

How to Reach more than 1 Million Touchdowns per Probe Head when Testing High Current / High Pin Count Microprocessors ???

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AGENDA

- Probe Card - Requirements
- Probe Card - Issues Testing on Bumps
- Test Program – Protecting the Probe Card
- Probe Card Maintenance - Cleaning Methods
- Probe Card Tracking System
- Summary

Probe Card - Requirements

- Trends

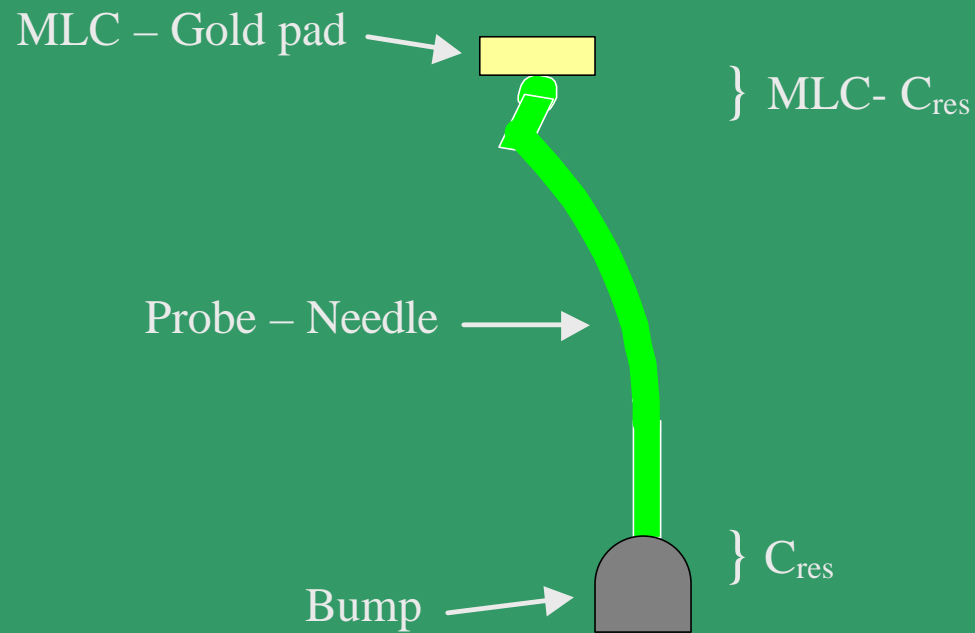
- Increasing number of I/O pins
- Increasing number of power and ground pins
- Smaller pad pitches
- Smaller probe diameter
- Voltages decreasing
- Current increasing
- Power is exponentially increasing

- Challenge

- **Keep the total cost of ownership for the probe hardware down and guarantee a high probe card performance all the time!!!**

Probe Card – Issues Testing on Bumps

- Probe Needle – Schematic (not to scale)



Probe Card – Issues Testing on Bumps

- **Burning Probes**

- Can be caused by bump material between needles \Rightarrow shorts between adjacent probes



- C_{res} increases due to sticky bump material on the needle tip \Rightarrow more current goes through other clean probes with low C_{res}
- MLC- C_{res} increases due to pad wear out \Rightarrow more current goes through other clean probes with low C_{res}

Probe Card – Issues Testing on Bumps

- **Burning Probes (continued)**
 - Asymmetrical power distribution in the power and ground grid due to wafer manufacturing process issues

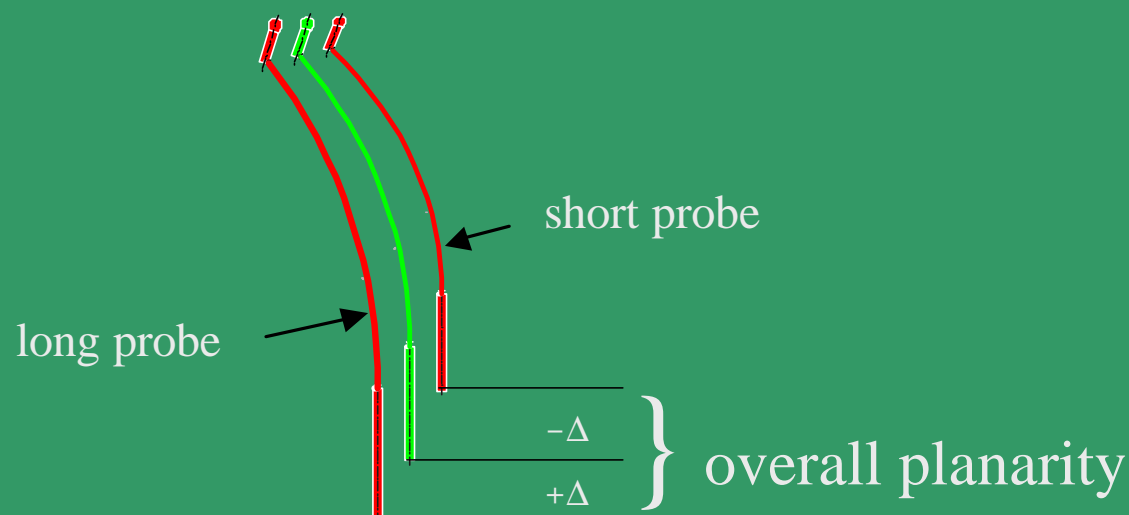


All this can cause
burned probes



Probe Card – Issues Testing on Bumps

- How to Determine that there are Burned Probes ???
 - Burned probes change their mechanical shape over time due to the applied mechanical force from the prober-chuck when getting in touch with the wafer – high current heats up the probe and the applied contact force can deform the needle



Probe Card – Issues Testing on Bumps

- **How to Determine that there are Burned Probes ??? (contd.)**
 - Probe head planarity is a very good indicator \Rightarrow mechanical and electrical performance of the probes is proportional to the overall probe head planarity
 - Measure the planarity for all signal, power and ground needles off-line at the probe card check station
 - Measure the planarity for all signal pins at every lot start at the prober-tester system \Rightarrow probe card on-line process control

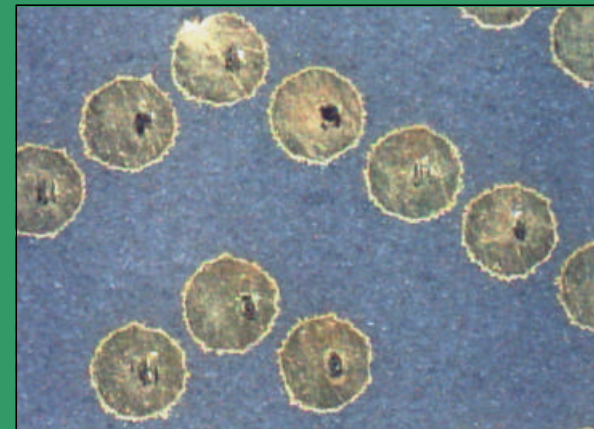
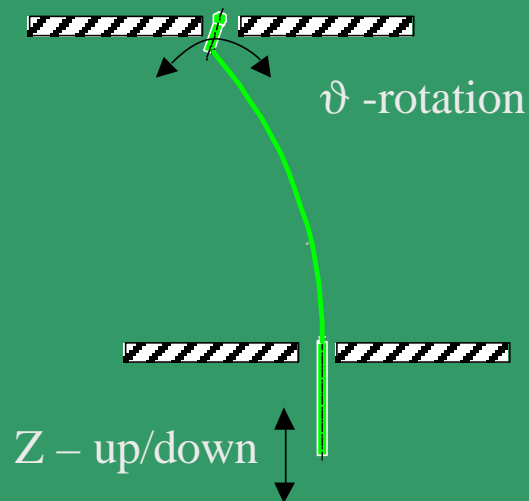


Do replace probes in the probe head if they are out of the planarity spec-window !!!

PREVENTIVE PROBE CARD MAINTENANCE

Probe Card – Preventive Maintenance

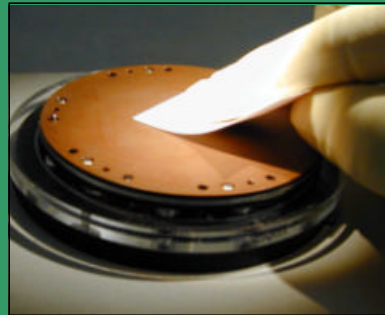
- Probe Card Maintenance - Plating
 - Mechanical wear-out problem over time
 - Re-plating MLC Gold contacts \Rightarrow reduces MLC- C_{res}



MLC-Gold pad -
mechanical wear-out

Probe Card – Preventive Maintenance

- Probe Card Maintenance – Lapping Backside
 - Probe backside lapping \Rightarrow increases contact area \Rightarrow reduces MLC- C_{res}



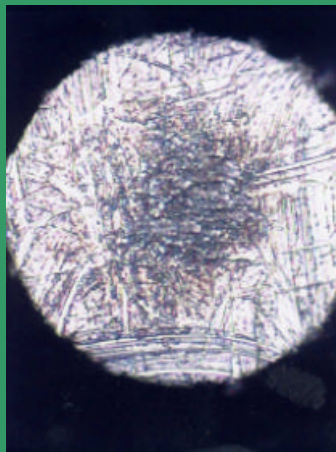
Before-Lapping



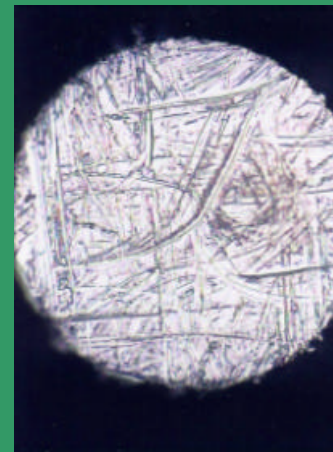
After-Lapping

Probe Card – Preventive Maintenance

- Probe Card Maintenance – Cleaning Probes
 - Probe tip cleaning / lapping \Rightarrow reduces C_{res}
 - Probe tip cleaning on-line at the prober and off-line



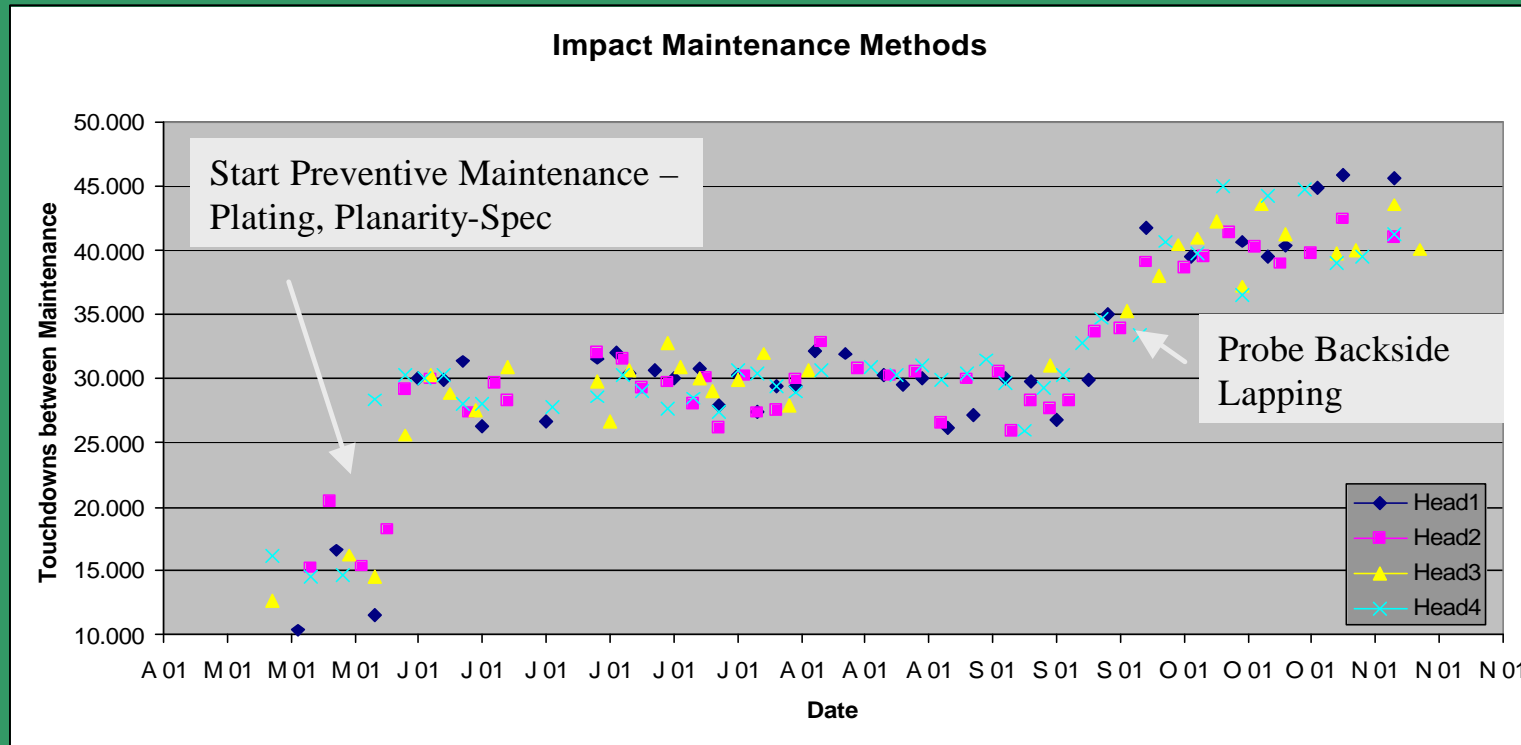
Before-Cleaning



After-Cleaning

Probe Card – Performance

- Probe Card
 - Preventive probe card maintenance improves the performance and life of the probe hardware



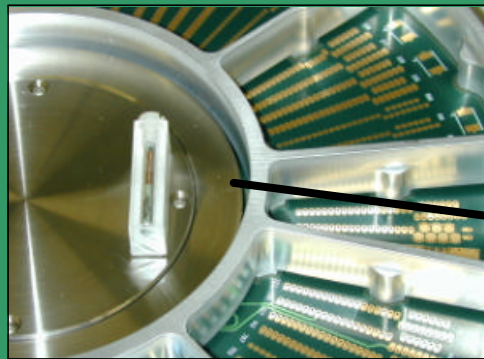
Test Program - Protecting the Probe Card

- **Test Program - Probe Card Protection Tests**
 - Signal Pin Continuity Tests - OPENS / SHORTS
 - Abort testing when fail
 - Power-Ground Continuity Test
 - Abort testing when fail
 - Power-Supply Shorts Test – current monitoring
 - Abort testing when fail
 - Device - Power-Up-Static Test – power up the part at a low voltage, run a pattern and stop ⇨ measure static current
 - Abort testing when fail
 - Current Clamp Alarms – monitor the power supply current while testing the part for each test executed
 - Abort testing when fail – exceeding a defined current limit

Probe Card Tracking System

- **Probe Card Tracking - Purpose**

- Efficient system to keep track of all relevant probe card parameters and maintenance events
 - touchdown count
 - maintenance events - MLC re-plating, replacing probes
 - X-Y alignment parameters
 - overall planarity
 - Probe card relevant operation parameters



Tag attached to probe card



RF-Micro-Tag with mounting kit

Probe Card Tracking System

- Probe Card Tracking (continued)
 - Defined limits for all probe card parameters for each probe card type
 - Tracking of maintenance events

Probecard Manager, Version 005_alpha

Running Mode: DEBUG and ONLINE

Devise Types Maintenance Status

Create Remove Edit Groups Help Exit

Type Name: testtyp01

Copy Specifications: Palomino Head Flat

Parameter:

Parameter	Value	Unit
planarity_spe	85	um
down_insp_spe	26800	number
overdrive_spe	85	um

Probecard Manager, Version 005_alpha

Running Mode: DEBUG and ONLINE

Devise Types Maintenance Status

Standard Assemble Special Checkin Checkout Help Exit

SORT Probecard: 7FAP05W8 - TPAF12V4H

Specify your maintenance:

Date: 14.12.2001 14:17:00

Technician: akirstan

Number of needles changed: 4

Probe length: 10

Comment: keine besonderen Vorkommnisse

Plating:

Checkstation testfiles: Select File Submit

Probe Card Tracking System

- Probe Card Tracking (continued)
 - Probe card real time status information available
 - All data will get loaded into a database ⇨ trends and charts can be used to monitor probe card performance ⇨ Statistical Probe Card Process Control possible !!!

Probe Card Manager, Version 1.2

Device Types Maintenance Status Online

SDRT WET

All Assemble Maint

Types: WET

- 80PC-AL
- 80PC-CU
- 8LD-CU
- SLM-AL
- SLM-CU

Devices of SLM-AL

- SLM-AL-EW01
- SLM-AL-EW02
- SLM-AL-EW03
- SLM-AL-EW04
- SLM-AL-EW07
- SLM-AL-EW08

WET devices total: 77 SLM-AL devices: 25

Device Name: SLM-AL-EW03

Creation Date: 13 Jan 02, 02:31

Vendor + Serial Number: HTI, SerialNumber -

Last Location: 1306r15

Last Maintenance: 01 May 02, 03:02

Touchdowns Inspection: 126044

Touchdowns total: 1146216

Device State: Device is DOWN

Help Exit

Probe Card Manager, Version 1.2

Device Types Maintenance Status Online

All Assemble Maint

Select Type: Thoroughbred Head Flat

Select Device: 70HF08WH

Select Maintenance: 07 Mar 02, 15:15

Date: 07 Mar 02, 15:15

Technician: fauel

Probe Length: 0

Changed Needles: 5

Plating done: Plating done

Maintenance Comment: Richte zwischen Power und Ground, vorhegene Nadeln gereinigt, Goldpads der MUC hatten leecher, 13um Plan.

Help Exit

Conclusions

- Need to understand the possible root cause of probe burning
- Use the planarity of the probes as a parameter to qualify the probe card quality on the test floor on the test system
- Preventive Maintenance guarantees high quality of the probe card for the entire life in the field
- Probe card protection tests implemented in the test program help to reduce the risk of damaging the probe card while testing
- Probe Card tracking system can be used for statistical process control and monitoring the quality of the probe card

Conclusions

- With the methods and tools in place more than 1.5 million touchdowns per Probe Head and more than 2 million touchdowns per Space Transformer using the same MLC could be achieved – still in use ⇨ numbers will increase even more



**TOTAL COST OF OWNERSHIP REDUCED !!!
PERFORMANCE OF THE PROBE CARDS
STAY AT A HIGH LEVEL FOR THE ENTIRE
LIFE OF THE PROBE HARDWARE !!!**