Probing Lead Free Solder Bumps in Final Wafer Test

By

Sam McKnight

Southwest Test Workshop

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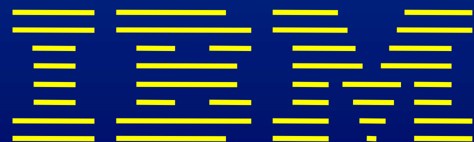

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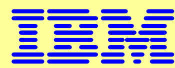
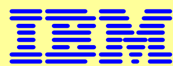


Outline

- Why lead free ?
- Background Info
- Focus areas
- Setup
- Lead/Tin and Tin “Rich” results
- Summary
- Acknowledgements



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Why Lead Free?

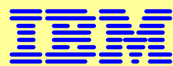
- Increasing use of integrated circuits and shortened product life cycles prompted a world wide environmental concern regarding the disposal of electronic components.
- Lead countries with environmental initiatives are Japan, Europe and the US
- All levels of packaging including the interconnect to the integrated circuit are being addressed.
- This presentation focuses on wafer level only

Background Info

- Cobra probe (5 mil diameter - flat tipped) is the primary contacting system for C4 VLSI test
- C4 = Controlled Collapse Chip Connection (Solder Bumps)
- C4's are normally reflowed before and after test
- Tests temperatures -10, 25, 85 and 100C
- Thermal unit range is -10 - 140C probe space transformer limit 100C (self imposed)

Focus areas

- Baseline comparison measurements to Lead Tin
  - Contact Resistance
  - Cleaning
  - Material Transfer (Pickup) To Probe Tip
  - Pad Deformation
  - Alignment to C4's (Solder Bumps)

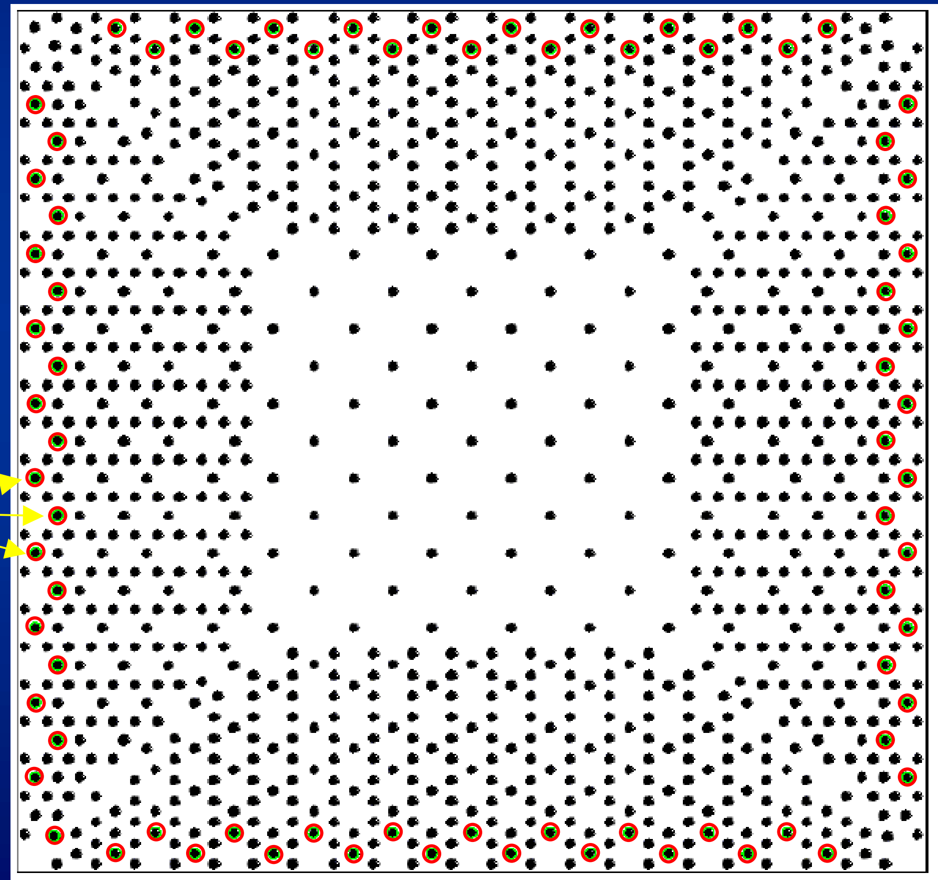


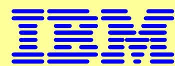
Probe layout

76 contacts total

Die size ~ 9.1 mm square

Probed pads





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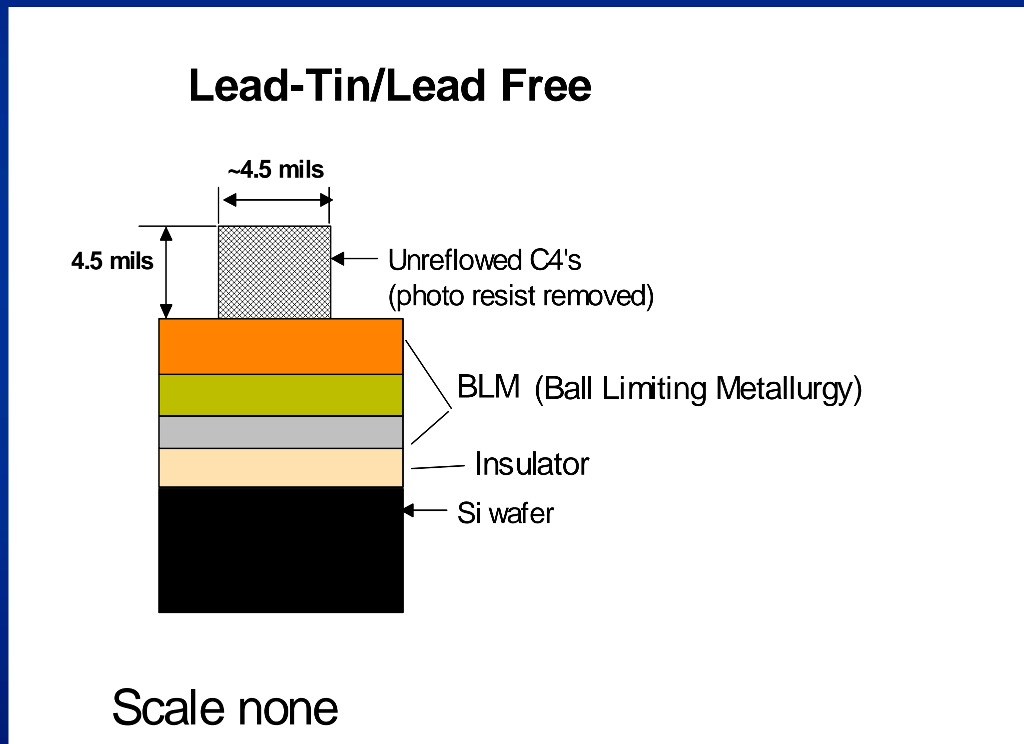
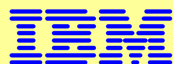
Test wafer build structure



Setup

- TEL P8XL wafer probing system with integral -10 to 140C thermal unit w/ IBM custom tester interface with hand wired space transformer
- Z drive - maximum impact velocity (~40 mm/sec)
- SARA (Socket Analog Resistance Analyzer) (DC switching matrix with measurement unit)
- Cres Measurement method - "pin return" with 10 ma forcing current and 5V clamp w/nulling file - to subtract path resistance
- Cleaning frequency - 1/wafer (>300 sites) - 5 micron abrasive material
- Environment - mini-clean hood over prober



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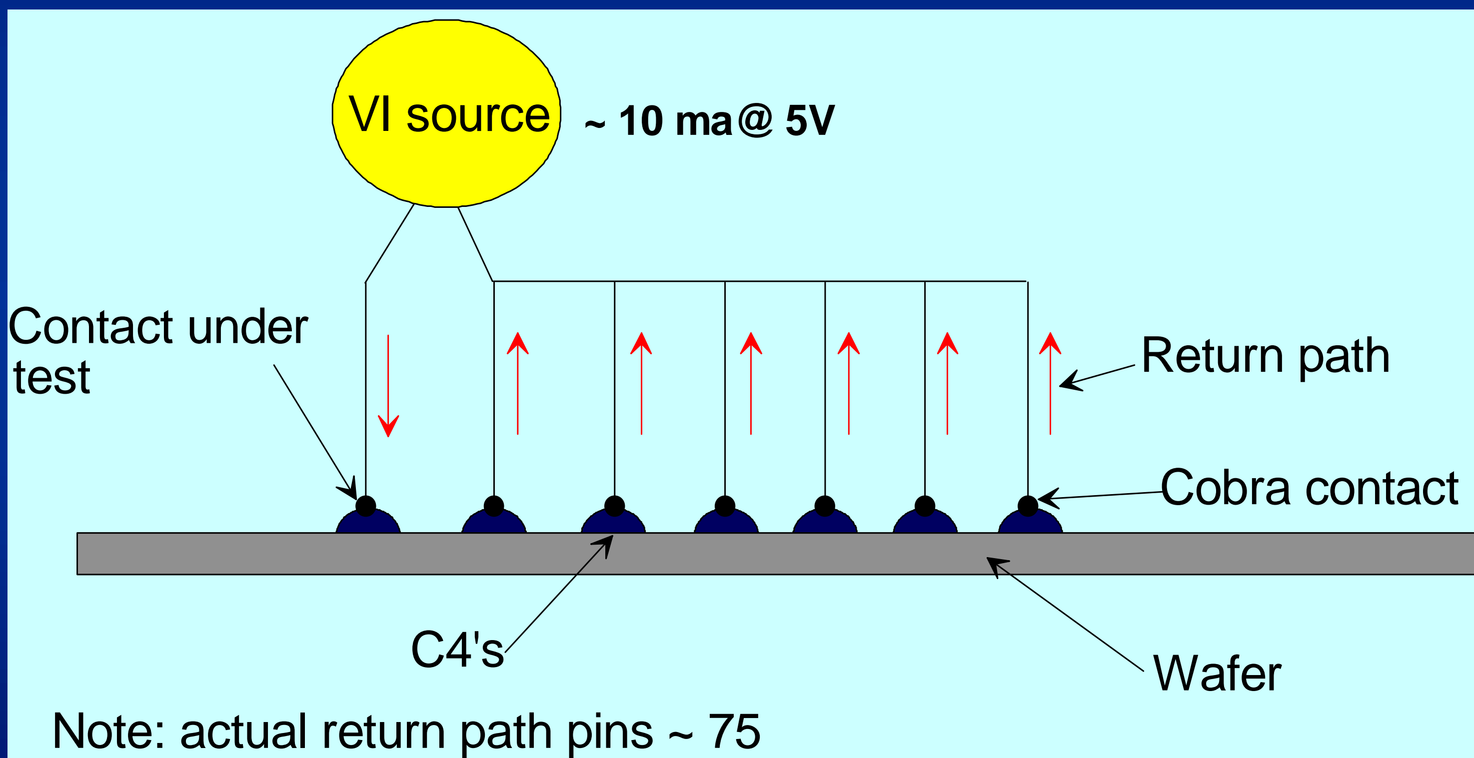
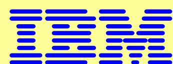
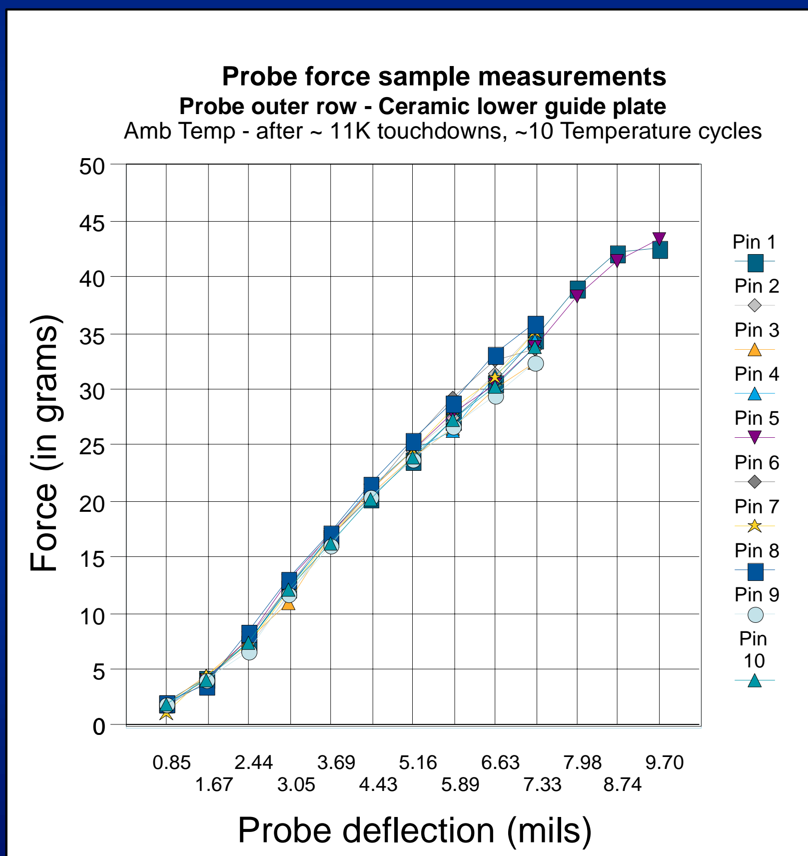
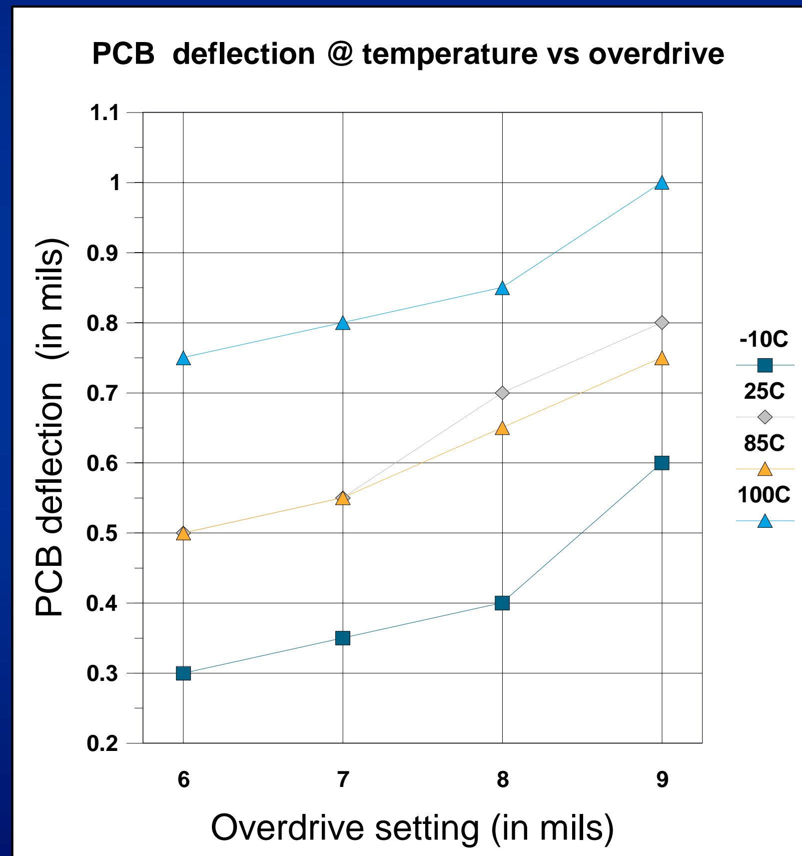
Contact Resistance Measurement



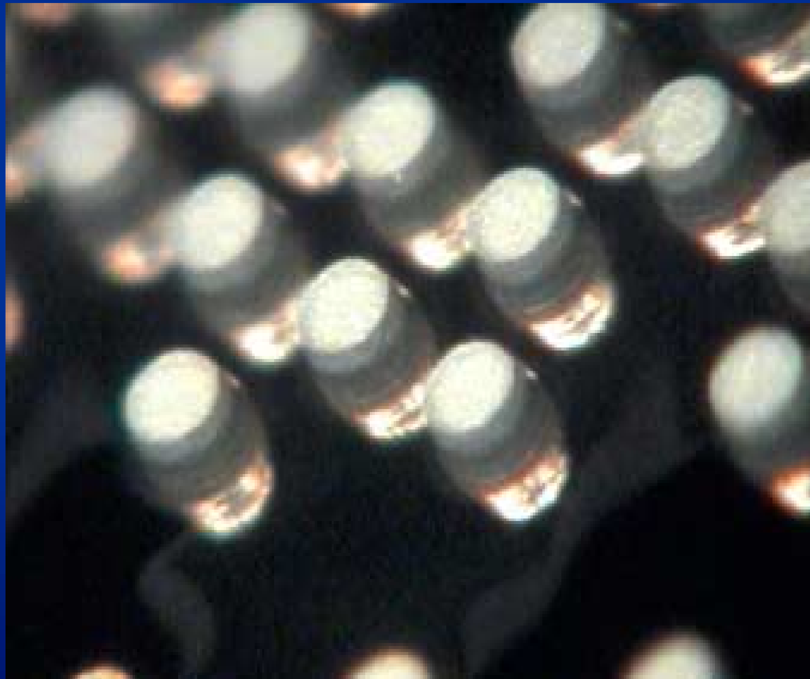
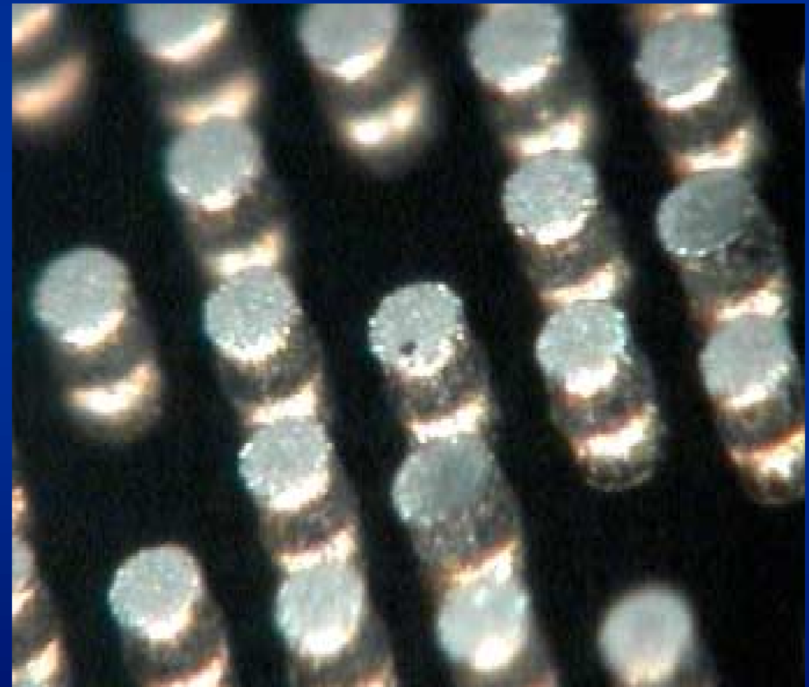


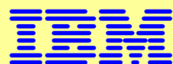
Cobra Probe Measurements





Un Reflowed C4's

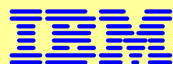
Lead free	Lead Tin
	



Contact Resistance – Lead Tin C4's

Average Contact resistance
PbSn 97/3 UNREFLOWED C4's
Each plot point = 86K measurements

Contact + Overdrive	-10C	25C	85C	100C
6 mils	~1.2	~7.8	>10	~0.9
7 mils	~0.15	~1.5	~2.2	~0.75
8 mils	~0.3	~0.6	~1.5	~0.35
9 mils	~0.9	~0.3	~0.2	~0.2



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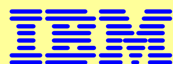
Contact Resistance - Lead Free C4's



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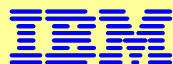
-10°C Cobra/C4 Photos

Probe	Probe	Probe	Probe
6 MIL O D	7 MIL O D	8 MIL O D	9 MIL O D
C4 Pad	C4 Pad	C4 Pad	C4 Pad
6 MIL O D	7 MIL O D	8 MIL O D	9 MIL O D

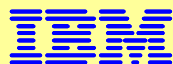
25°C Cobra/C4 Photos

Probe	Probe	Probe	Probe
6 MIL O D	7 MIL O D	8 MIL O D	9 MIL O D
C4 Pad	C4 Pad	C4 Pad	C4 Pad
6 MIL O D	7 MIL O D	8 MIL O D	9 MIL O D



85º C Cobra/C4 Photo's

Probe	Probe	Probe	Probe
6 MIL O D	7 MIL O D	8 MIL O D	9 MIL O D
C4 Pad	C4 Pad	C4 Pad	C4 Pad
6 MIL O D	7 MIL O D	8 MIL O D	9 MIL O D



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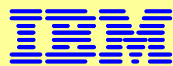
100°C Cobra/C4 Photo's

Probe	Probe	Probe	Probe
6 MIL OD	7 MIL OD	8 MIL OD	9 MIL OD
C4 Pad	C4 Pad	C4 Pad	C4 Pad
6 MIL OD	7 MIL OD	8 MIL OD	9 MIL OD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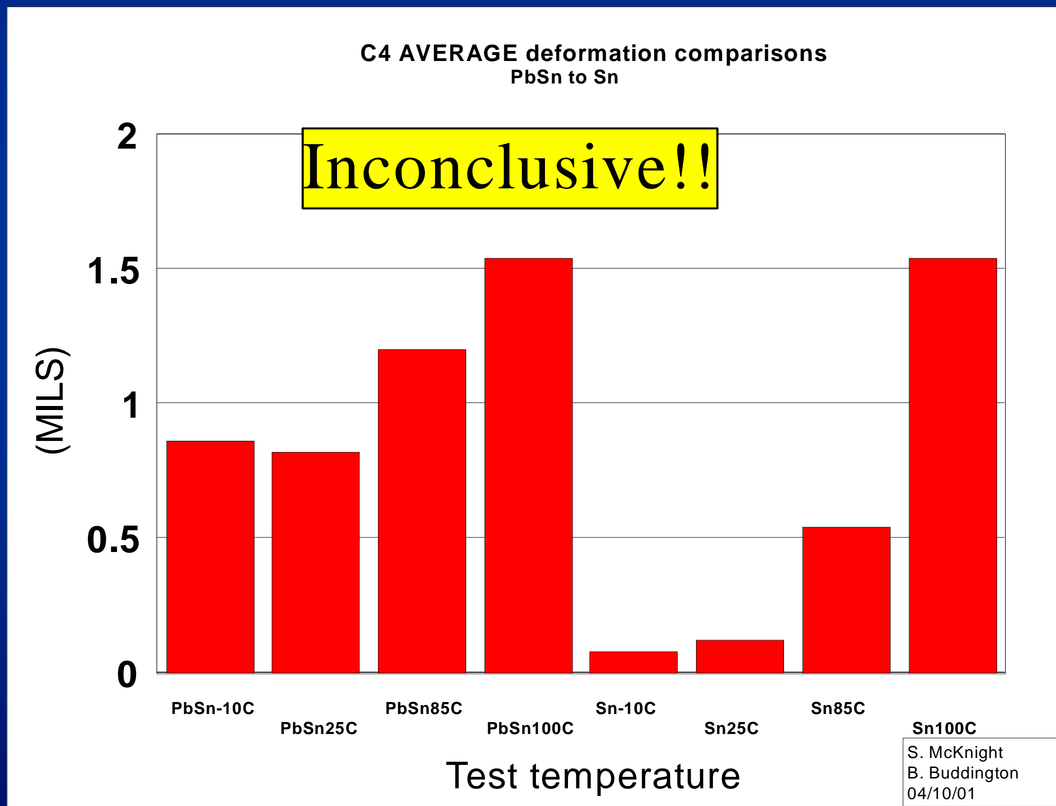
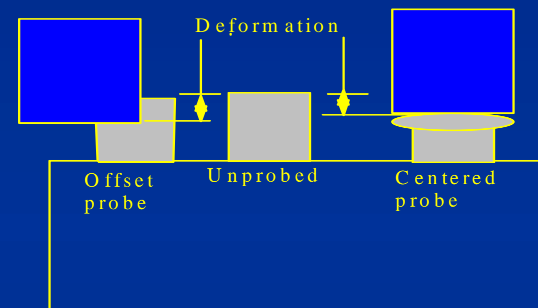
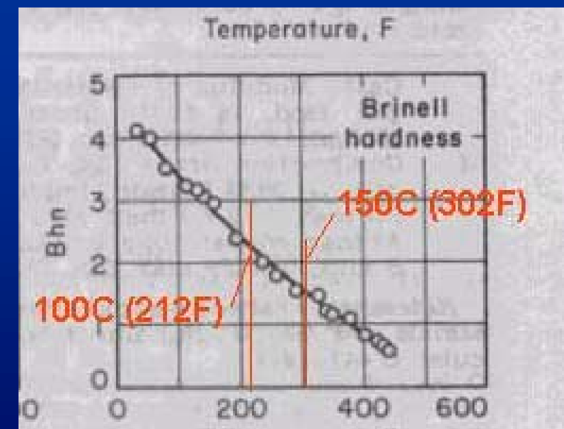
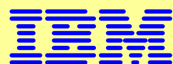
Pad Deformation









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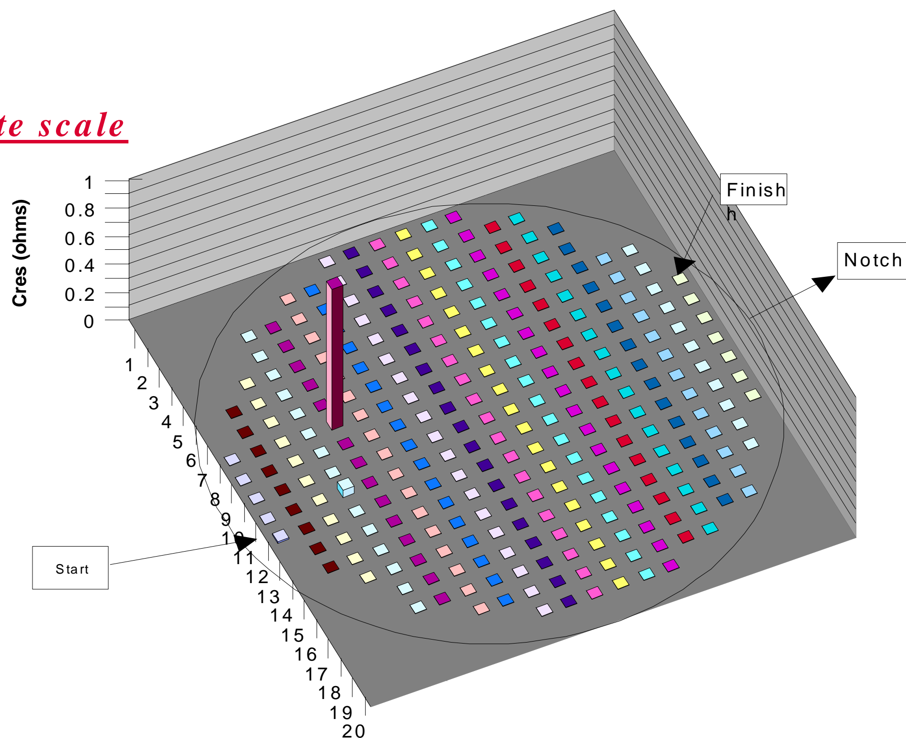
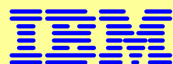
Typical Wafer level Contact Resistance plot Lead Free C4's

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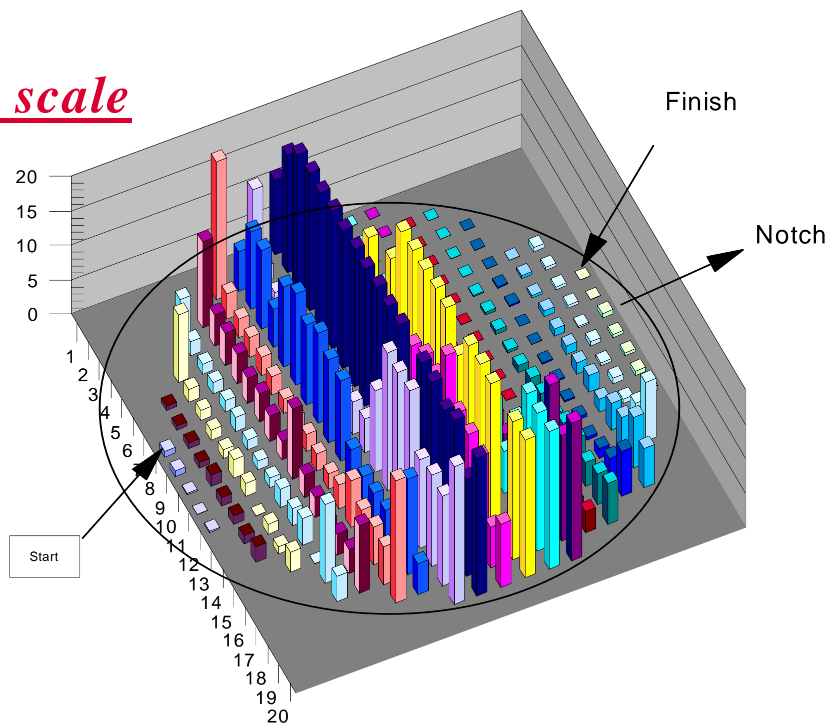
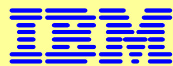
Typical Wafer level Contact Resistance plot for Lead/Tin C4's

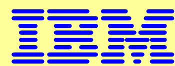
Note scale





Summary

- Contact resistance for Lead Free << 1-2 Ohms (temperature independent)
- Pad deformation – inconclusive – not an issue for post reflow operation
- Prober issues - auto alignment (non production wafers) Partial radius on top of pad not an issue
- Cleaning frequency, 1/wafer (~300+Die) is anticipated using standard (abrasive) cleaning materials
- Material transfer to probe tip comparable to Lead/Tin



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