

IEEE SW Test Workshop

Semiconductor Wafer Test Workshop



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Advances in Offline Reshaping and Cleaning for Cantilever, Vertical and Lithographic Probe Cards



June 7-10, 2009
San Diego, CA USA

This presentation is dedicated to
Franck Pietzschmann,
a colleague and friend from Infineon Dresden
who's recovering from serious health problem...



June 7 to 10, 2009

OVERVIEW

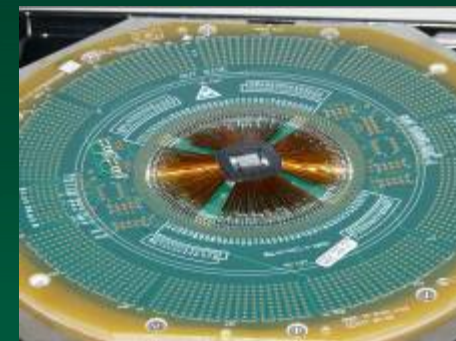
- ALTIS – PC Cleaning history / back ground
- Evolution of PC Off-line cleaning
- Off-Line cleaning experiences / complexity / constraints
- What is the ideal tool for the Off line cleaning ?
- Gain / Disadvantages of TPR03 REFRESHER
- Principle of machine operation
- SEM pictures of "TIPSeD" probes
- CRes lab test results
- Summary



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ALTIS – PC Cleaning history / back ground

Until 1996, Altis Semiconductor (IBM / Infineon joint venture) used to produce DRAM only



- Only Cantilever Probe-cards were used at that time
- On line cleaning was performed with Ceramic Pad or 3M paper stuck on PAD

- Off line cleaning was done by:
 - One skilled technician ...using
 - a solvent, a brush and an air gun
- It was mostly operated in case of yield drop seen at test



Starting 1996, production of logic products began
By 2001, production was fully turned to logic products



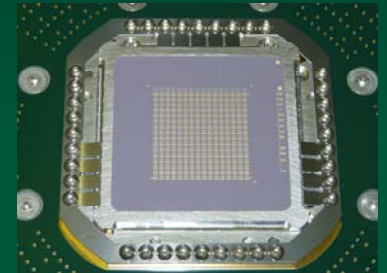
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PROBE-CARD OFF-LINE CLEANING... the evolution

The situation in ALTIS became more complicated with the introduction of FFI micro-spring technologies in ALTIS :

- Cleaning constraints:

- No brush and no alcohol allowed
- Mix of Gel Pak and Tungsten carbide cleaning



- Without probe-cleaning system the only way was special cleaning cycle on prober

In 1996, it was decided to purchase a needle dresser from JEM (was the only probe-card cleaning system available at that time)

Advantages:

- Easy to use
- Fits all cleaning material
- Fast to clean
- Manual equipment
- Fits all types of test platform



Drawbacks:

- Can not lap flat TIPS
- Slow reshaping time
- Cleaning material cannot be fully used
- Need many fixtures
- No more support by JEM since 2008... thus risk of issue with spare parts



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OFF LINE CLEANING EXPERIENCES

MICROBURST (API)

- 2 weeks evaluation performed in 2004
 - Innovative Tool but too long process...
 - High risk of destroying active components such as IC, relays,...



Ultrasonic bath in IPA

- Required by one COBRA PC VENDOR to remove debris
 - Drying is needed (adding more than 2 hours to cycle time)
 - Making it not manufacturable for productive environment



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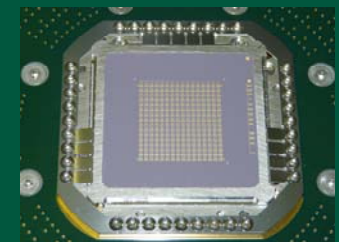
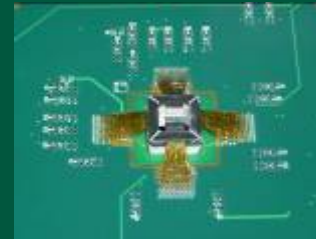
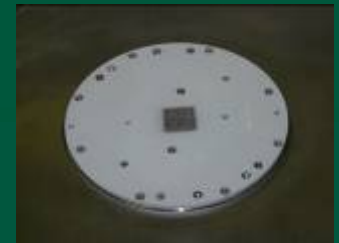
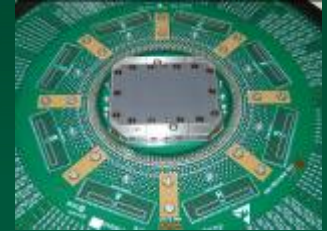
OFF LINE CLEANING COMPLEXITY

Off line cleaning solution must handle probe card and cleaning wafers mix used on floor

- Standard & Advanced (POAA) Cantilever
- Membrane
- Micro springs
- Cobra (flat and pointed)
- VI Probe (pointed)
- 10 types of cleaning materials

It also must perform the following operations

- Cleaning
- Reshaping
- Lapping



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WHICH IS THE IDEAL OFF-LINE CLEANING TOOL ?

10+ years of experience brought us the following learning

Probe card cleaning must:

- reduce contact resistance
- remove (stick) debris to avoid leakage
- preserve original tip shape
- be fast and repetitive
- be friendly using (to be used by all operators)
- clean all type PC technologies
- use all type of cleaning material

But probe card cleaning must not:

- destroy components (relay IC)(electricity ESD, etc...)
- use chemicals (health issue + contamination)
- use water (contact oxidation + PC drying needed)
- misalign needles
- contaminate the beams and reduce PC life time



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WHICH IS THE IDEAL OFF-LINE CLEANING TOOL ?



NEEDLE DRESSER

- Cantilever cleaning
- Micro spring cleaning

4 TOOLS IN ONE... TIPS TPR03



PRVX3

- Cascade Allied film cleaning
- Cobra flat tip lapping
- Tungsten carbide for cantilever lapping



EG 4080 RESHAPPER

- Parametric PCs reshaping
(up to 8 hours per PC)



UF200 PROBER

- Cascade Allied film cleaning
(up to 2000 TDs)



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IMPROVEMENT REQUIRED ON TIPS REFRESHER....

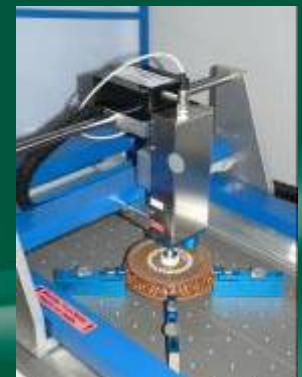
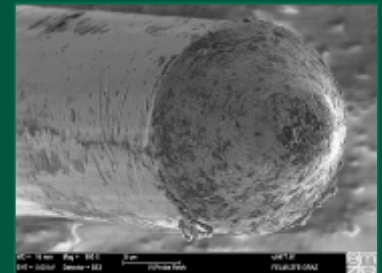
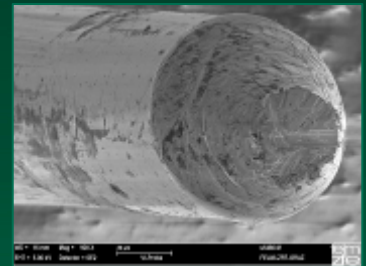
No one is perfect, no tool either...

Drawbacks of TIPS TPR03 refresher:

- After a run, debris of cleaning material have to be removed with a brush
- Probe-Head of vertical PC technologies should be disassembled before cleaning, inducing risk of damages of MLC/MLO or WW space transformer.
- Large number of runs may reduce life time of PC
- On vertical PbB probe-card, change from pointed tip to bullet shape could generate cracks for POAA pads
- Cleaning pads only supplied by TIPS
- Recipe can only be created or modified by TIPS

Improvements done or under work:

- Fixturing system → home made redesign done
- PH support fixture → home made redesign done
- Micro spring and membrane cleaning still under work



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BENEFIT OF TIPS REFRESFER....

Tool is anyway showing extended features

- Safe tool, preventing from any probe card crash
- 3 in 1 tool:
 - Cleaning, Reshaping, Lapping
- Fast reshaping time, from 3 to 15 minutes
- Dedicated and pre-defined recipes available
- Directly usable by test floor operators
- Repetitive and constant process
 - No human adjustments
 - Automatic Z detection / over travel set in recipe
- No readjustment (planarity/alignment) of needles after process
- Lifetime increase on vertical pointed PC (Cobra / ViProbe), only limited by beam length

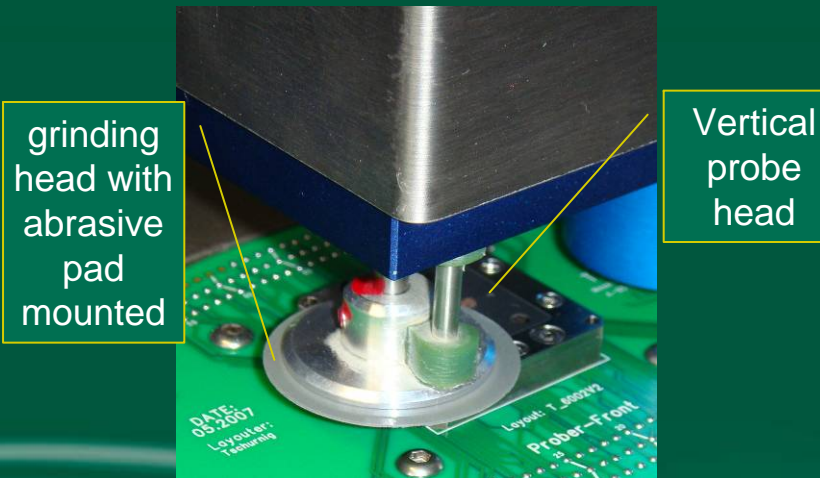


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PRINCIPLE OF OPERATION (1)

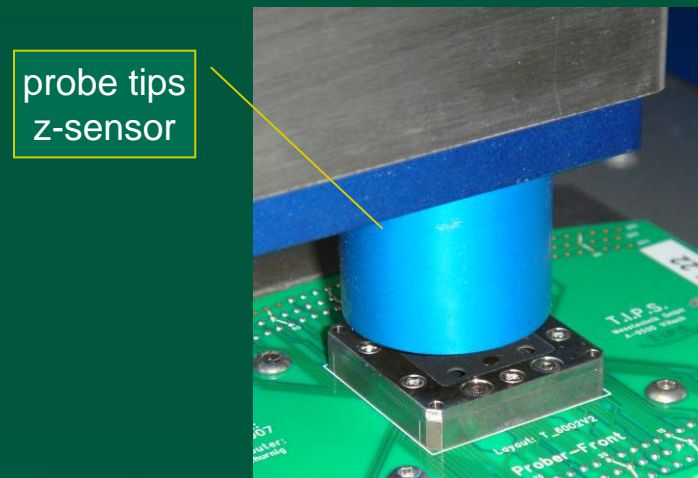
Grinding head

- different "tools" can be chucked
- abrasive polymers
- lapping films
- cleaning pads
- motion controlled by software recipes



Probes z-sensing

- Precision automatic probe tips z-sensing allows for accurate control of cleaning overdrive and ease of operation
- Defining "reference-zero" for software recipes

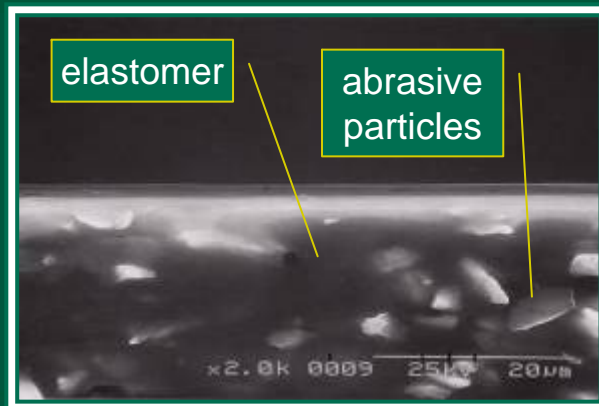


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PRINCIPLE OF OPERATION (2)

(Re)shape

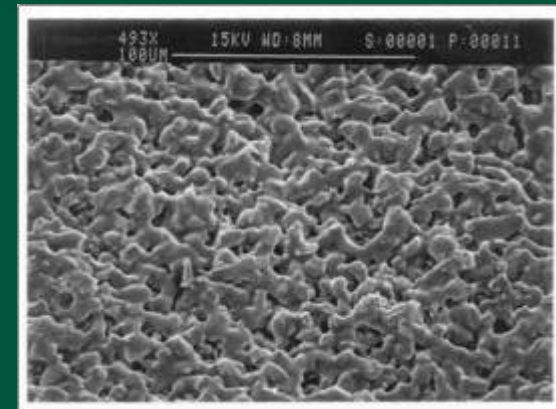
- Grinding head equipped with abrasive elastomer pads, executes fast z-movement
- Probe tips puncture repeatedly into the elastomer, probe tips are polished by embedded abrasive particles



"round" shape

Lapping

- Grinding head equipped with hard lapping film, executes fast z-movement
- Probe tips performing repeatedly small scrubbing motion on lapping film



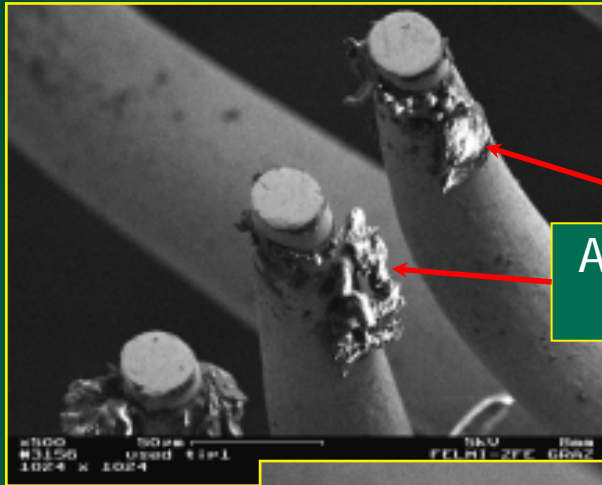
"flat" shape



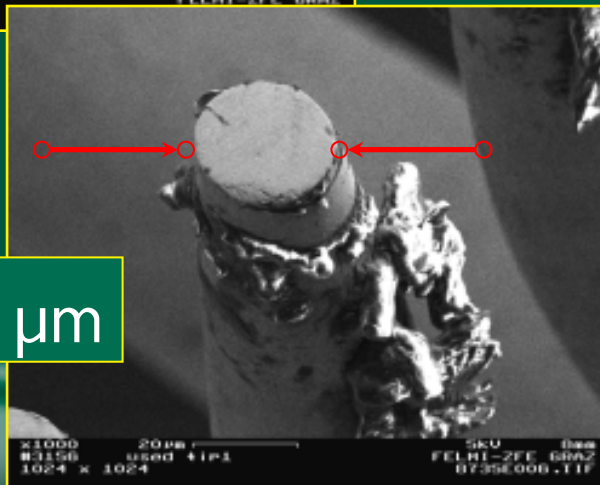
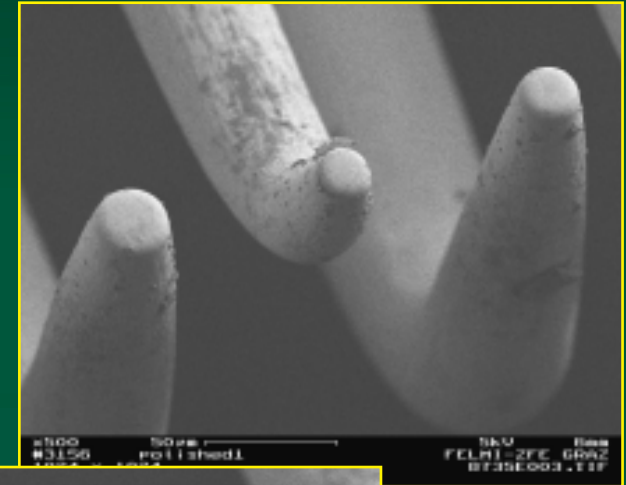
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1) photos by courtesy of
International Test Solutions

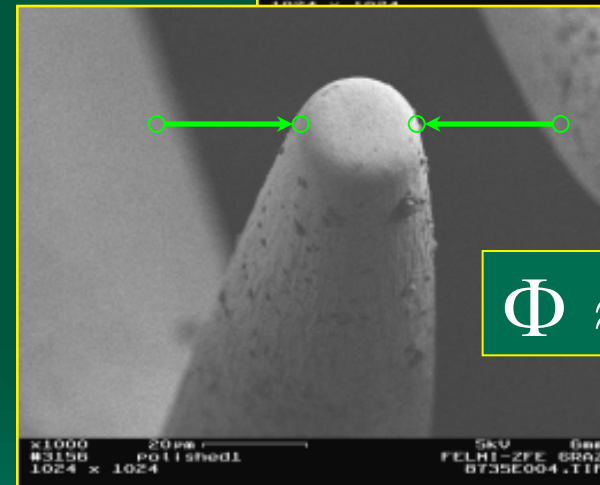
RESHAPING FINE PITCH PROBE TIPS



Adherent Bond Pad Debris



$\Phi \approx 25 \mu\text{m}$



$\Phi \approx 16 \mu\text{m}$

Before ...

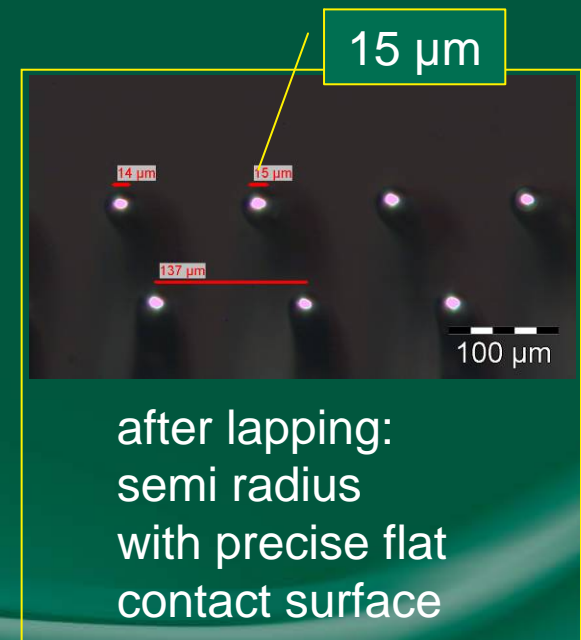
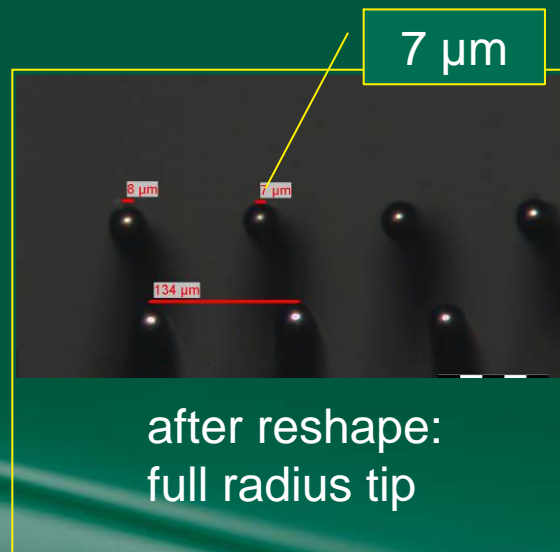
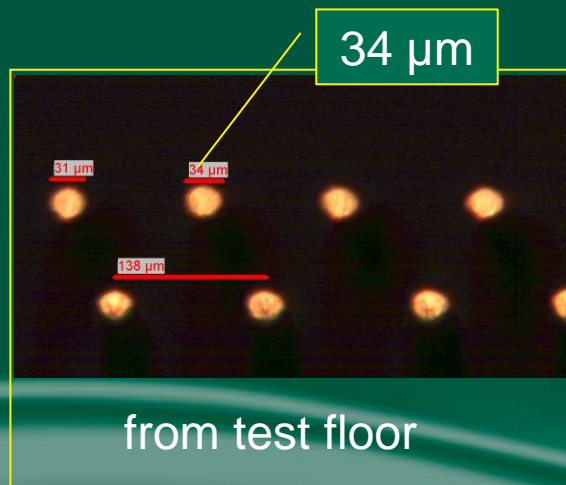
...after reshape!



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LAPPING – CONTACT AREA CONTROL (POAA)

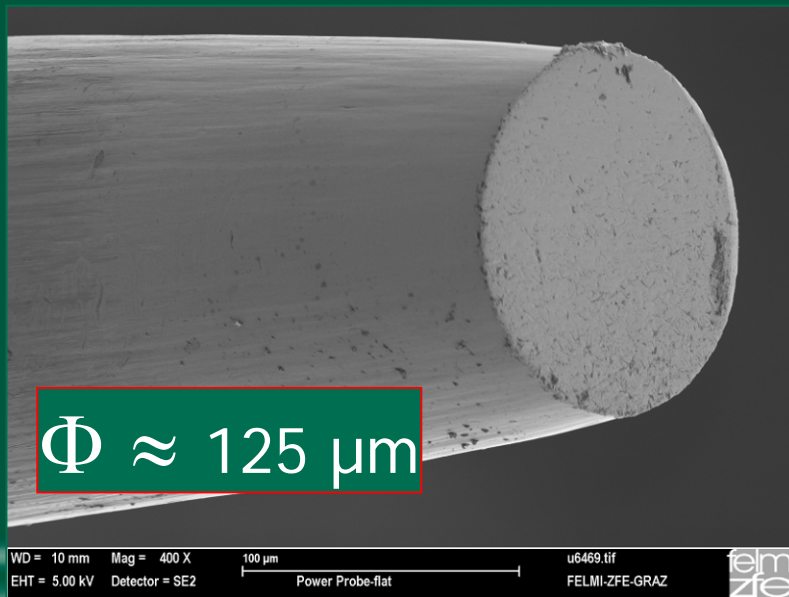
- Fragile pad structures – low k dielectrics, pad over active area (POAA) demand precise control over probe force and contact area to avoid pad cracks
- Lapping operation after reshape enables restoration of well-defined flat contact surface on "refreshed" probes.



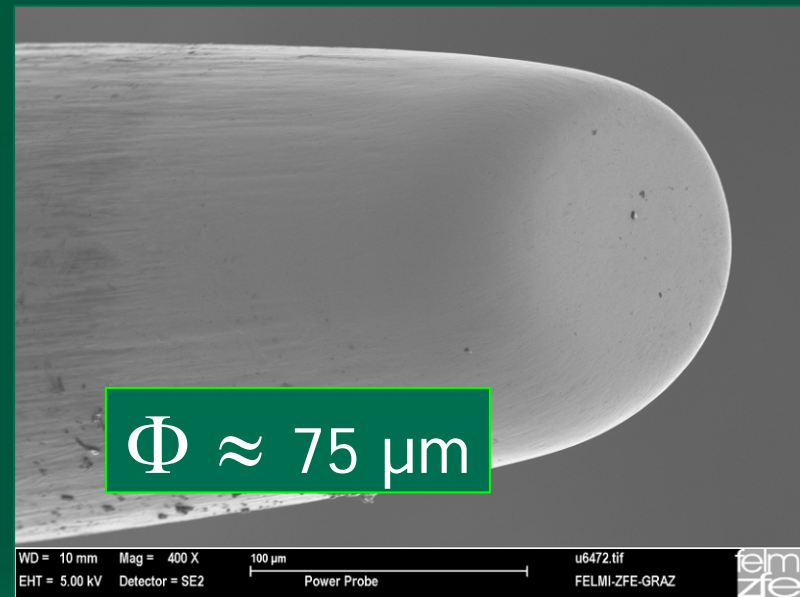
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RESHAPING POWER PROBES

- "Pseudo-random" motion patterns of grinding head allow for homogenous reshaping and efficient polish pad usage in "heavy machining" operation



Power probe, flat,
tip diameter 125 μm

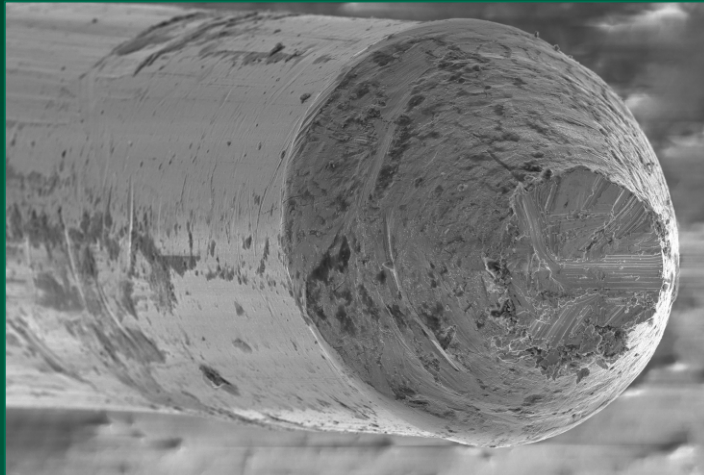


Power probe, shaped to
semi radius tip, diameter 75 μm

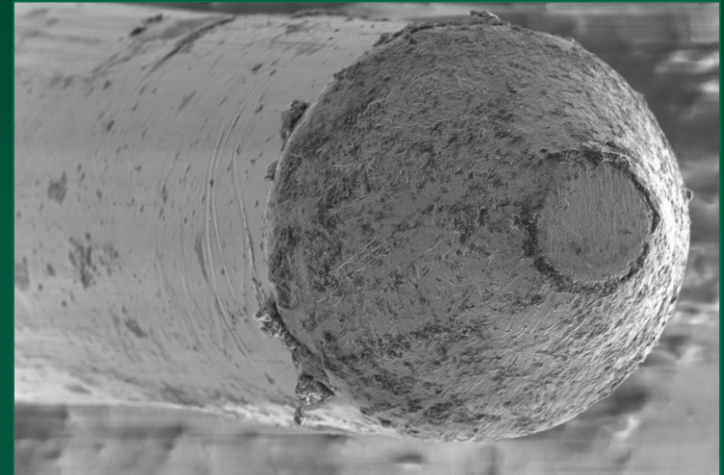


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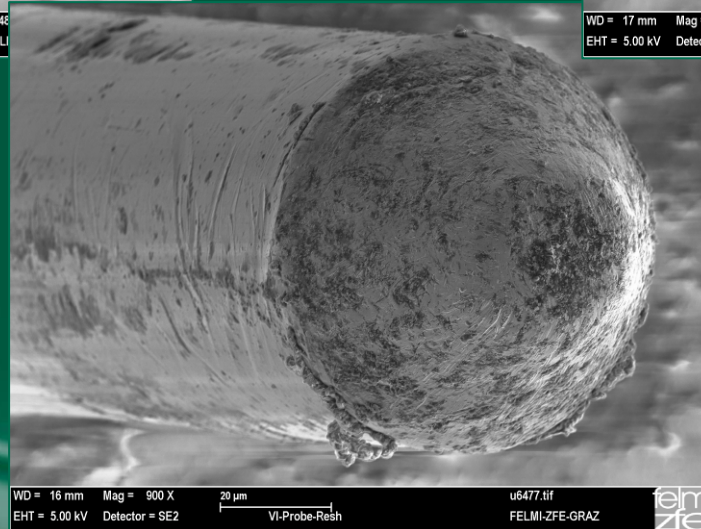
VERTICAL PROBES – BUCKLING BEAM / COBRA



from test floor



final lapping for POAA

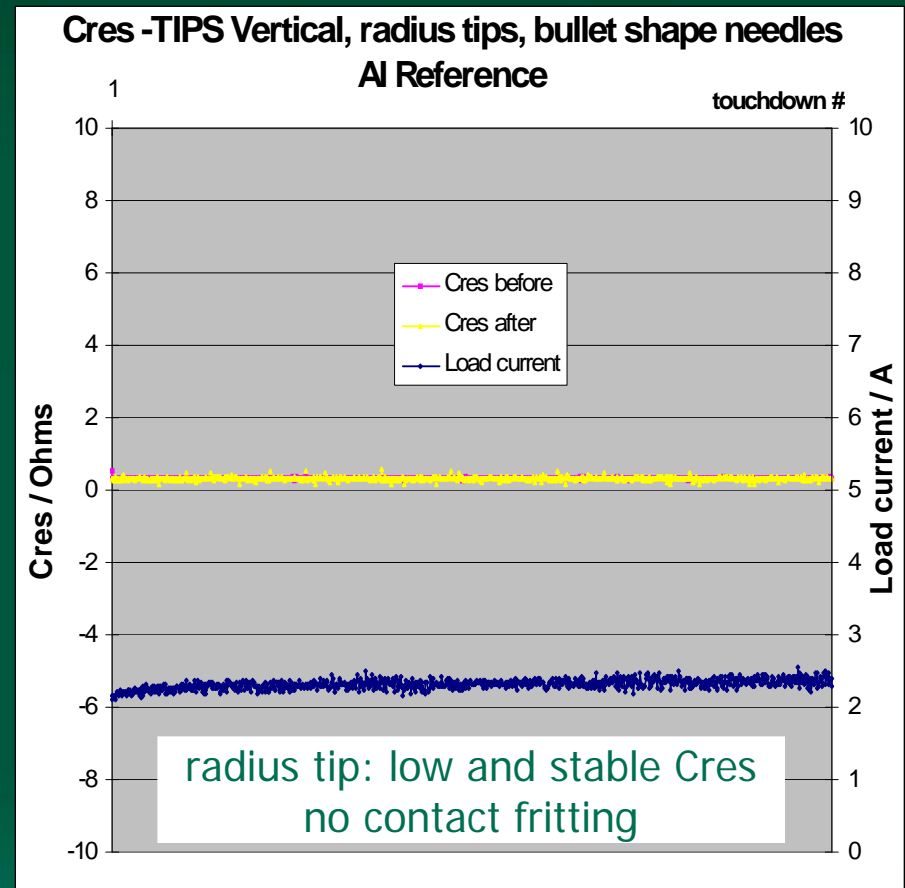
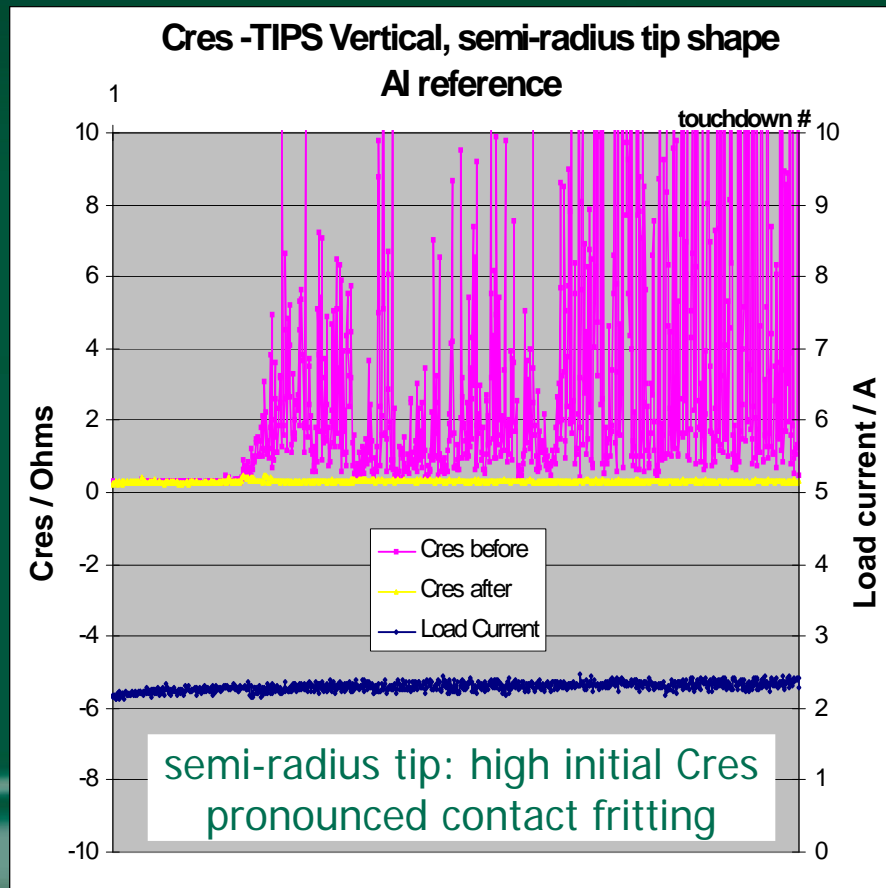


shaping to radius tip



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HIGH CURRENT VERTICAL PC CRes LAB TEST



semi-radius and radius tip shape compared at 2.3 A load current

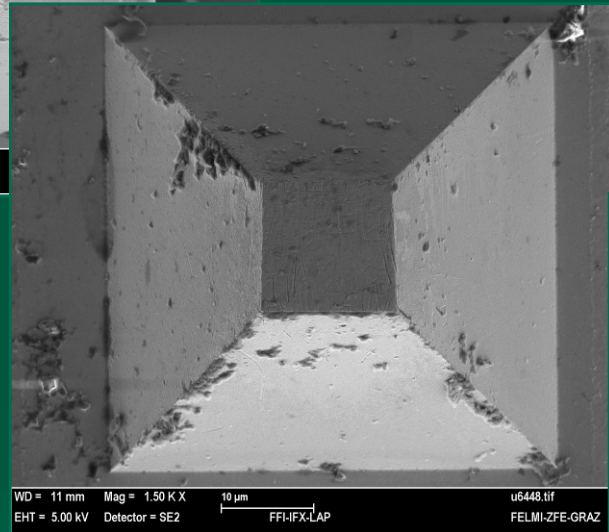


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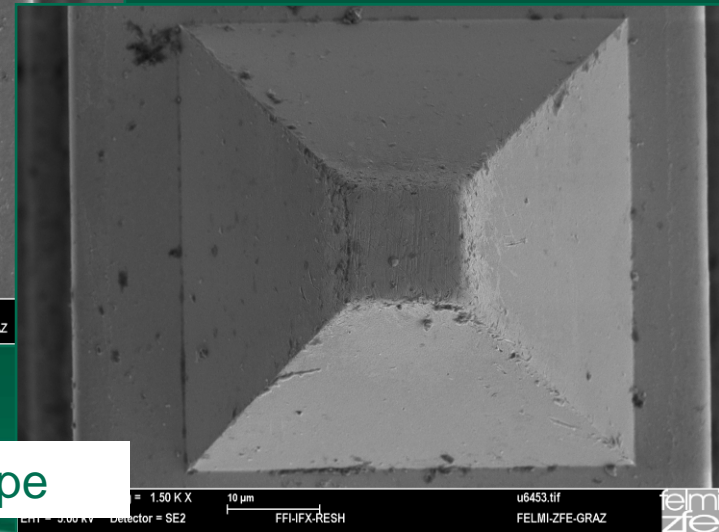
LITHOGRAPHIC PROBES – PYRAMID TIP



from test floor



after lapping



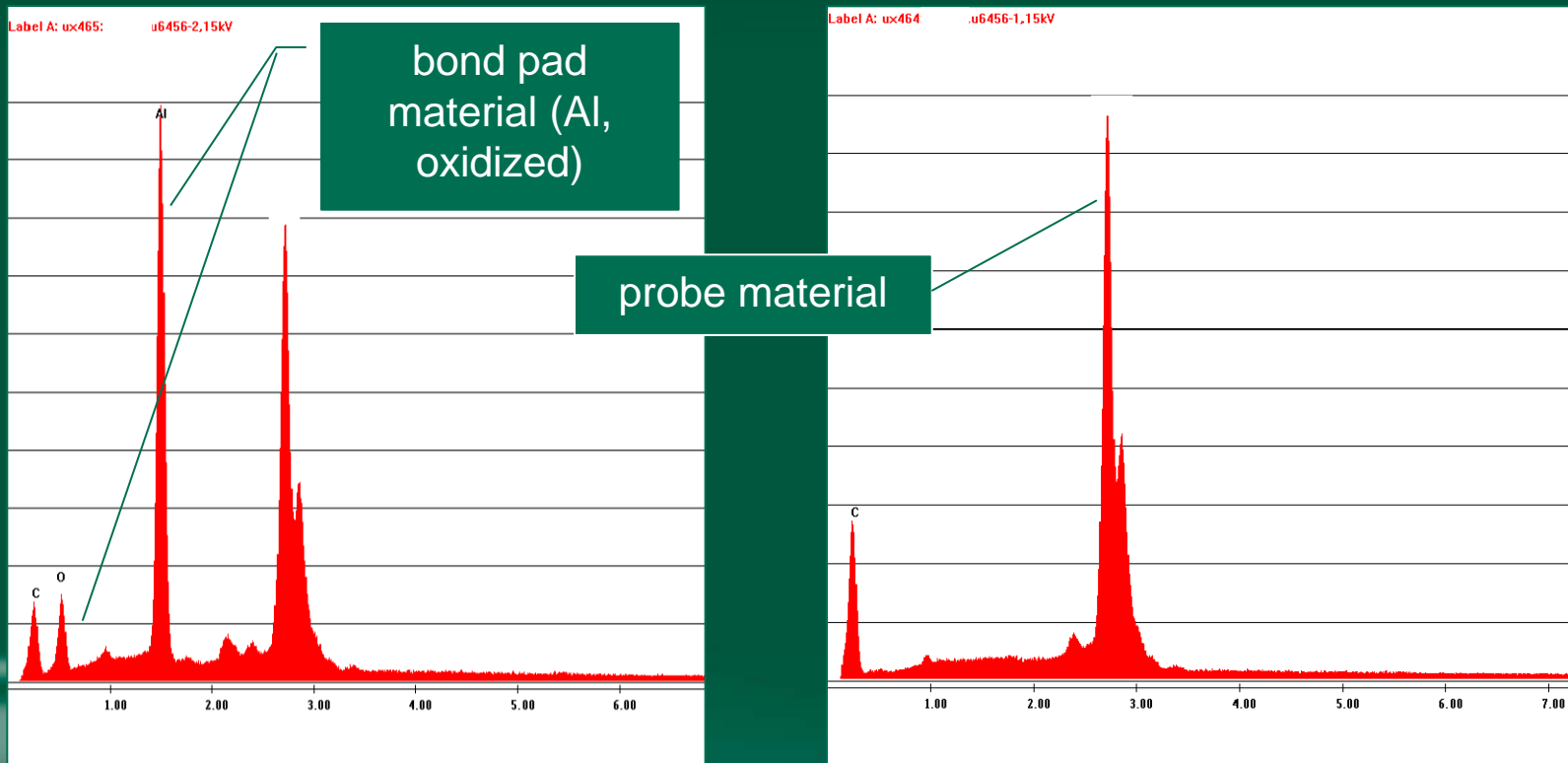
after reshape



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CLEANING LITHOGRAPHIC PROBES

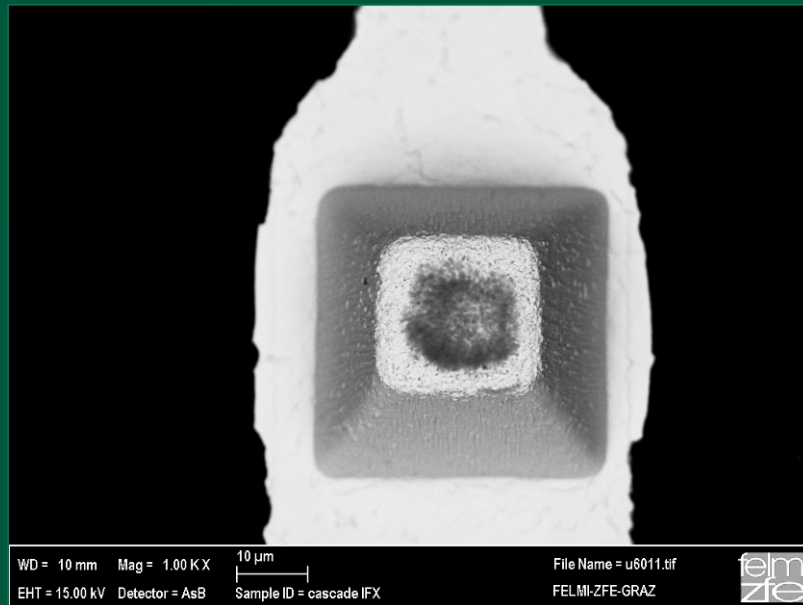
EDX spectra of contaminated vs. cleaned probe tips



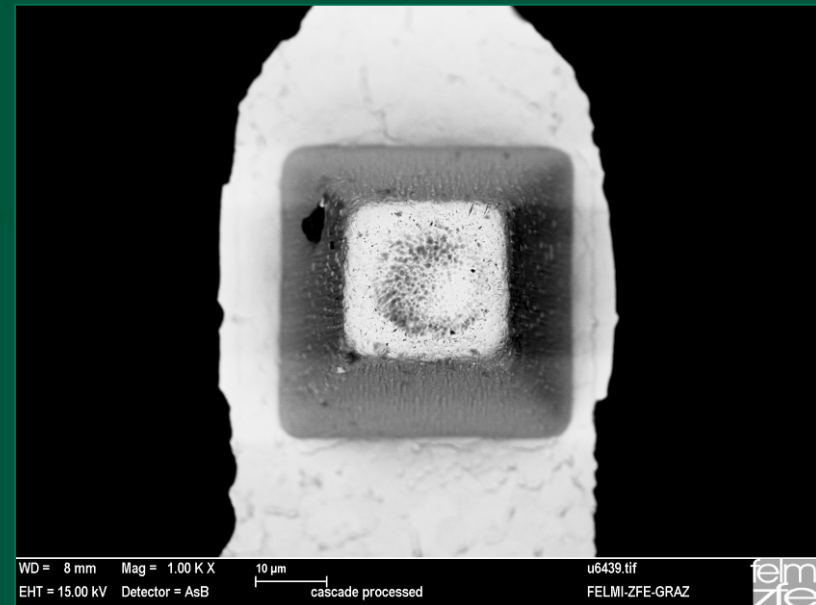
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LITHOGRAPHIC PROBES – MEMBRANE

Burned in bond pad material on pyramid probe tip
- causing high Cres contact fail



probe tip untreated



after lapping + polish



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ACKNOWLEDGEMENTS

- FELMI-ZFE Graz Electron Microscopy.
- J. Harrault Altis Semiconductor.
- J. Broz, G. Humphrey International Test Solutions.

Glossary:

- PC Probe Card
- POAA Probe Over Active Area
- PbB Probe Before Bump
- PCB Printed Circuit Board
- TD Touch Down
- TPR03 TIPs Refresher version 3
- MLC Multi Layer Ceramic
- MLO Multi Layer Organic
- WW XMER Wiring Space Transformer
- OT Overtravel
- Cres Contact Resistance

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