The Path from Lab to Fab

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EUVL Symposium
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Inpria Design Principles

- Small Molecular Building Blocks
- Photocondensed Molecular Metal Oxides
- High EUV Absorbance
- Robust Etch & Mechanical Properties
Development Strategy

Patterning Performance

Fab Integration (Lab2Fab)

+ materials, equipment, university and device manufacturer partners
## EUV Platform Development

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<th>1Q14</th>
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<td>YA-AA</td>
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- **First in Gen 2 family**
- **Resolution**
- **Low sensitivity**
- **Insufficient contrast**

**SPIE’14**

- **First integration**
- **Proxy material**

### Images

- **22nm HP**: ~90 mJ/cm²
- **16nm HP**: ~90 mJ/cm²
### EUV Platform Development

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- Substantially improved sensitivity and contrast
- Conventional organic solvents for casting & develop
- Negative tone

- Sn based: absorbance 19/µm (~4-5X typical CAR)
- Target film thickness ~22-30nm
YA-BA: Pitch 32nm, 59 mJ/cm² (PSI)
CD 16.5nm, LWR 1.7nm
YA-BA: Pitch 32nm, 39 mJ/cm^2 (PSI)
CD 14.0nm, LWR 2.2nm
YA-BA: Pitch 32nm, 36 mJ/cm² (PSI)
CD 12.2nm, LWR 2.5nm
YA-BA Contact Imaging (BMET)

26nm 1:1 Contacts
36mJ/cm²
1.3nm CDU (1σ)
C31P44 quad illumination

22nm 1:1 Contacts
36mJ/cm²
C26P44 quad illumination
YA-BA Contact Imaging (BMET)

Size (26hp to 18hp)

At limit of reticle

18hp ~ equivalent to 16hp on NXE3300

Bias

Quad illumination

C31P52  36mJ/cm²
C28P52  30mJ/cm²
C26P52  25mJ/cm²
C26P44  36mJ/cm²
C24P40  36mJ/cm²
C23P36  36mJ/cm²
EUV Platform Development

1Q14  2Q14  3Q14  4Q14  1Q15  2Q15  3Q15  4Q15

YAxxA

YAxxB & YDxxAA

New systems in development

Further improved sensitivity and contrast
YD-AA Patterning (BMET)

Initial results
Further development underway
Development Strategy

Patterning Performance

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+ materials, equipment, university and device manufacturer partners
Track Integration

• Fab-compatible organic solvents
• Plumbed
  – SVDU
  – Gallon (with 5nm filter)
• Uniform coating
  – Unoptimized film thickness variation: 0.2nm (3σ)
Managing Metals

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Backside rinse (BSR)

Edge-bead removal (EBR)

Strip & rework

Wafer-wafer contamination
Wafer-Wafer Metal Contamination

Dry process monitor wafers (front / back) ➔ Plumb resist ➔ Coat batch with resist ➔ Remove resist ➔ Dry process monitor wafers (front / back)

TXRF  VPD-ICP-MS

Sn Atoms/cm²

Reference

Monitor
Backside Post Coat

1.0E+07  1.0E+08  1.0E+09  1.0E+10  1.0E+11

DL  Track A  Track B Trial 1  Track B Trial 2

Inpria
# Managing Metals

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Initial processes developed with path to solution

- Backside rinse (BSR)
- Edge-bead removal (EBR)
- Strip & rework
- Wafer-wafer contamination

[Logos: inpria, imec]
Outgassing

- Cleanables: pass
  - 3 materials tested
  - EUV & EB
  - No Sn in RGA signal

- Non-cleanables: pass
  - Undetectable (incl Sn)

- Pass conventional test
  - Provisional access to NXE3100 ✔

- Updated method under development w/ ASML
  - Film thickness vs absorbance
Initial Patterning on NXE3100

18nm HP
4nm LWR
85 mJ/cm²

24nm dense CH
C32P48
Quasar illumination
46 mJ/cm²

22nm dense CH
C31P44
49 mJ/cm²

Resist: YA80BA
Contact reticle not optimized for negative tone cell or characterized. Improved LCDU expected with reticle targeted for negative tone.
Pattern Transfer: Etch into SOC

20 nm lines

High selectivity provides large process window for SOC open

20nm Inpria Resist

100nm Spin-on-Carbon

EB expose

O_2:N_2 etch
The Path Ahead

Patterning Performance

Fab Integration (Lab2Fab)

Further improvements in RLS

Full support for regular sampling on NXE33x0
Thank You!

- Inpria team
- LBNL & SEMATECH  
  - Chris Anderson, Patrick Naulleau, and MET team
- PSI  
  - Yasin Ekinci, Michaela Vockenhuber, and team
- IMEC  
  - Danilo De Simone, Ivan Pollentier, Mieke Goethals, Geert Vandenberghe, and team

- ... and to all of our partners