Photolithography and Mask Creation at MiRC

Zhiping (James) Zhou

Senior Research Scientist

Georgia Institute of Technology, USA

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Introduction

- *Photolithography:*
  - A process for pattern transfer between thin layers.
- *Mask:*
  - An interface between designer and fabrication process, containing an image of one layer of the process.
- *MiRC facility:*
  - MJB-3, MA6, OAI, GCA Contact Printer, GCA 3600F, and GCA 6100B

Photolithography

--General description

- *Tools*:
  - a spinner, a hotplate/an oven, and a mask aligner
- *Chemicals*:
  - HMDS, Photoresist, developer, remover
- *Processing steps*:
  - wafer cleaning, resist coating, soft bake, alignment, expose, develop, hard bake

Photolithography

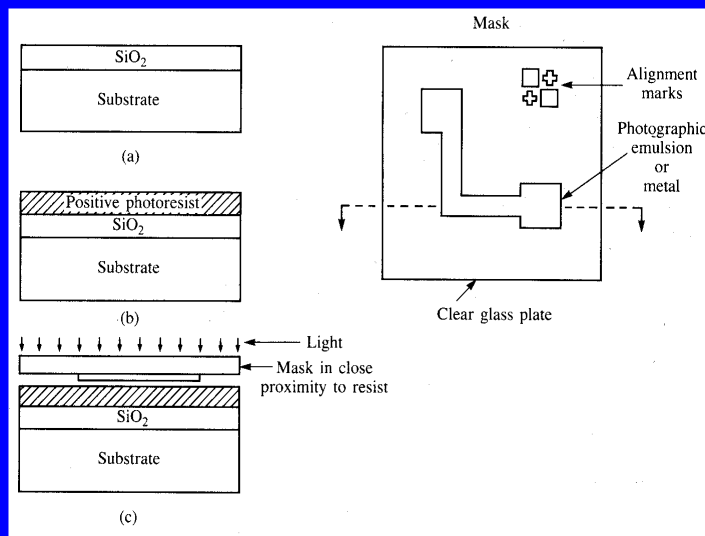
--General description

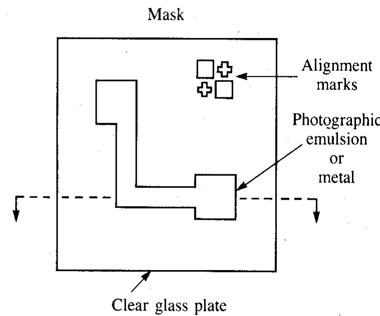
- *Flow chart*

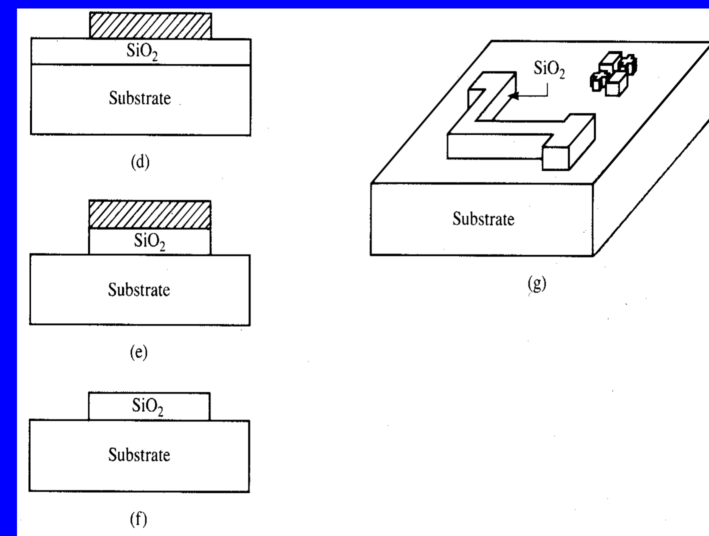
Photolithography

--General description

- Cross section view







Photolithography

--An example

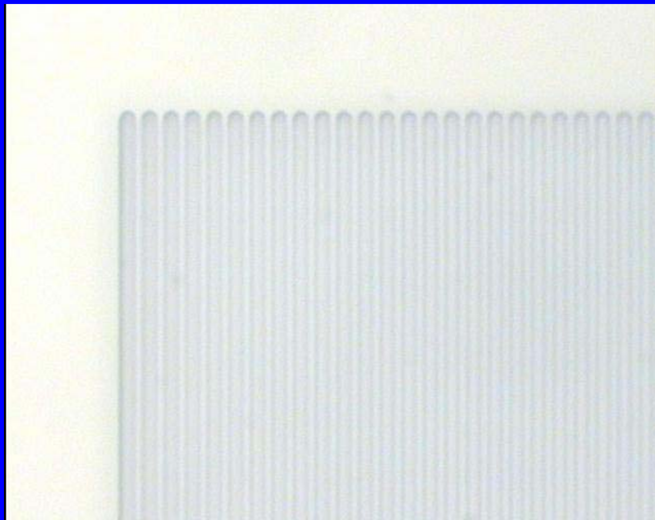
Grating with 1 micron line and spacing

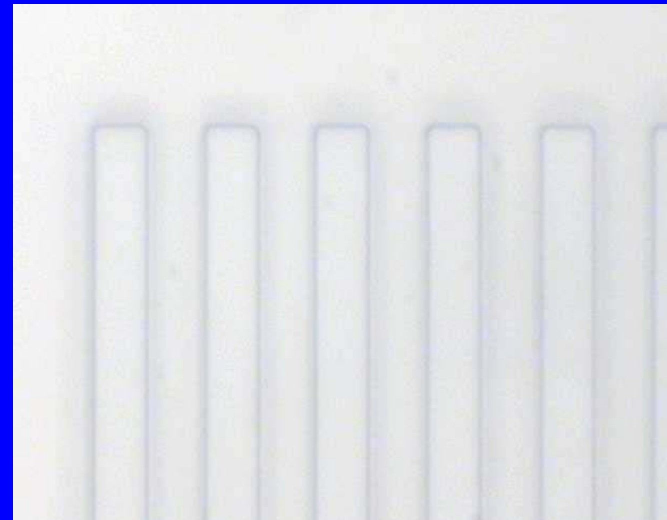
- Spin S1813 at 5000 rpm, 2500 r/s, for 30 seconds → 1.2 micron (apply HMDS before PR coating, if necessary)
- Soft bake on leveled hot plate for 60 seconds @ 115C
- Align wafer using MA6 (Vac Contact, Al. Gap: 30 micron)
- Expose (Wavelength @436 nm, intensity @ 20 mW [CI2]) for 4 seconds
- Develop using MF 319 for 45 seconds
- Inspect the photoresist pattern
- Hard bake in oven for 30 minutes @120C, if needed

Photolithography

--An example

Good PR patterns

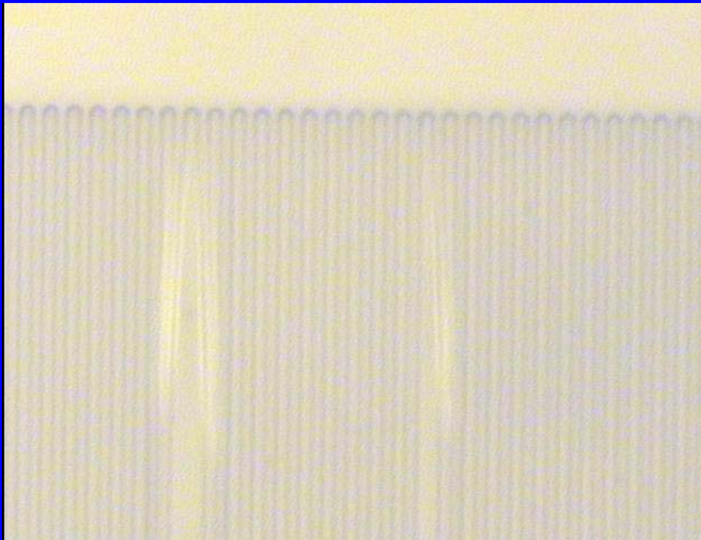




Photolithography

--An example

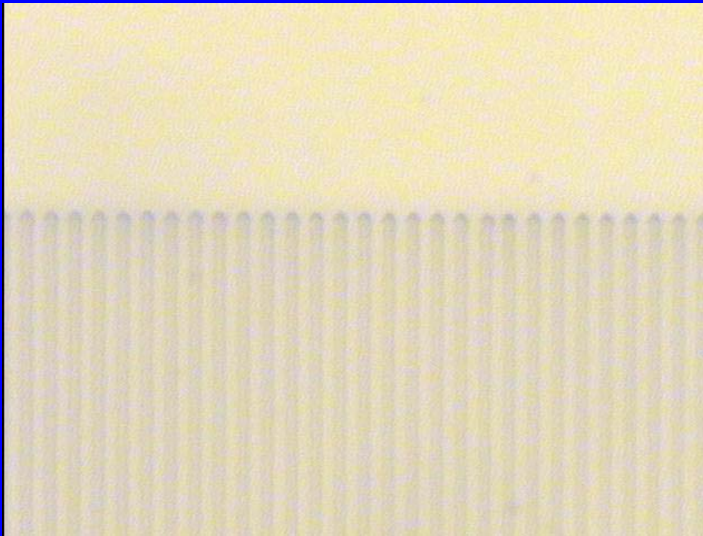
Not Good PR patterns

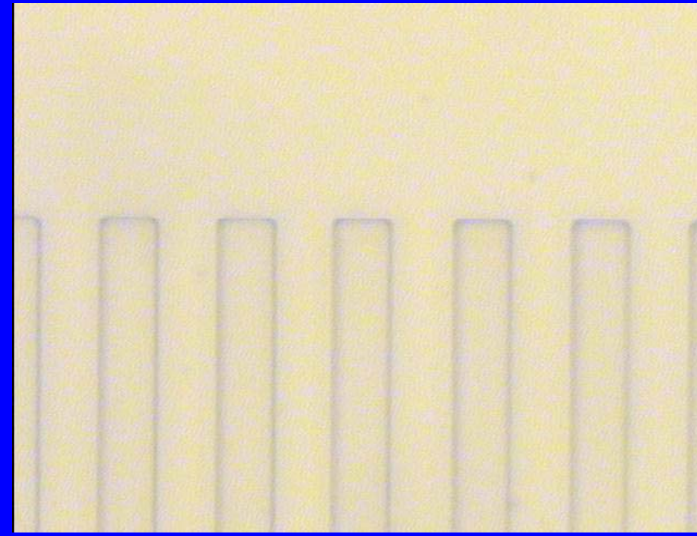


Photolithography

--An example

Not Good PR patterns





Mask Creation

--Mask Plates

- *Chrome Plate*
- *Iron Oxide Plate*
- *Emulsion Plate*
- *Clear Field*
- *Dark Field*

Mask Creation

--Mask Making

- *Contact Printer*
- *Pattern Generator (PG)*
- *PG and Stepper*

Mask Creation

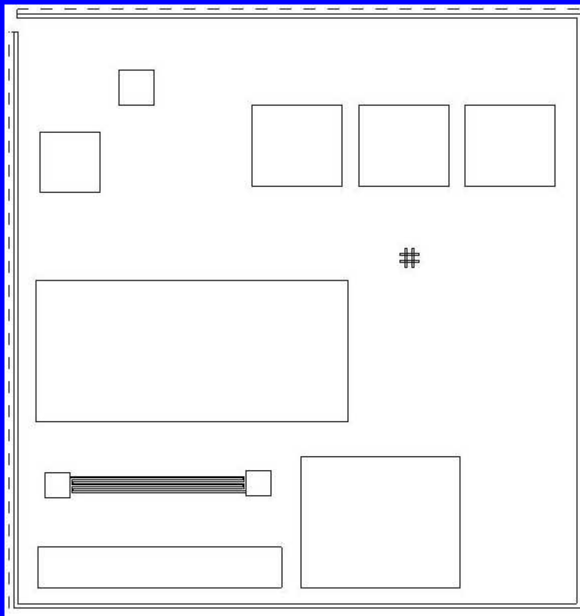
--Pattern Design

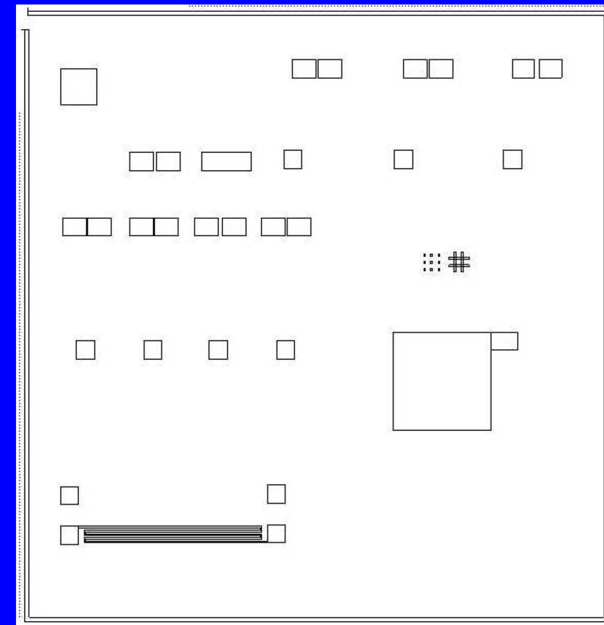
- *Software:*
  - AutoCAD outputs ***.DXF** files
  - Cadence, Kic, Lasi, L-edit, Magic, or others generate ***.CIF** files.
- *Design rules (for pattern generator):*
  - Minimum feature size: 3 μm
  - Minimum feature increment: 1 μm
  - Minimum position increment: 0.5 μm
  - Maximum layout size: 85 mm x 85 mm
  - Snap grid: 0.5 μm (or integral multiple)

Mask Creation

--Pattern Design

- *CMOS mask 1 and 2 by Magic*

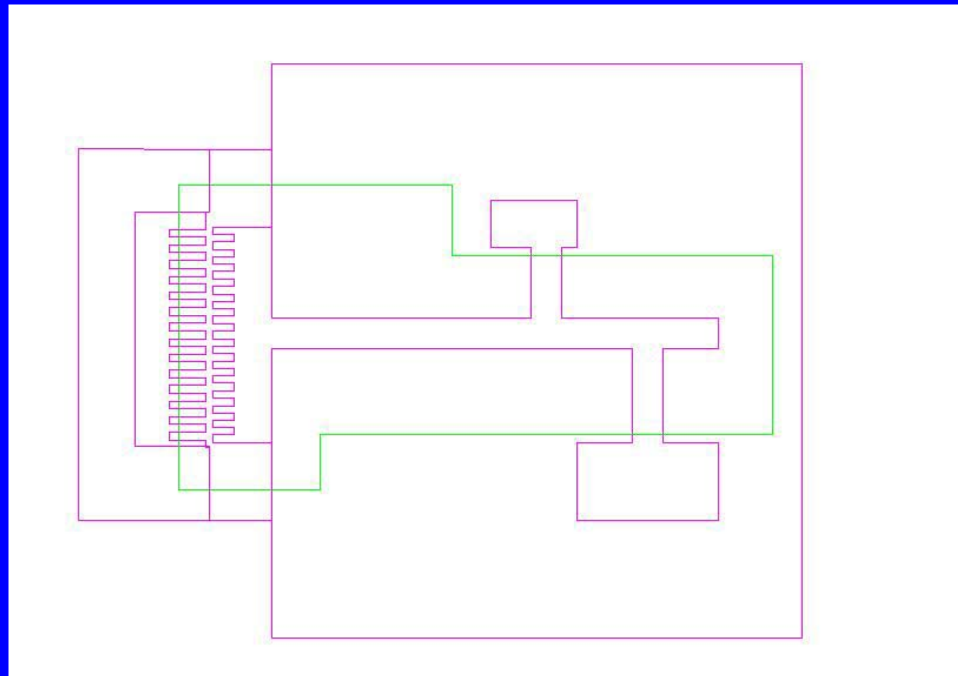




Mask Creation

--Pattern Design

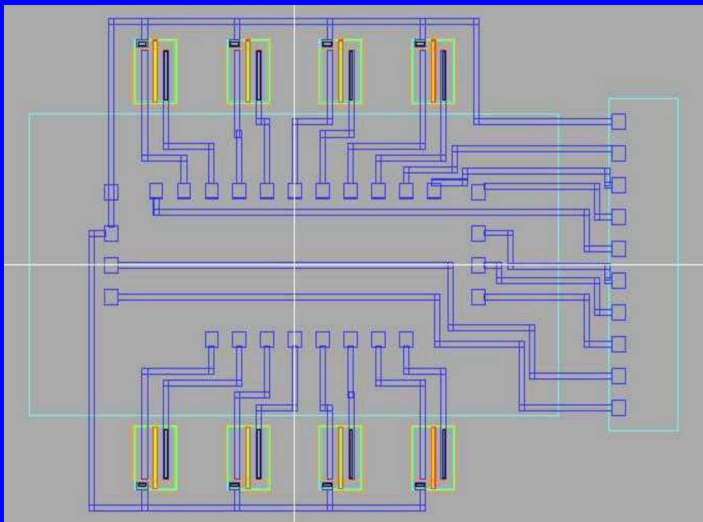
Vernier Gauge by AutoCAD

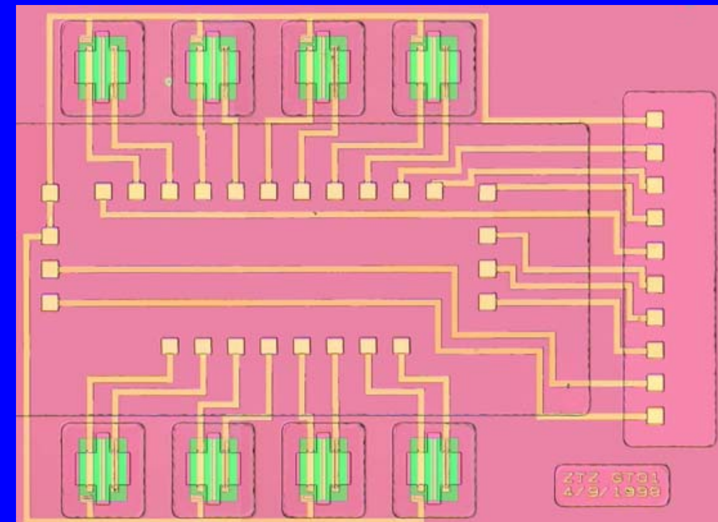


Mask Creation

-- Pattern Design

Georgia Tech's CHEMFET by Kic





Mask Creation

--Pattern Design

- *Design tips:*
  - Center your design and place a set of small boxes at the lower left and upper right corners of the design
  - Avoid acute angles
  - Frame the clear field mask with a 3mm border if the stepper is requested
  - Resolution for chrome plate: 3 μm (PG) or 1 μm (Stepper) (Emulsion has a fuzzy edge so its resolution is worse)
  - File size less than 1Mb is recommended

Mask Creation

--Data Conversion

*The Mann 3600 pattern generator requires the resulting *.DXF or *.CIF files from design software be converted to EBCIDC format.*

- *DXF to EBCIDC (Using commercial software)*
- *CIF to EBCIDC (Using existing MiRC software)*
  - *cifdiv* * .CIF to separate the *.CIF file into single layer files
  - *cgdirect* * to get *.mann files centering at (76.2mm, 76.2mm)
  - *offset4* *.man *.tmp to recenter the file at (0,0)
  - *un2vms* *.tmp > *.ext to remove hidden “soft” returns from file
  - *atoebc* *.ext *.ebc to obtain EBCIDC format

Mask Creation

--Mask Specifications

- *Reference and job submission http://cmos.mirc.gatech.edu/request/maskreq.html*
- *Die size, step size, and file size (PG or Stepper)*
- *Mask filed: Clear (emulsion) or Dark (chrome and iron oxide)*
- *Mask size: 4 inch or 5 inch*
- *Material: Soda-lime glass or Quartz*
- *Rotation and Mirror*
- *Pricing and Timing*

Acknowledgement

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