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Novel Probe Card with High Count of Needles in Single Sheet for Universal Wafer Testing

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Overview

- Introduction
- Background
- Objectives
- AMMECSTH Method
- Fine-pitch Probe Card and Results
- Summary
- Future Work

Brief Introduction of "Kimoto" and "ProbeAce"

- Invented and completed the Japan's first "dot-impact Kanji printer" at NEC in 1972.
- Established ProbeAce in 1999, and started researching a novel probe card design and manufacturing methodology.
- Arrived at "AMMECS[TH]" method with patents.
- Awarded the degree of Doctor
  (Mechanical engineering)
  from Chiba University in 2011.

Background

What should we try to solve in High-pin-count and Fine-pitch Probe Card Era?

- Probe head assembly
  - "Manual to Automatic" assembly is the most difficult challenge.
- Connection of probe head to circuit patterns
  - Precise and cost-effective connecting technology is unknown.
  - Market needs "maintainability," as well as "connectivity."
- Wiring on PCB or Interposers
  - Number of layers is increasing endlessly; 20,30,...50...?
  - Market needs also "alterability" in card design process.

AMMECSTH has many solutions.

Objectives Using the AMMECSTH

- High-pin-count and fine-pitch needles in a single sheet for productivity and high quality .
- A combination of some sheets meets universal assembly.
- Tip motion controllable structure for contamination-free probe.
- Automatic Cu-wiring system for small-layer and HF-oriented board.
- Fully-automated design and manufacture process for lower initial cost and shorter initial delivery, as well as repeatability.

What Is the AMMECSTH Method?

- Advanced Micro-Mechanical Electrical Chemical System
- A Novel and PA-original design and manufacturing methodology that enables high quality and cost effective probe card.
- Consists of “Gun-Kimo Probe” and “Gun-Kimo Card”.

AMMECS^{TM}

Gun-Kimo Probe

fusion

Gun-Kimo Card

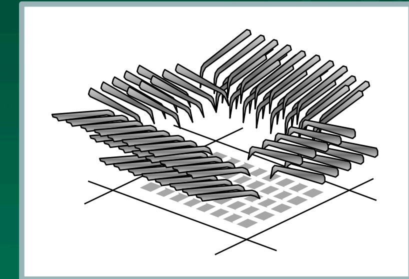
- Advanced -------------- for the next-generation
- Micro-Mechanical ---- for precise fabrication and assembly
- Electrical --------------- for high frequency
- Chemical --------------- for precise fabrication and surface treatment

Gun-Kimo Probe

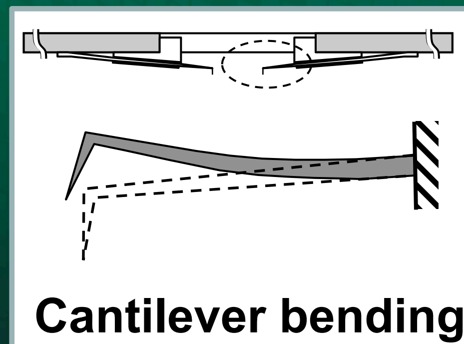
Many solutions to “Bottlenecks” of conventional probes

Bottlenecks of Conventional Probes

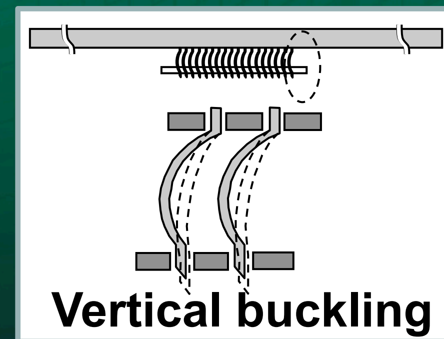
- Stagnant productivity
  - Manual assembly of thousands of needle pins.
  - N-pin-accuracy needs N-pin-adjustment.



- Geometrical restriction
  - Cantilever arms are obstructive to fine-pitch arrangement.
  - Vertical needle pitches have reached the limit.
- Uncontrollable "three" parameters of Fc, OD, Scr
  - Unnecessary large Scr, excessive Fc, and dispersed OD leads pad damage, contamination, and contactless.



Cantilever bending

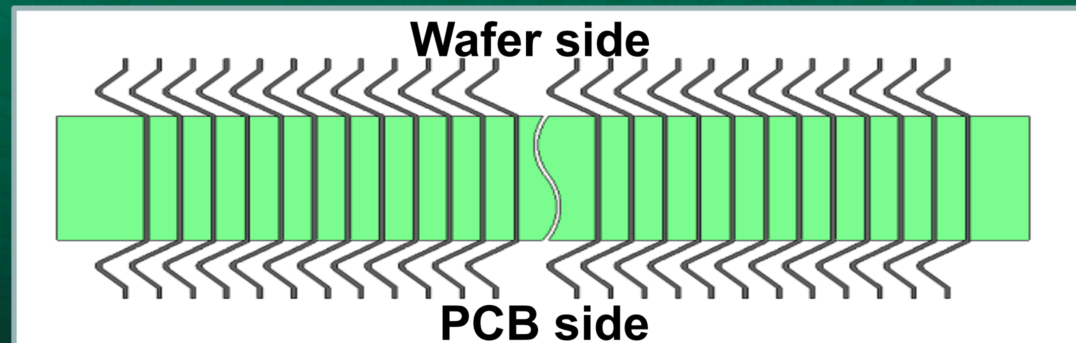


Vertical buckling

Solution-1

High-pin-count and Fine-pitch Multiple Needles in a Single Sheet

- This is a basic probe element of all probe cards.
- More than a hundred probes are simultaneously fabricated on a thin Be-Cu sheet.
  - Laser or etching process, partially plating
- Insulating material filled between probe patterns and on both surfaces.
- Ground metal film between adjacent probe sheets for shield or guard.



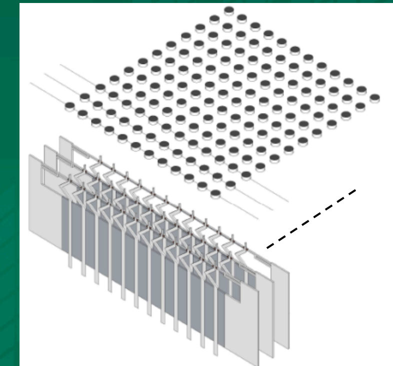
Solution-2

A Combination of Some Probe Sheets Meets Universal Assembly

- A combination of multiple probe sheets can be adapted to any pad configuration.

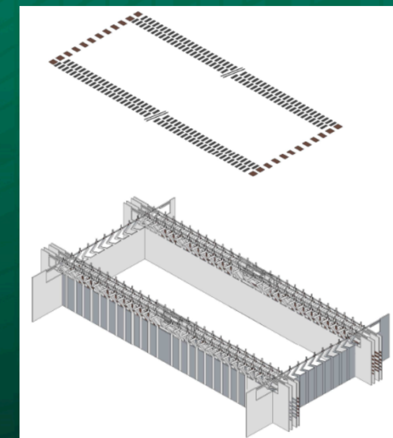
(Case-1) Area array:

- A row is composed by multi-probe needles in a single sheet.
- Columns are composed by multiple probe sheets arranged repeatedly in parallel.



(Case-2) Peripheral with staggered:

- Fine-pitch line is composed by multiple probe sheets arranged adjacently in parallel along the same pad line.

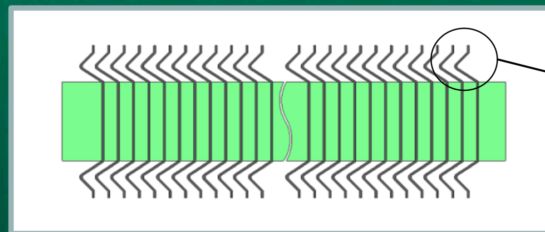


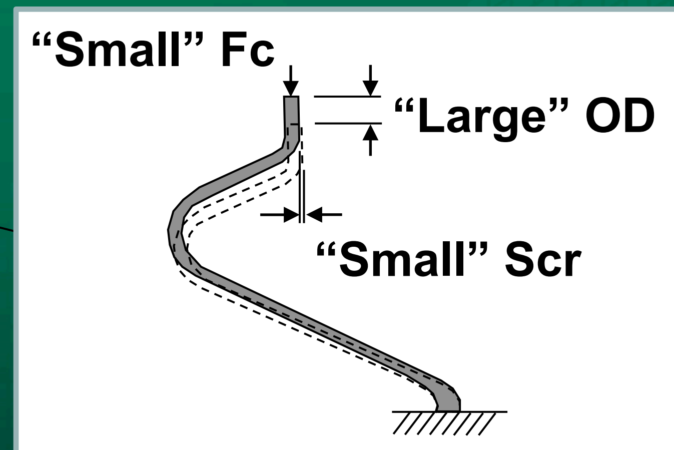
Solution-3

Precise Tip Motion Controllable Structure for Contamination-free

- The "three" parameters can be decided independently.
- Lasering or etching enables complicated curves.
- The target "three" is:

L-size OD >60um, S-size Fc ~10mN, S-size or Non Scr <3um





Design example of

"Small" or "Non" Scr design with "Large" OD and "Small" Fc

Gun-Kimo Card

AMMECS™

Gun-Kimo Probe

fusion

Gun-Kimo Card

Many solutions to "Bottlenecks" of conventional PCB

Bottlenecks of PCB in Probe Card

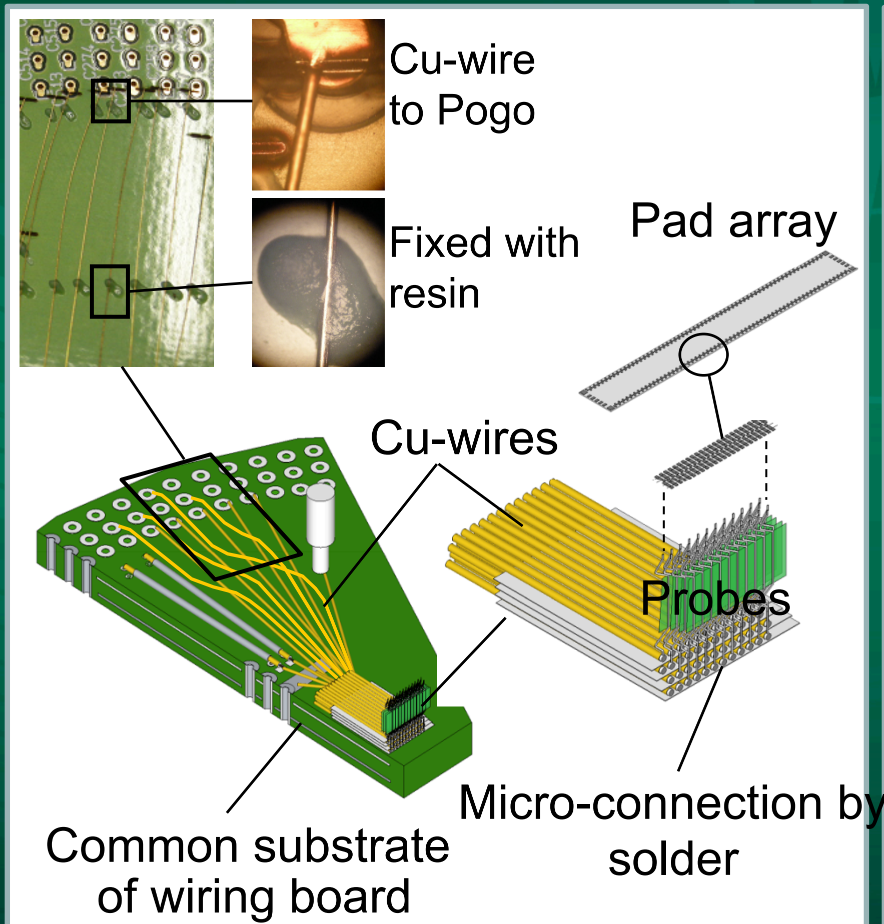
- High cost of multi-layered PCB or interposer
  - High-end IC probing requires at least 20 to 30 layers, or more.
  - Multi-layered ceramic interposer to disperse dense connection area.
- Difficult to connect fine-pitch probe needles with circuit patterns
  - Precise and efficient connecting technology is unknown.
  - Market needs both of “connectivity” and “maintainability.”
- Unfit for increased signal speed
  - Roughness of cross-sectional conductive shape on.
  - Discontinuity of many through-hole connections.

Automatic Cu-wiring System for Small-layer and HF-oriented Board

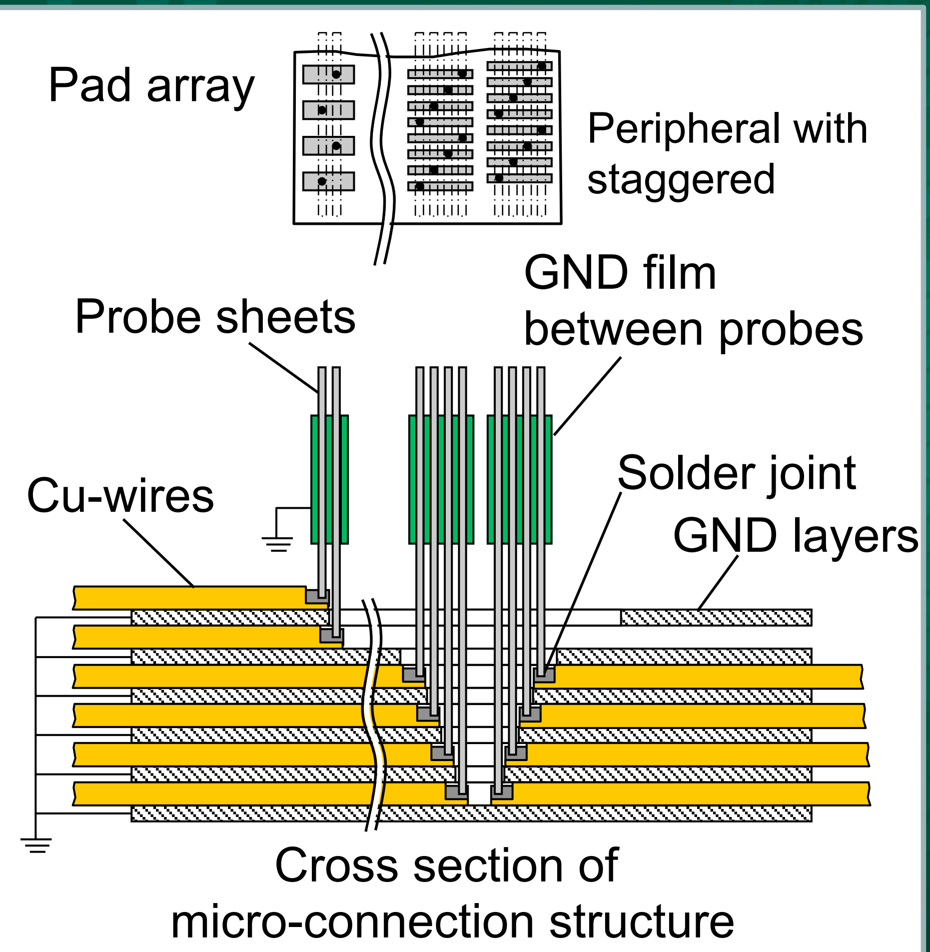
- Cu-wiring between probe terminals and Pogo pads, as a standard wiring process
- Interposer-less micro-connection structure between probe terminals and Cu-wires
- The other selective wiring structure, if necessary.
  - Co-axial shield wiring
  - Thick wires for high power wiring
  - Connection with additional circuits like bypass capacitors and signal relays.

Cu-wiring Board Structure -1

Cu-wiring as a standard wiring process

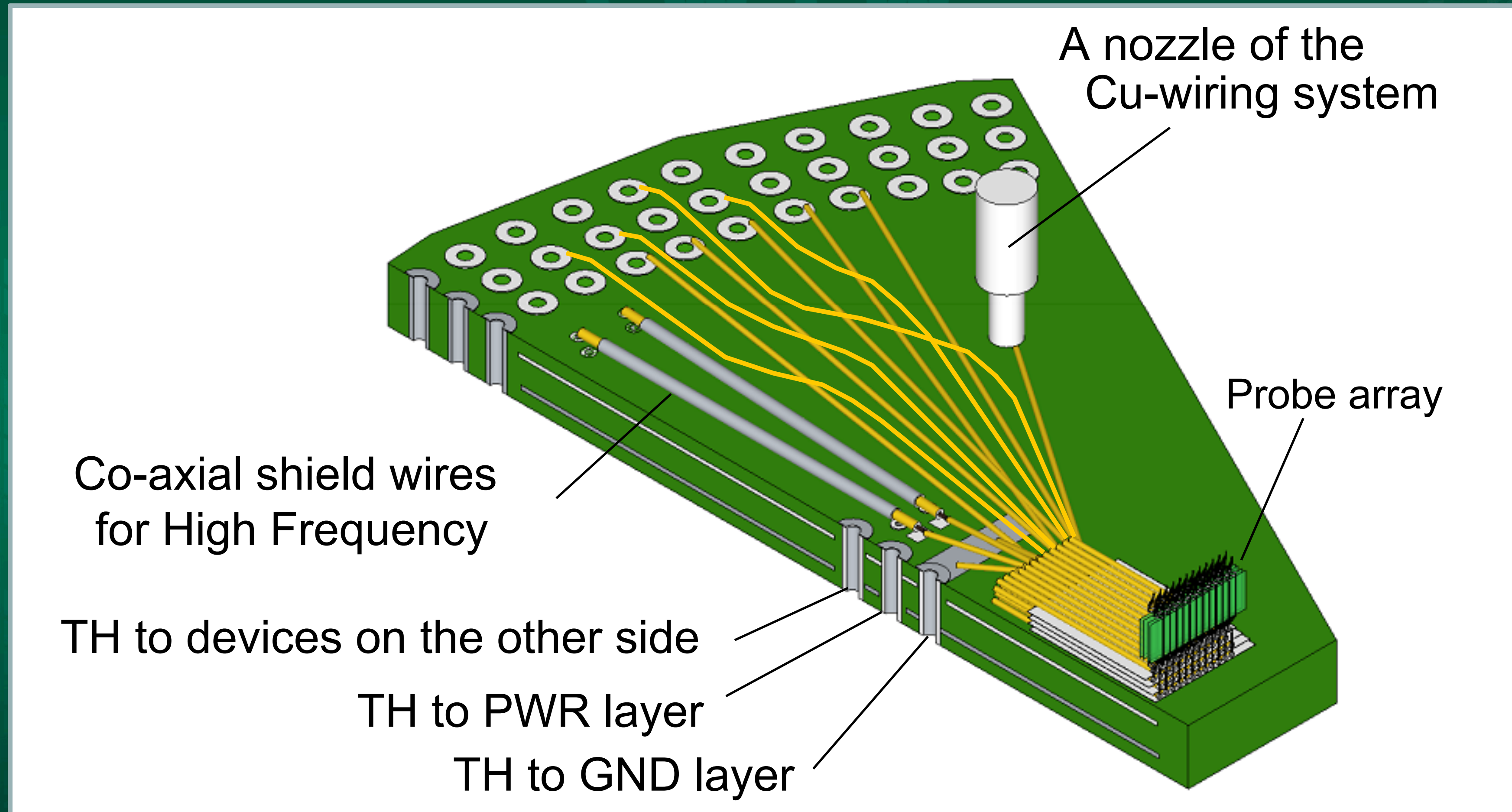


Interposer-less micro-connection structure



Cu-wiring Board Structure -2

The other selective wiring structure for HF

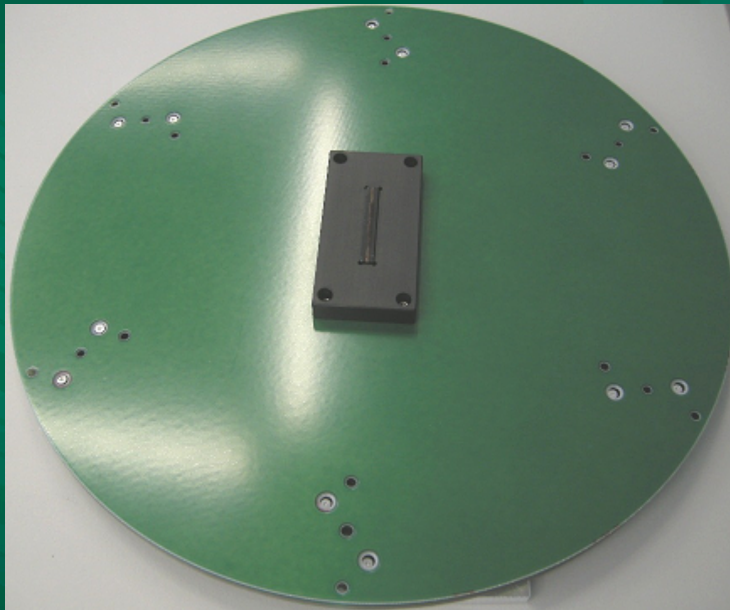


Fine-pitch Probe Card and Results

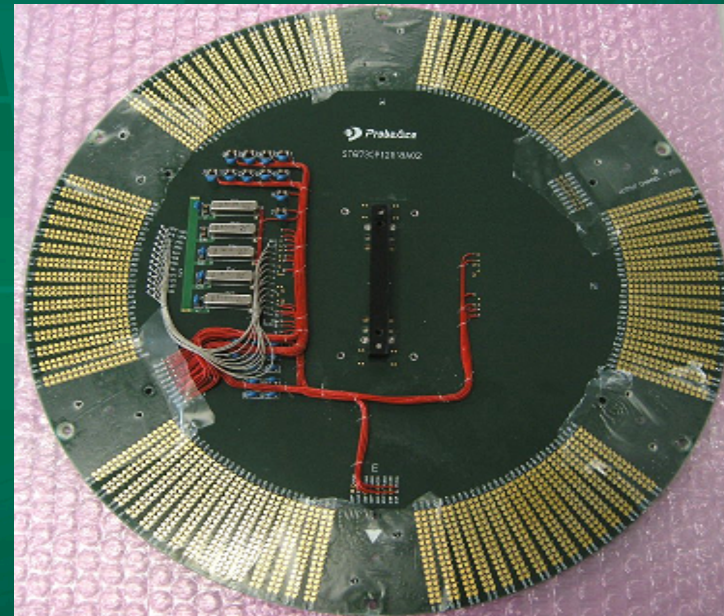
Probe Card for Fine-pitch LCD driver

High-pin-count: >1700 pins

Fine-pitch: 14um in staggered pads



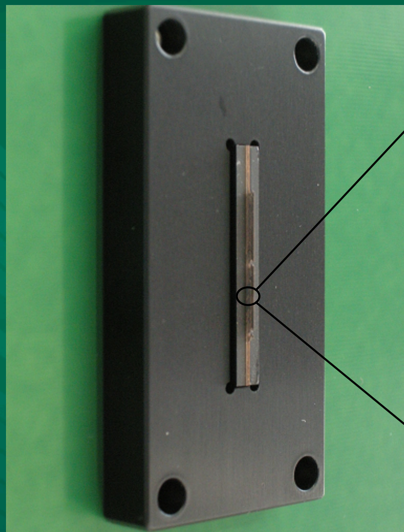
Probe side overview
(Cu-wire area covered)



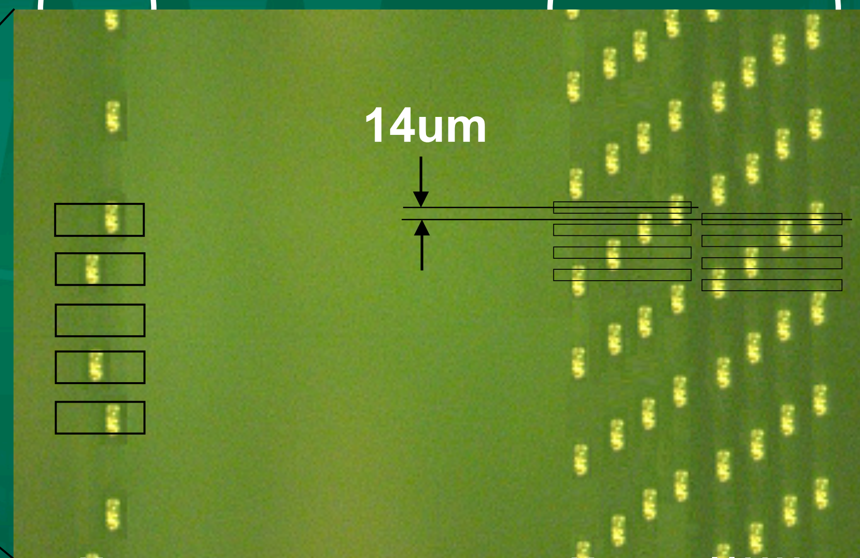
Tester side overview

SWTW

Probe Card for Fine-pitch LCD driver



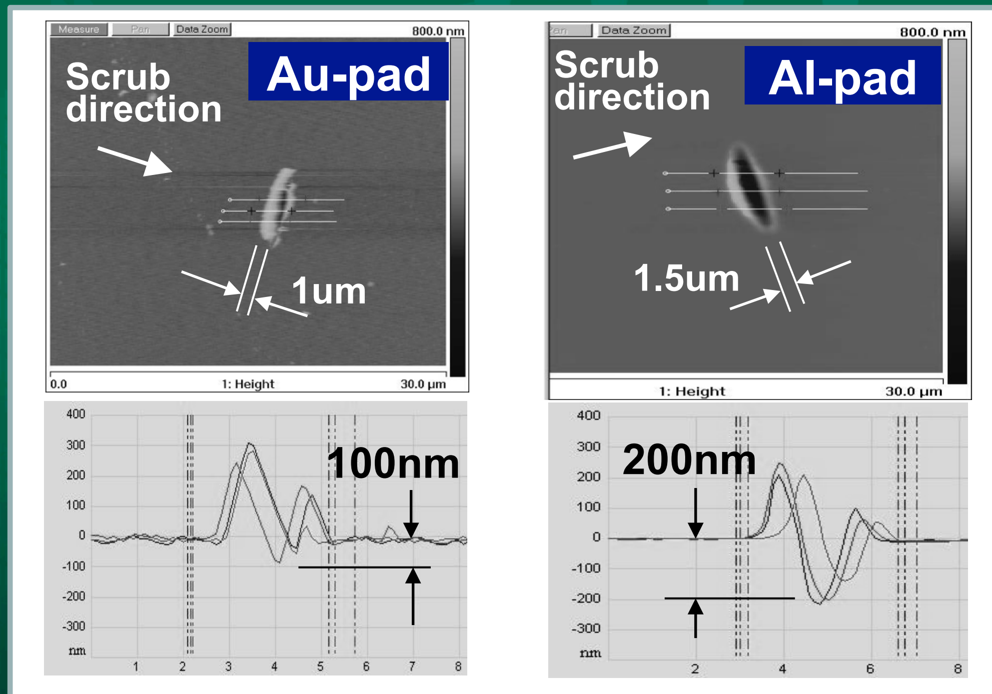
Probe head

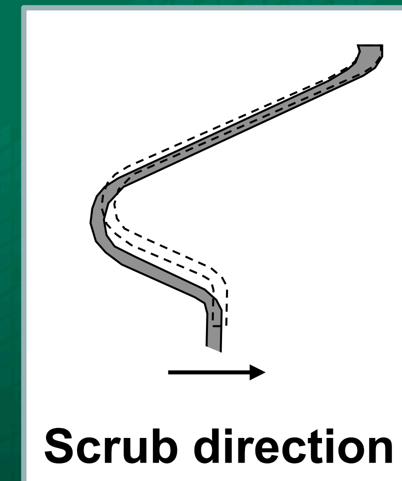


Probe tips

Pad Damage

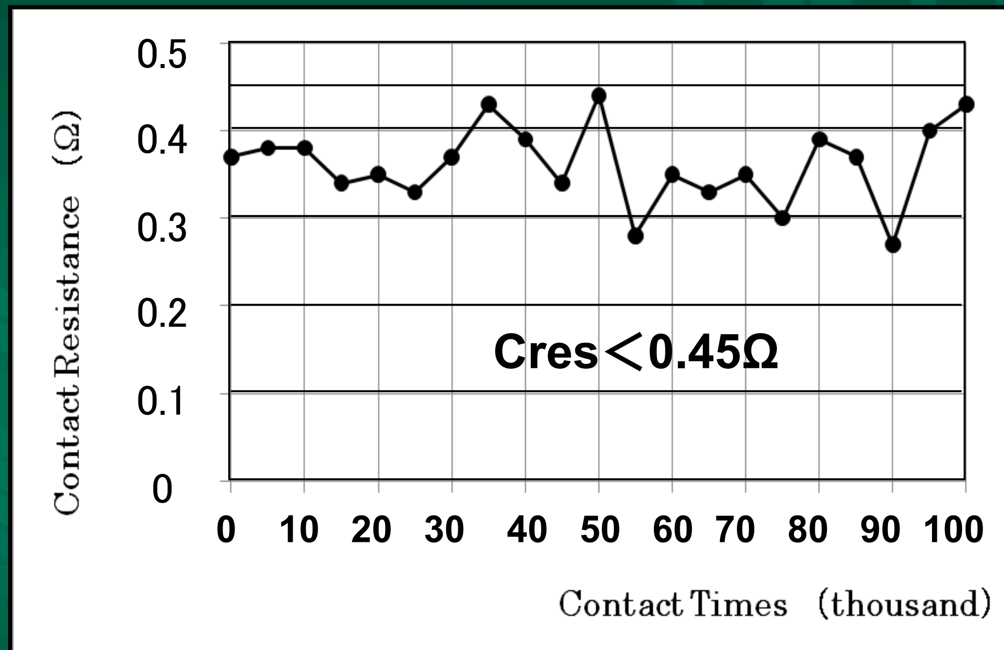
- Pad damage can be very small and non-destructive to the pad material.
  - Pad damage depth is 100-200nm in PA technology, while 400-800nm in conventional technology.

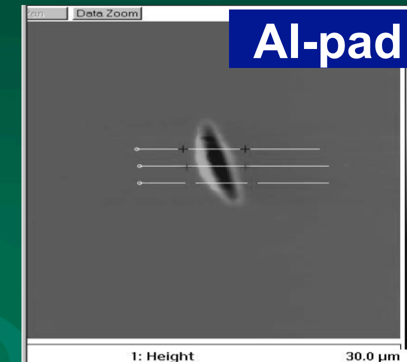


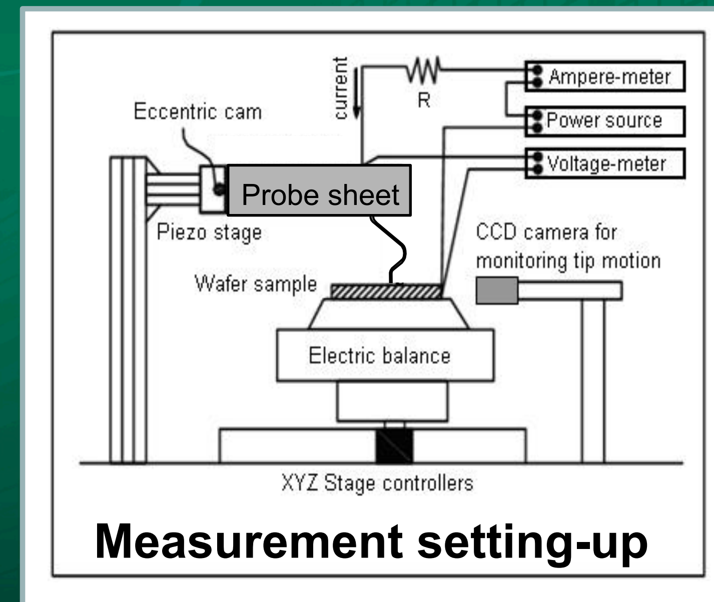


Tip motion “Controllable” PA technology

TD Test without Tip Cleaning





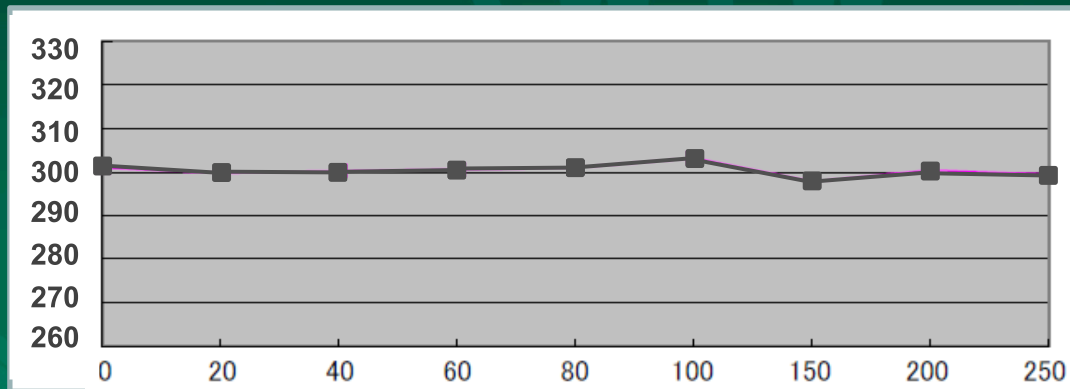


Cres.vs.100,000 TDs; F=10mN
Without tip cleaning

High Durability of Be-Cu Needles

-- Durability test of 2,500,000 TDs --

32pin Total Fc (mN)

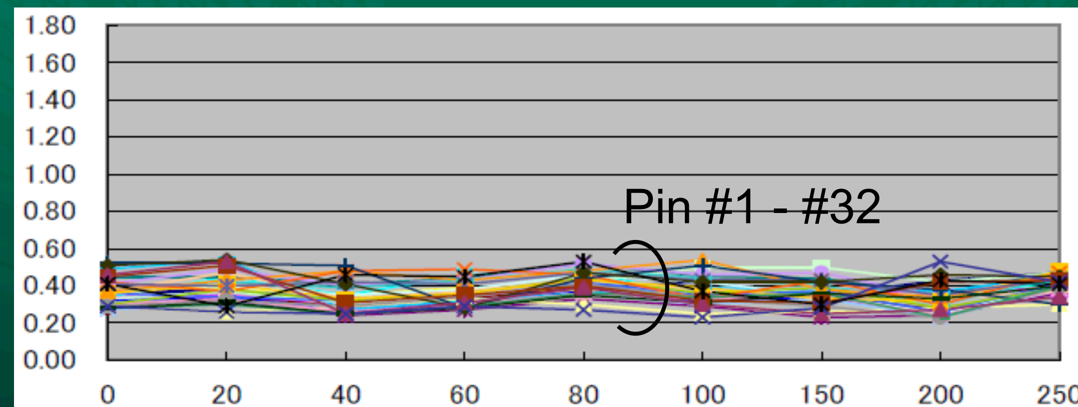


32−pins assy.
To Au-spattering wafer
80um OD, 10mN Fc/pin
At 80 ℃−temp.
Cleaning/20000TDs

X10^4 TDs

Total Contact Force vs. TDs

Cres (Ω)

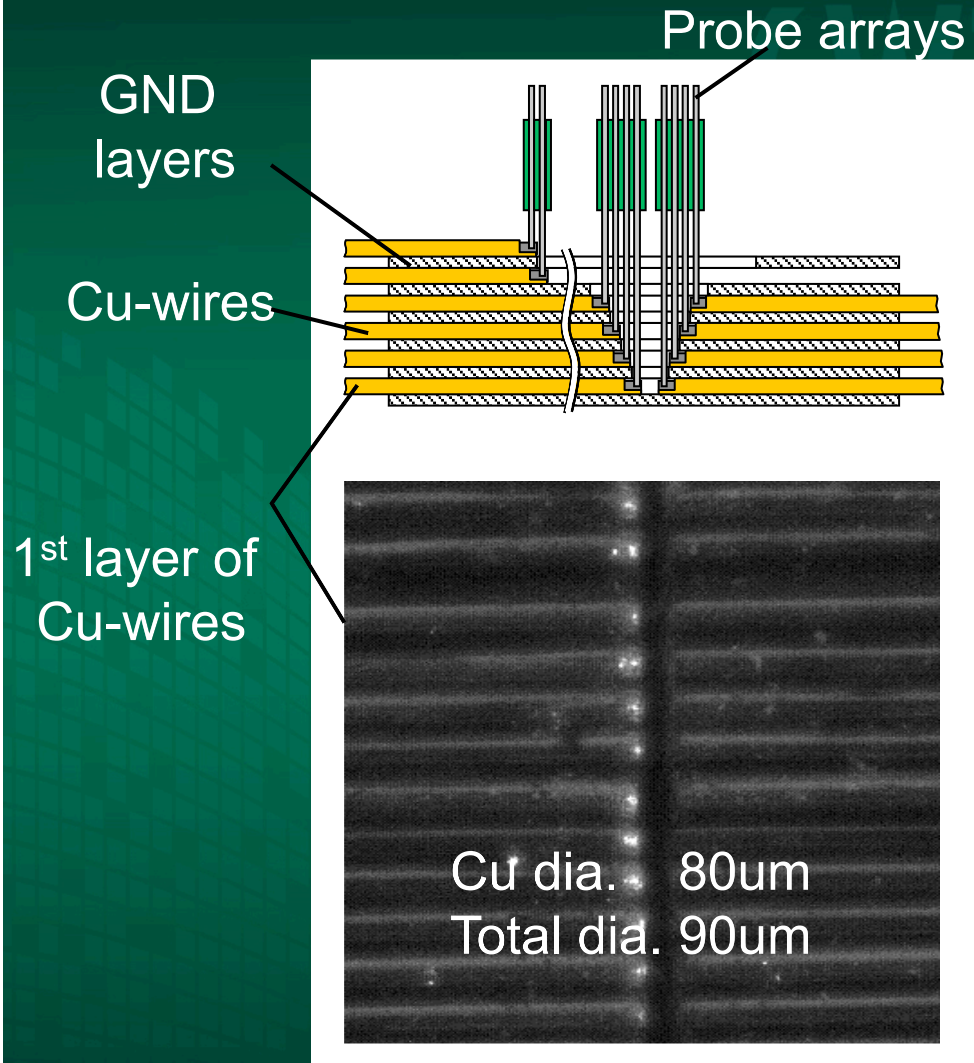


< 0.5Ω

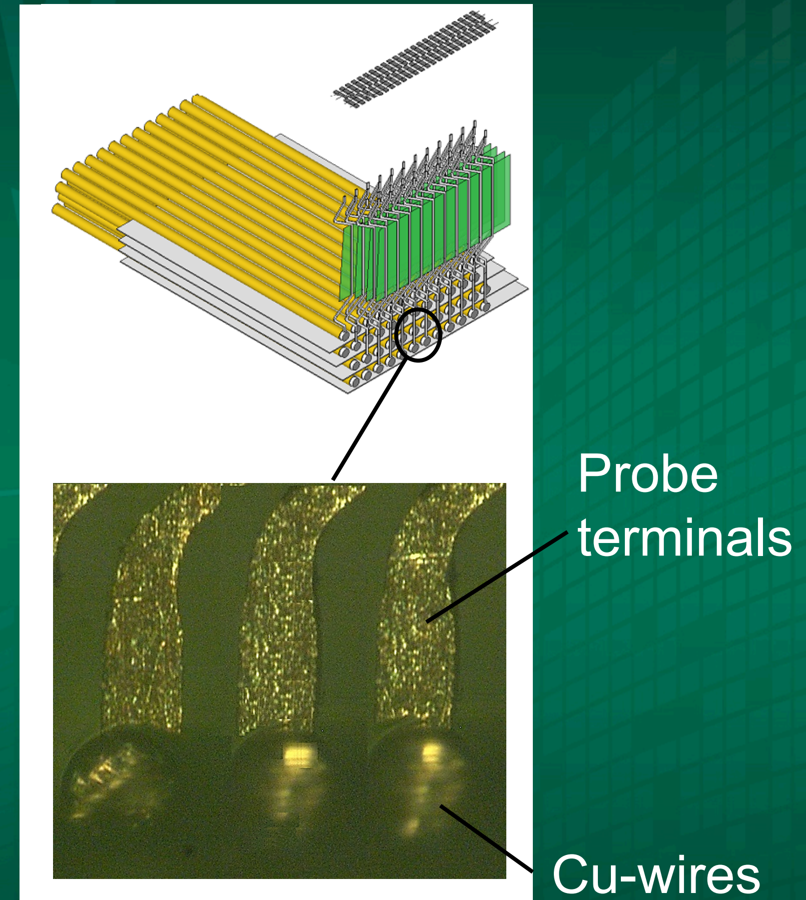
X10^4 TDs

Contact Resistance vs. TDs

Connection of Probes to Cu-wires



Cu-wire-array for probe connection (1st layer)



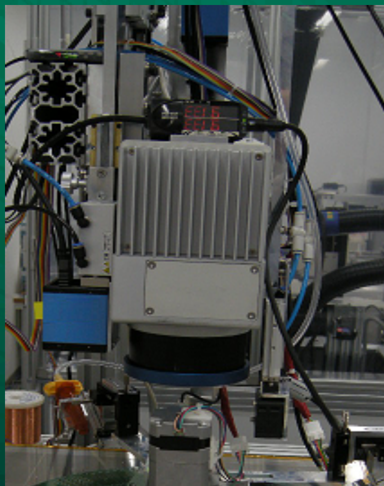
Connection between Cu-wires and probes

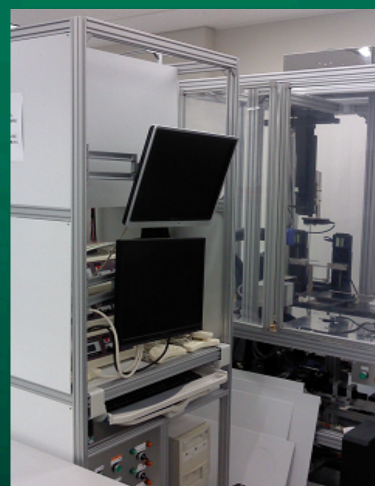
PA's Own Automatic Systems

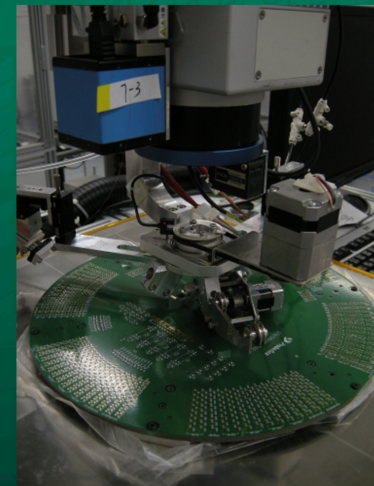
For lower initial cost and shorter initial delivery, as well as repeatability.

Automatic arrangement and wiring design system

Automatic probe fabrication system	Automatic probe assembly system	Automatic Cu-wiring system







Summary

- The novel probe card design and manufacturing method "AMMECSTH" can contribute the next generation PC with following features.
  - High-pin-count and fine-pitch needles in a single sheet for productivity and high quality .
  - A combination of the above sheets meets geometrical independent universal assembly.
  - Tip motion controllable structure for contamination-free probe.
  - Automatic Cu-wiring system for small-layer and HF-oriented board.
  - Fully-automated design and manufacture process for lower initial cost and shorter initial delivery, as well as repeatability.

Future Work

- This new technology "AMMECS" can be applied to:
  - Increased parallel test with fine pitch and high pin count of high-end ICs, and
  - Direct probing to TSVs in 3D IC for higher yield with ultra fine pitch area array.

Thank you !

- Please contact us with any questions …

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