

**Elevated Temperature Probing
Development at SEMATECH**

**Southwest Test Workshop
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Elevated Temperature Probing Development Subcommittee

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Phil Seitzer - Lucent Technologies

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SEMATECH

Mission Statement

- **SEMATECH members will create shared competitive advantage by working together to achieve and strengthen manufacturing technology leadership.**

The SEMATECH Probes PTAB Members and their Member Companies

- AMD Pete Dodd
- Digital Al Miller Suresh Nadig
- HP Susan Stirrat Henry Chen
- IBM Gobinda Das Norm Rapoport
- Intel Barry Lieberman Ken Karklin
- Lucent Phil Seitzer
- Motorola Ken Papworth Bill Williams
- National John Hsia
- Rockwell Mike Nakamura
- TI Rex Lewis Mike Wong
- TI/SEMATECH Rey Rincon (Project Manager)

SEMATECH Elevated Temperature Development

- **Background -**
 - 👉 **Why do we need elevated temperature probing?**
 - 👉 **What are the associated problems?**
- **What is SEMATECH's development roadmap for elevated temperature probing?**
 - 👉 **1997 Benchmarking**
 - 👉 **High Temperature Experiments**
- **What will be the outcome of these development efforts?**

Why Probe at Elevated Temperature?

SOME REASONS:

- Improved package yield.
- Required for “trim” operations.
- Customer specified test requirements.
- Test yield affected on temperature sensitive devices.
- Requirement to demonstrate that the device functions over a temperature range.
- KGD requirements
 - ✎ No package test
 - ✎ Low cost test option

What are the Problems with Elevated Temperature Probing?

- **Everything moves around**

-  Different parts of the probe card have different TCEs*.

-  Material expansion plus mechanical constraint produce forces that cause twists, warps and bends.

-  Some critical materials (such as epoxy) develop undesirable characteristics:

 - (soften, become electrically conductive)

-  The wafer expands, but not as much as the probe card.

 - Most new probers can compensate for wafer expansion.

* TCE = Temperature Coefficient of Expansion

Probe Card Material TCEs

<u>MATERIAL</u>	<u>TEMP. COEFF. of EXP.</u>		
Silicon Wafer	2.50	X	10^{-6} /deg. C
Beryllium Copper (Cu)	7.78	X	10^{-6} /deg. C
Tungsten/Rhenium	4.92	X	10^{-6} /deg. C
Tungsten *	4.43	X	10^{-6} /deg. C
Aluminum *	24.00	X	10^{-6} /deg. C
Ceramic *	9.30	X	10^{-6} /deg. C
PCB (FR4) *	13 - 18	X	10^{-6} /deg. C
PCB (Polyimide) *	12 - 16	X	10^{-6} /deg. C
Epoxy (Typical-25C) *	65.00	X	10^{-6} /deg. C
Epoxy (PTC125) *	25.00	X	10^{-6} /deg. C

* = Probe Technology Corporation supplied data

More Elevated Temperature Problems.....

- **Characteristics of the probe/pad interface change**

-  **Contact resistance is believed to increase for some metal systems.**

Tungsten Vs. Tungsten/Rhenium on Aluminum

-  **Scrub length has been observed to vary:**

Change in Aluminum texture, oxide characteristics

OR - is it purely mechanical?

-  **Enhancement of Contamination.**

Environmental contaminants cause more problems when heated.

-  **These problems definitely increase with finer pad pitches and higher probing temperatures.**

SEMATECH's Development Roadmap

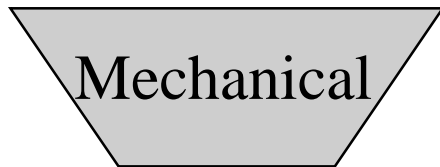
Probes & KGD PTAB's

(Peripheral Probe - Aluminum Pads Only)

	1997	1998	1999
Probes	70 μm pitch	50 μm pitch	50 μm pitch
	25°C/85°C	25°C/85°C	25°C/85°C/125°C
	500 in-line pads	500 staggered pads	500 in-line pads
KGD Wafer Level Test	125/100 μm pitch	70 μm pitch	
	125°C	125°C	
	150 in-line pads	500 in-line pads	

SEMATECH's 1997 Benchmarking

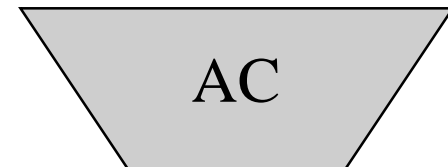
Peripheral (70 μm pitch) @ 85 C



Probe Card Analyzer
Scrub Mark Analysis
Prober for Lifetest



Tester (Lifetest)
Parametric Analyzer



AC Characterization

CHARTER of the Elevated Temperature Development Subcommittee

- **Define experiments to insure that our 1998 probe requirements will be met.**
 - ✍ **Experiments that will reveal the “*best known practices*” for manufacturing a 70 μm pitch, 125° C probe card by EOY 1997.**
 - ✍ **Determine which probe needle metal system at 125° C (Tungsten or Tungsten/Rhenium) performs better over time on Aluminum pads.**

High Temp. Experiments

- **Selected probe card vendor(s) will provide the following:**

-  **An assembled 70 μm probe card built for 125 C:**

- Hot chuck alignment**

- Tested for Continuity, Planarity and Alignment**

- High temperature epoxy (125 C)**

- Best known manufacturing methods for a 125 C probe card**

- 50% of the probes will be Tungsten and the other half will be Tungsten/Rhenium (separated to avoid mechanical coupling)**

- Room temperature probe card analyzer data**

-  **Recommended cleaning procedure and frequency**

-  **Wiring information to differentiate needle materials**

High Temp. Experiments Test Plan

- **Initial Mechanical Metrology**

- 👉 Probe card analyzer

- Planarity and Alignment

- Tip Diameter

- **DC Metrology (125 C)**

- 👉 CRES over 500k touchdowns, sampling every Nth touchdown

- Separate CRES between Tungsten & Tungsten/Rhenium probes

- Plot of Max., Min., Avg. CRES Vs. # of touchdowns

- 👉 Cleaning at manufacturer's recommended interval

- **Mechanical Metrology (Initial, 25k, 125k, 250k and 500k touchdowns)**

- 👉 Probe card analyzer (change over time)



- Planarity and Alignment

- Tip Diameter


- Scrub mark damage measured

Schedule

- **Benchmarking**

	Start	End
 Peripheral	May	June
 Report	August	Sept.

- **High Temp. Experiments**

 Probe card		
Vendors selection	June	July
Test program complete	May	July
Probe card build	July	August
Test Wafers	June	July
Lifetesting	August	Oct.
Report	Nov.	Dec.

Expected Outcomes

- **We anticipate that:**
 - ✎ **One needle metal system (either Tungsten or Tungsten/Rhenium) will perform better at elevated temperature over time.**
 - ✎ **One or more of the selected probe card vendors will produce a probe card with acceptable life and performance.**
- **Leverage the lessons learned from the Benchmarking and High Temperature experiments**
- **Provide feedback to the probe card industry such that our future requirements of finer pad pitches at higher probing temperatures will be met.**