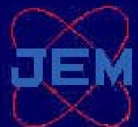
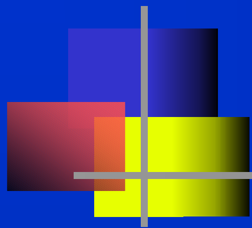
Study on microprobe processing by LIGA on Si

Fundamental study for 3-D mold -Report 1-

Teppei Kimura, JEM Japan (Japan Electronic Materials Corp.)

Tadashi Hattori Himeji Institute of Technology





A potential new technology for probing super-fine-pitch LCD drivers with Au bumps

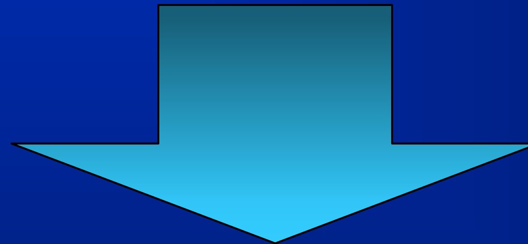
Outline

- Introduction
- Experimental Procedures
- Results
- Conclusions

Background

Problem

Conventional cantilever probe cards may not achieve the pitch requirement in the near future.



Need

New fabrication process to achieve the finer pitch probing.

LIGA : Lithographie, Galvanoformung und Abformung

- High aspect ratio : > 20
- High accuracy : < 0.5 um
- High uniformity

Purpose

Requirements for probing LCD drivers

- Fine pitch (< 35um)
- Good contact with gold bump
- Minimal bump damage
- Low cost

Concept of 3-D Micro Probe Processing

<u>LIGA process</u>

- Pros

High aspect ratio & High accuracy

- Con

High processing cost per mask

<u>Si anisotropic etching</u>

- Pro

Can form sloped shape with only 1 standard UV mask

- Con

Limit on probe tip shape

Combination

<u>3-D micro probe</u>

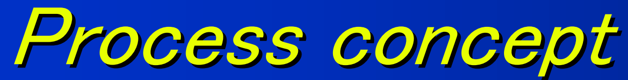
Probe model by Ni electroforming

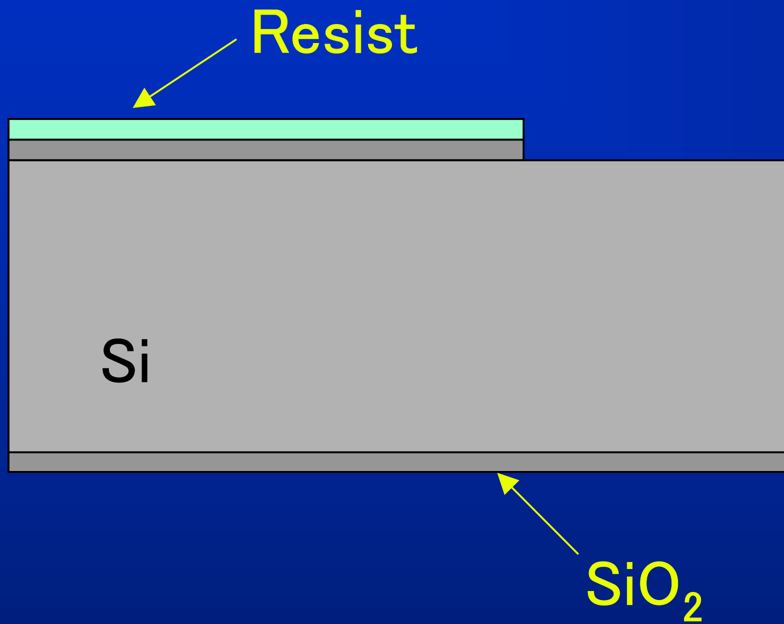
1200um

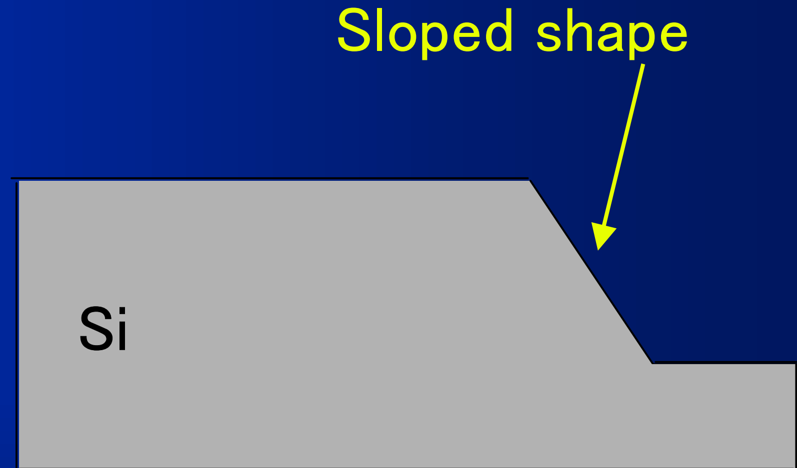
20um

50um

180um







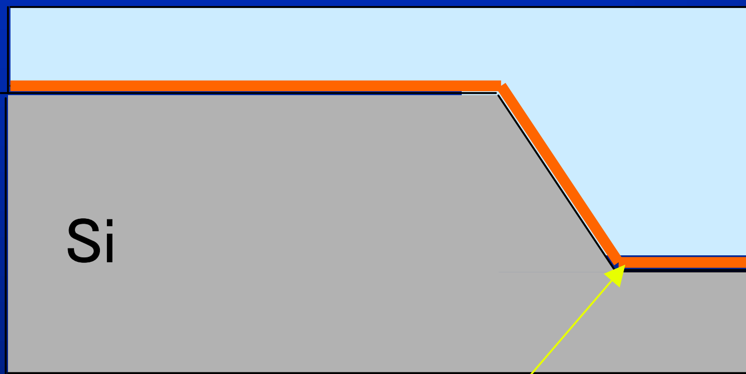
Preparation for etching

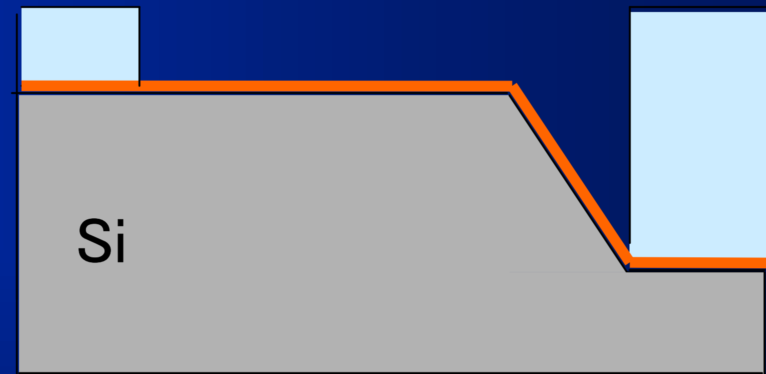
Si anisotropic etching

Process concept

X-ray lithography

Thick resist





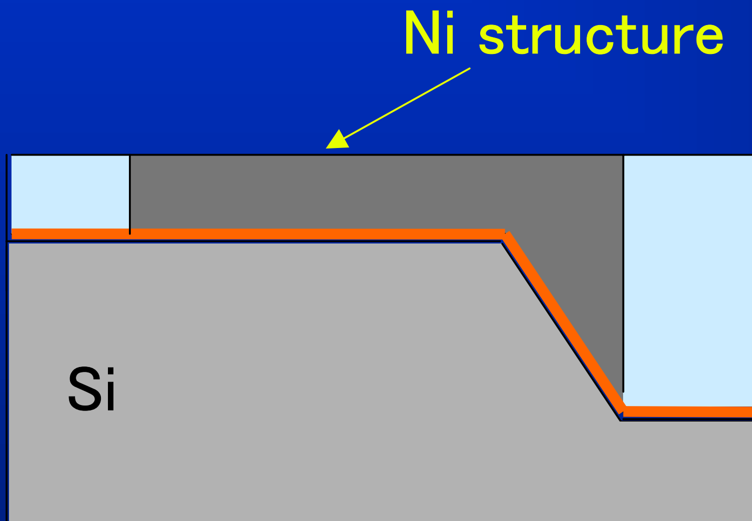
Plating seed layer

Thick resist preparation

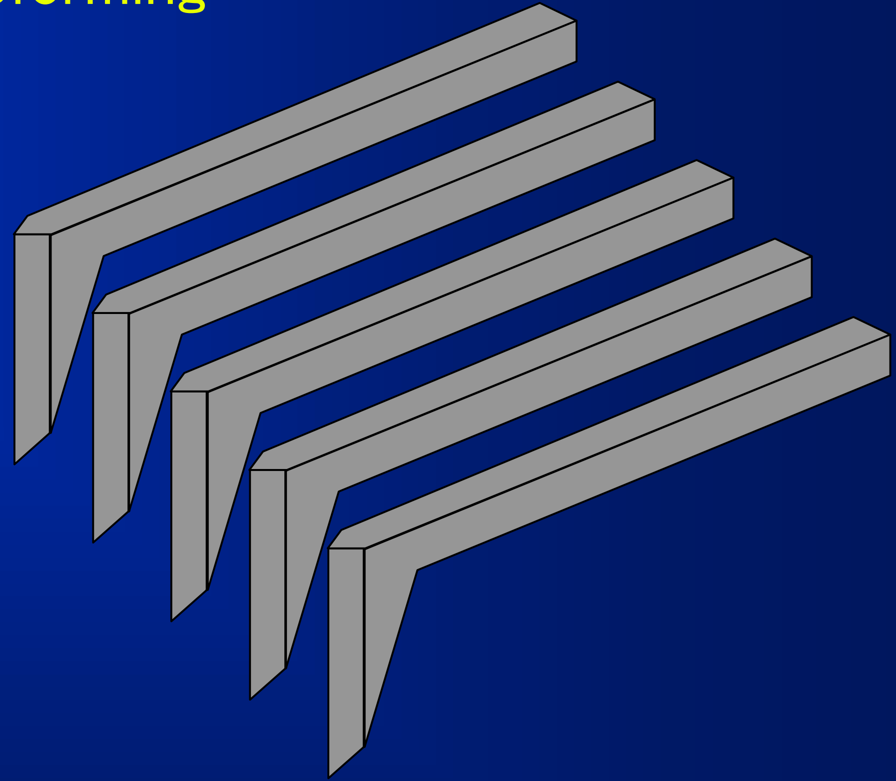
X-ray lithography

Process concept

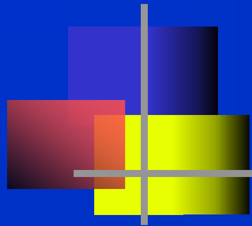
Ni electroforming



Ni electroforming



Resist and substrate removal

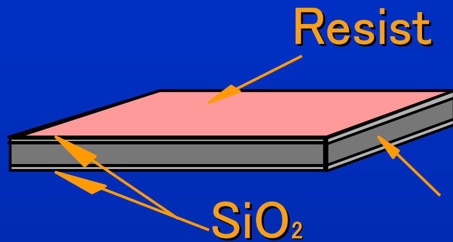


Experimental procedures

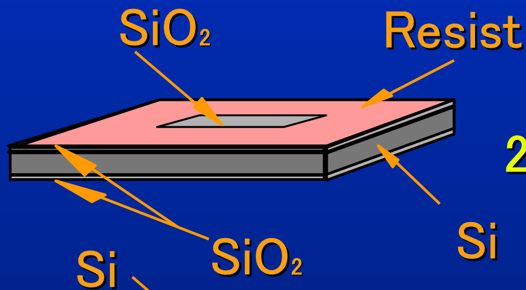
- Si anisotropic etching
- X-Ray lithography
- Ni electroforming & Lapping

Si anisotropic etching

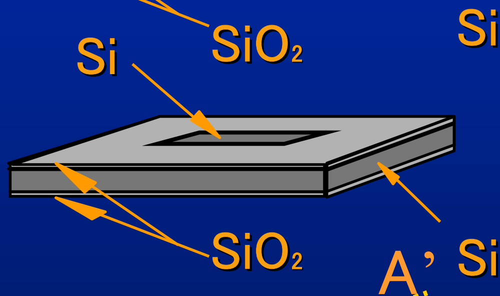
Slope formation for 3-D mold



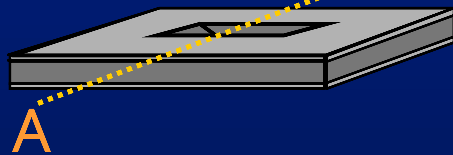
1. Photo resist formation



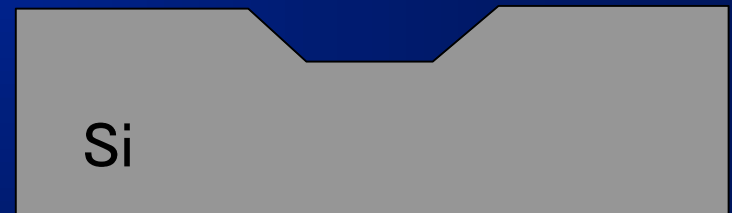
2. UV lithography



3. SiO_2 layer removal



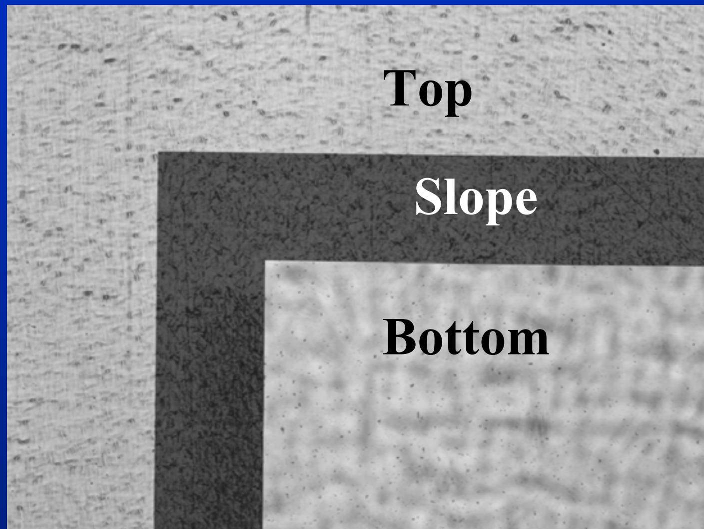
4. Si anisotropic etching



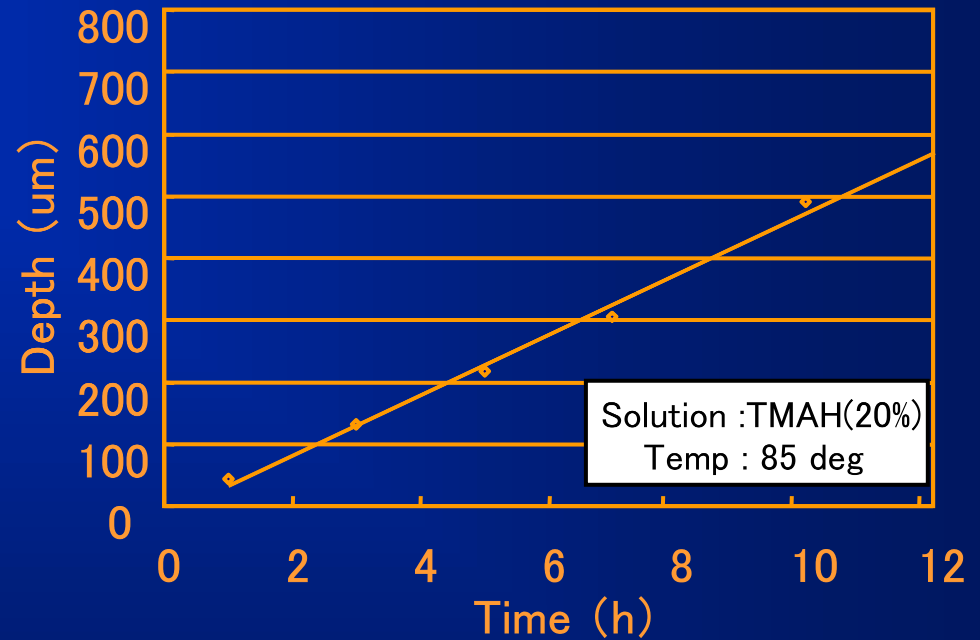
Cross section of A-A'

Process step of Si anisotropic etching

Si anisotropic etching



Photograph of slope

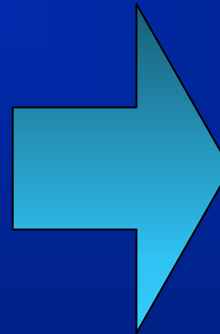


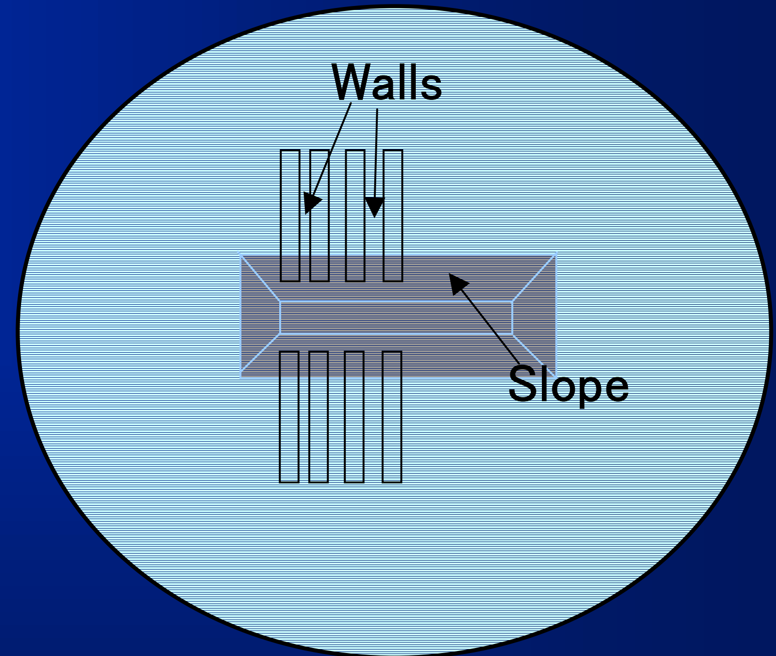
Etching rate

X-ray lithography

Thick resist preparation on mold

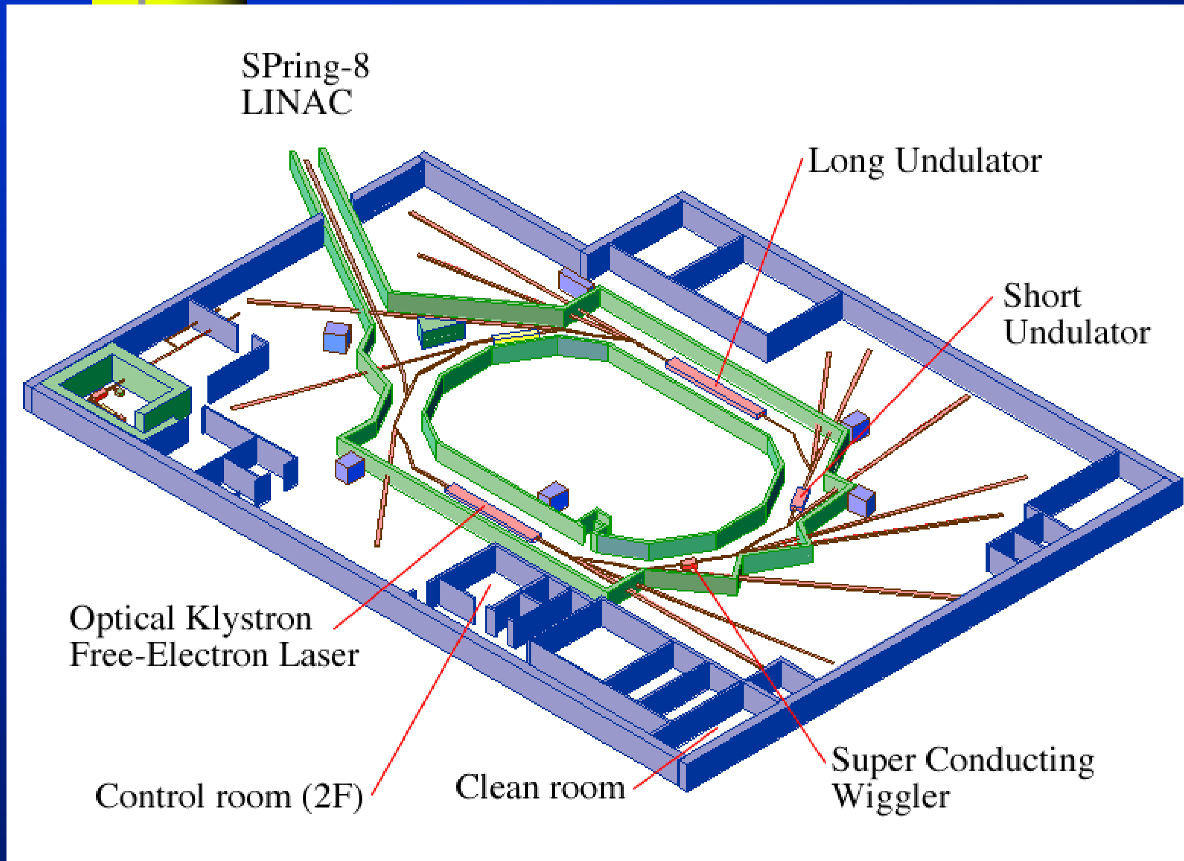
Photograph of substrate





Enlarged view

X-ray lithography



New Subaru Radiation Facility

Characteristics of X-ray lithography

Wavelength	0.1–1 nm
Storage energy	1.5 GeV

X-ray lithography

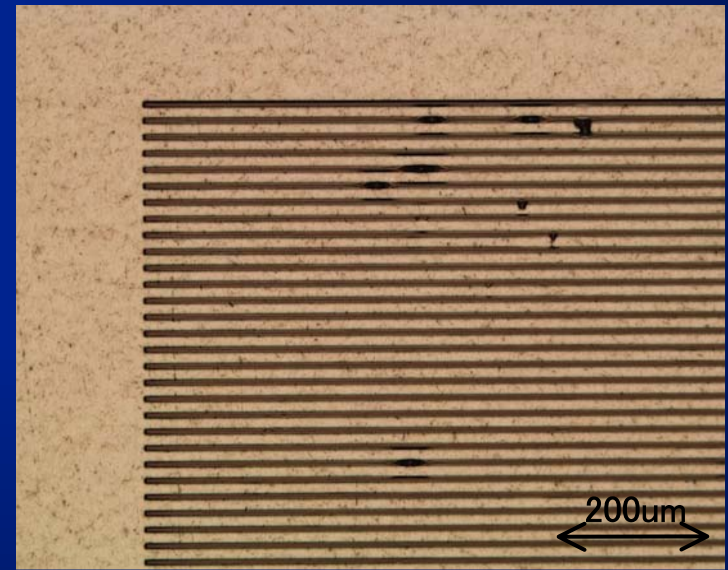
Processes

X-ray

Mask

Si mold with thick resist

X-ray lithography

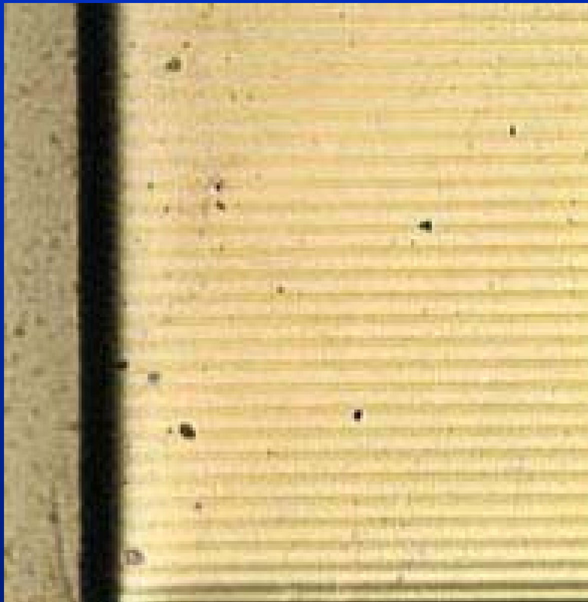


Surface view after lithography

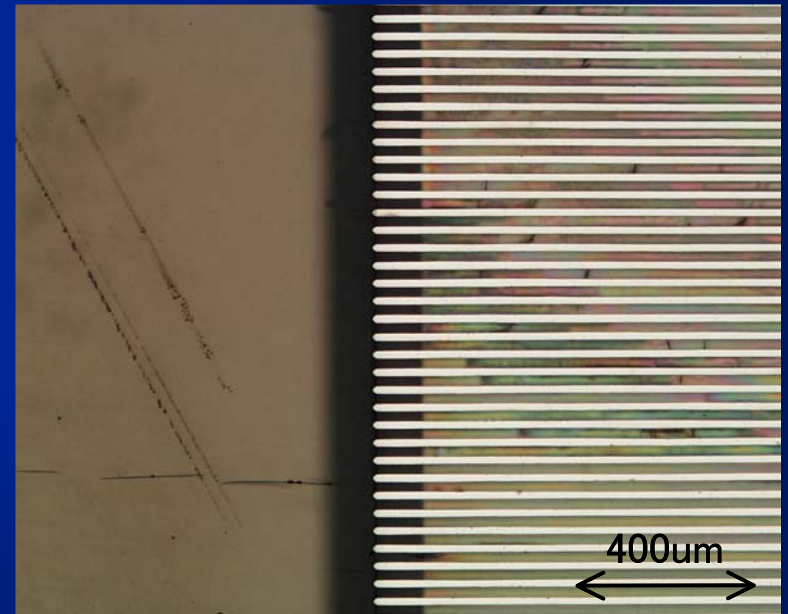
Development

Process step of X-ray lithography

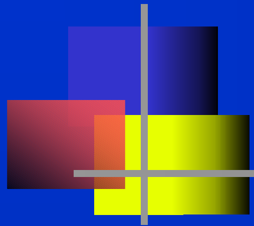
Electroforming & lapping



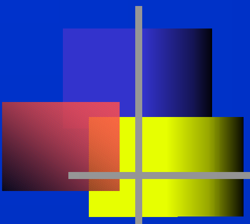
Probe array after electroforming



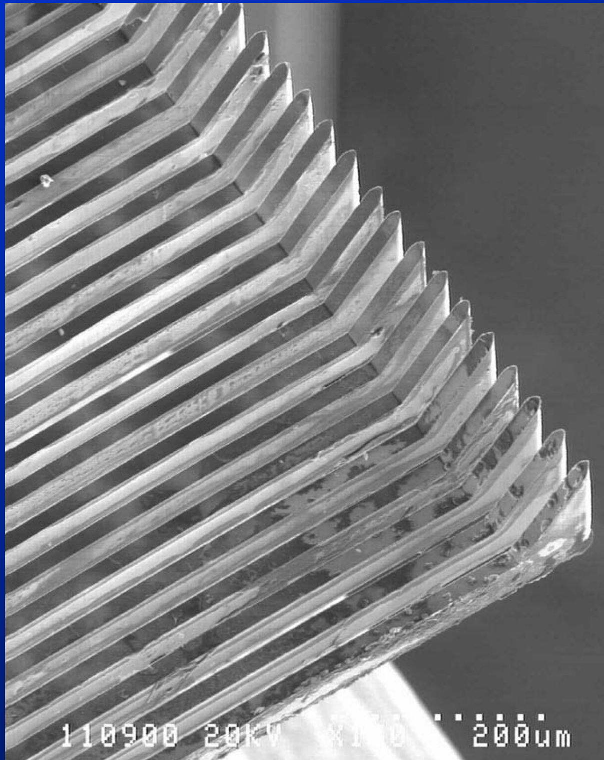
Probe array after lapping



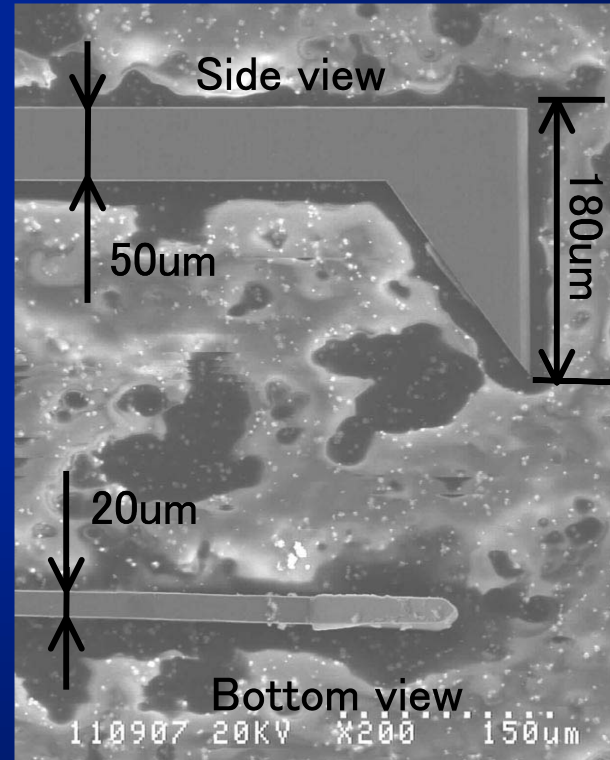
Results



Probes

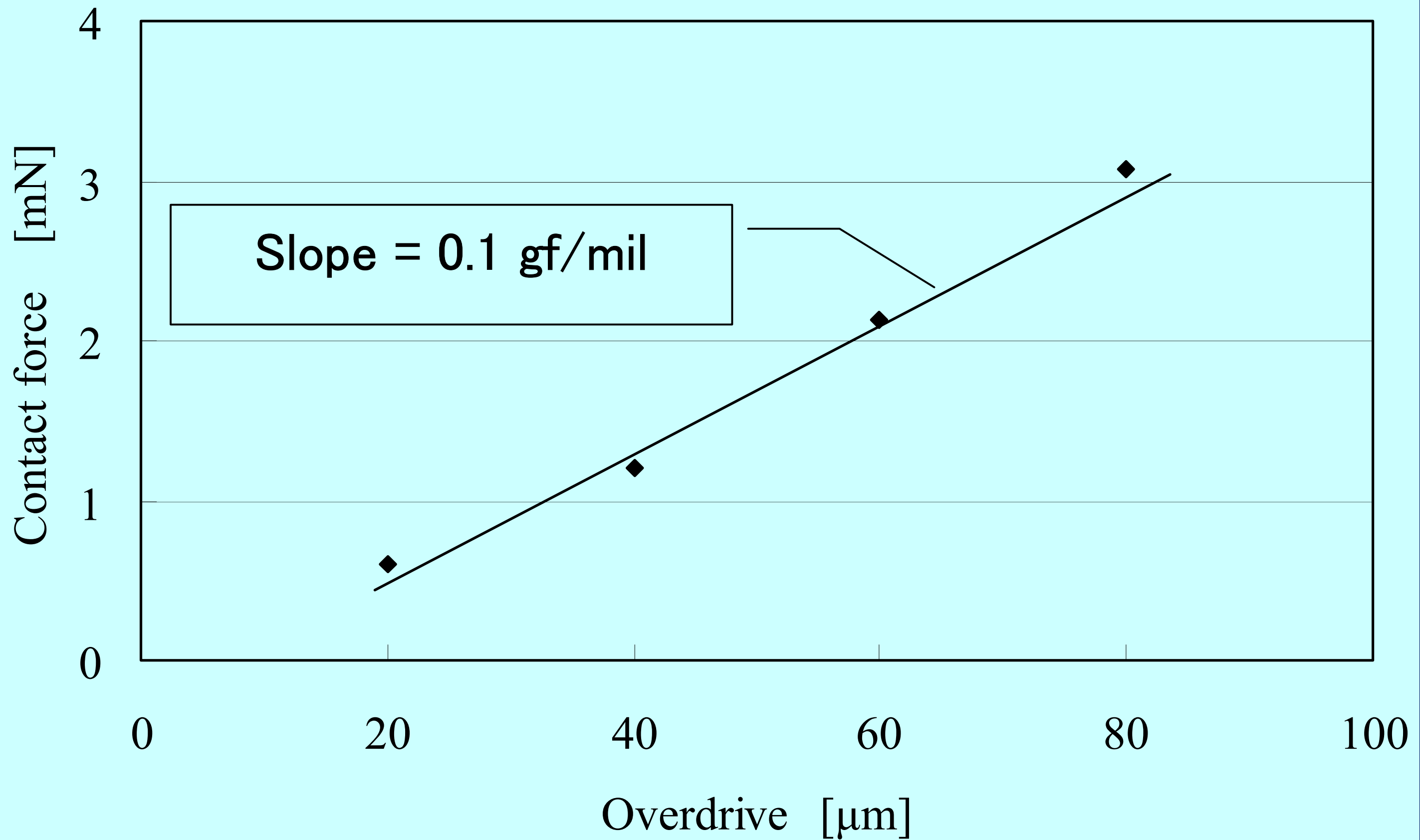


40um pitch

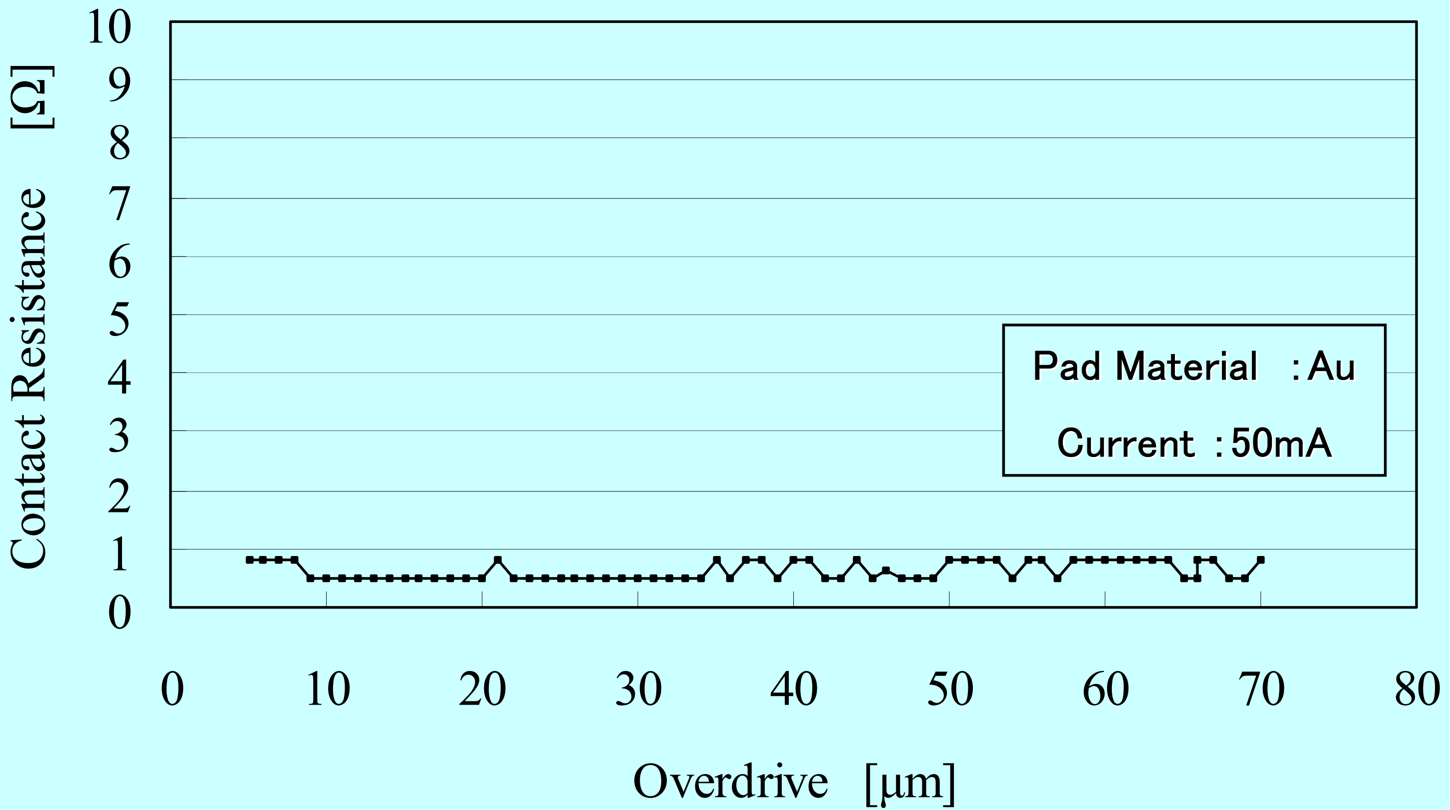


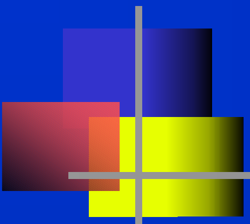
SEM photograph of micro probe

Contact force vs Overdrive



Contact resistance vs Overdrive





Conclusions

Conclusions

1. Micro probe with 3-D shape is manufactured by combining the processes of LIGA and Si anisotropic etching.
2. 80um of allowable probe tip deflection
3. Satisfactory electrical contact within 10um to 70um overdrive can be obtained.
4. 3-D micro probe has the potential to be used for probing super-fine-pitch LCD drivers with gold pads.

1. Continue to evaluate the probes
   - Mechanical contact test (scrub, wear)
   - Electrical test (Cres vs. No of touchdowns)
   - Cleaning process and frequency

2. Reduce pitch (<25 um)

3. Finalize assembly process