Wafer Heat Distribution Analysis during Heated Chuck Wafer Probing using Automated Visual Inspection

By
Thomas Dabelstein, **Philips Semiconductors, Hamburg (PSH)**
Hans-Uwe Nitschke, **Philips Semiconductors, Hamburg (PSH)**
Mike Clay, **Semiconductor Technologies & Instruments, Inc. (STI)**
Larissa Dodson, **Semiconductor Technologies & Instruments, Inc. (STI)**

For
SouthWest Test Workshop, 2001
June 4, 2001

Purpose and Design of the Experiment

- A Way to Characterize Heat Distribution during Heated Chuck Probing
- Automated Visual Inspection and Probe Mark Signature Analysis
- The Wafers and Device Under Test

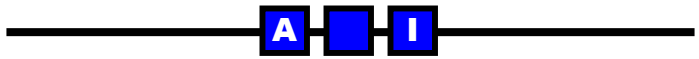
The Data

- Correlation of Probe Mark to Percentage of Bond Pad Area
- Heat Uniformity and Bond Pad Damage Distribution

Conclusions

- AVI as a Valid Supplement to Probe Card Analysis
- Other Possibilities for AVI and Probe Process Monitoring

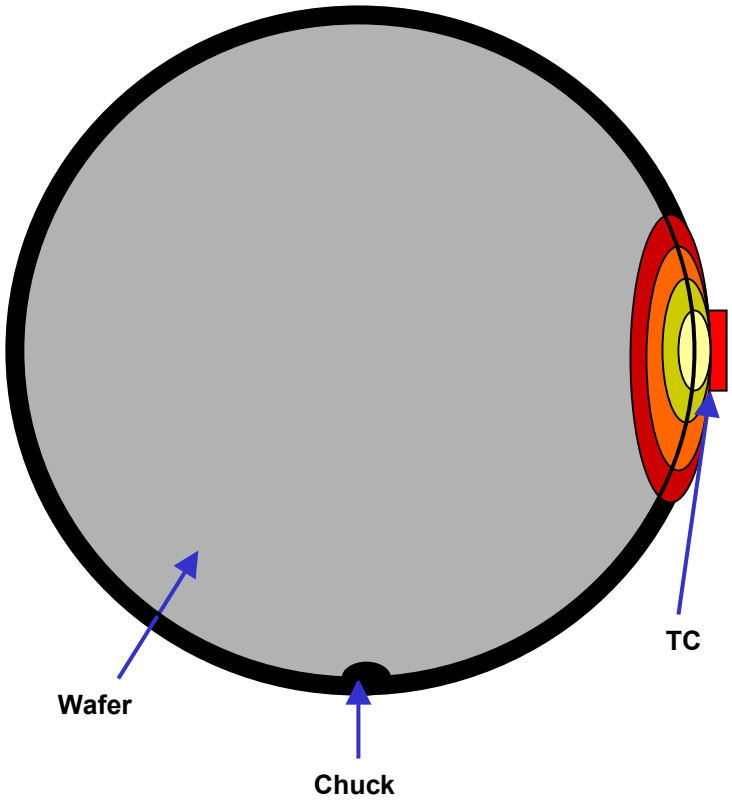
Purpose and Design of Experiment



The Data

Conclusions

Purpose & DOE: A Way to Gauge Wafer Heat Distribution



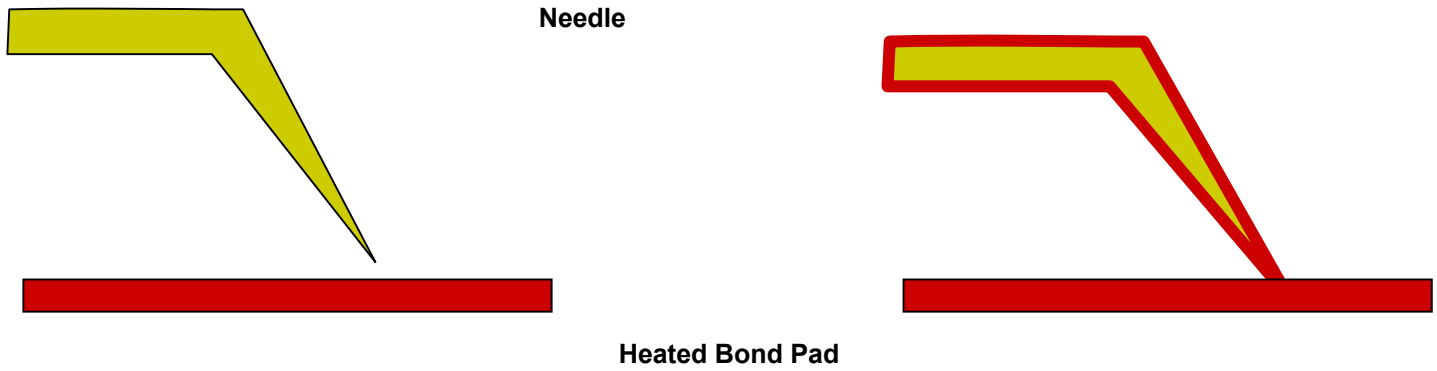
Heat measurement using a single thermocouple

A thermocouple mounted at a fixed point on the wafer chuck does not provide a gauge for heat distribution across the entire wafer.

It is not feasible to place many thermocouples across the entire chuck surface during wafer probing.

It would be valuable to explore other means to monitor heat distribution across the entire wafer during heated chuck processing.

Purpose & DOE: A Way to Gauge Wafer Heat Distribution



The probe needle needle increases in size due to heat expansion from contact with heated pad. If the amount of bond pad damage could be measured, and correlated to ranges in temperature, this could provide some indication of the heat distribution across the wafer.

Off line inspection of the probe needles using a Probe Card Analyzer cannot provide information regarding the uniformity of needle expansion. The needles contract to their normal size soon after contact with the heated wafer surface is removed.

Purpose & DOE: Probe Mark Characterization with AVI

Probe Mark Dimensions:

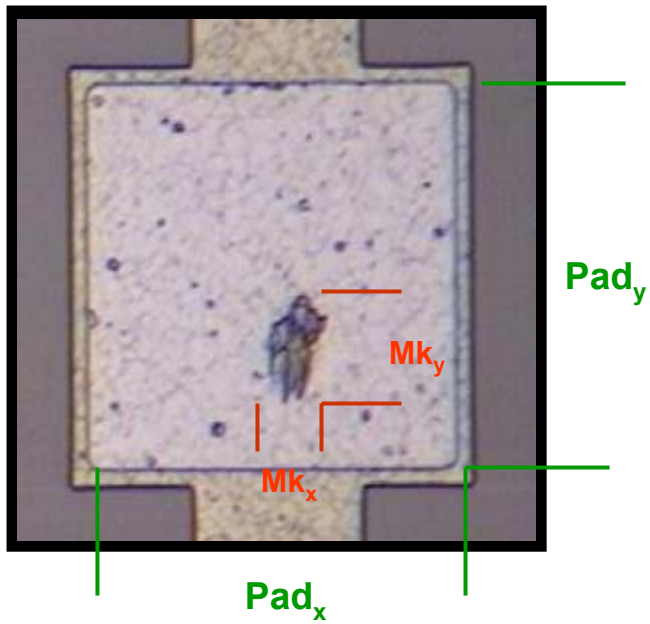
Mk_x = 16.0 um
Mk_y = 25.5 um
Area = 408.0 um^2

(measured manually)

Bond Pad Dimensions:

Pad_x = 90.5 um
Pad_y = 91.5 um
Area = 8280.75 um^2

(measured manually)



Mark Area/Bond Pad Area:

Pad Damage = 4.92 %

(measured manually)

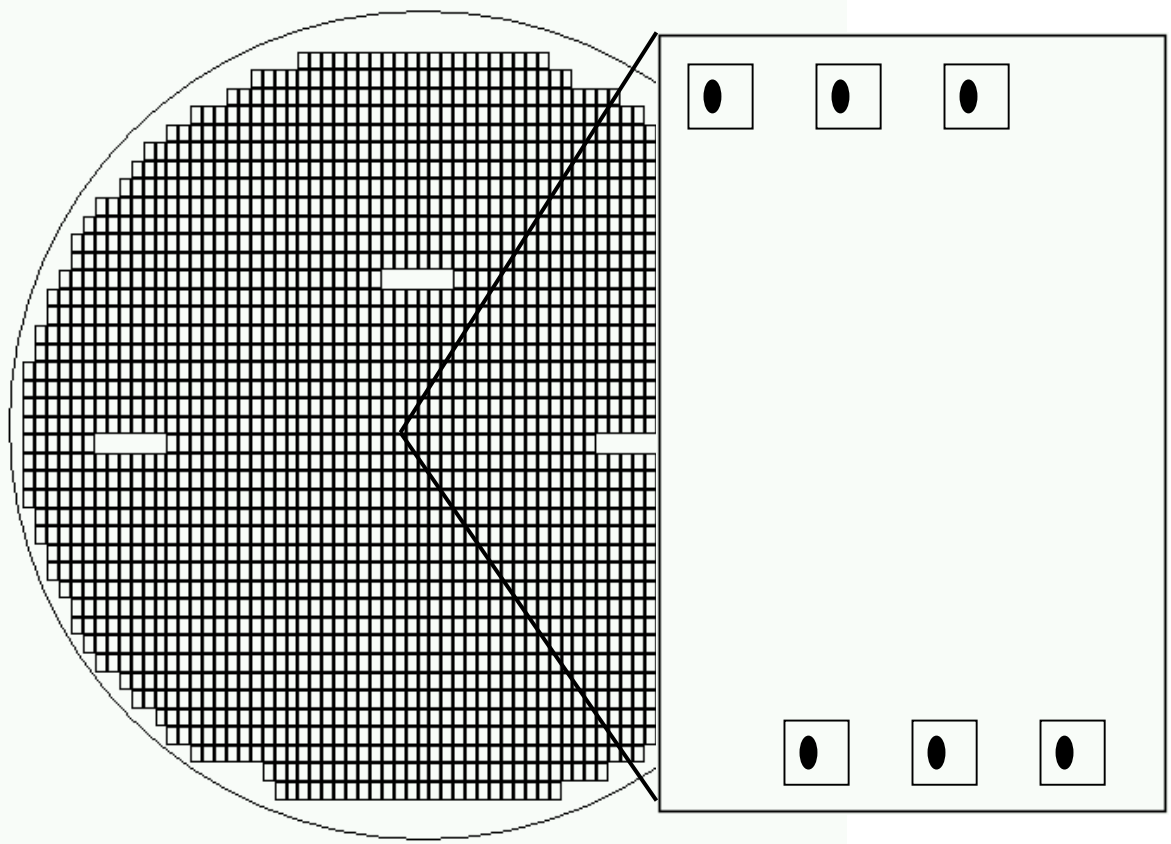
AVI calculation:

Pad Damage = 5.05%

Correlation of Probe Mark/Bond Pad dimensions between manual and Automated Visual Inspection (AVI) shows the same percentage of Bond Pad Damage (within 0.13%).

If % of Bond Pad damage increases as probe needles expand, AVI inspection could provide the means to monitor heat uniformity during the heated chuck probing process.

Purpose & DOE: The Device/Wafers Under Test



Number of wafers: 3

Wafer Diameter: 200mm

Total Die: 2173

Die Size: 2150um x 3298um

Pad Size: 90.5um x 91.5um

Pads per Die: 6

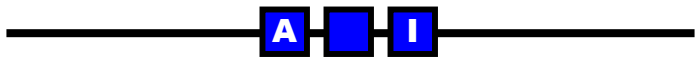
Temperature Ranges:
30 C (room temp)
85 C (med temp)
110 C (high temp)

One wafer probed for each temperature and then inspected with AVI.

All probing performed on TSK, UF 200 – All AVI data gathered on STI, WAV 1000

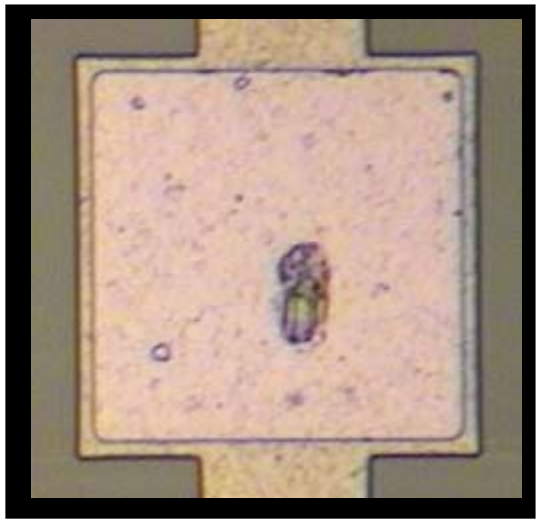
Purpose and Design of Experiment

The Data

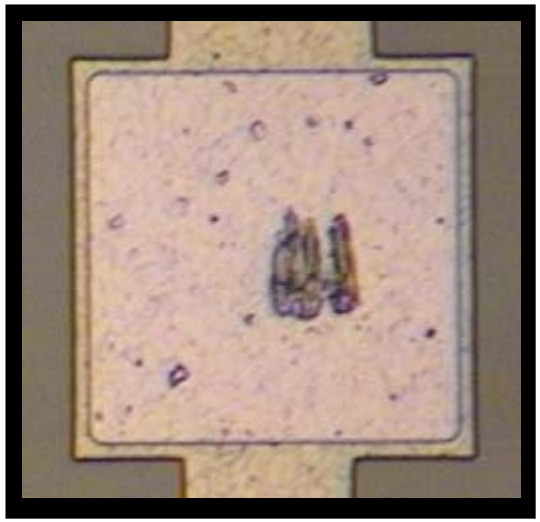


Conclusions

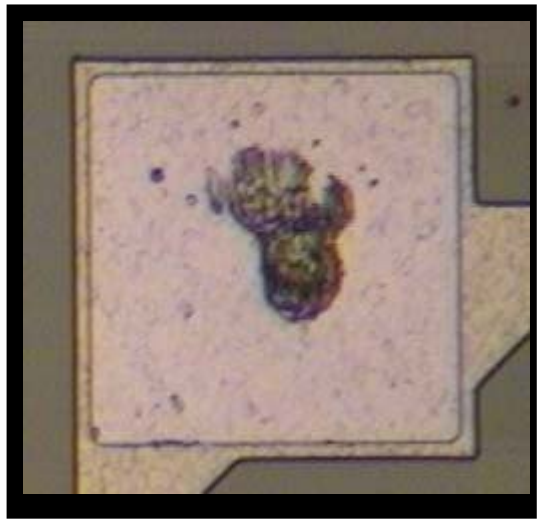
The Data: Probe Mark Size and Temperature



5 – 9.99 % Damage



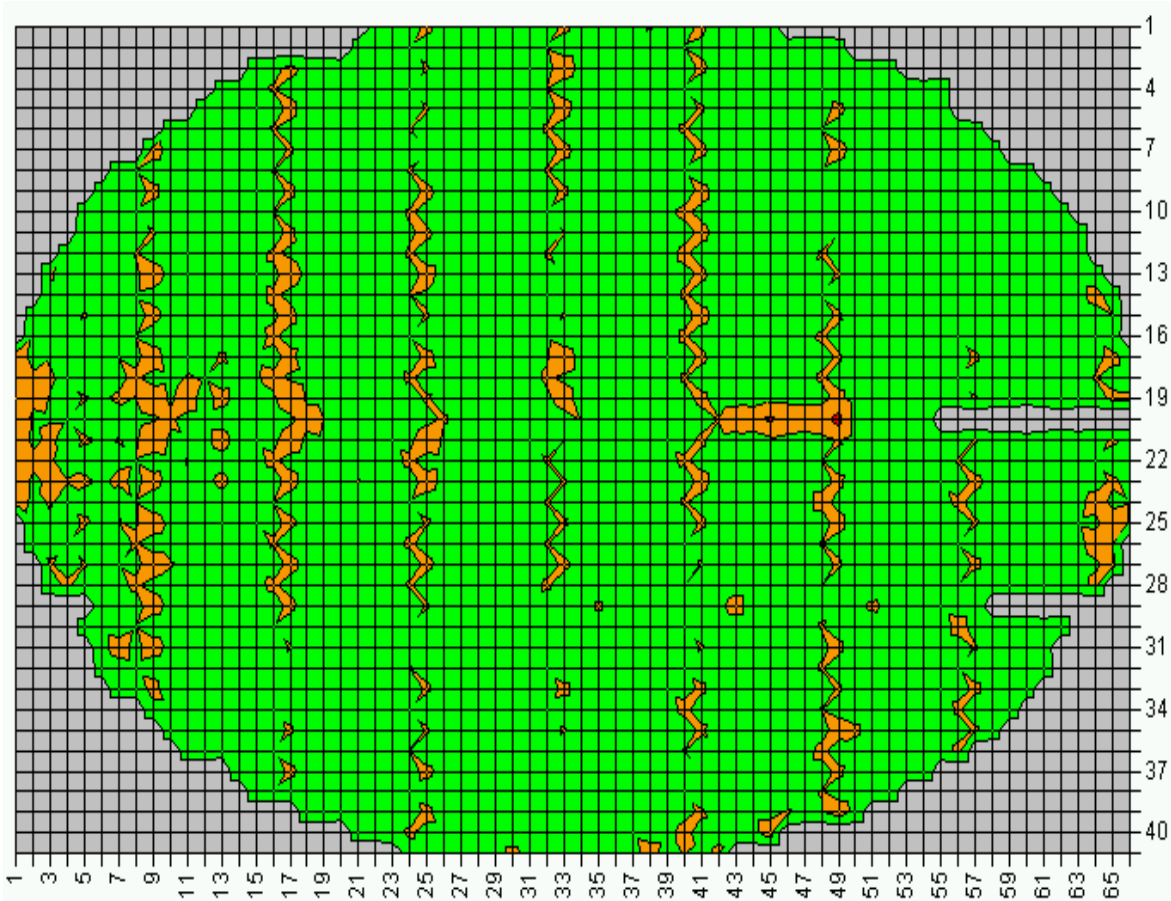
10 – 14.99 % Damage



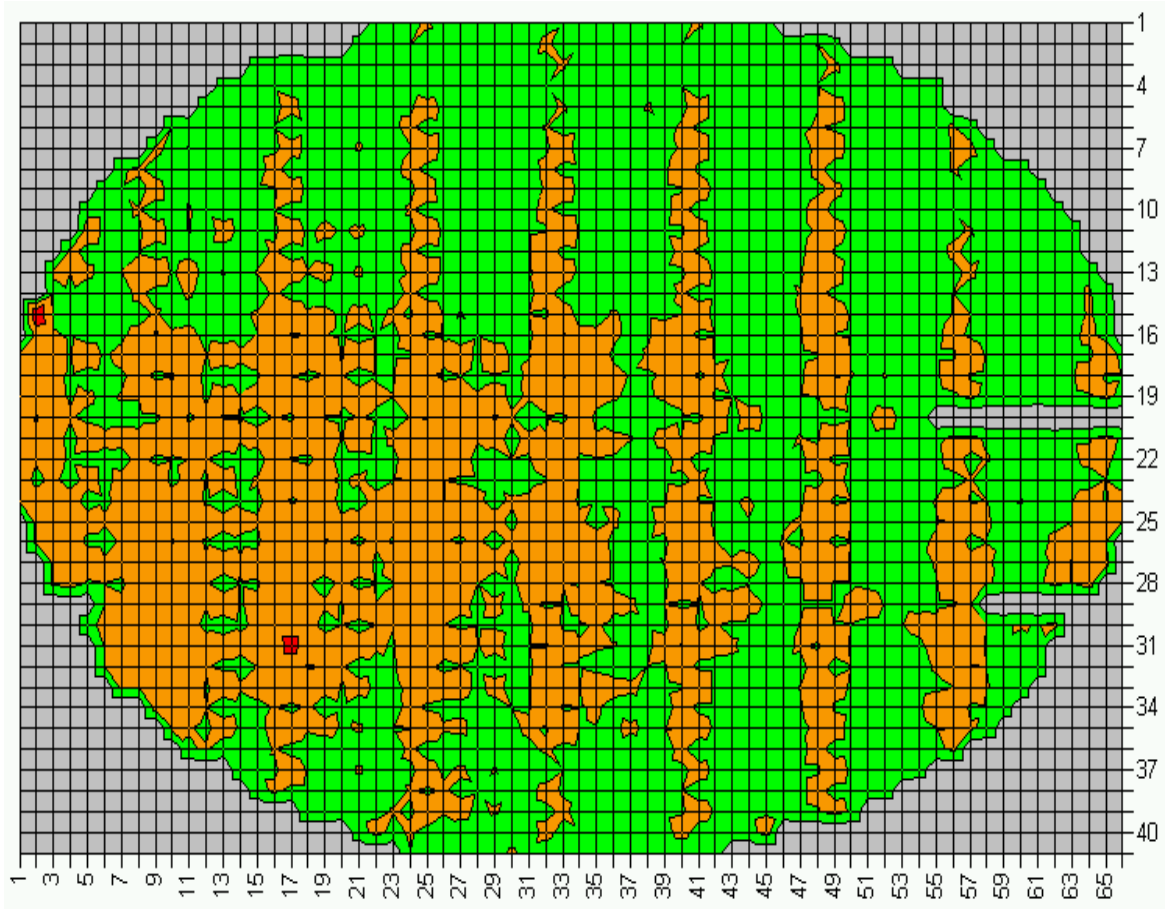
15 – 20 % Damage

At 30C (Room Temp), the % pad damage per die is mostly 5 – 9.99% across the wafer. At 85C (Medium Temp), more die with damage at 10 – 14.99% appear, with a few at 15 –20%. At 110C (High Temp), the greatest number of die with 10 – 14.99% damage appear. In the cases of Medium and High Temp, the distribution of the different percentages of pad damage is non-uniform.

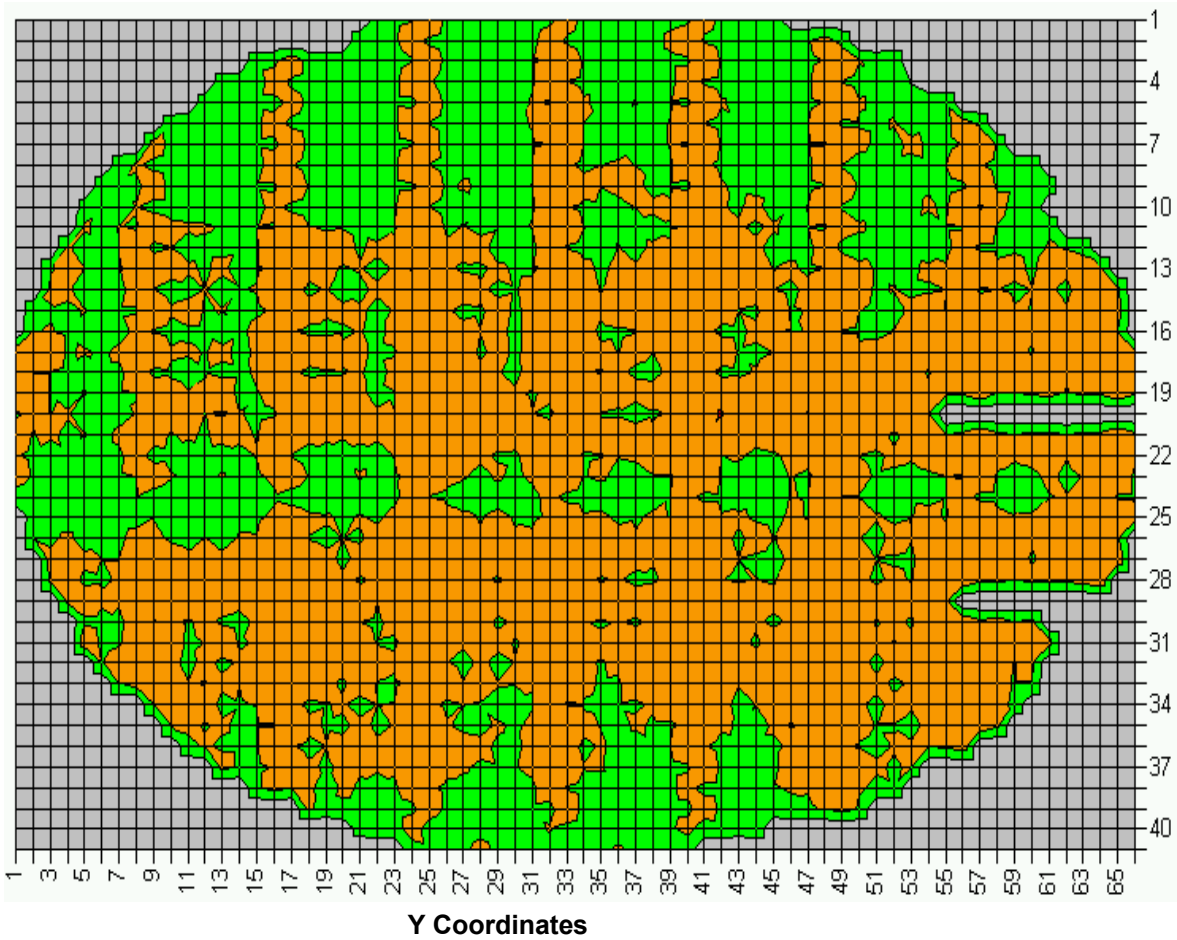
The Data: Room Temperature Pad Damage Distribution



The Data: Medium Temperature Pad Damage Distribution



The Data: High Temperature Pad Damage Distribution



15 – 20.00 % Pad Damage

10 – 14.99 % Pad Damage

5 – 9.99 % Pad Damage

0 – 5.00 % Pad Damage

Wafer probed at High Temperature: 110 C

Purpose and Design of Experiment

The Data

Conclusions

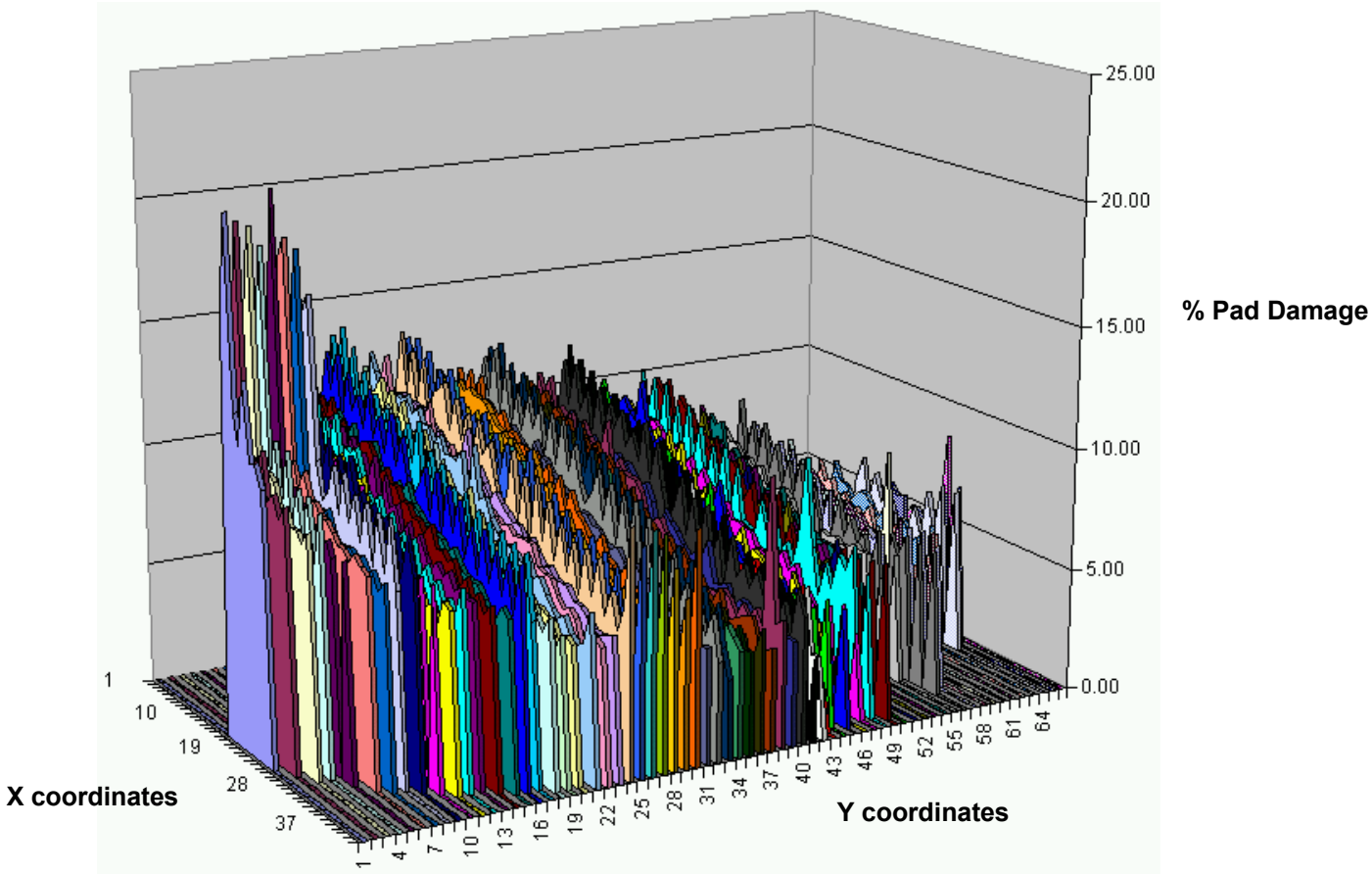
Conclusions: AVI as a Valid Supplement to Probe Card Analysis for Monitoring the Probing Process

- Probe Card Analysis provides vital information regarding probe card needle alignment, wear, etc.

- Automated Visual Inspection provides supplemental data regarding the probe process, i. e., heat distribution, wafer chuck alignment, probe chuck alignment.

- AVI provides timely feedback: after probe card installation or prober preventive maintenance, AVI can be used on test wafers to profile the process. Last minute adjustments can be made prior to running production lots.

Conclusions: Other AVI uses for Monitoring the Probing Process



This 3D plot of average % Pad Damage per die illustrates a non-level wafer chuck