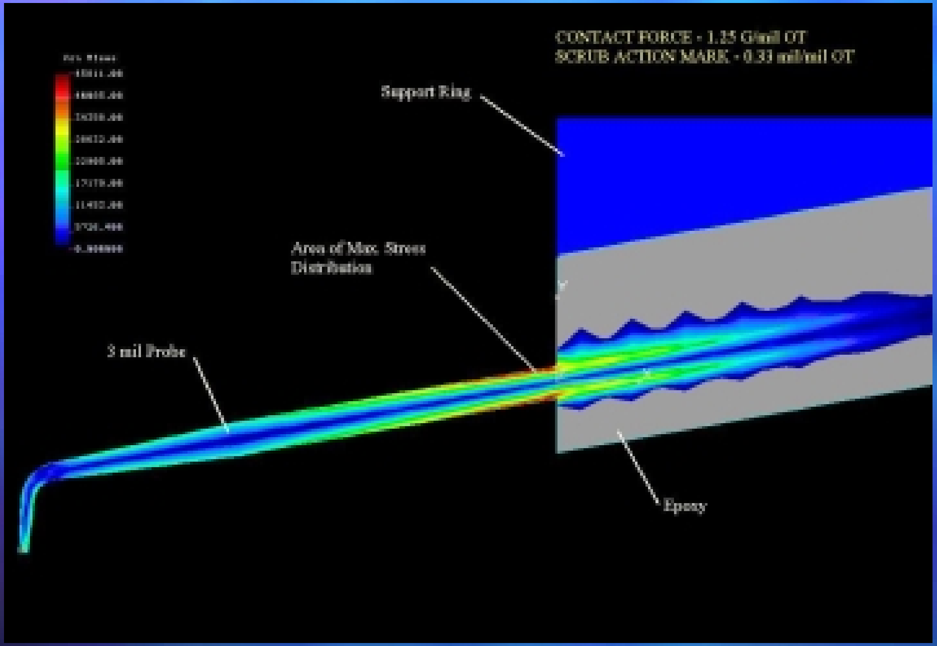


Parametric Finite Element Analysis has been used to predict forces, stresses and strains in deformed probe and epoxy.

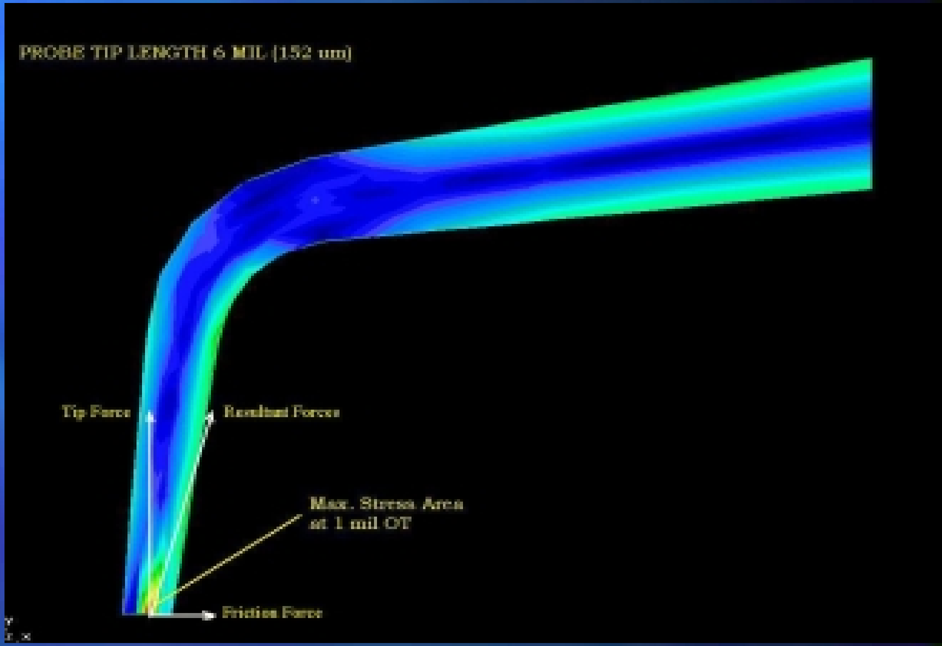
The presented model provides valuable insight into the probe tip movement simulation using displacement method.

Mini DuraProbe Stress Distribution in Probe and Epoxy at Room Temperature

Tier 1



Deformed Probe Shape at 1 mil (25 um) OT



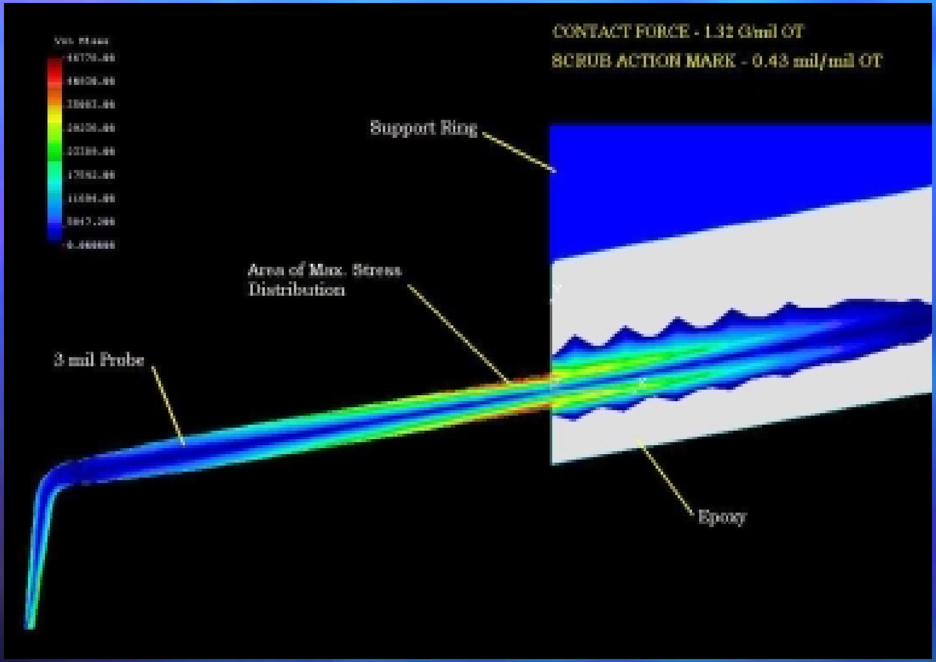
Probe Tip Close-up

Linear Static Analysis
Number of elements - 1632
Number of corner nodes - 2049
Number of degree of freedom - 23163

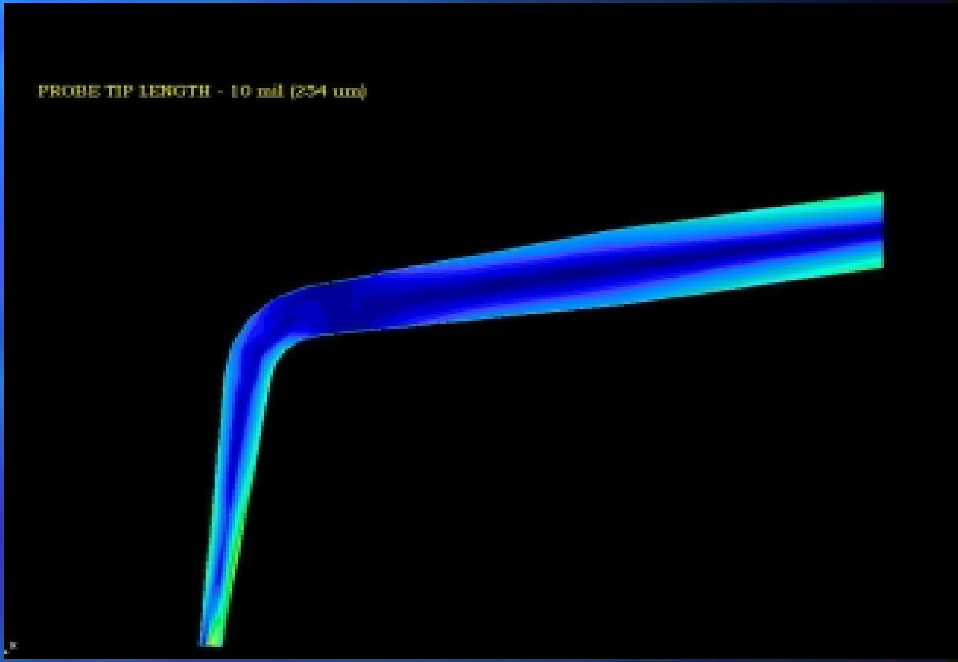
Note: Tensile strengths for tungsten fine wire have been reported to be over 600,000 psi

Mini DuraProbe Stress Distribution in Probe and Epoxy at Room Temperature

Tier 2



Deformed Probe Shape at 1 mil (25 um) OT



Probe Tip Close-up

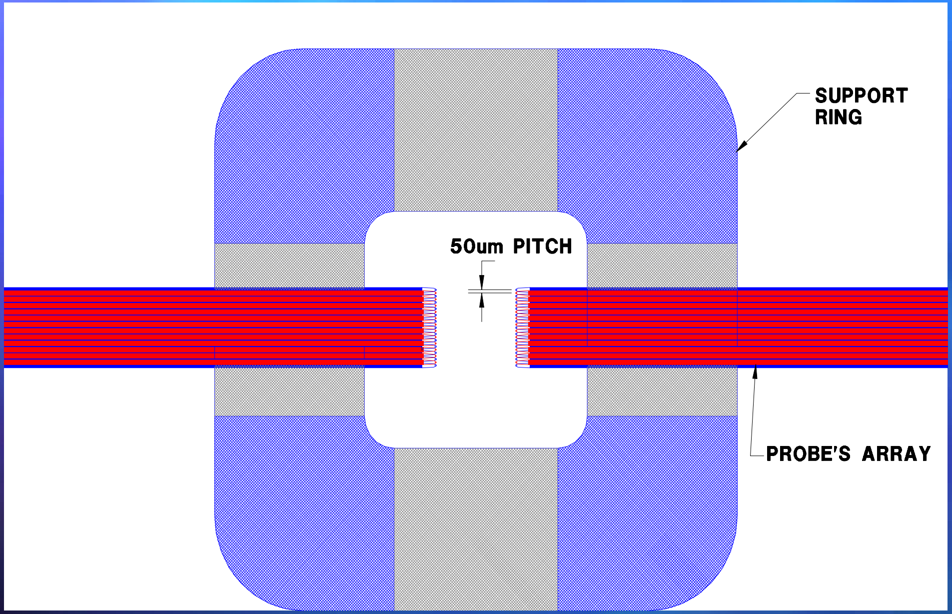
Linear Static Analysis

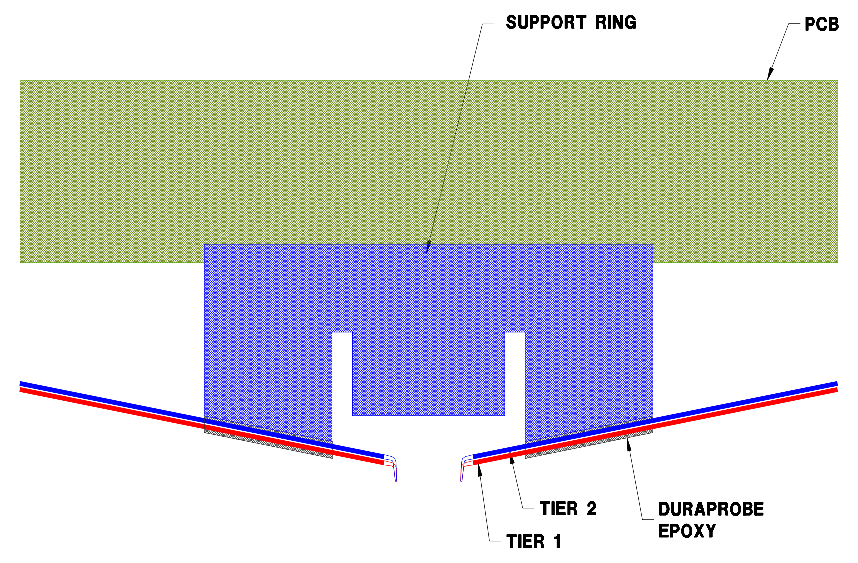
Number of elements - 1656

Number of corner nodes - 2079

Number of degree of freedom - 23487

Mini DuraProbe Layout and Profile





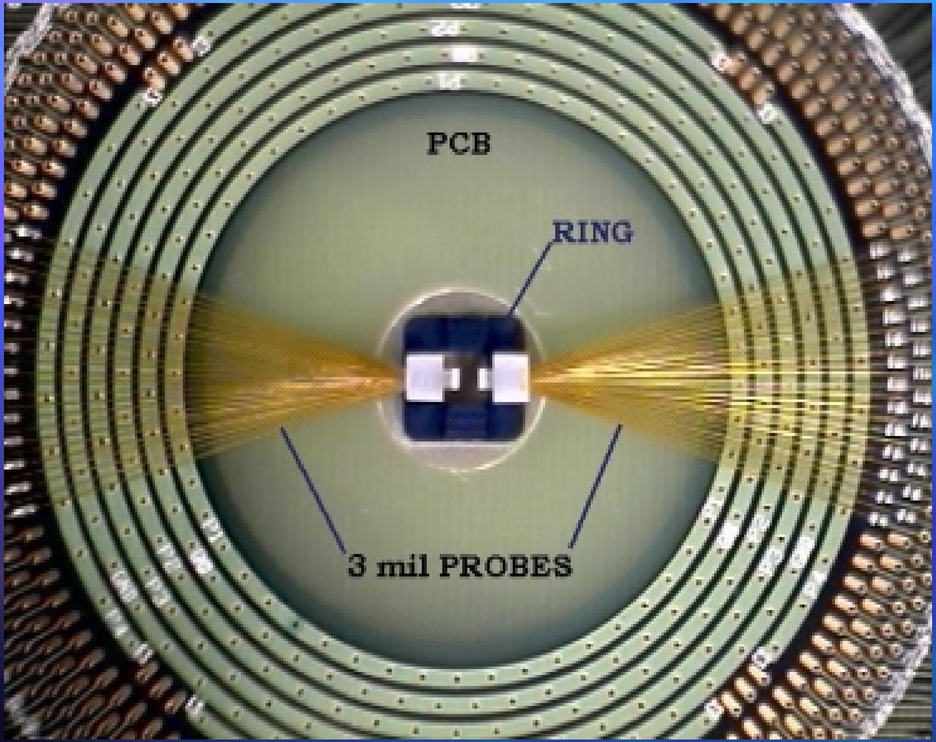
Mini DuraProbe Design Specification

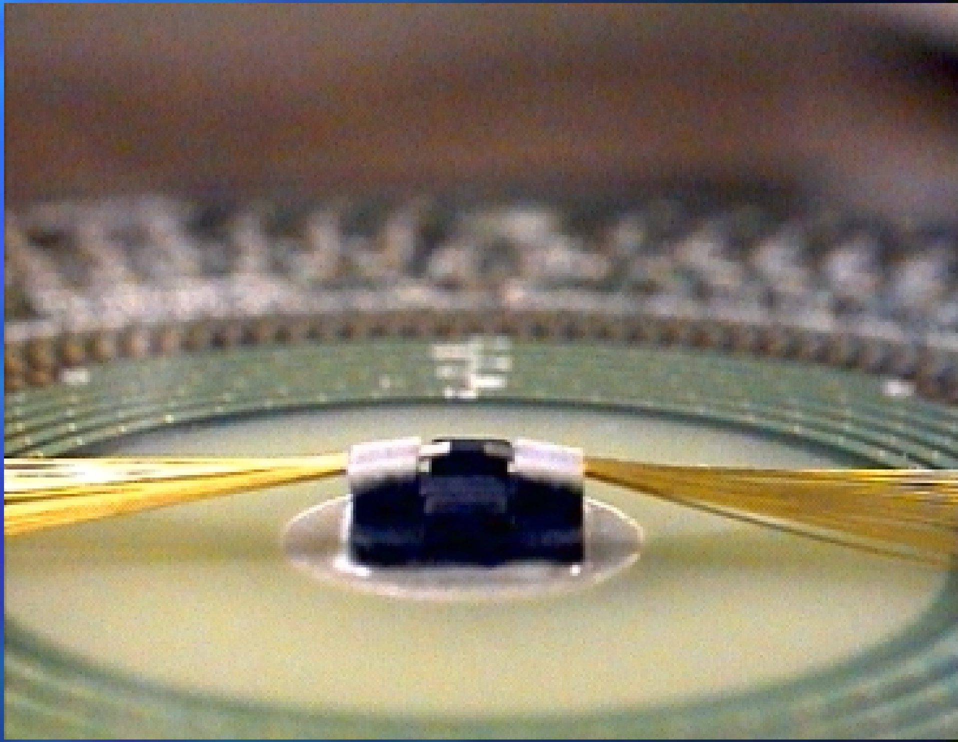
WIRE MATERIAL	Tungsten (Rhenium Tungsten)
WIRE DIAMETER	3.0 mils (76 um)
TIP DIAMETER	0.7 +/-0.1 mils (18 +/-2.5 um)
TIP SHAPE	Flat
TIP LENGTH - TIER 1	6 +2/-1 mils (152 + 50/-25 um)
TIP LENGTH - TIER 2	10 +2/-1 mils (254 + 50/-25 um)
PROBE ANGLE	105 +/-2 degree
FANOUT ANGLE	3 degree (Maximum)
NUMBER OF TIERS	2
EPOXY	DuraProbe Formula
OPERATING TEMP	Ambient to 125 C

Electro-Mechanical Specification

TIP ALIGNMENT	**+/-0.3 mils (+/-7.5 um)**
TIP PLANARITY	**+/-0.2 mils (+/-5 um)**
OVERTRAVEL	**2.0 mils (50 um)**
CONTACT FORCE	**1.3 G/mil OT +/- 20%**
SCRUB ACTION	**0.3-0.4 mils/ mil OT (7.6-10 um)**
PAD SIZE	**1.85 x 2.44 mils (48x62 um)**
CONTACT RESISTANCE	**<2.5 Ohm (tip on gold plate)**
PIN TO PIN LEAKAGE	**<10 nA**

Mini DuraProbe Test Probe Card Top and Profile Views



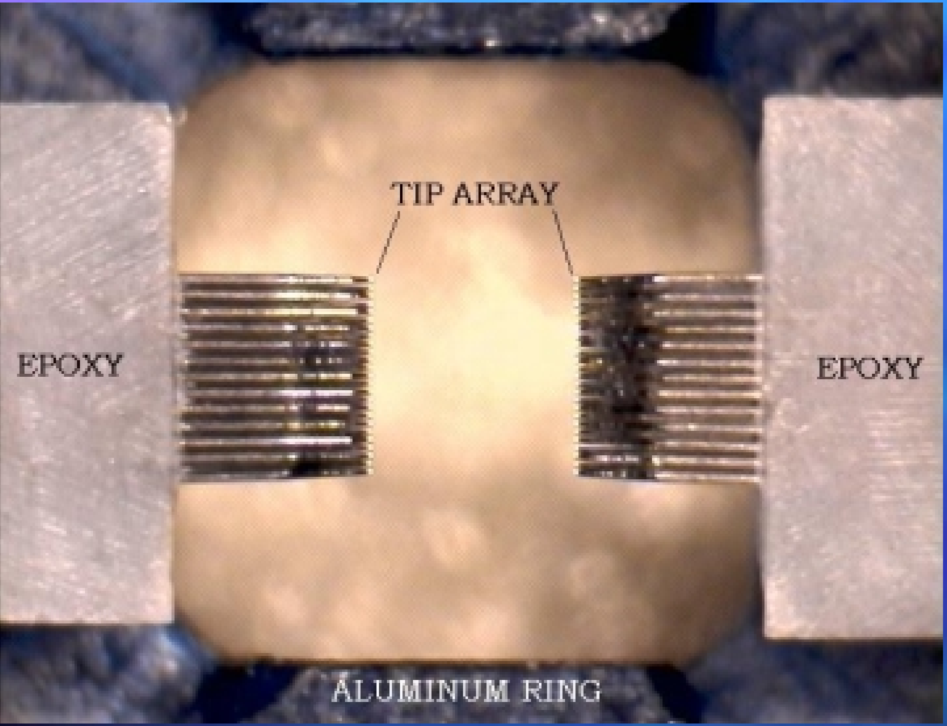


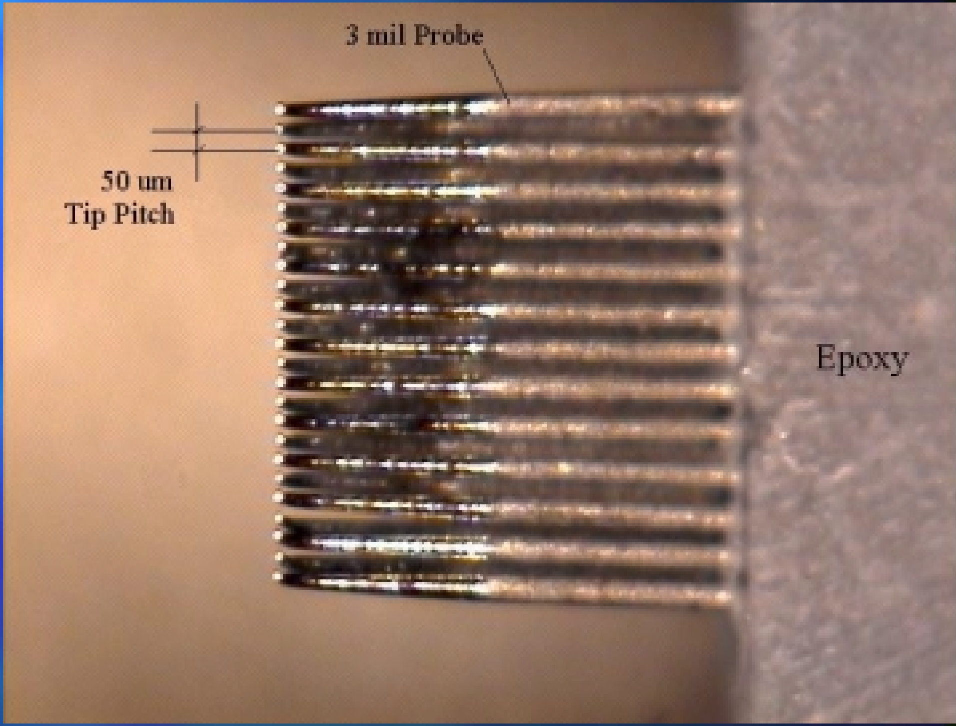
50 points Test Probe Card

Ring Material: Aluminum (Ceramic)

Printed Circuit Board: Generic PTC Design

Mini DuraProbe Tips Array Close-Up





Probe Card with 2 Tiers Array

Wire Diameter - 3 mil (76 um)

Tip Diameter - 0.7 +/-0.1 mil (18 +/-2.5 um)

Tip Pitch - 2.0 mil (50 um)

Test Equipment Description

BCF Station - PTC with SCAIME head, force up to 60 G

Motherboard - PTC C288

Probe Card Analyzer - Applied Precision PRV

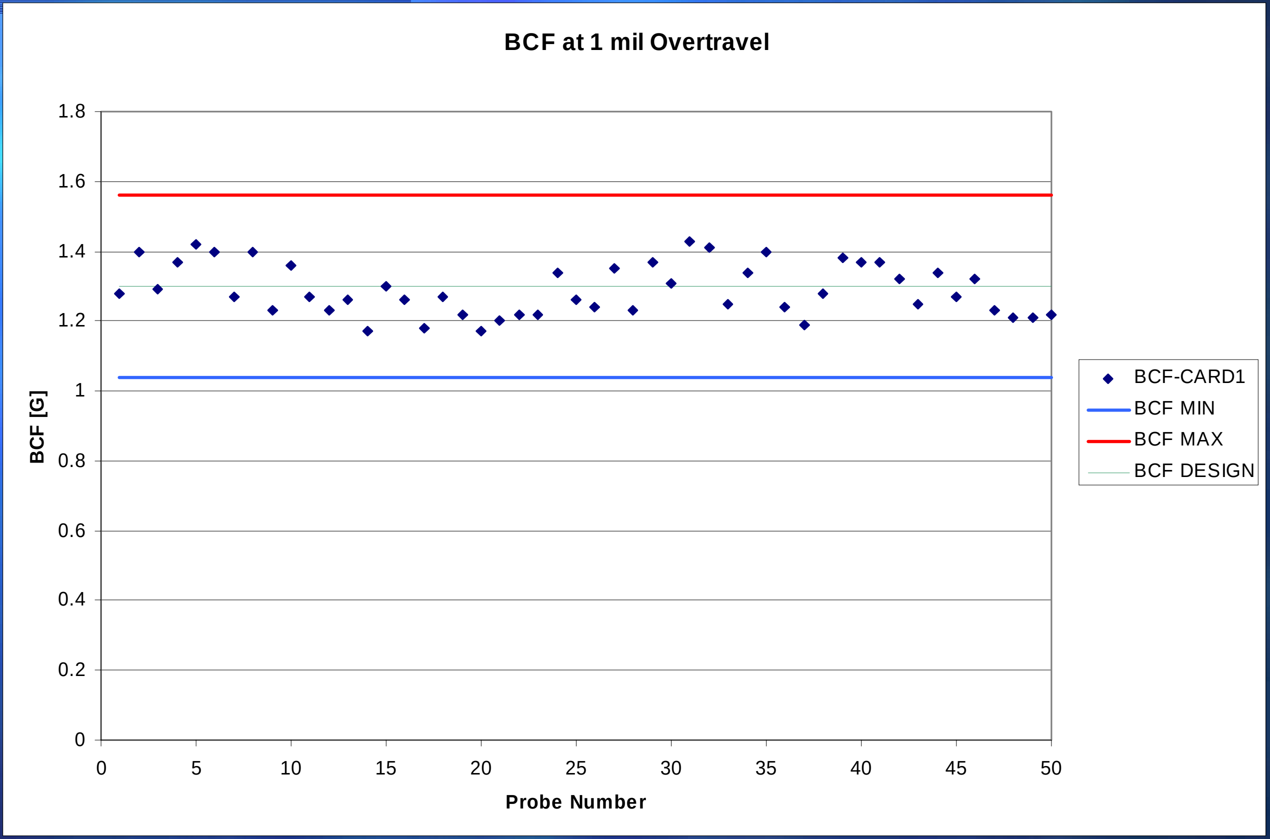
- Contact Resistance
- Leakage pin to pin
- Alignment at x, y directions
- Planarity at z direction

Metrology performed after 0, 50k, 250k, 500k, 1 million, 2 millions interval

Probe Card Prober - Electroglas 2001x with “Hot” Chuck

Test Wafer - 6 inch metallized wafer, 1 um thick aluminum layer

Measured Balanced Contact Force

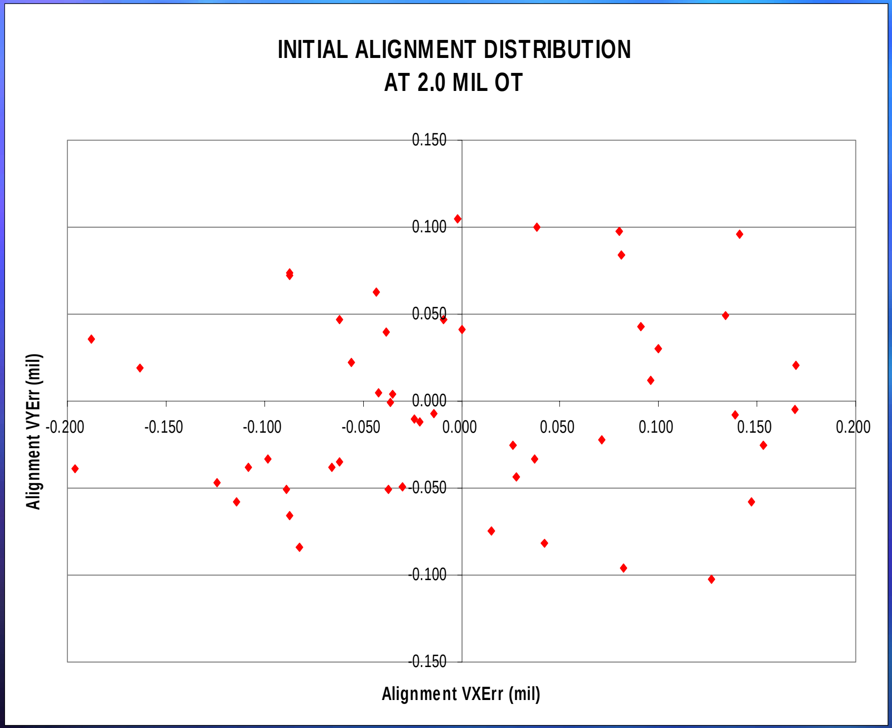


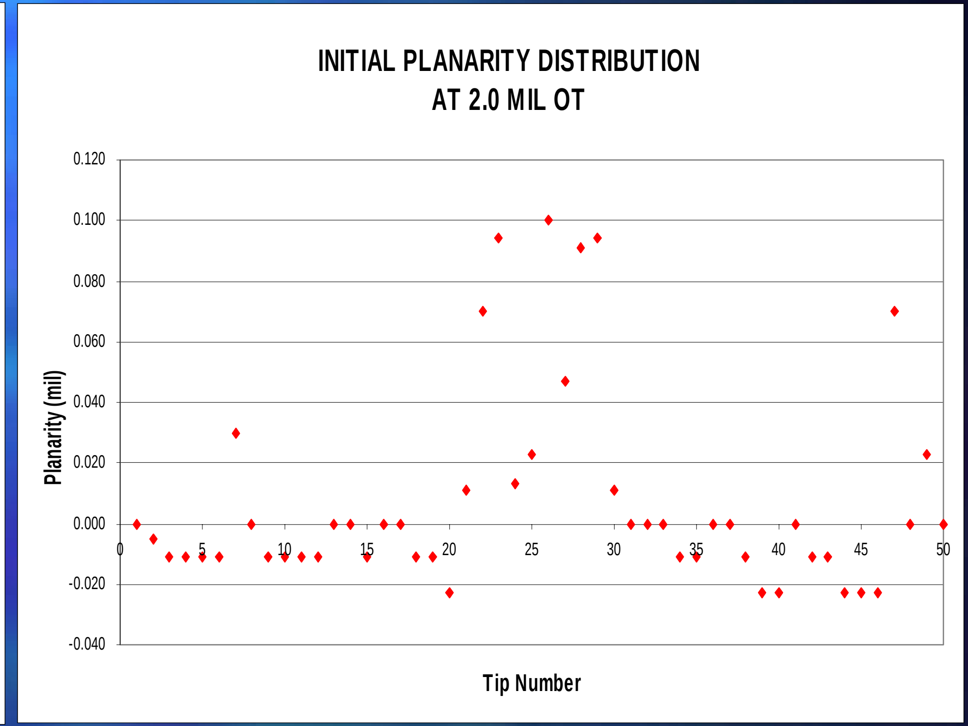
Minimum Measured BCF = 1.17 G/mil OT

Maximum Measured BCF = 1.42 G/mil OT

Note: FEM have shown very good agreement to the measured BCF (tolerance +/-10%)

Alignment and Planarity Distributions
Initial Test - 0 TD's





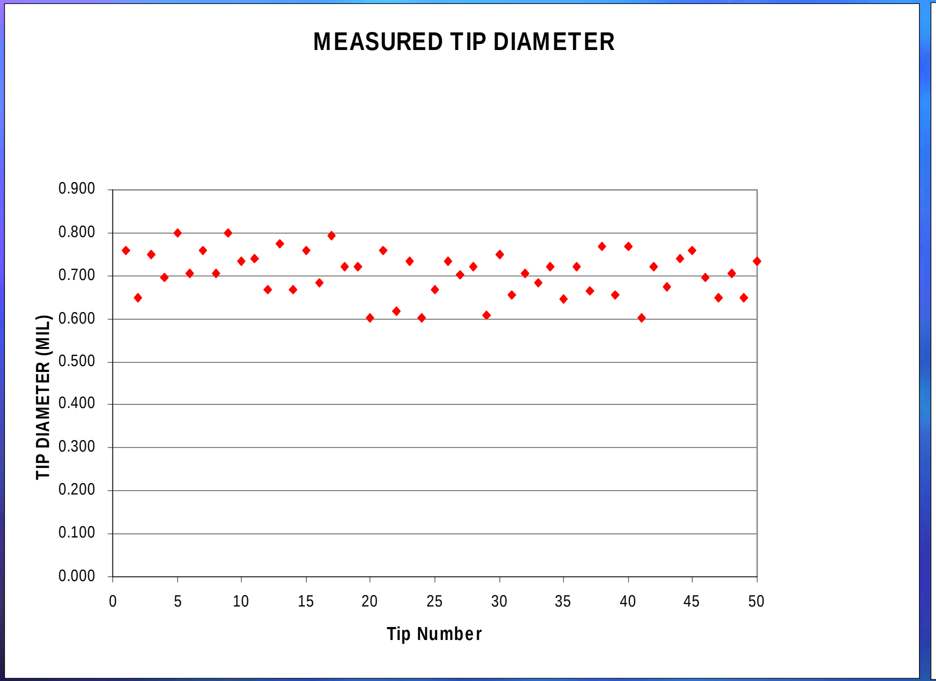
Tips Alignment - +/- 0.3 mil (+/-7.5 um)

All probes passed alignment test

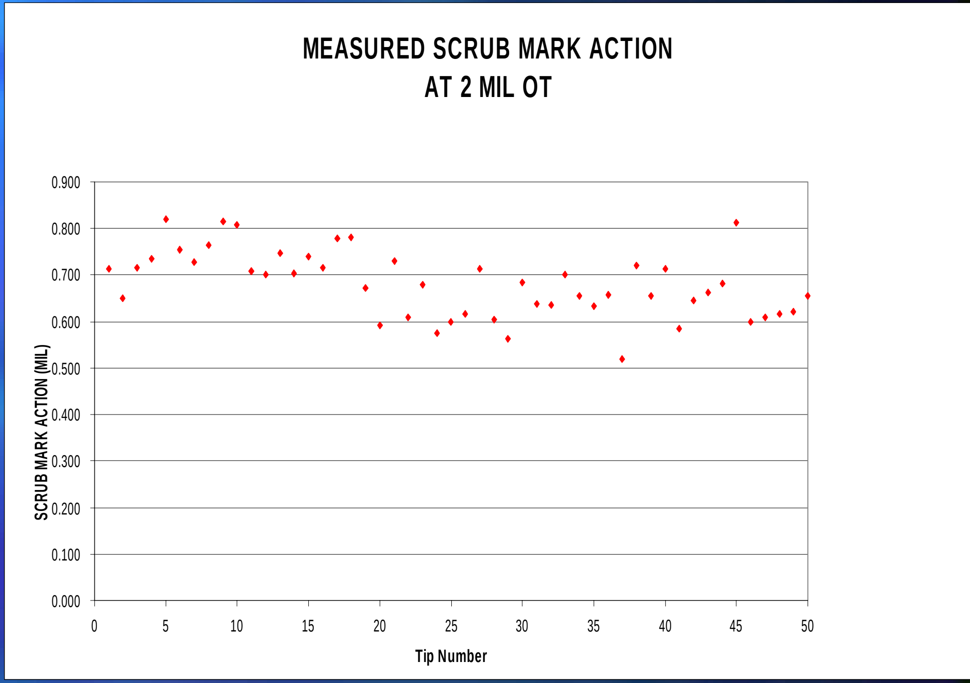
Tips Planarity - +/- 0.2 mil (+/-5 um)

All probes passed planarity test

Measured Tip Diameter and Scrub Mark Action



MEASURED TIP DIAMETER



MEASURED SCRUB MARK ACTION
AT 2 MIL OT

Max. Measured Tip Diameter - 0.80 mil (20 um)

Min. measured Tip Diameter - 0.60 mil (15.2 um)

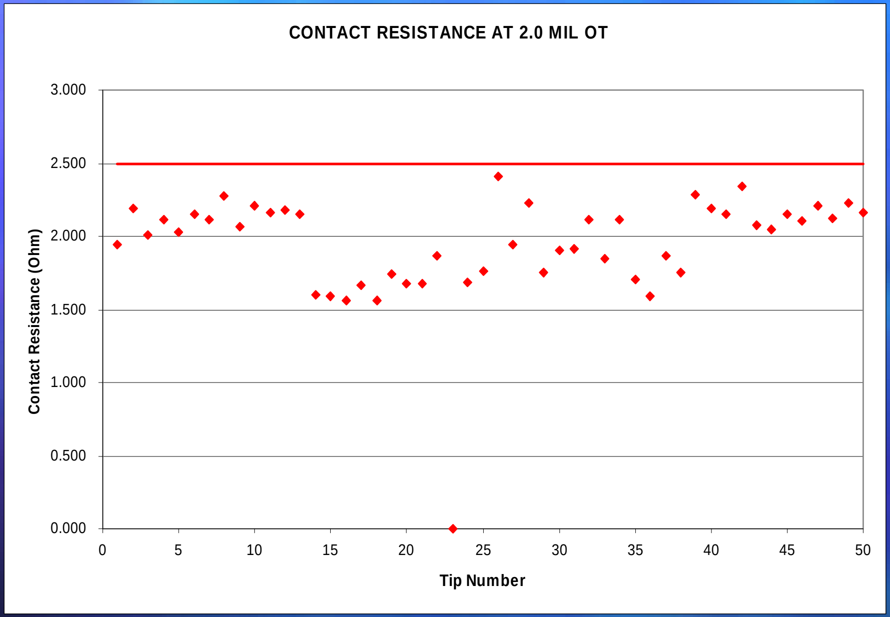
Spec. Tip Diameter - 0.7+/-0.1 mil (18+/-2.5 um)

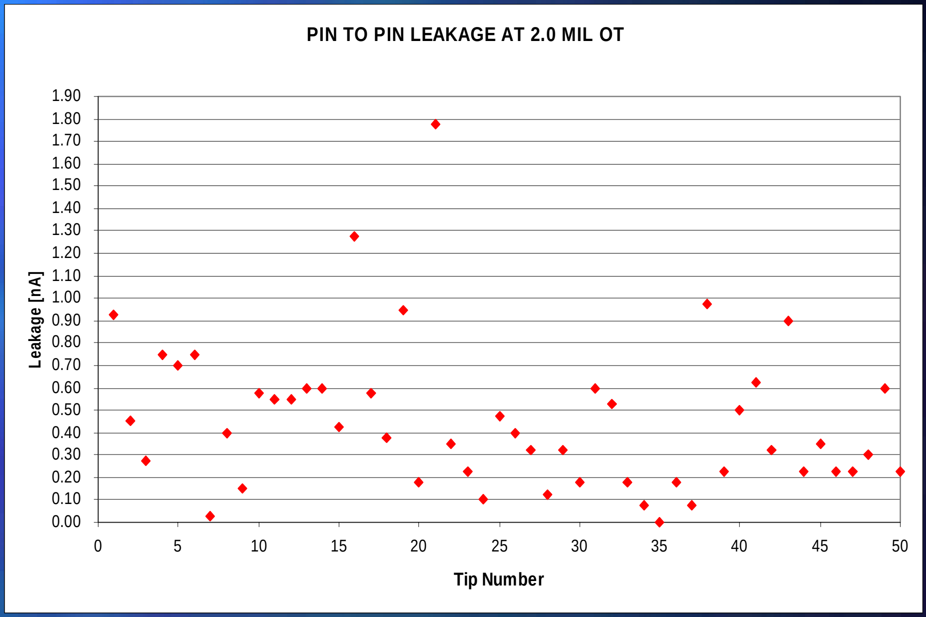
Max. SMA - 0.83 mil (21 um)

Min. SMA - 0.56 mil (14.2 um)

Note: FEM have shown good correlation with the measured scrub marks

Measured Contact Resistance and Leakage Current





Max. Measured CRes - 2.41 Ohm

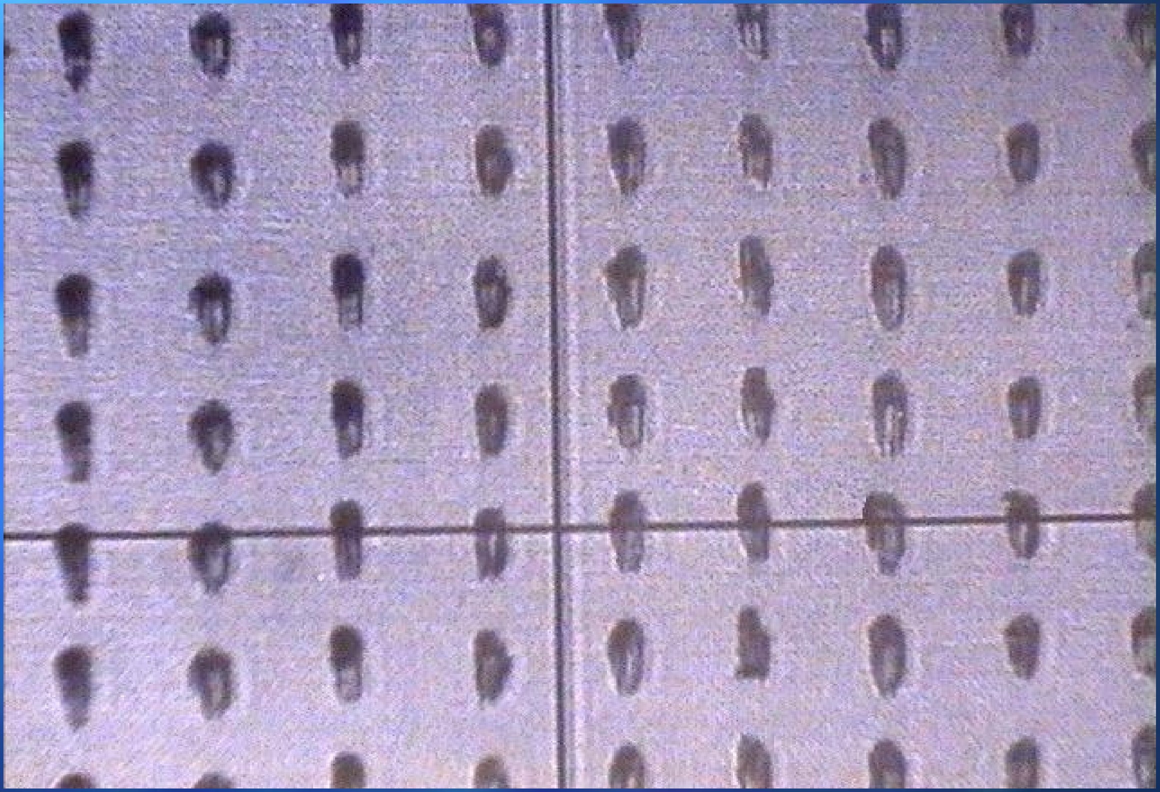
Min. Measured CRes - 1.56 Ohm

Spec. CRes - < 2.5 Ohm on the gold plate

Max. Measured Leakage Current - 1.78 nA

Spec. Leakage - < 10 nA at 10V

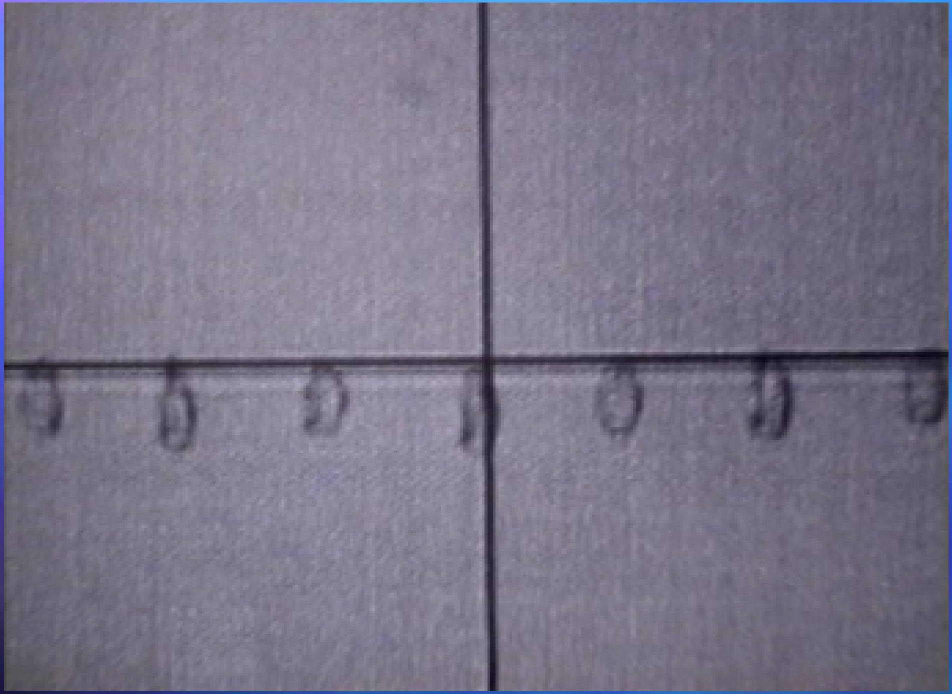
Scrub Matrix on an Aluminum Wafer

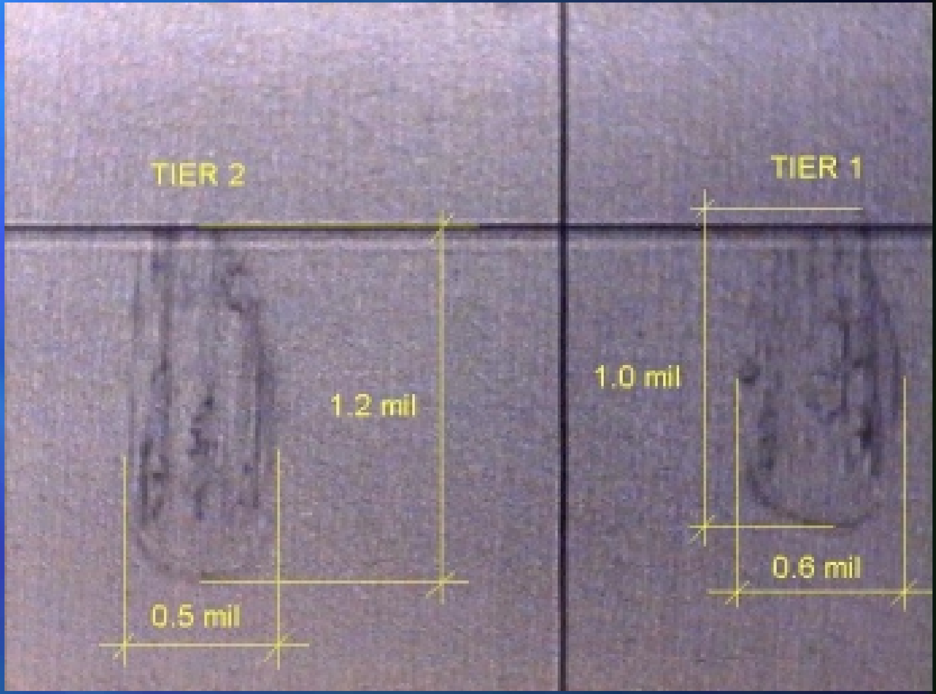


2 mil stepping in x and y directions at 2 mil overdrive

Note: Picture shows shape, uniformity and repeatability of scrub marks

Measured Scrub Marks





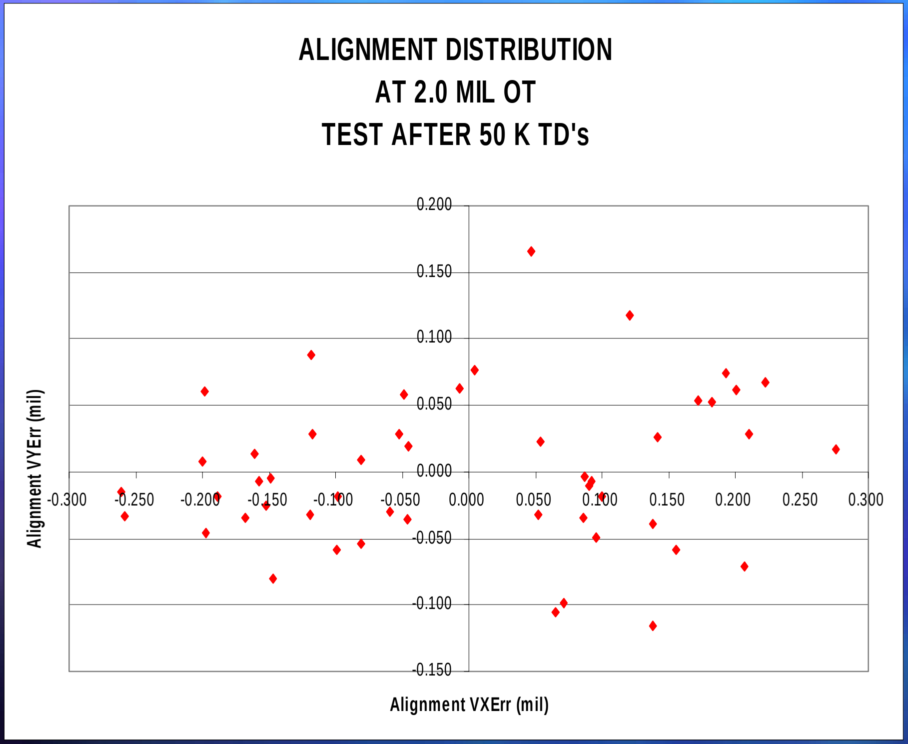
Scrub Marks Array at Overtravel 2 mil (50 um)

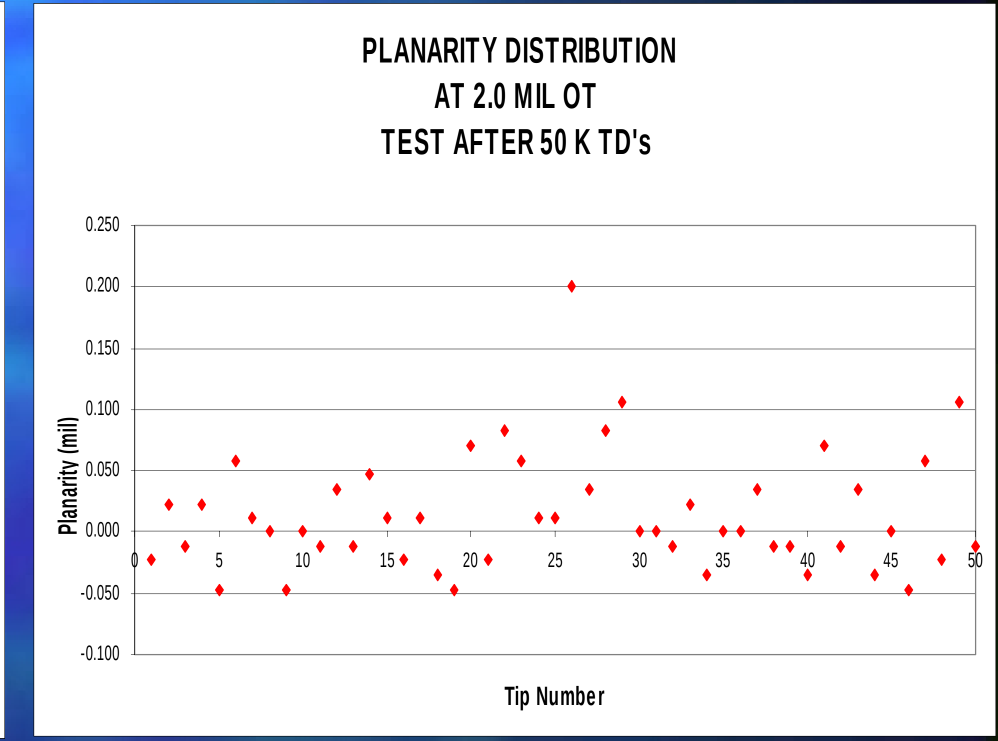
Total Scrub Mark Length 1.0-1.2 mil (25.4-30.5 um)

Total Scrub Mark Width 0.5-0.6 mil (12.7-15.2 um)

Measured Scrub Mark Depth 0.039 mil (1.0 um)

Alignment and Planarity Distributions Test after 50k TD's





Max. Tips Alignment - 0.262 mil (6.6 um)

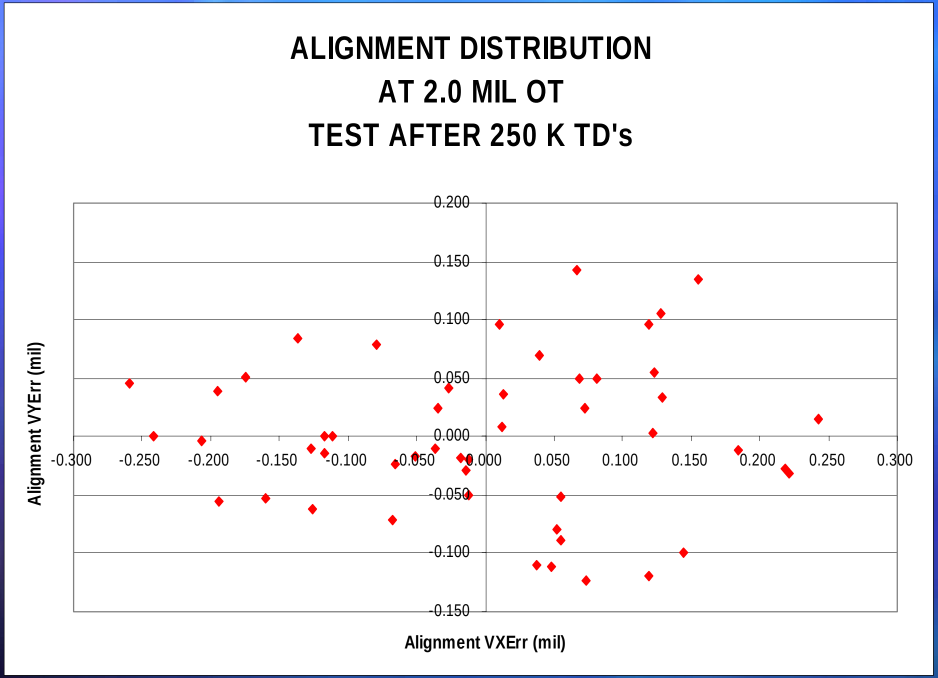
All probes passed alignment test +/-0.3 (+/-7.5 um)

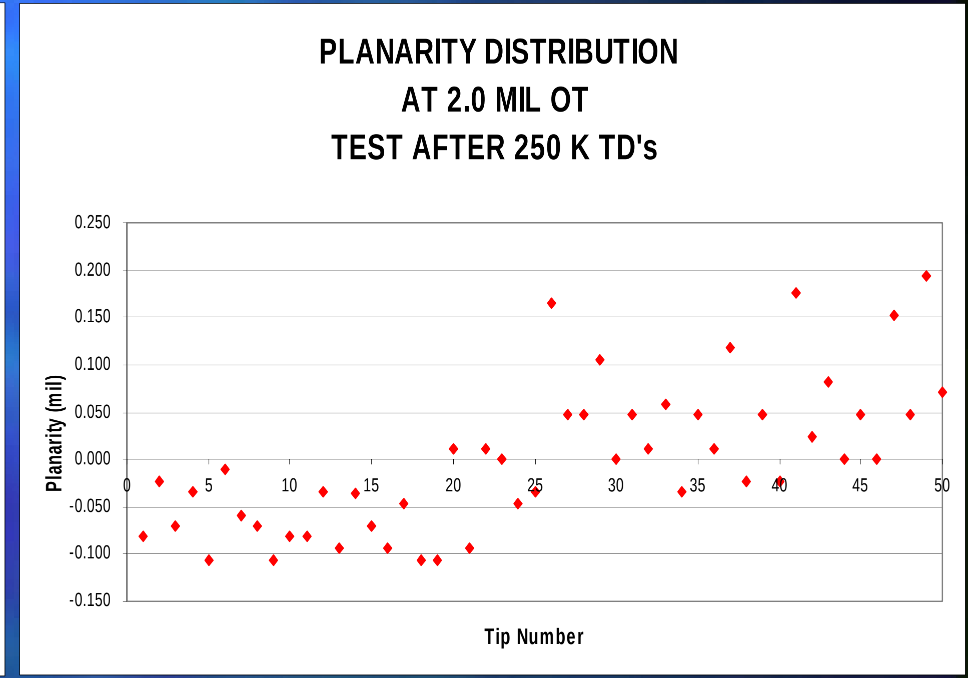
(without rework)

Max Tips Planarity - 0.200 mil (5 um)

All probes passed planarity test +/-0.2 (+/-5 um)

Alignment and Planarity Distributions Test after 250k TD's





Max. Tips Alignment - 0.259 mil (6.5 um)

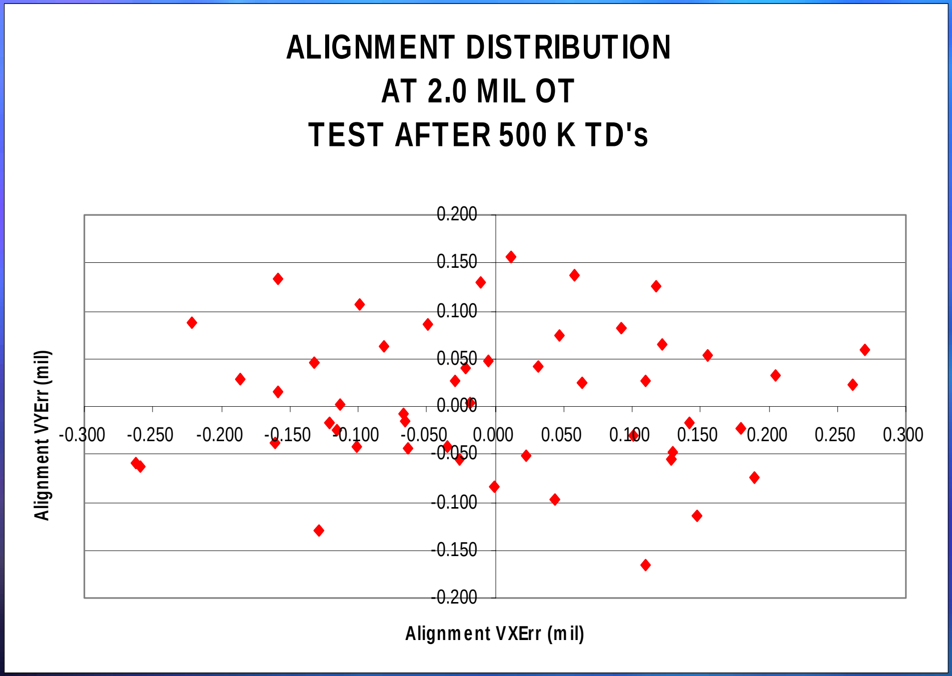
All probes passed alignment test +/-0.3 (+/-7.5 um)

(without rework)

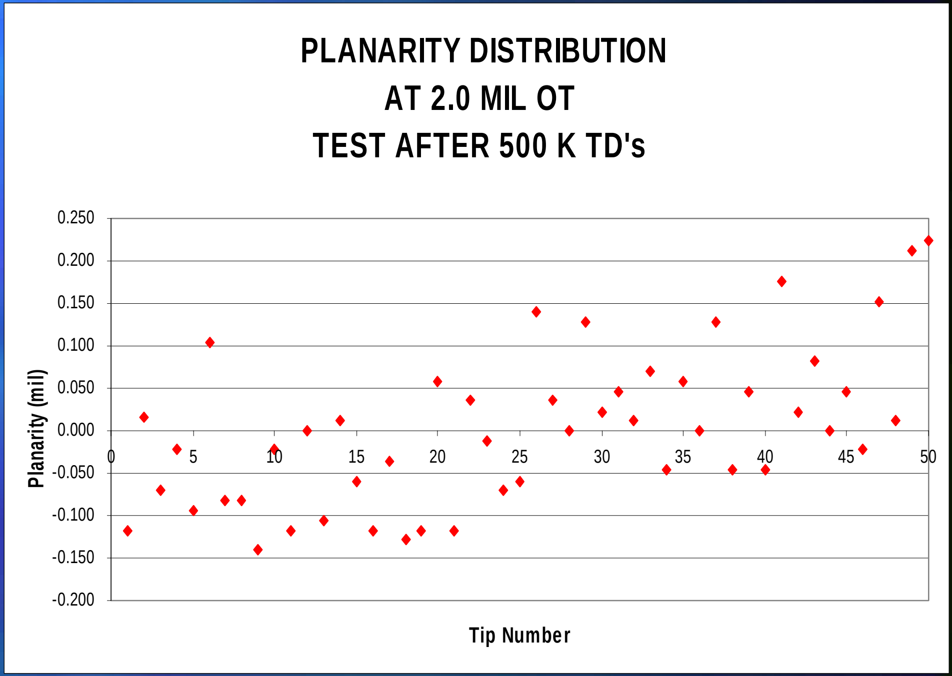
Max Tips Planarity - 0.193 mil (4.9 um)

All probes passed planarity test +/-0.2 (+/-5 um)

Alignment and Planarity Distributions Test after 500k TD's



ALIGNMENT DISTRIBUTION
AT 2.0 MIL OT
TEST AFTER 500 K TD's



PLANARITY DISTRIBUTION
AT 2.0 MIL OT
TEST AFTER 500 K TD's

Max. Tips Alignment - 0.270 mil (6.8 um)

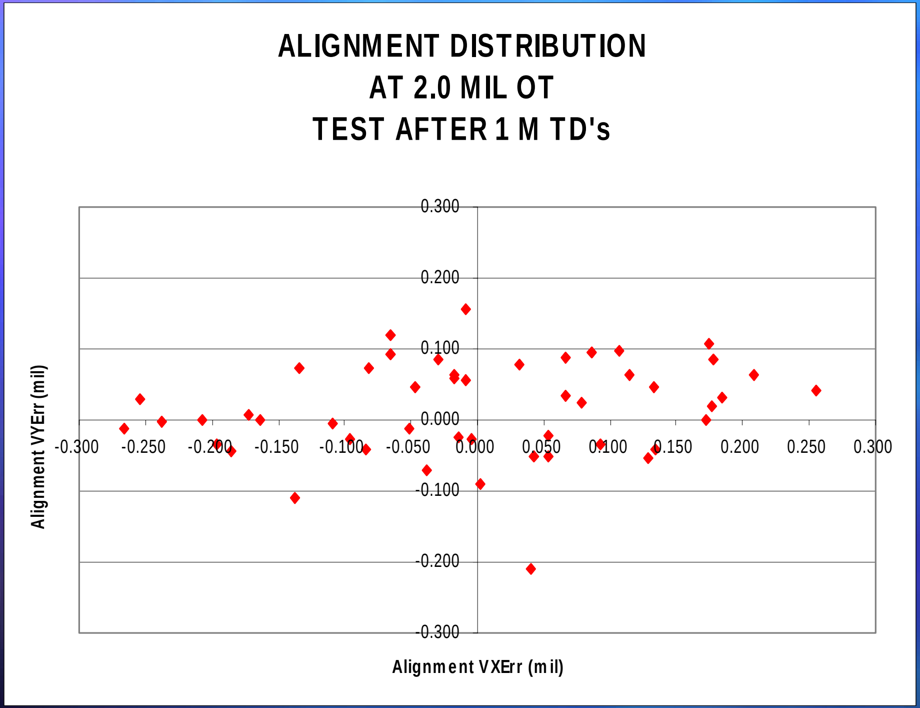
All probes passed alignment test +/-0.3 (+/-7.5 um)

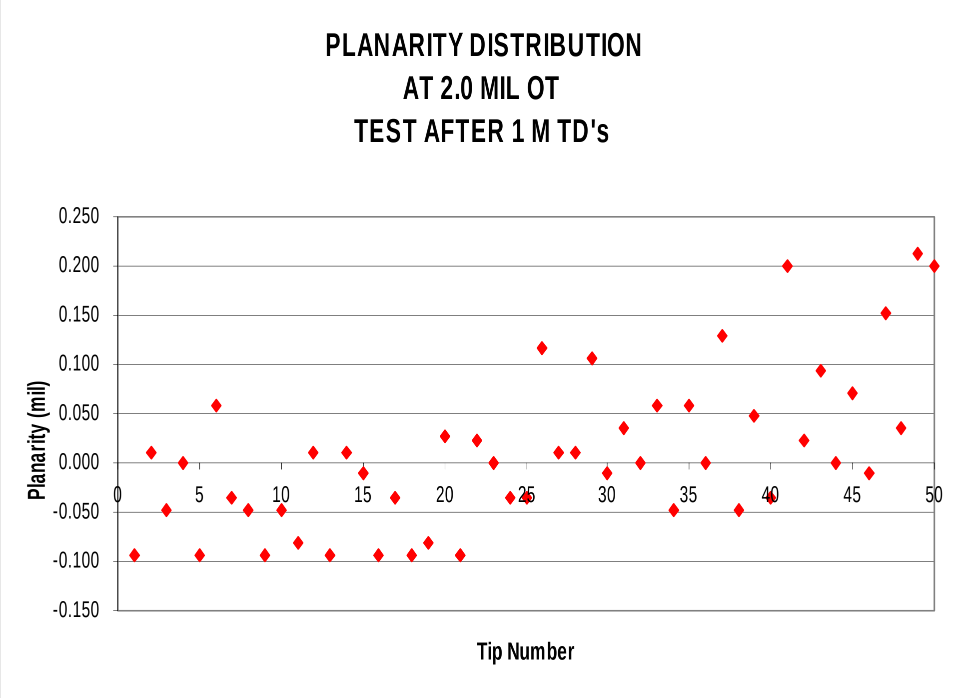
(without rework)

Max Tips Planarity - 0.255 mil (6.4 um)

2 probes failed planarity +/-0.2 (+/-5 um)

Alignment and Planarity Distributions
Test after 1 M TD's





Max. Tips Alignment - 0.266 mil (6.4 um)

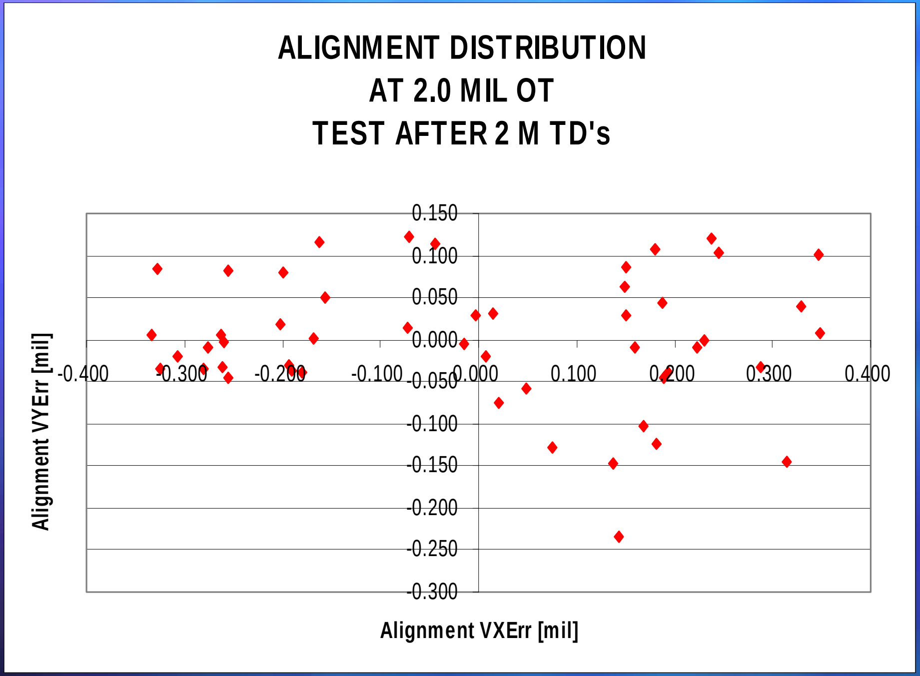
All probes passed alignment test +/-0.3 (+/-7.5 um)

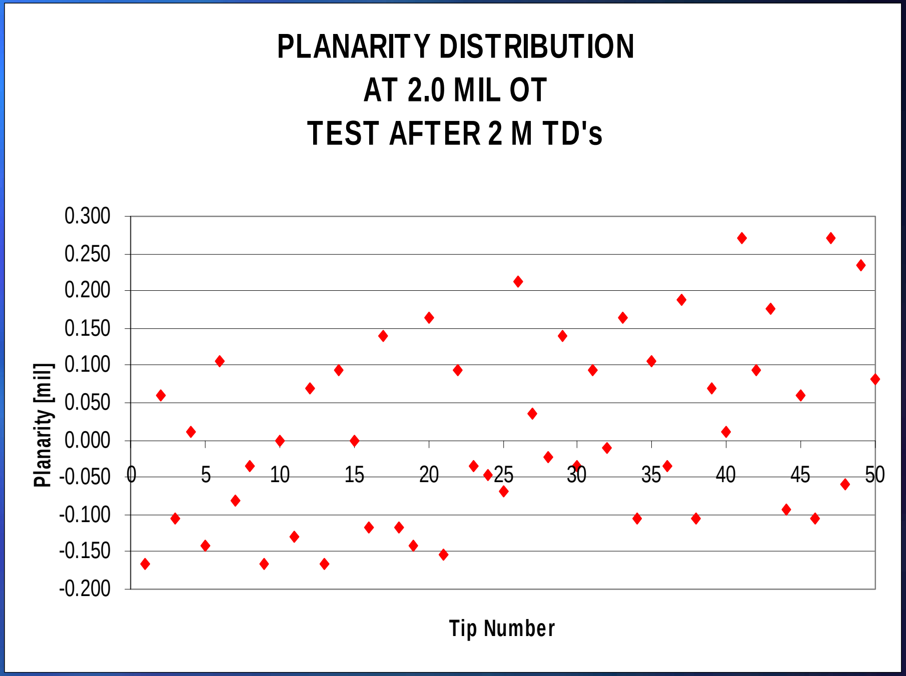
(without rework)

Max Tips Planarity - 0.212 mil (5.4 um)

3 probes failed planarity +/-0.2 (+/-5 um)

Alignment and Planarity Distributions Test after 2 M TD's





Max. Tips Alignment - 0.349 mil (8.8 um)

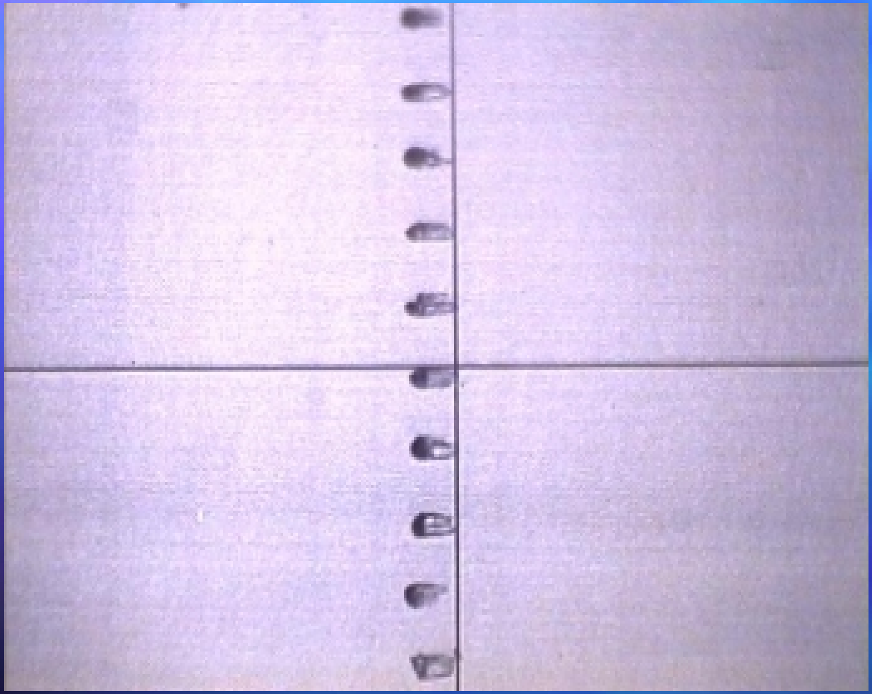
8 probes failed alignment test +/-0.3 (+/-7.5 um)

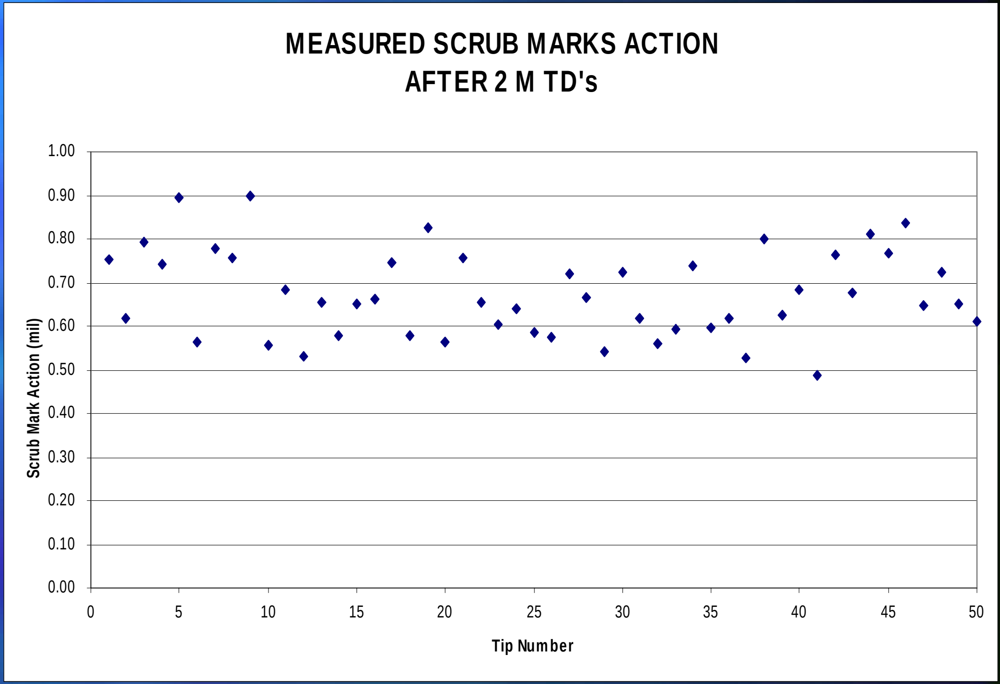
(without rework)

Max Tips Planarity - 0.271 mil (6.9 um)

4 probes failed planarity test +/-0.2 (+/-5 um)

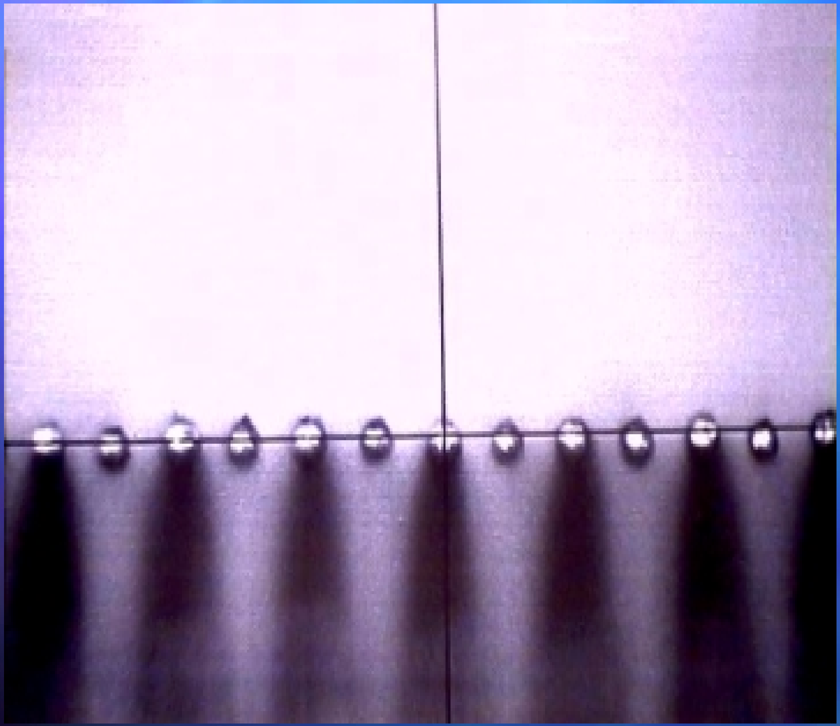
Mini DuraProbe Scrub Marks after 2 M TD's

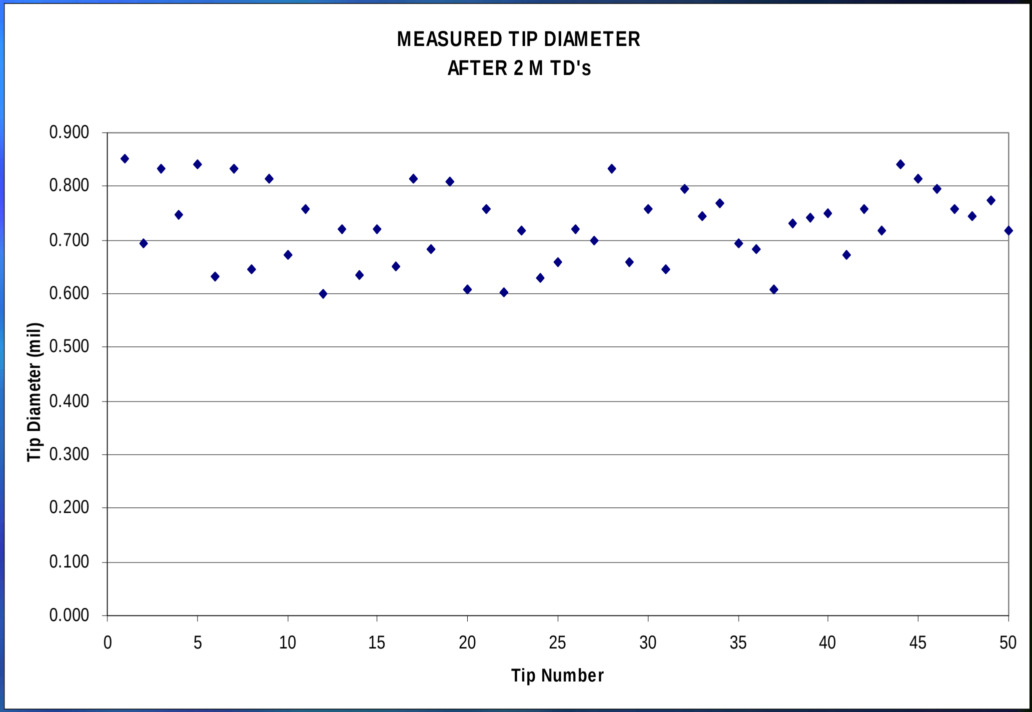




Picture shows scrub marks on the aluminum wafer at
2 mil OT after 2 millions touchdowns

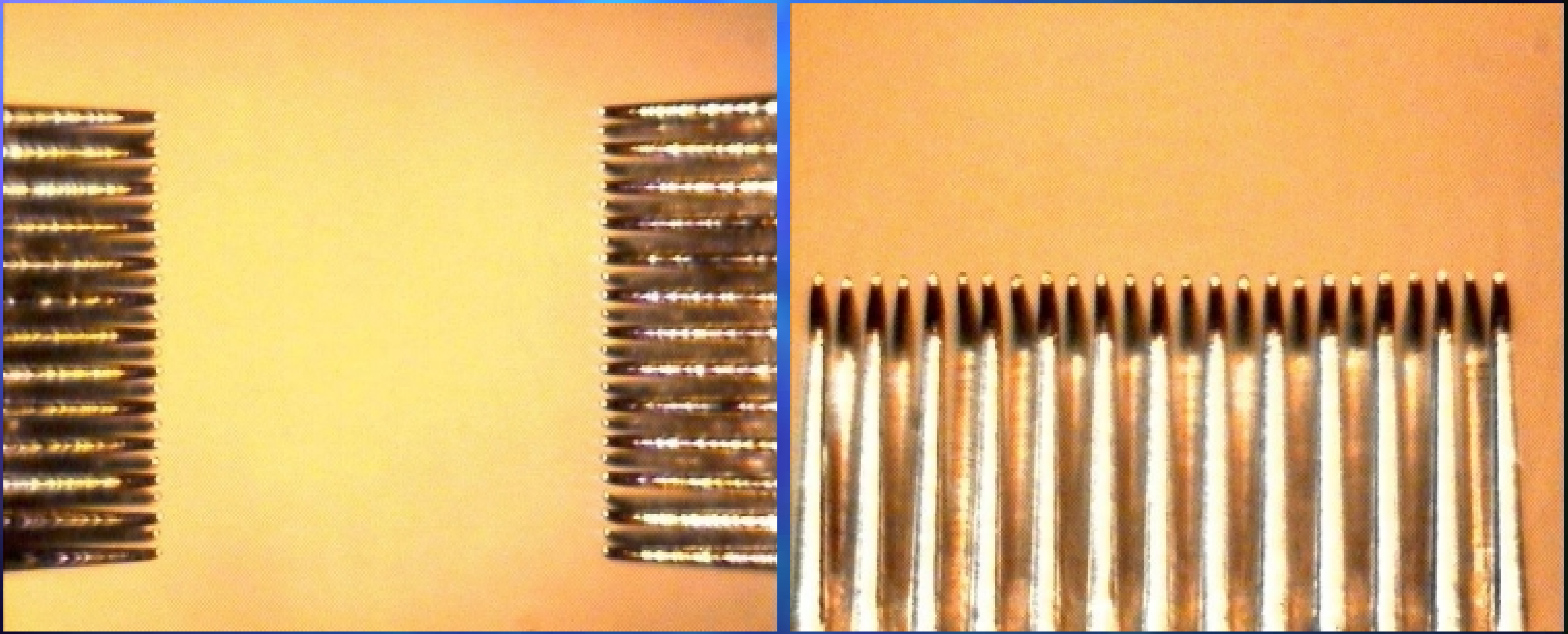
Mini DuraProbe Tip Diameter after 2 M TD's





Picture shows probe tips after 2 millions touchdowns

Mini DuraProbe Tips after 2 M TD's



Note: Probe tips have not shown any damage, bend or curl.

Summary and Conclusions

- Mini DuraProbe with 3 mil wire and with two tiers is feasible and manufacturable

- Mini DuraProbe provides a robust probing process for 50 um inline pad pitch

  - alignment is very stable up to 2 millions touchdowns
  - reliable planarity up to 2 millions touchdowns
  - scrub marks are sharp, uniform and relatively short (due to tip dia, overdrive)
  - good contact resistance with lower BCF and 2 mil overtravel

- Total probe length (from the tip to the solder point) can be reduced to 250-300 mil, which will significantly increase electrical AC performance