CHE323/CHE384
Chemical Processes for Micro- and Nanofabrication
www.lithoguru.com/scientist/CHE323

Lecture 64 Nanoimprint Lithography, part 2

Chris A. Mack
Adjunct Associate Professor

 www.lithoguru.com

Nanoimprint Lithography

- Advantages of Imprint Lithography
  - Relatively inexpensive
  - Easy to get high resolution
  - Can be used for mass production
- Disadvantages of Imprint Lithography
  - Defects
  - Overlay
  - Throughput (for semiconductor lithography)
  - Template Manufacturing (1X)

Problem - Defects

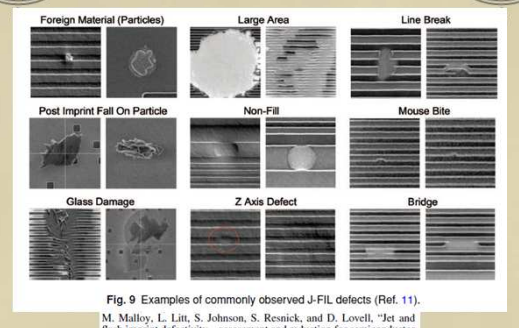
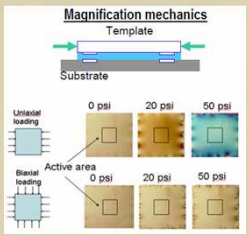


Fig. 9 Examples of commonly observed J-FIL defects (Ref. 11).

M. Malloy, L. Litt, S. Johnson, S. Resnick, and D. Lovell, "Jet and flash imprint defectivity – assessment and reduction for semiconductor applications," *Proc. SPIE* **7970**, 797006 (2011).

Problem – Magnification Correction (Overlay)

- When aligning new pattern to old, differences in thermal expansion can mean the new template is not the same size as the existing substrate (magnification error)
- Solution: squeeze or stretch the template



Source: Molecular Imprints

Problem – Throughput

- It takes time to dispense the fluid and press the template
- Attempting to go too fast increases defectivity (fluid doesn't fill into the small openings of the template)
- But imprint heads are small and cheap – so use many of them
  - But templates are not cheap!

Problems - Status

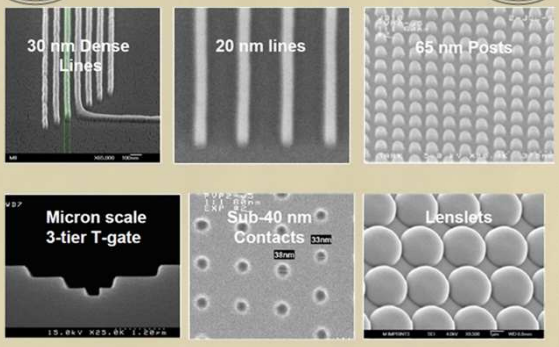
Current Status of NIL

Attribute	Target	Status
Template		
Master CDU	2.4nm	1.2nm
Image Placement	3nm	4nm
Master Defectivity	0.1/cm²	10/cm²
Replica Defectivity	1/cm²	TBD
Imprint		
LER	2nm	2nm
Fill time	1 sec	2 sec
Overlay Accuracy	8nm	10nm
Defectivity	0.1/cm²	10/cm²

Fig. 14 Current status of jet and flash imprint lithography.

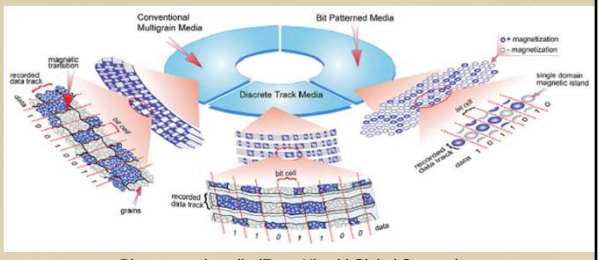
Higashi, et al., "Nanoimprint Lithography and Future Patterning for Semiconductor Manufacturing", JM3 10(4) p. 043008 (2011).

NIL Applications



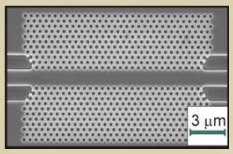
Source: Molecular Imprints

NIL Applications



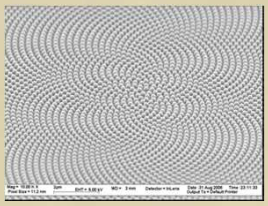
Bit patterned media (From Hitachi Global Storage)

NIL Applications



Photonic Crystal Waveguide

(physicsworld.com, Apr 8, 2005)



LED Surface Pattern

Commercial Systems

Obducat – thermal NIL, hot embossing, UV NIL, combined Thermal and UV

Nanonex – thermal NIL, hot embossing, UV NIL, alignment capability

Commercial Systems

Imprio 300

NuTera HD7000

Molecular Imprints – UV step and flash NIL, geared towards hard drive, LED, and semiconductor manufacturing

Lecture 64: What have we Learned?

- What are the main advantages of NIL?
- What are the main disadvantages of NIL?
- How many applications of NIL can you name?