Study on microprobe processing by LIGA on Si

Fundamental study for 3-D mold – Report 1 –

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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 Features

- High aspect ratio: \( \geq 20 \)
- High accuracy: \(< 0.5 \text{ um}\)
- High uniformity
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

LIGA process
- Pros
  High aspect ratio & High accuracy
- Con
  High processing cost per mask

Si anisotropic etching
- Pro
  Can form sloped shape with only 1 standard UV mask
- Con
  Limit on probe tip shape

Combination
3-D micro probe

2004 SWTW
Design target of 3-D probe

Probe model by Ni electroforming

- 1200um
- 20um
- 180um
- 50um
Process concept

Preparation for etching

SiO₂

Si

Resist

Sloped shape

Si anisotropic etching
**Process concept**

**X-ray lithography**

- Thick resist
- Plating seed layer
- Thick resist preparation
- **Si**

**2004 SWTW**
Ni electroforming

Ni structure

Si

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. SiO₂ layer removal
4. Si anisotropic etching

Process step of Si anisotropic etching

Cross section of A–A’
Si anisotropic etching

Photograph of slope

Etching rate

Solution: TMAH (20%)
Temp: 85 deg

2004 SWTW
X-ray lithography

Thick resist preparation on mold

Photograph of substrate

Enlarged view
**1.5 GeV**

**Storage energy**

**Wavelength**

**Characteristics of X-ray lithography**

**New Subaru Radiation Facility**

SPring-8 LINAC

Long Undulator

Short Undulator

Optical Klystron
Free-Electron Laser

Clean room

Control room (2F)

Super Conducting Wiggler
**X-ray lithography**

Processes:

- X-ray
- Mask
- Si mold with thick resist
- Development

Surface view after lithography

Process step of X-ray lithography
Results
**Probes**

SEM photograph of micro probe

40µm pitch

Side view

50µm

Bottom view

20µm

180µm

SEM photograph of micro probe
Contact force vs Overdrive

Slope = 0.1 gf/mil
Contact resistance vs Overdrive

Pad Material: Au
Current: 50mA

Contact Resistance [Ω]

Overdrive [µm]
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.
What are the next steps?

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