Imprio 55

Penn State Nanofabrication Facility

Overview

Product Features

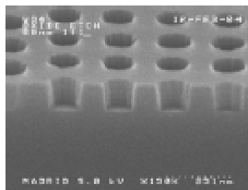
Systems with
- Step and repeat approach
- Self leveling flexure
- Fully automatic, reliable separation
- Up to 200 mm substrates

Materials with
- High strength
- Optimized release

Templates with
- Fine features
- Hard robust patterns

Process Benefits

- Flexible processes
- Low defects



- High resolution
- Robust etch
- Fine overlay

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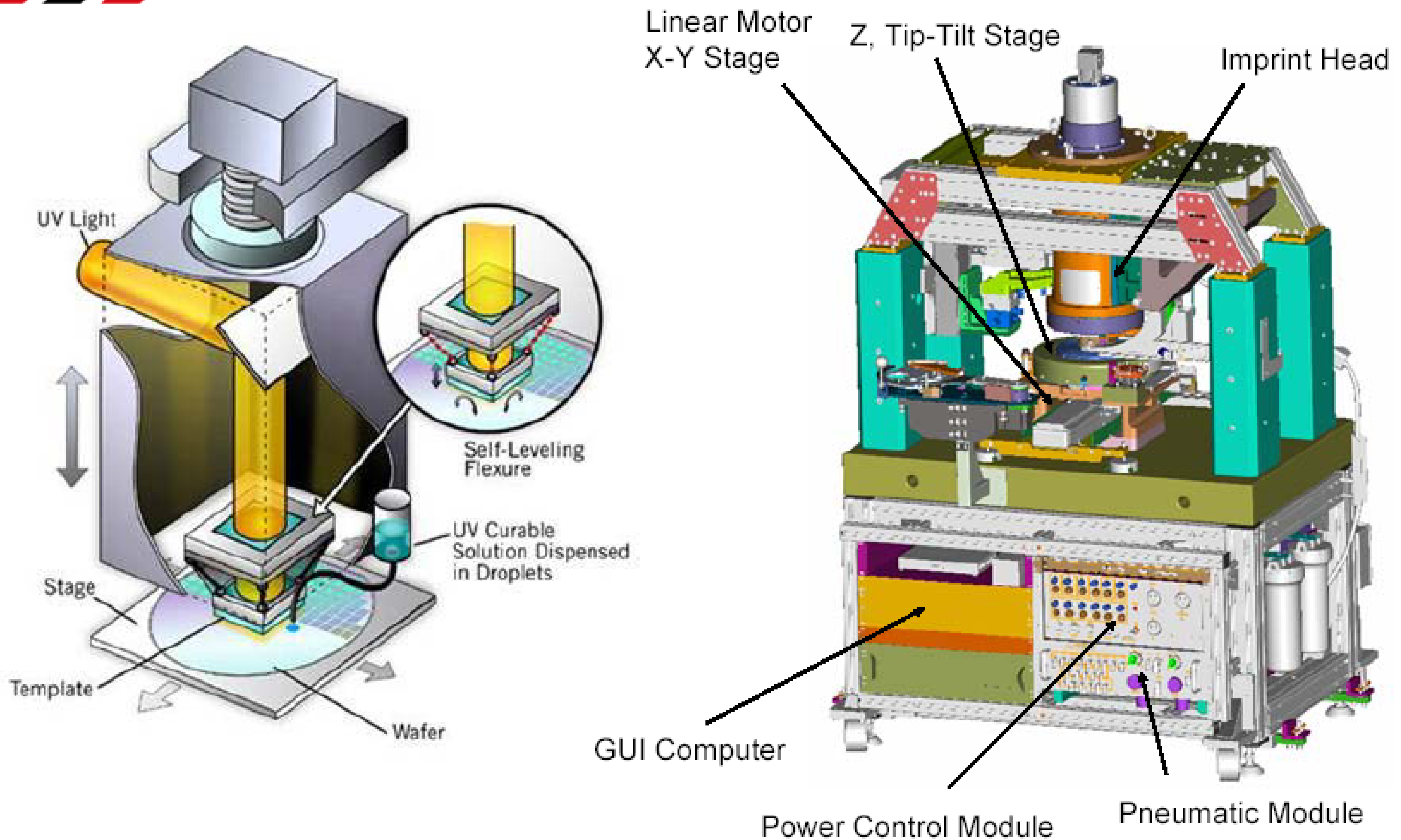
Imprio 55 System Schematic



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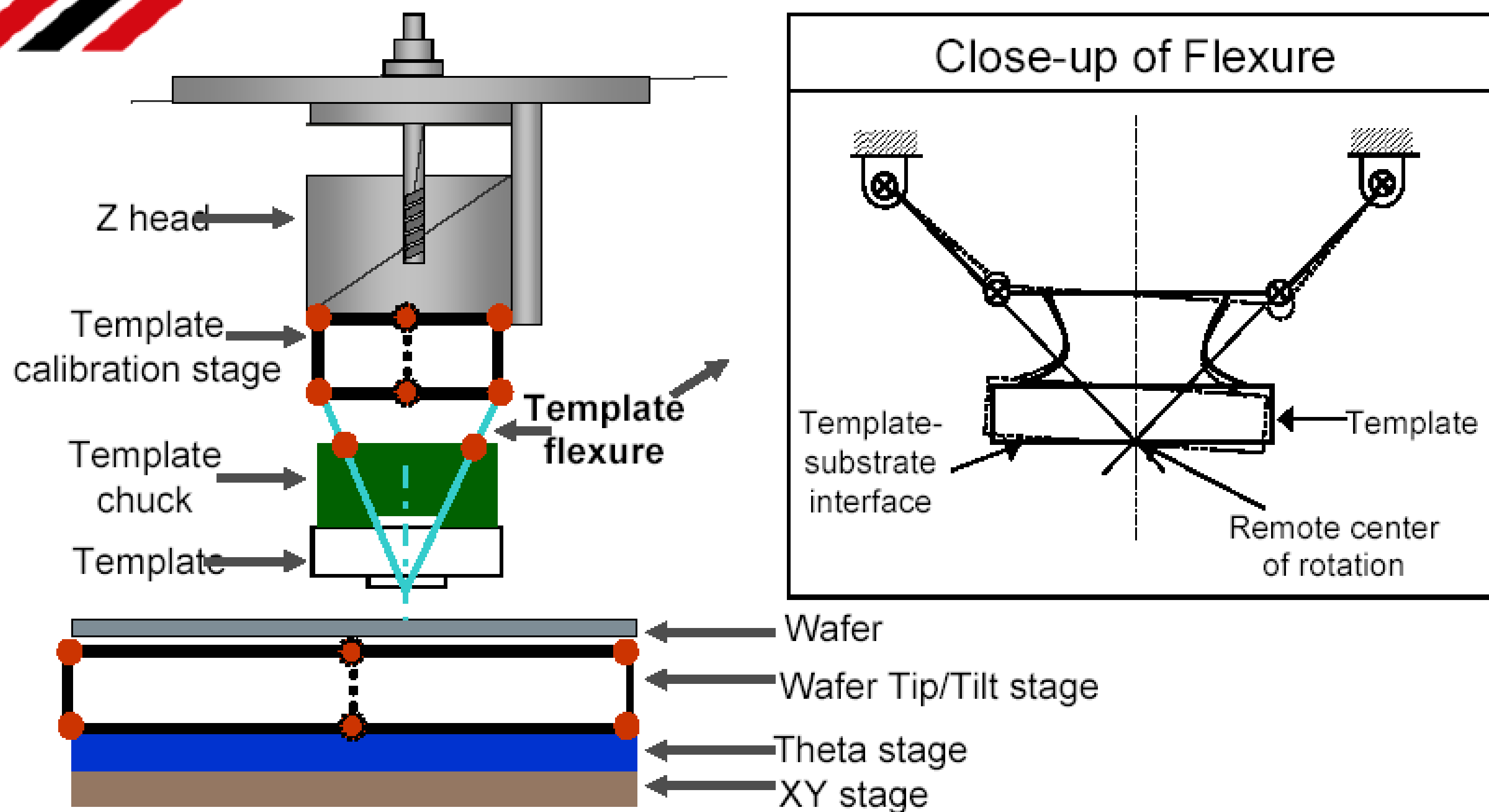
Self-Leveling Template Flexure



Leveling without translation = uniform residual layers and fine align

Separation normal to wafer = no feature shear

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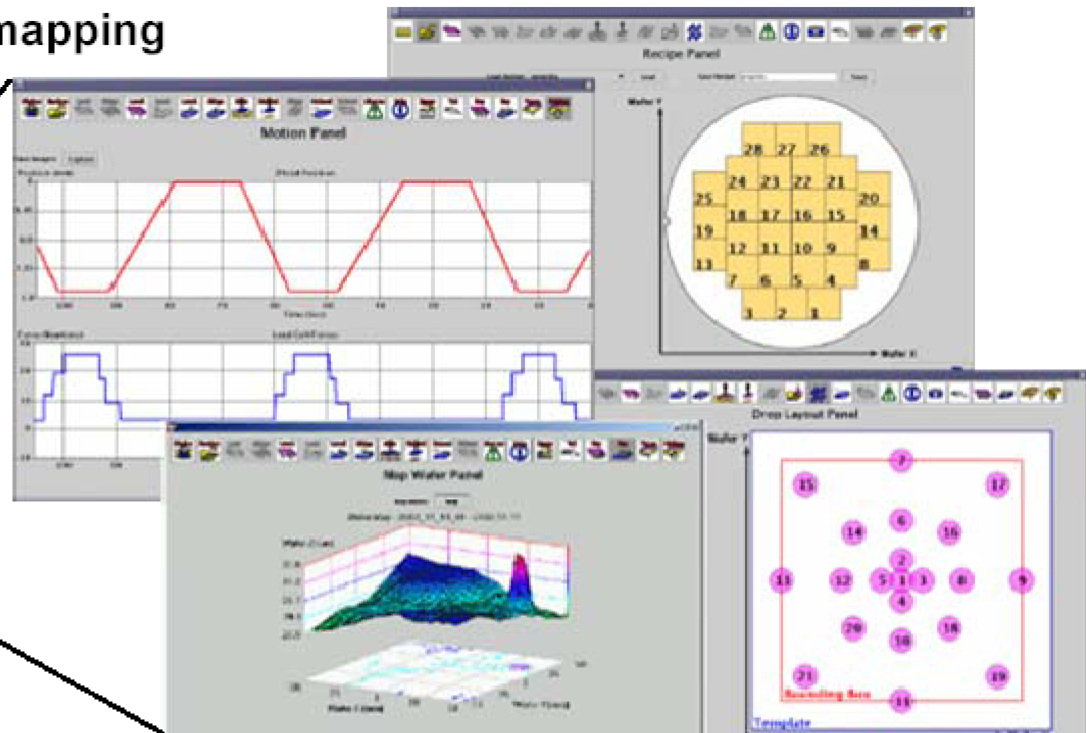
Advanced Software and Diagnostics

- User-friendly graphical user interface
- Ability to create custom drop patterns and manage imprint recipes
- In-line motion and force monitoring capability
- Wafer and template mapping



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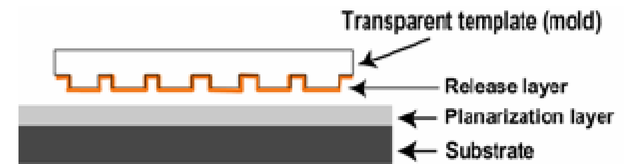
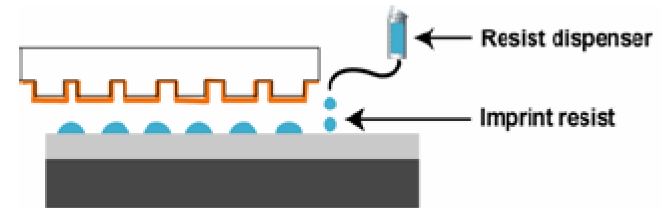
Step & Flash Imprint Lithography (S-FIL™)

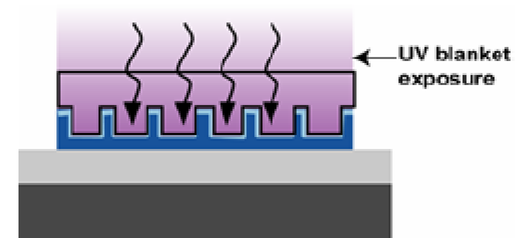
1. Orient pre-planarized substrate and treated template



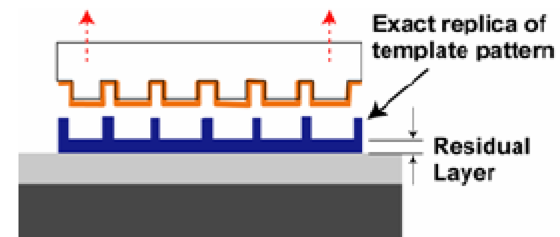
2. Dispense drops of UV-curable, low viscosity Imprint resist



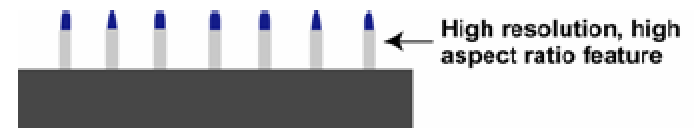
3. Lower template, fill pattern, and polymerize imprint fluid with UV light (at room temperature, low pressure)



4. Separate the template from the imprinted substrate



5. Halogen break-through etch followed by oxygen reactive ion etch



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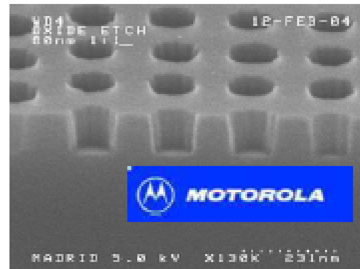
Robust S-FIL Etch

We have etched into

- Imprint layer
- Planarization layer
- Substrates
  - Silicon
  - Silicon dioxide
    - Structures etched through 1000 A of oxide to stop on Si
    - 80 nm 1:1
  - Aluminum
  - Indium phosphide
  - Gold

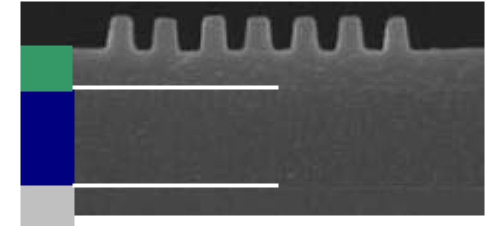


Starting Point:
Pattern transfer

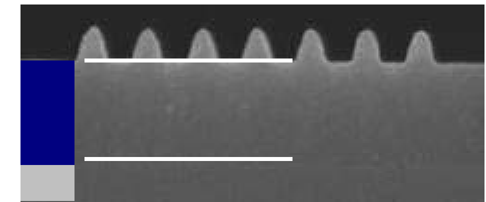
Imprint material

Planarization Layer

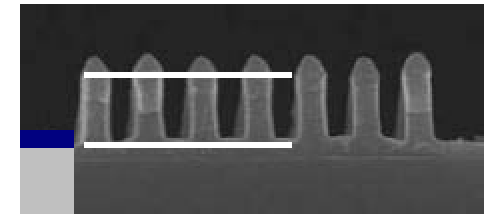
Substrate



Step 1:
Halogen break-thru etch



Step 2:
Oxygen Etch



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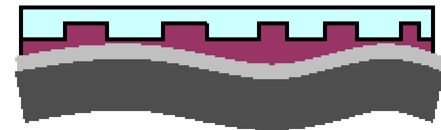
S-FIL Reverse Tone (S-FIL/R)

1. Imprint Step (Standard S-FIL Process):
   - Non-Si imprint material
   - Active planarization

2. Spin-on Hardmask:
   - Si-containing material
   - Configurable Si content for enhanced control of etch selectivity



3. Mask Definition Etch:
   - Endpoint on imprint material
   - No faceting of features

4. Pattern Transfer Etch:
   - CD less sensitive to residual layer uniformity
   - Good for non-flat substrates

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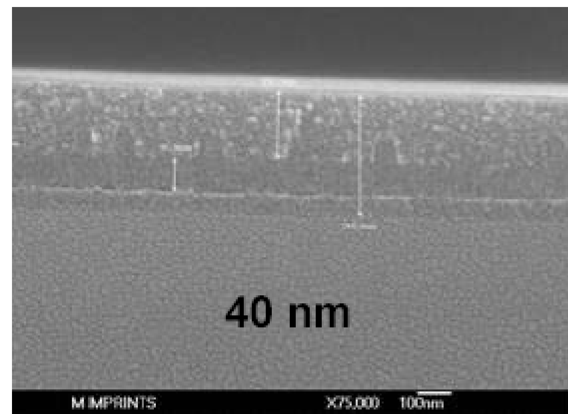
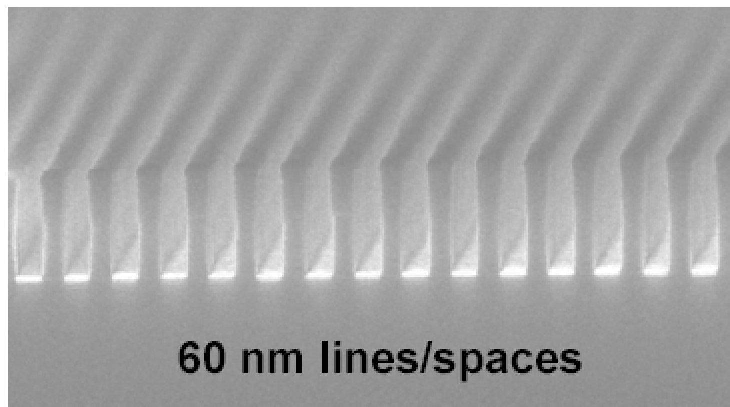
Robust SFIL/R Etch

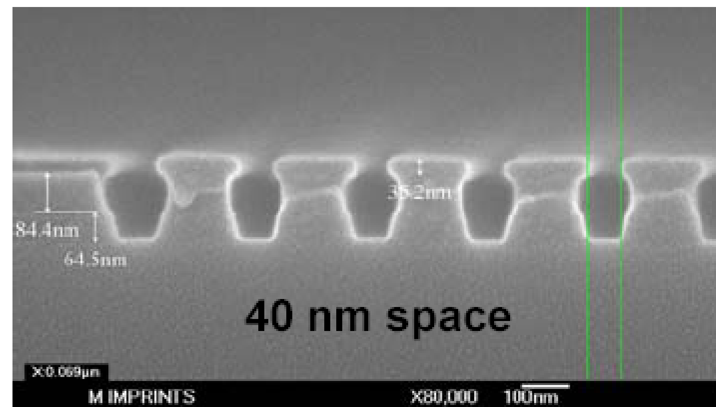
- Imprint on rough substrates
- Quicker spread times
- Higher Si content materials
- Better CD control - no faceting



Spun on silicon top layer



Anisotropic planarization etch



Lift off structures from a Isotropic planarization etch

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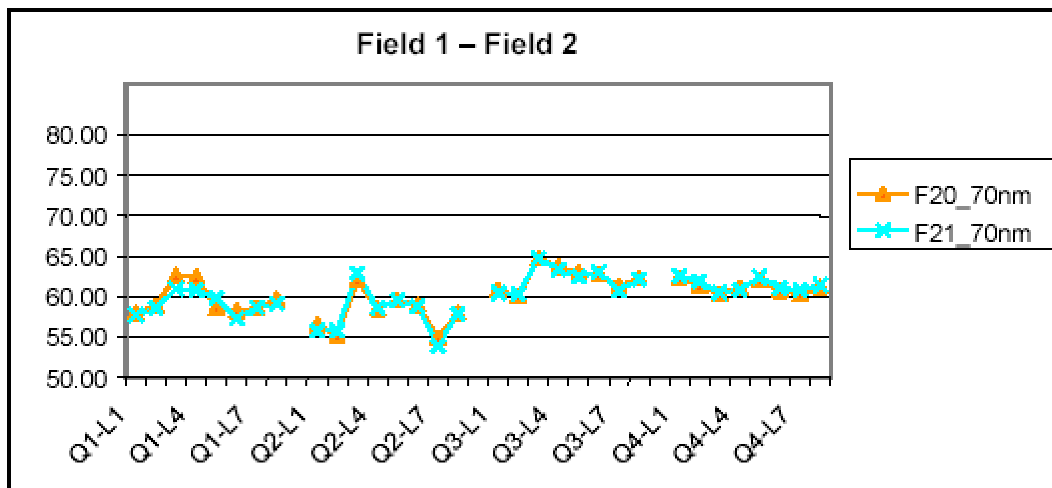
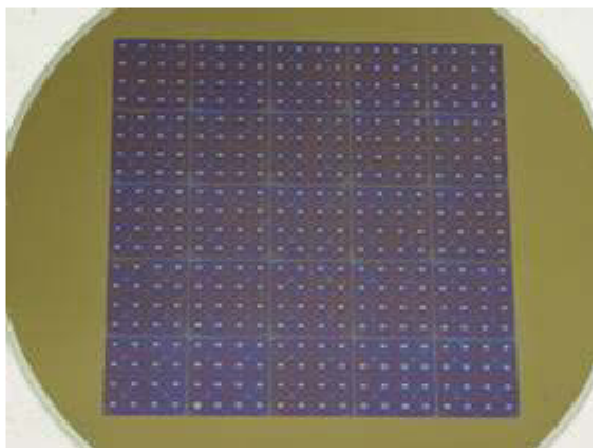
High Resolution: As Good as the Template

- CD repeatability
- Template quality
- Pattern independent
- Residual layer control





Difference (Field 1 – Field 2)

Mean:	0.0 nm
3 sigma:	1.3 nm

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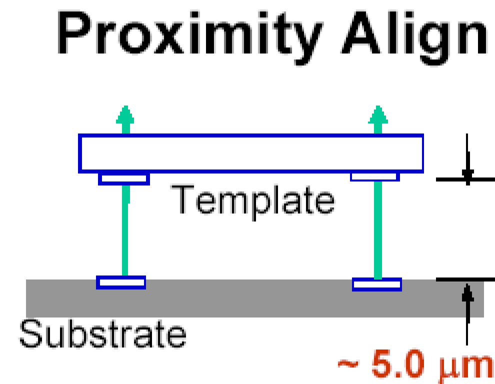
Fine Overlay

- Overlay X,Y and theta for 25 mm fields over a 200 mm wafer
- Corrects for
  - Field rotation on layer 1
  - Wafer rotation on layer 2 to layer 1
  - Template rotation on layer 2
- Enabled by
  - Direct template to wafer imaging
  - Leveling and material spreading without XY translation
  - Low pressure, room temperature process

Proximity Align



Imprio 100	X-mean (nm)	Y-mean (nm)	$3\sigma_X$ (nm)	$3\sigma_Y$ (nm)
Wafer A	29	-8	325	374
Wafer B	-12	20	252	225
Imprio 55	**X-mean (nm)**	**Y-mean (nm)**	**$3\sigma_X$ (nm)**	**$3\sigma_Y$ (nm)**
Wafer A	-63	145	643	944
Wafer B	-55	150	740	953

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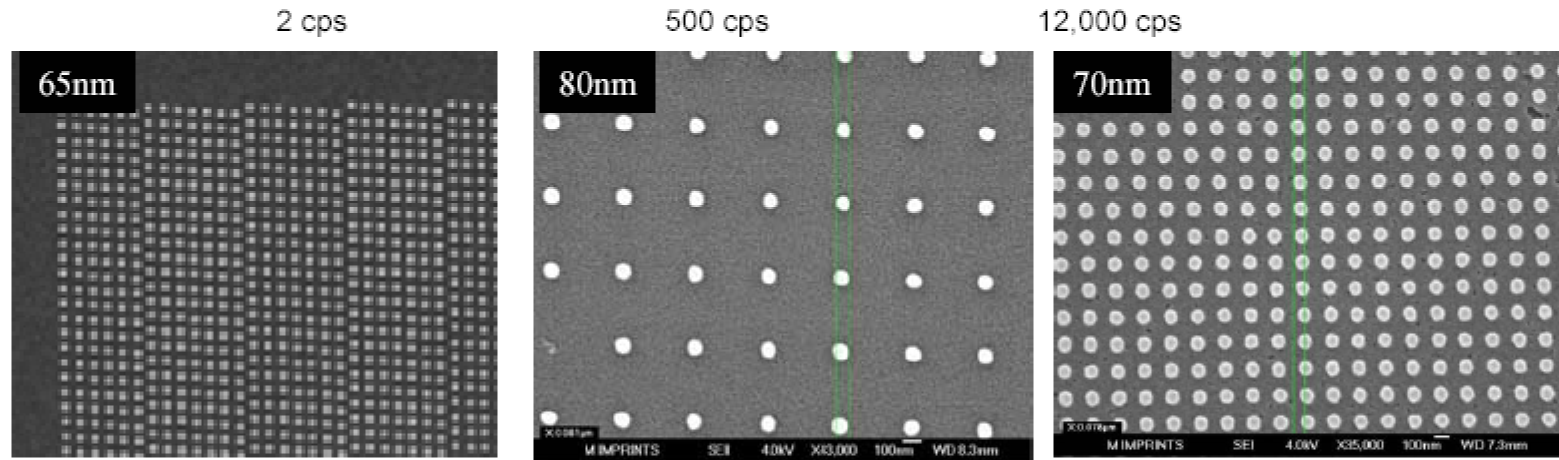
S-FIL Material Flexibility

- **Almost any UV curable formulation can be imprinted from monomer mixtures to high molecular weight polymers**
  - Viscosities from 2 cps up to 12,000 centipoise
  - 300 drop sub nanoliter dispense and "spin on" materials



  - Pressures from 1/20 of an atmosphere over 25 x 25 mm field to 10 atmospheres over a 5 x 5 mm field

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