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SCS Hightech Inc.

MEMS Solution for Semiconductor Probing

South-Western Testing Workshop Presentation

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06-06-2005

Presentation Overview

Introduction

- Device Geometry vs. IC Characteristics
- Device Geometry vs. Pad Layout Rule and Package Technology
- Classical Probing Technology is Insufficient at These Circumstances
- Mechanical Probing Has Shown Productivity Degradation in Volume Production
- **MEMS VPC Solution**

Probing Mechanism Comparison – Classical vs. MEMS

- Structural Differences
- Material Combination & Technology Development
- Mechanism Practices
- Performance Comparison

Development Challenges & Solutions for MEMS Probing

- Test, Assembly, and Operation
- Reliability
- IC Concerns

MEMS Probing Technology Roadmap

- Compliant Probing Structure
- Tighter Control of Electrical Connection

MEMS Solution for Semiconductor Probing

Introduction

Introduction

Device Geometry vs. IC Characteristics

	2003-2005	Remarks 備註
Process Technology 製程技術	Copper Process	Low Resistance & Electronic migration High conductivity & Thermal Conductivity
	SOI Capacitor	Low power consume & voltage, Energy storage
	Low k – dielectric ~ 2.2	Low leakage, capacitor effects, thermal conductivity, power consumption, and higher integration ability.
	Stepper / Photo down to 0.065 um	Smaller transistor, large quantity, faster speed.
Components 元件	Power – Increase	Number of function, I/O, power, and Vdd & Vss are increasing. Speed faster than 300 MHz, package no wire bond. Number of I/Os increases too fast, therefore Array Design is the major trend.
	Speed greater than 300 MHz	
	Number of transistors – Increase	
Package 封裝	Flip Chip Package	Materials, Reliability, MCM COB BBUL
	Unferfill Development	
	Pb-Free Solder Bump	
Testing 測試	Vertical Probe Card	I/O pins over 1000 High speed test Burn-in and test before package
	Wafer Level Burn In	
	KGD	

Introduction

Device Geometry vs. Pad Layout Rule and Package Technology

Device Technology is going further…

Above 0.35um ~2000	0.35um ~ 0.18um 2000~2002	0.18um ~ 0.13um 2002~2004	0.13um below 2004~

IC Pad Layout Rule is getting more and more critical…

Pad Pitch over 200um	Pad Pitch over 200um	Pad Pitch under 100um
Linear Bump Design	Stagger Bump Design	Array Bump Design

Package Technology has to be changed in order to fit the progress…

Wire Bonding Package	Flip chip package

Introduction

Classical Probing Technology is Insufficient at These Circumstances

- **Array Bump Probing**

  - Bump pitch will need to go lower than 150um
  - Maintenance free probe card
  - No burning tips
  - Short lead-time for order delivery
  - Consistent probing; no need to re-probe
  - High frequency probing

- **Aluminum Pad Probing**

  - Multiple sites
  - Small pad pitch ~ 50um

Introduction

Mechanical Probing Has Shown Productivity Degradation in Volume Production

- Long repair time
- Pad Scratch
- Low probing life
- Burning Tips

Results huge customer service efforts!!!

- Long offline cleaning
- Higher noise
- Expensive rework
- Low productivity

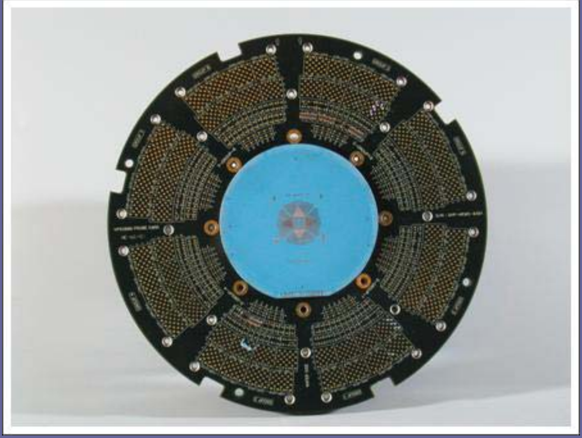
Results a higher cost and lower efficiency!!!

Introduction

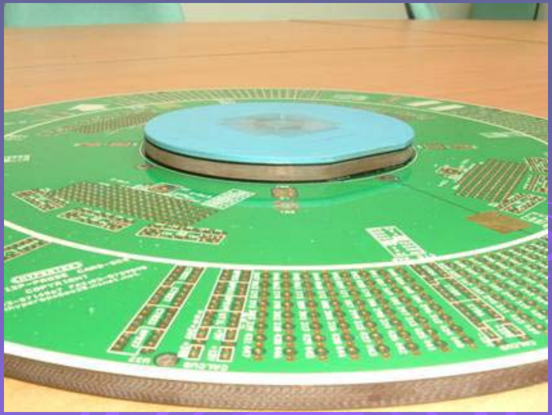
MEMS VPC Solution

MEMS Prove Card Specifications	
Probe Tip Dimension	8 ~ 12 um
Probe Tip Height	Up to 100um
Max. Probing Area	0 ~ 4 inch
Min. Probing Pitch	120um array, 35um LDI
Accuracy	1um
Planarity	< 1.5um
Max. Current	1 A
Shear Force	100g / pin
Major Material	Nickel, Copper, and Silver
Path Resistance	2 ohm whole path
Impendence Match	50 ohm plus minus 5 ohm
Leakage	Smaller than 10nA at 5 volts
1st order Lead-time	6~8 weeks (design related)
Repeat order LT	< 2 weeks

Here is the solution!!



Vertical Probe card for Aglient 93000



Vertical Probe Card for Cadence Type

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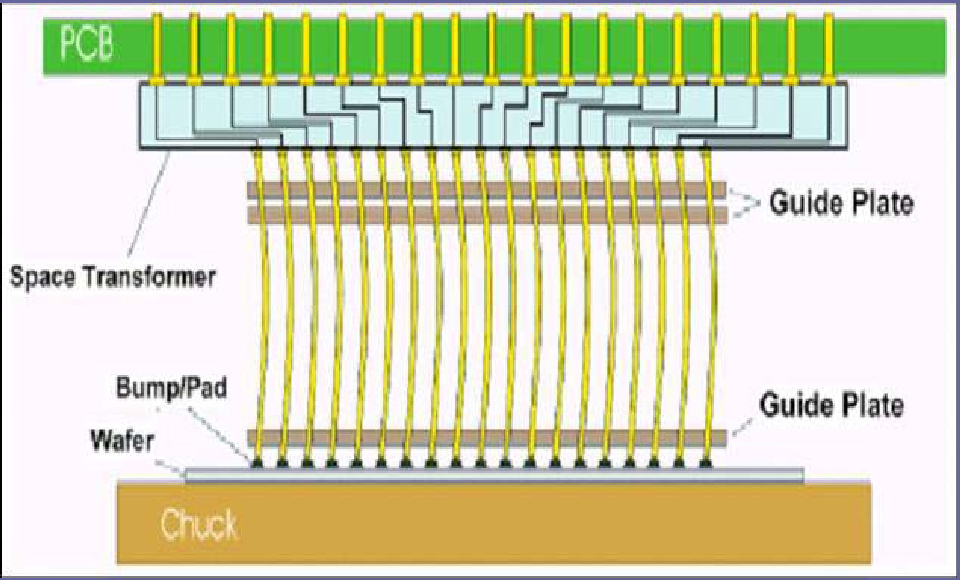
Probing Mechanism Comparison – Classical vs. MEMS

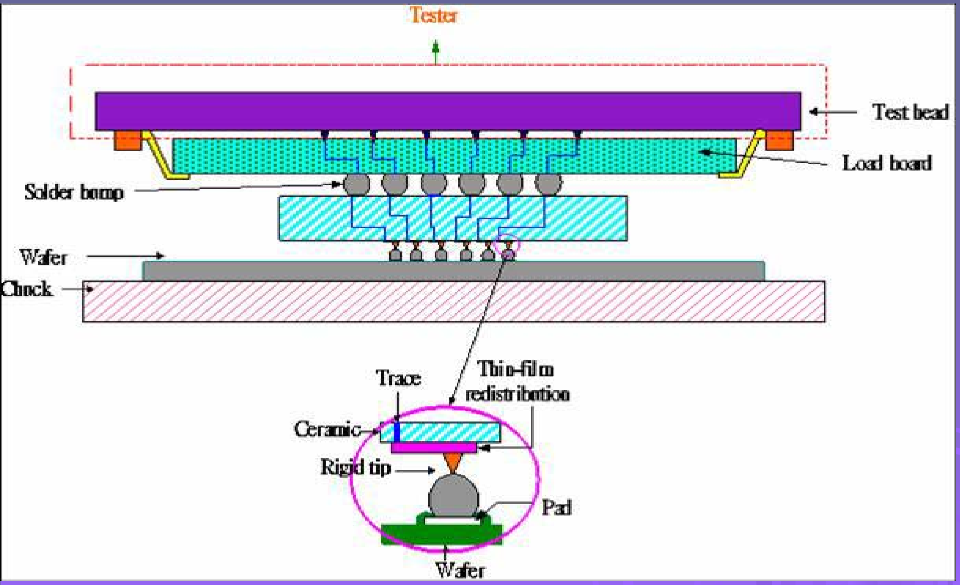
Probing Mechanism Comparison – Classical vs. MEMS

Structure Differences



Classical Vertical Type Probe Card

- Probing tip will deform cause open issue
- Use PCB substrate
- Need cleaning both online and offline



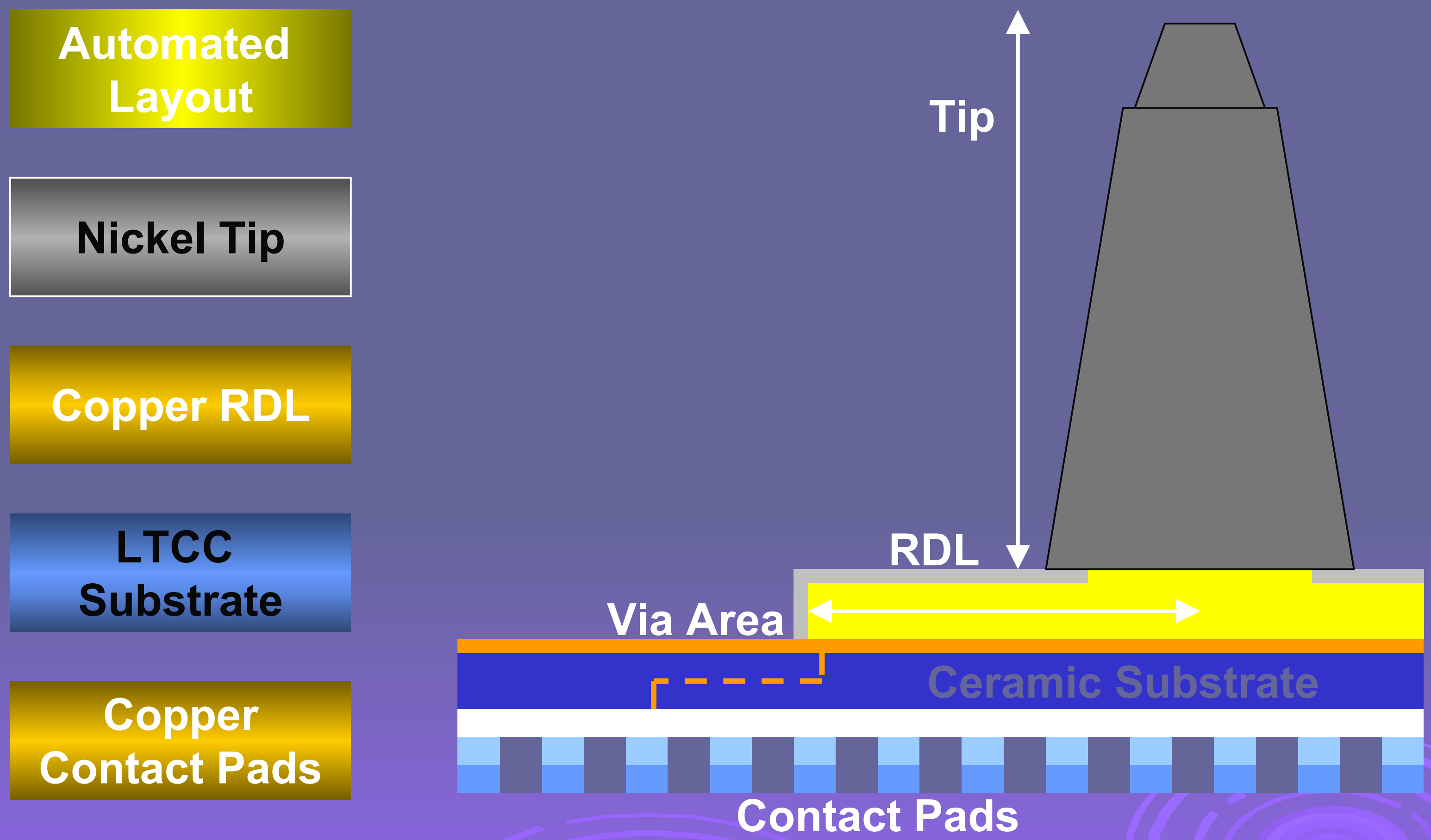
MEMS Vertical Type Probe Card

- Rigid tip will never deform
- Use ceramic substrate
- Excellent co-planarity w/o manual adjustment
- No cleaning, no re-probing, and no repairing

Probing Mechanism Comparison – Classical vs. MEMS

Material Combination

Material content of each part



Inter-relation of all process parameters: Chemicals, Temp., Plasma, double side process…. etc

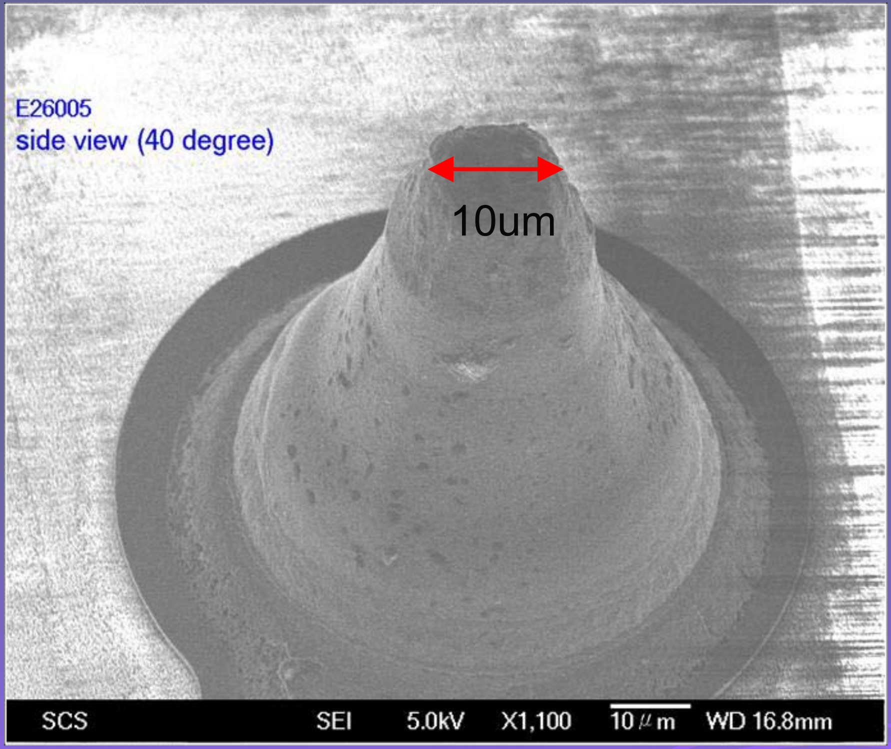
Probing Mechanism Comparison – Classical vs. MEMS

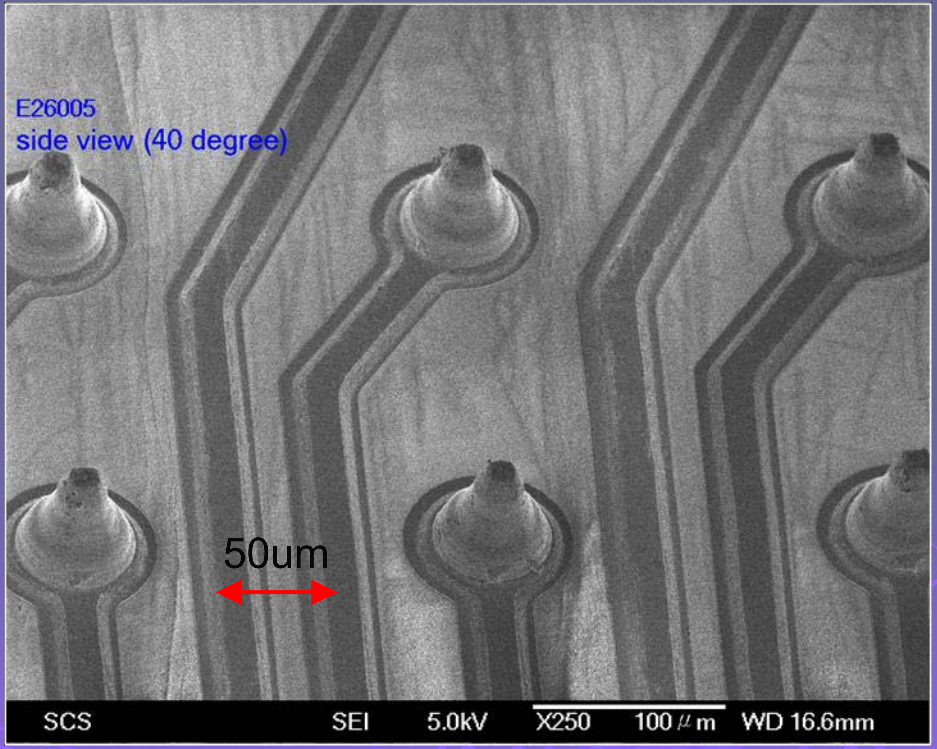
Technology Development

MEMS VPC:

Use the same process to fabricate the sub-micron level rigid tips.

Can be applied to small pitch ~35um multiple die sorting.





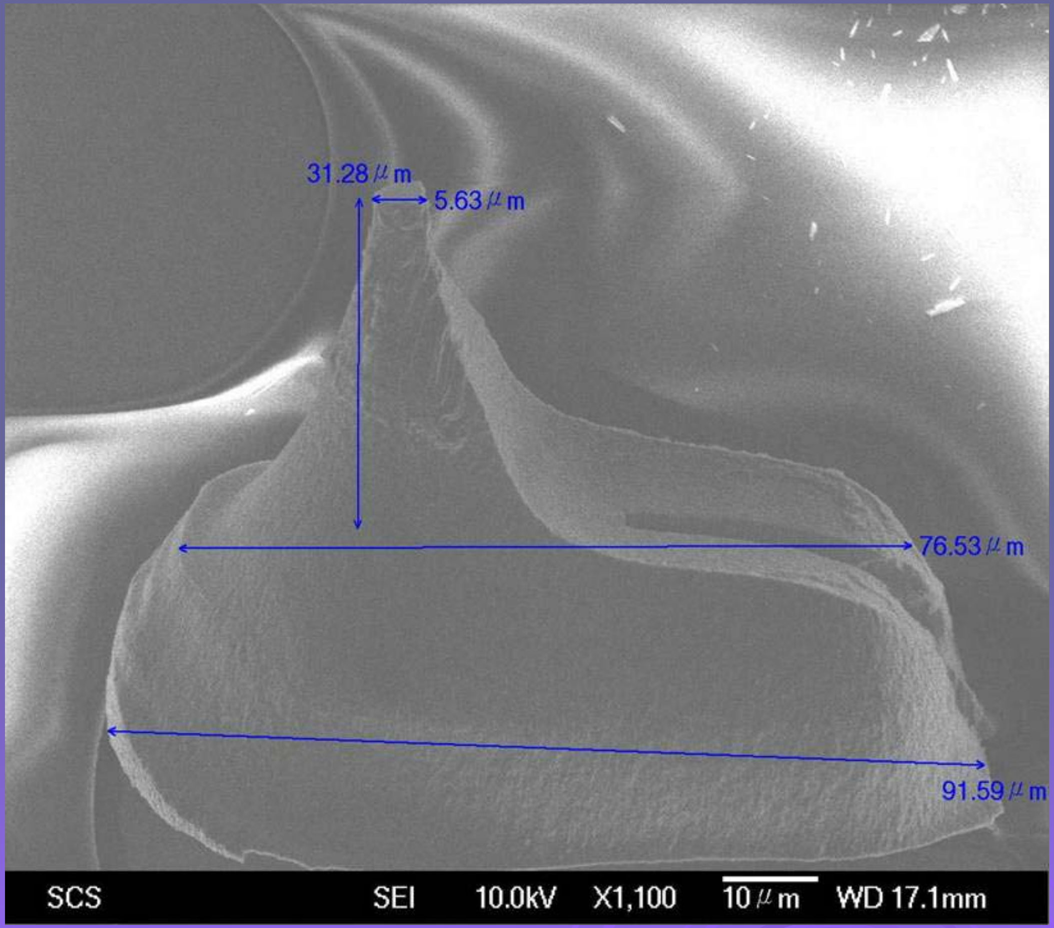
Classical VPC:

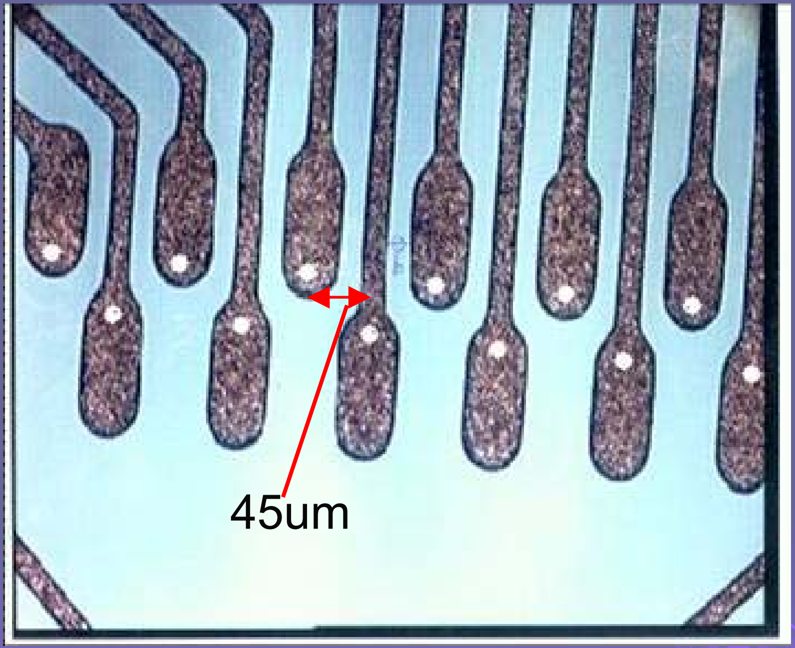
Use the mechanical technology – minimum pitch is ~150um for array VPC

Probing Mechanism Comparison – Classical vs. MEMS

Technology Development

Use the same process technology to fabricate the sub-micron level rigid tips for LCD driver IC probing.

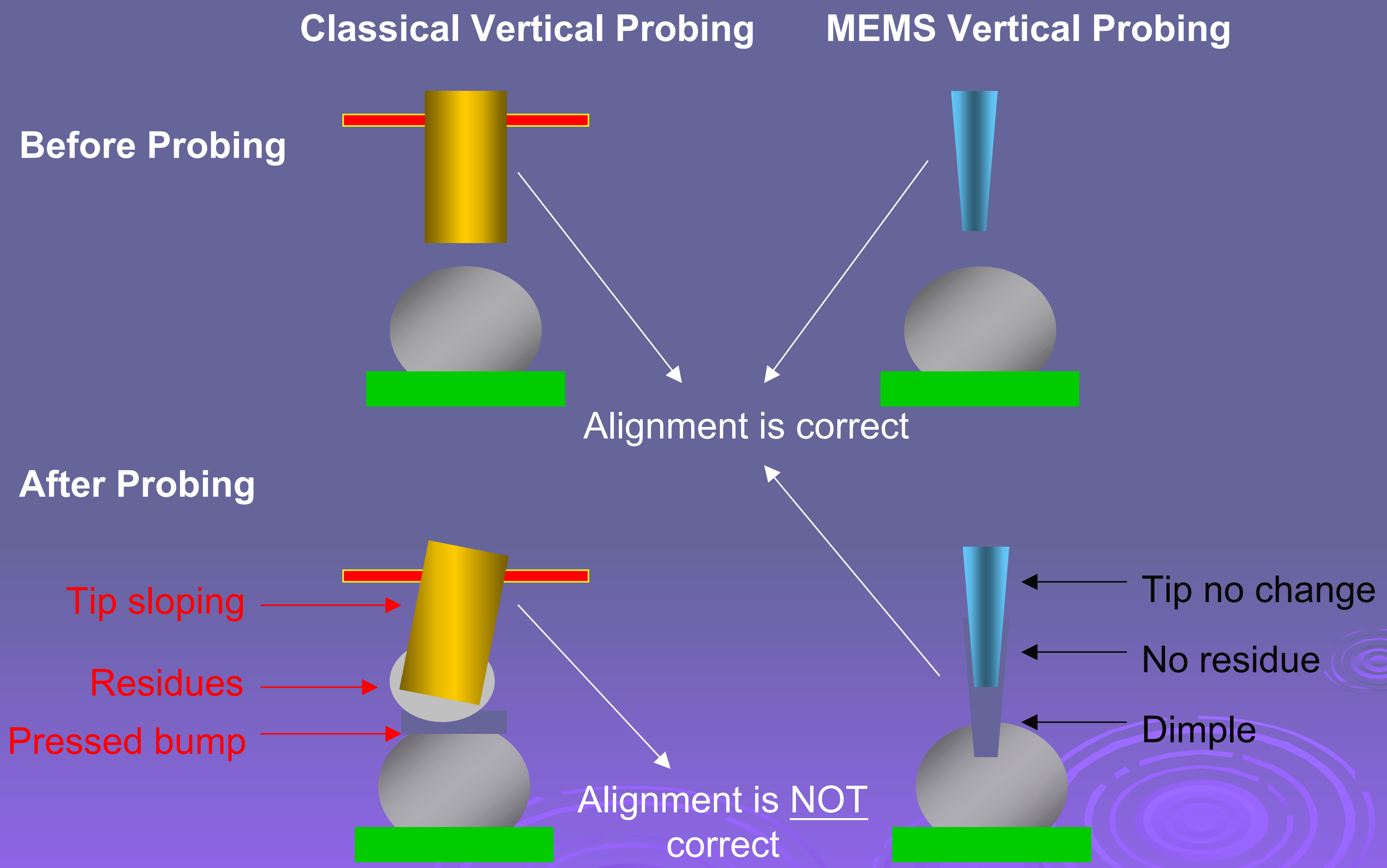




The 45um pitch rigid tip of dual-site LCD Driver IC probe card photo under microscope.

Probing Mechanism Comparison – Classical vs. MEMS

Mechanism



Probing Mechanism Comparison – Classical vs. MEMS

Performance

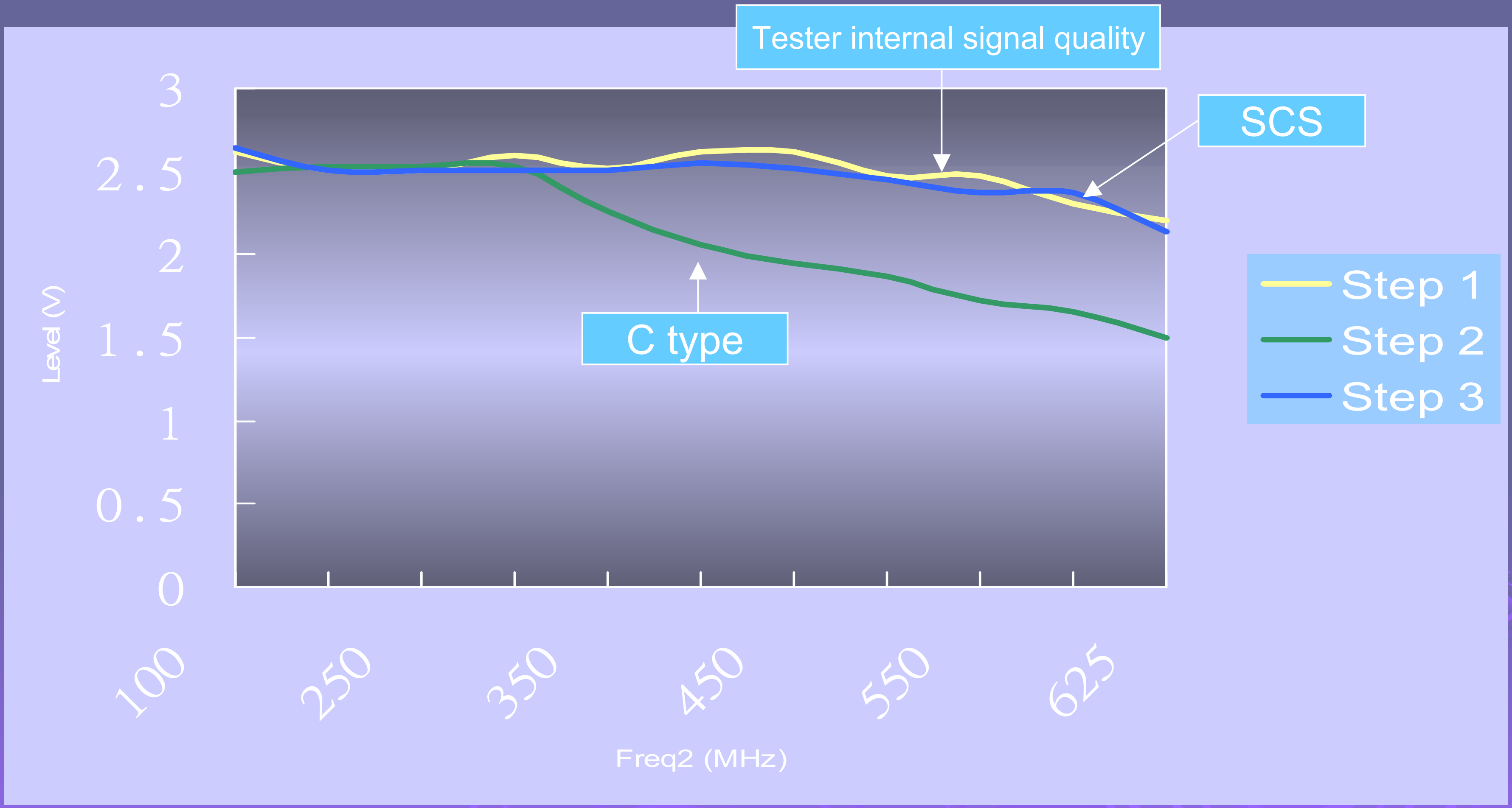
	Classical C type Probe Card	SCS Diamond Vespa MEMS VPC
Pad Pitch	> 150 um	Under 120 um
Volume lead time First order	6 ~ 8 weeks	5 ~ 6 weeks
Volume lead time Repeat order	4 weeks	2 weeks
Multiple Site Probing	Depends on pad pitch	Bumped pad only **for now**
LDI probing	Not available (other types, such as cantilever)	Already in evaluation sample
Reprobing	Need	No need
Tip cleaning	Need, because residue	No need, nor online maintenance

Comparison Table for different probe card

Probing Mechanism Comparison – Classical vs. MEMS

Performance

MEMS Vertical Probe Card : Has passed several qualifications in Taiwan. Electrical performance (up to 3GHz) is superior to classical manufactured probe cards.



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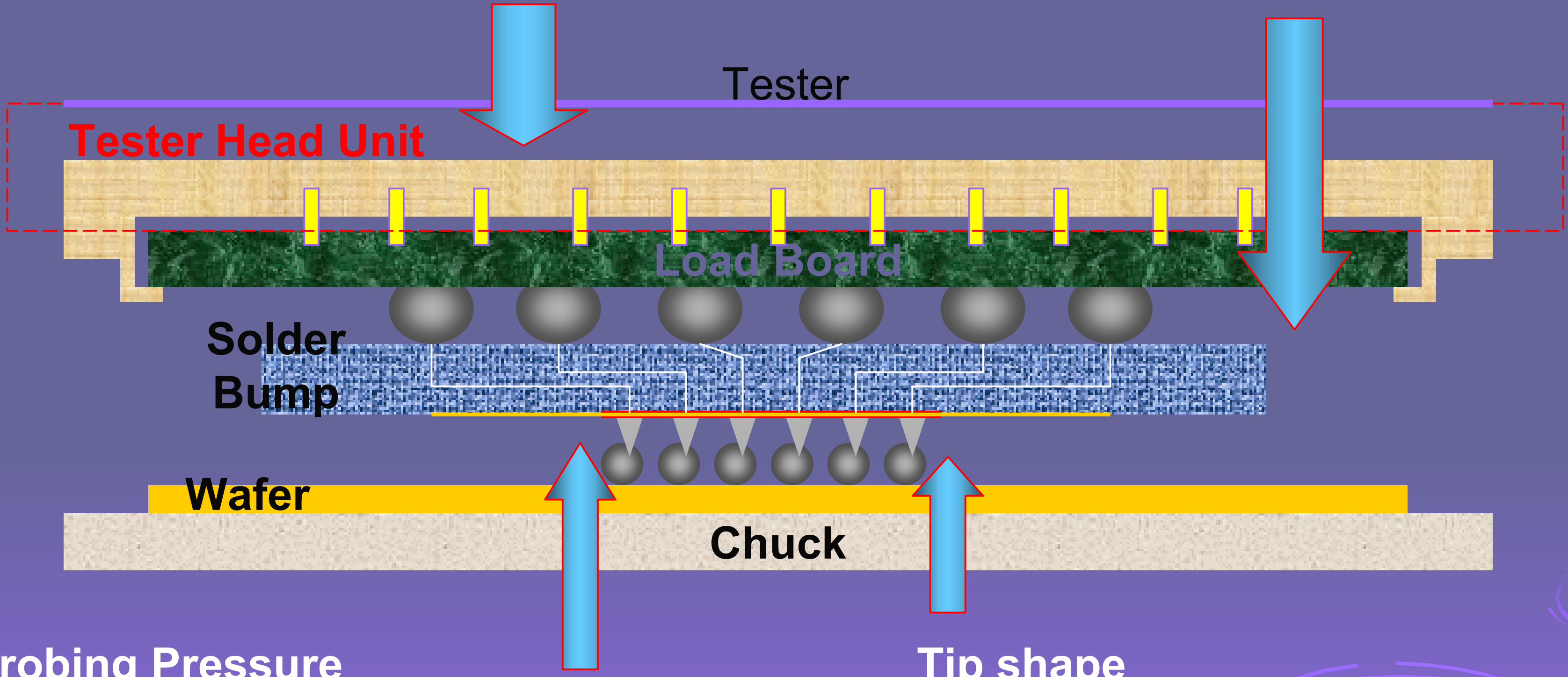
Development Challenges & Solutions For MEMS Probing

Development Challenges & Solutions For MEMS Probing

Test, Assembly, and Operation

Testing
Alignment focus issues – tip head is 10um
SOP training for using MEMS probe card.

Load Board
Parallelism between PCB and LTCC
Requires high stand-off.



Probing Pressure
About ~25g per tip with our tip head size.

Tip shape
Long neck cone shape for non-uniformity of the bumps.

Development Challenges & Solutions For MEMS Probing

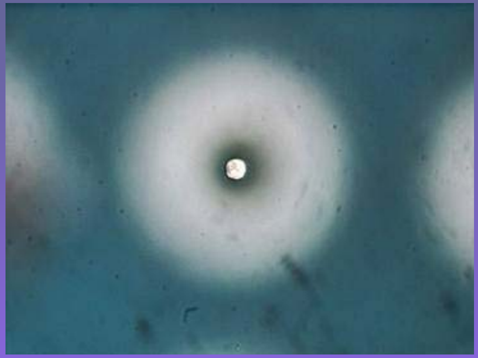
Reliability

<u>Durability</u> <u>for Probing ICs</u>

Excellent probing consistency (eliminate re-probing)
Excellent probing life time – some model probed over 1.3M, other around 1M.
Excellent maintenance – No need to repair anymore because lead time is short.

Subject: SCS MEMS VPC for 8" wafers(633 pins)
Tester/Prober: Agilent 93000/P600, P12/TEL
Clean sheet: Enhanced 3M type C (***type C + polish paper/pink type***)
Tool: Olympus microscope with micro meter
Reading: Check pin high twice(from ULTCC to tip) for average.

Before



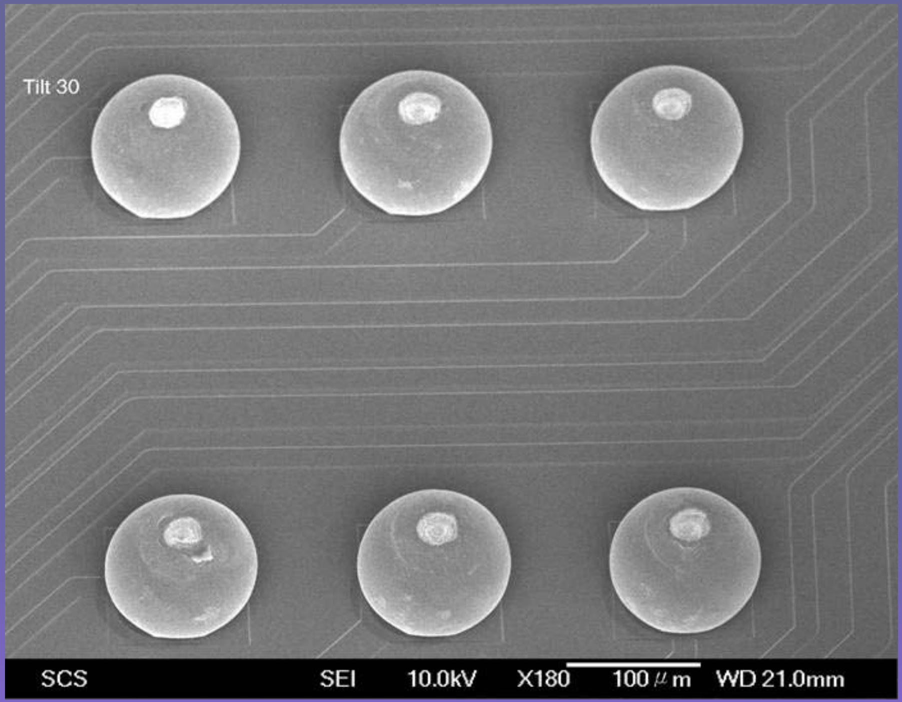
After 150K times

After 350K times

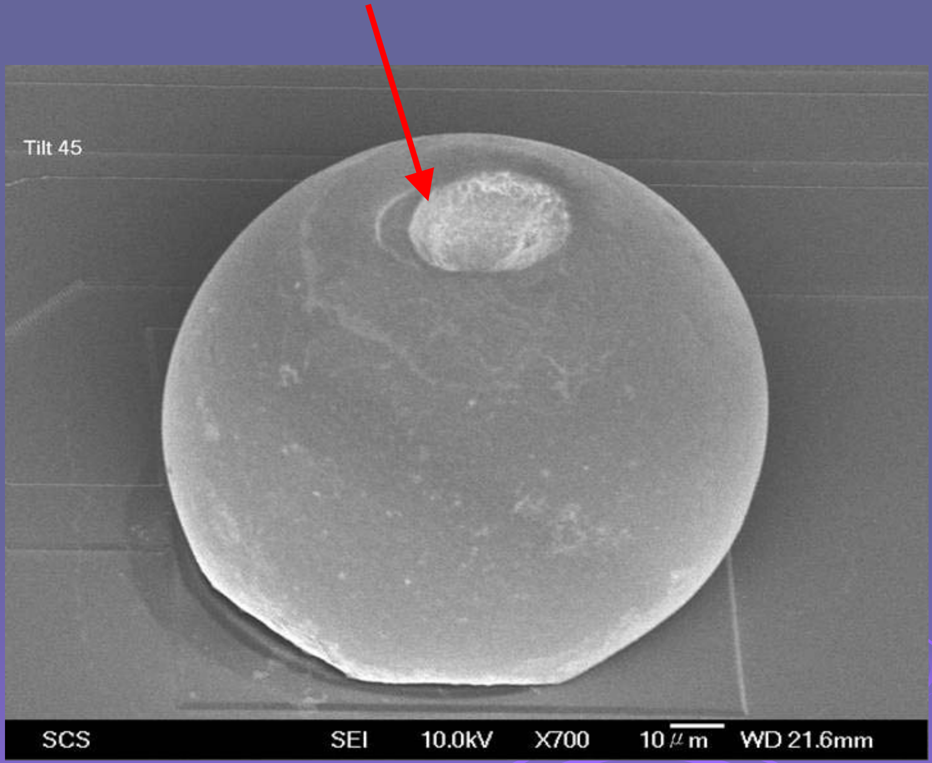
Development Challenges & Solutions For MEMS Probing

IC Concerns

Rigid Tip
After the tip probes into the bump, it will produce a “dimple” that looks like a crater.



Dimple
This has been notified and IC has also been checked out with reliability qualification.



Dimple Reliability
The reliability issue has been passed by a famous Taiwan foundries and packaging house.

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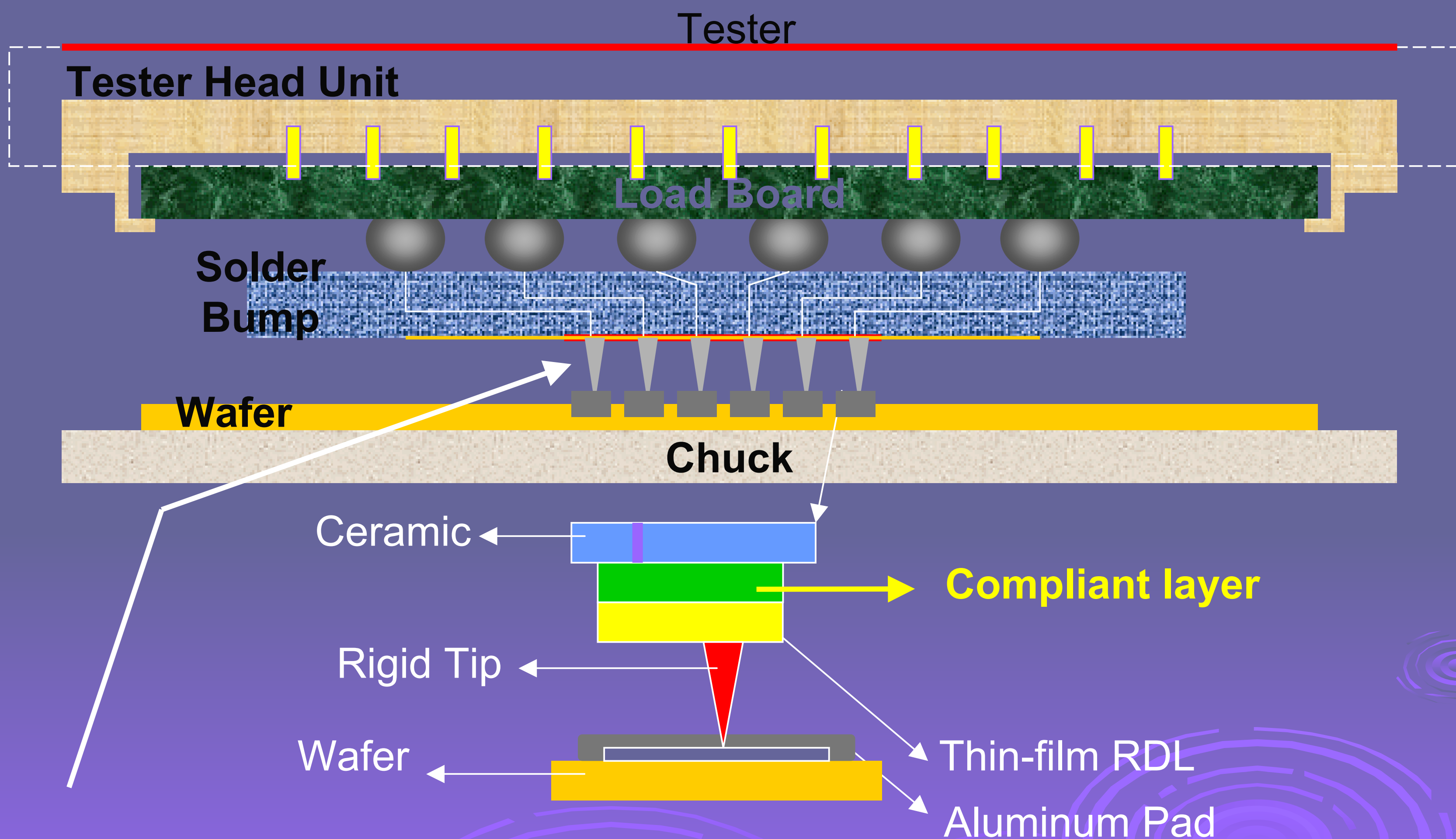
MEMS Probing Technology Roadmap

MEMS Probing Technology Roadmap

Compliant probing structure



To control the tip pressure

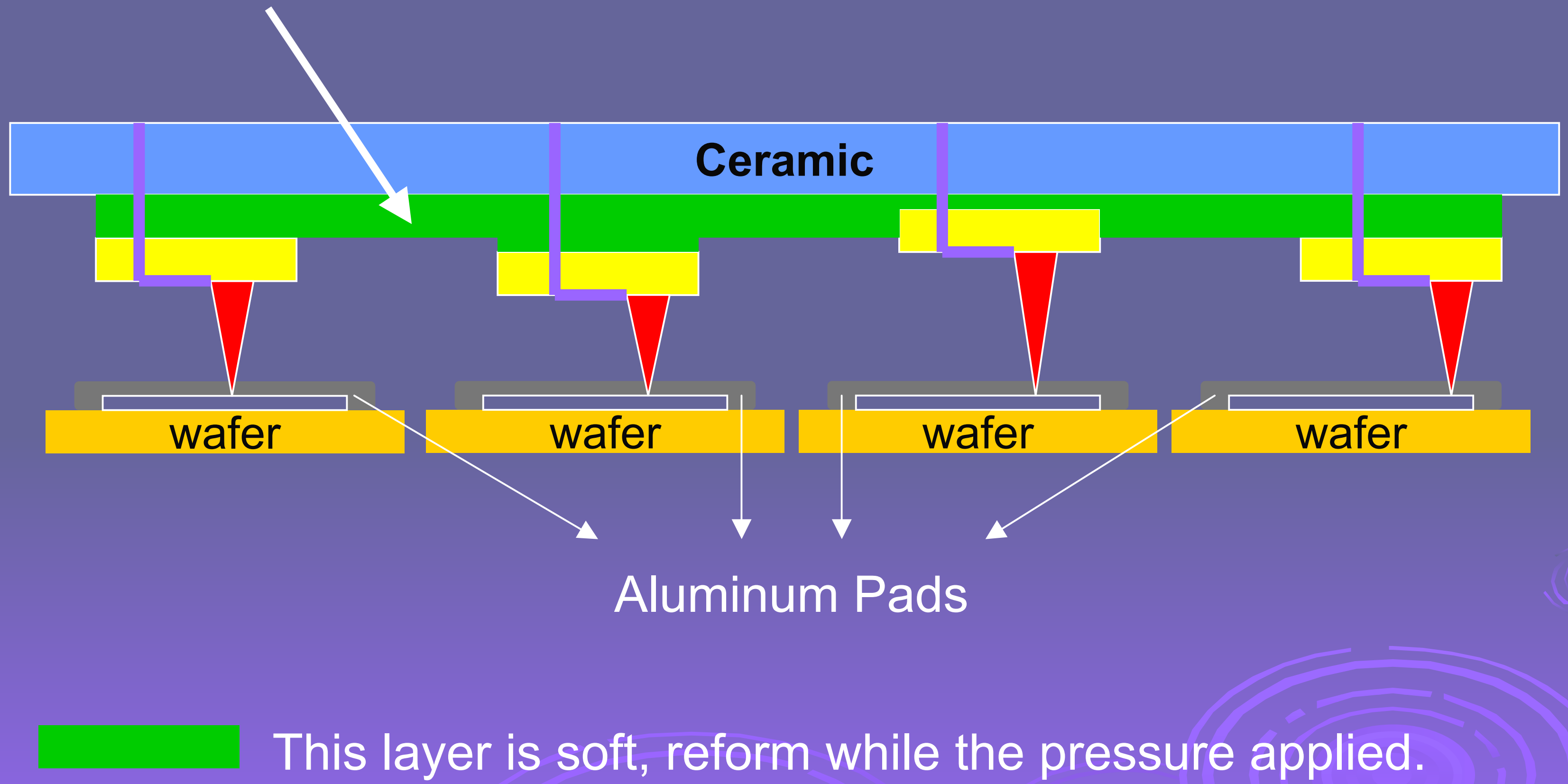
New material needed!! For aluminum pads!!

MEMS Probing Technology Roadmap

Compliant probing structure

Compliant layer

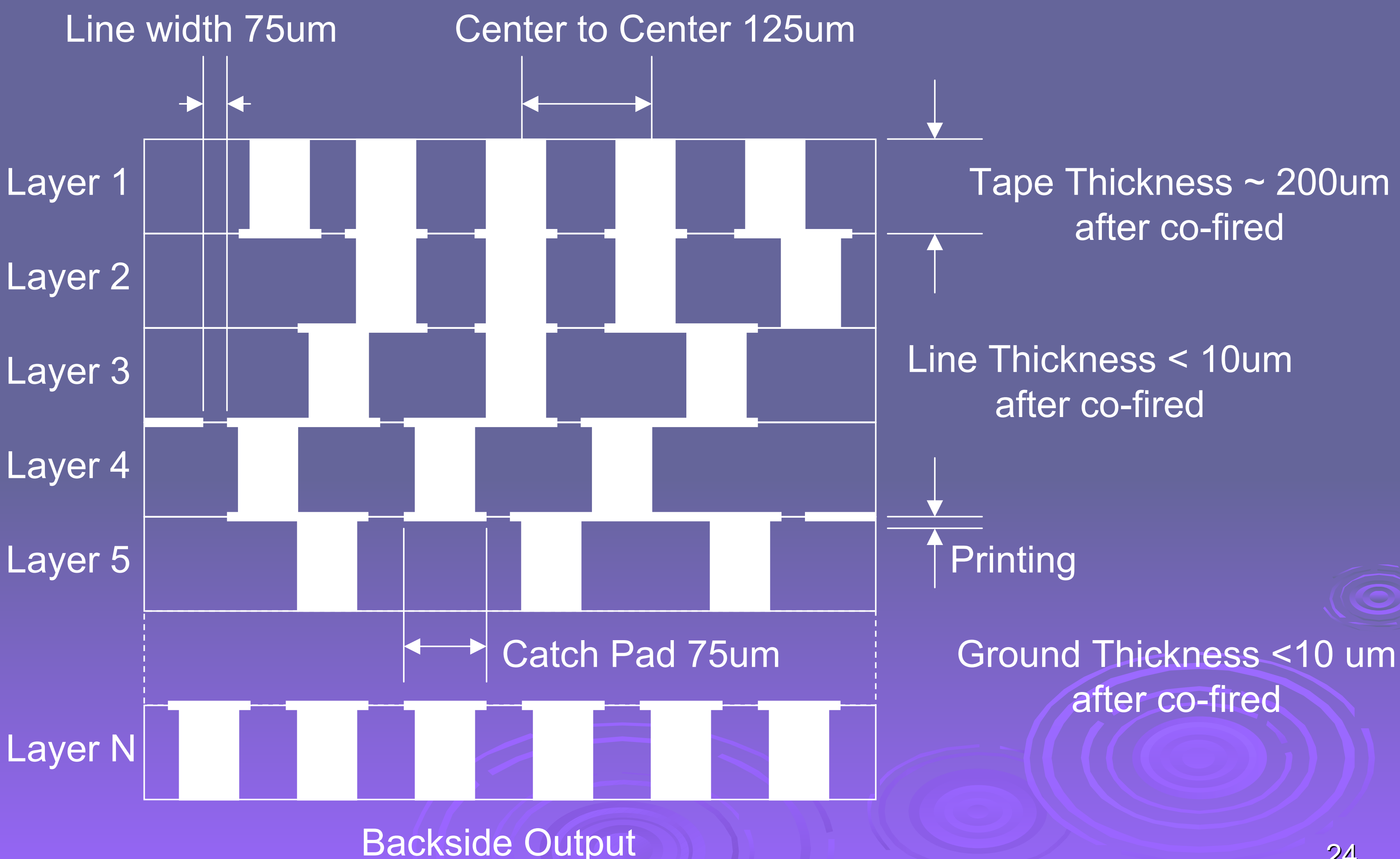
To provide adjustment for improving contact uniformity.



MEMS Product R&D Roadmap

Tighter Control of Electrical Connection – Ceramic Section

Improvement of the LTCC to improve the performance of the probe card



End of Presentation

Q & A