Printing Methods

Contact printing:

- Contact force: 0.05 to 0.3 atm
- Wavelength near 400 nm.
- Line width is possible under 1μm
- The 'work mask' must be replaced after every 5-25 operations.

Proximity printing:

- Longer mask life.
- Typical separation range: 2.0-25μm.
- Resolution: gaps of 10-15 μm limits the minimum feature size to 2-3 μm.

Projecting printing:

- Numerical aperture: $NA=\sin\alpha = R/D_I$
  R- radius of the exit pupil.
  D- distance from this pupil to the image plane
- Resolution: $0.6\lambda/\sin\alpha$
- Rayleith's criterionRayleith's depth of focus: $\pm \lambda /(2 \sin^2 \alpha)$
- Minimum feature size: $\sigma = k\lambda/NA$
  k: proportionality factor. For a diffraction-limited system, k=0.5

Outline

- Introduction
- Mask Design
- Mask Making
- Design Tools

Mask Design

- Device design
- Pattern design
- Process design
- Drawing your mask pattern

  - Finest line's line width
  - Pattern arranged uniformly
  - Positive/negative photoresist
  - Alignment marks
  - Bonding requirements

Introduction

- What is a mask?
- Mask principal parameters:

  Pattern position
  Feature size control
  Defect density
- Mask type:

  Binary Mask
  Proximity correction mask
  Phase shift mask

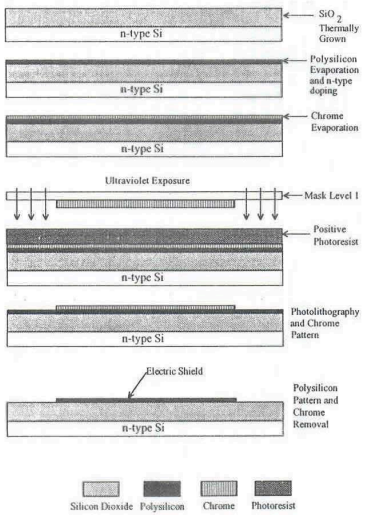


Figure 2. Process steps for the first level fabrication of electric shield.

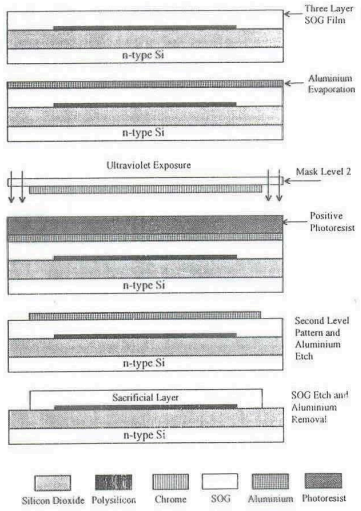


Figure 3. Process steps for the second level fabrication of sacrificial layer.

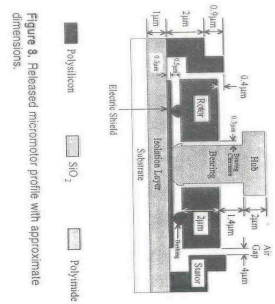
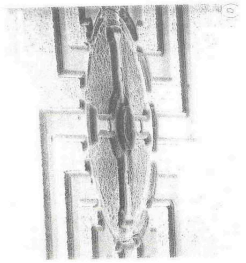


Figure 9. Released micromotor profile with approximate dimensions.



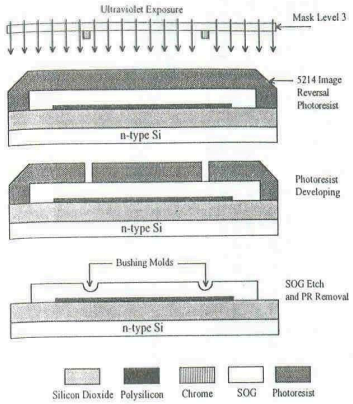


Figure 4. Process steps for the third level fabrication of bushing.

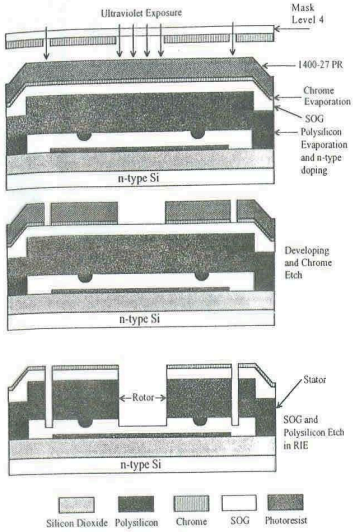
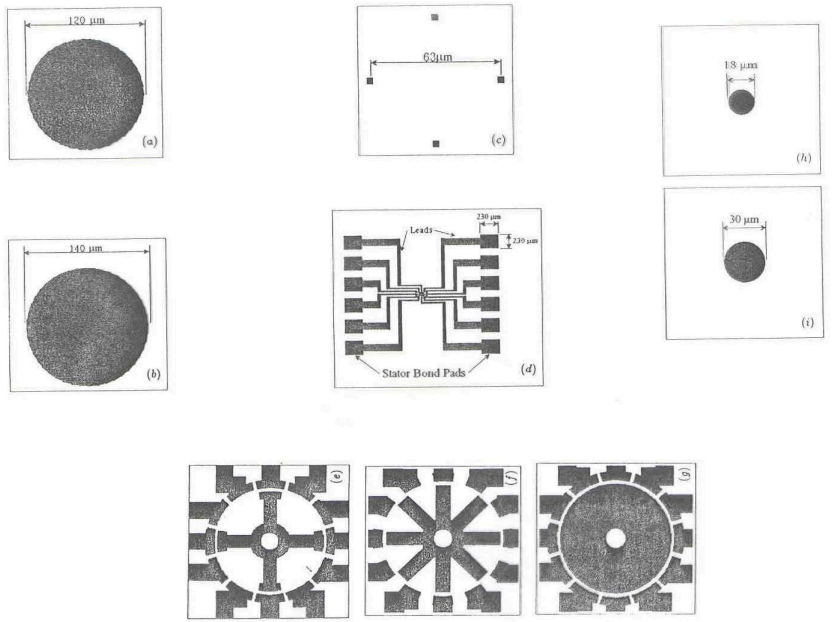
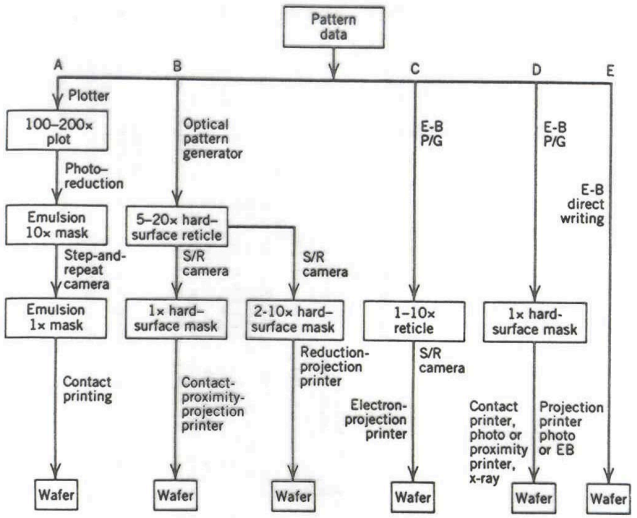


Figure 5. Process steps for the fourth level fabrication of stator and rotor.





PATHWAY FROM PATTERN DESIGN TO PATTERN TRANSFER

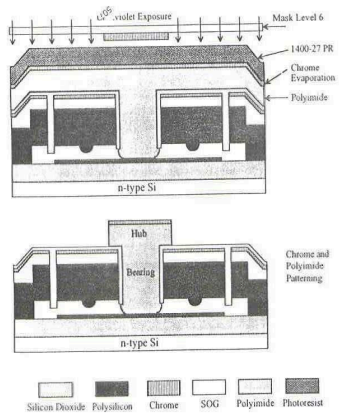


Figure 7. Process steps for the sixth level fabrication of hub and bearing.

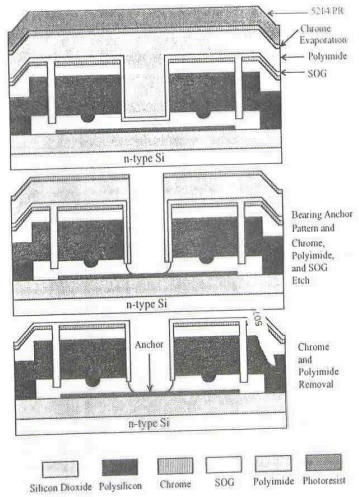


Figure 6. Process steps for the fifth level fabrication of bearing anchor.

Mask Design Tools

- Design tools: AutoCAD and L-edit
- Tanner Tool
- Introduce L-edit
- Pattern design request
- Mask order procedures

Mask Making

- Pathway pattern transfer
- Emulsion mask and Chrome mask
- Fabrication steps

1. Substrate preparation
2. Pattern writing or exposing
3. Pattern processing
4. Metrology
5. Inspection for pattern integrity
6. Cleaning
7. Repair
8. Pellicle attachment
9. Final defect inspection

Chromium Etchant

$(NH_4)_2$ $Ce(NO_3)_6$ Ceric Ammonium Nitrate		165 g
$HClO_4$		42 ml
DI Water	till	1000 ml