MRI Nanofab Lithography

An overview of the lithography equipment, the capabilities, and results of work completed at the MRI Nanofab

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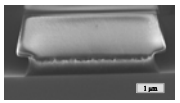
Contact Print

- Karl Suss MJB3 and MA/BA6
  - Wafer chucks to accommodate pieces, 1, 2, 3, 4, 5, and 6 inch whole wafers
  - Mask chucks for 4, 5, and 7 inch square plates
  - Broadband wavelength (at) including 365/405 nm
  - Modes of operation
    - Soft contact
    - Hard contact
    - Vacuum contact
    - Proximity
    - Flood exposure
  - Backside alignment capabilities

MJB3

MA/BA6

Results

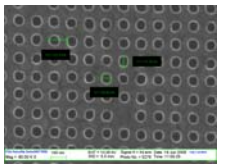


Bi-layer for Lift-off 0.5 µm thick isolated metal line

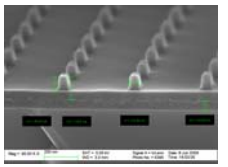
Imprint

- Step and Repeat Approach
- Self Leveling Flexture
- Alignment
  - 3 Sigma < 1 micron
- Feature Size
  - Template dependent (sub – 100 nm)
- Multiple Substrates
  - 2", 3", 4", 6", and Piece chucks
  - Si, SiO, GaAs, InP, Al, and Quartz
- Imprint Materials
  - 2 dispense nozzles
    - Silmat for SFIL
    - Monomat for SFIL-R

Imprio - 55



60 nm vias



60 nm pillars

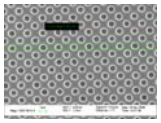
Step and Flash Imprint Lithography (SFIL)

Stepper

- Lens:
  - i-Line with Tropel 1635i lens
  - 5X Reduction
  - 0.35 NA
  - 11.3 mm x 11.3 mm Field Size
  - 1.49 µm Depth of Focus
- Resolution:
  - 0.83 µm lines/space in 1 µm thick resist
  - 0.64 µm lines/space with antireflective coatings, thin resist, flat substrate
- Alignment Overlay:
  - Global overlay system: ±0.25 µm
  - Local overlay system: ±0.15 µm
- Interchangeable Chuck System:
  - Small parts down to about 1 cm x 1 cm and ~275-725 µm thick (global overlay only)
- SEMI Standard Wafers:
  - 3 inch, 100 mm and 150 mm

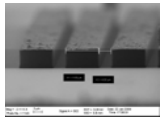
GCA 8000 Stepper

Stepper Results

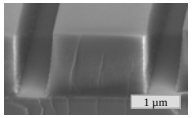


800 nm vias

Bi-layer lift-off resist profile



KMPR used for Ni Plating



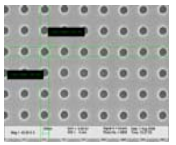
Deep Si etch with SPR3012 resist

E-Beam

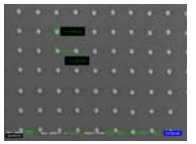
- Capabilities
  - Flexible direct write from CAD files
  - HT 20, 50 and 100 kV
  - Thermal emitter (LaB_6)
  - In Class 10 cleanroom
  - Automatic column adjustment
  - 5 nm resolution grid
  - Minimum Spot Size 12 nm
  - Stage has 125 mm of travel
  - 9 holders for masks/imprinter templates, wafers, and small parts in 10 position airlock
  - Alignment to metal & etched markers
  - Stitching & Overlay error typical 35 nm at reduced field size, 50 nm at full scan field

EBPG5HR

E-Beam Results

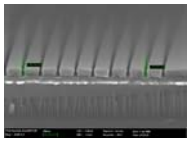


125 nm vias patterned in 140 nm thick ZEP520A Positive resist

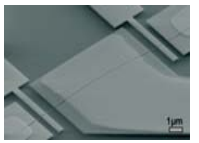


60 nm pillars patterned in 200 nm NEB31 Negative resist

(courtesy of Yun-ching Chan)



55 nm spaces patterned in 150 nm thick ZEP520A positive resist



Si nanowire MOSFET fabricated with direct write and liftoff of bi-layer PMMA resists

[Tsung-ta Ho et al. Nano Lett. Vol. 8, P4359 (2008)]

Lithography Benches

- Laurell Spin Processors
  - Polypropylene bowl and chucks
  - Programmable exhaust control
  - Programs stored locally and in a central computer
- Wenesco Integrated Hotplates
  - Displays temperature readout
  - PID controller to control overshoot
  - Fast increasing, slow decreasing temperature
- Integrated Pipette Waste Container
- Drawers for Chucks, Pipettes, and Wipes

- One Laurell "EDC" Resist Develop Processor
  - Plumbed with CD-26 (TMAH)
  - "Standard" sized substrates
    - Masks and whole wafers
  - Automatically
    - Dispense developer in a puddle on wafer
    - Spin off developer
    - Rinse with DI
    - Spin and blow dry
- Bench Space to Develop Manually
- Temperature Controlled Bath
- Deep Sink
- TMAH Waste Drains with Level Monitoring

Ancillary Equipment

- Surface Preparation
  - Clean Surface of Organics
    - Ammonium Hydroxide dip
    - Sulfuric Hydrogen Peroxide
    - Oxygen Plasma
  - Adhesion Promoter
    - HMDS – Hexamethyldisilazane, reacts with oxide surface that the same time free bonds are left that readily react with the photoresist
    - BARC – Bottom Anti-Reflective Coating

Summary

Each tool and technique has its advantages and disadvantages. The details of the process and materials needed for the fabrication of the end product combine with the tool capabilities to ultimately determine which tool set would be optimal. In an effort to determine which tools best fit a particular fabrication process users are encouraged to interface with the staff.

There are several mechanisms currently in place to help facilitate these interactions:

-New User Project Overviews
-Tool trainings
-Follow-up meeting with the staff

For more information on what tools are available or how to get started please visit:

http://www.mri.psu.edu/facilities/NNIN.asp