EUV Lithography Programs at Albany NanoTech

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Outline

- Background
- Lithography Tools at ANT
- Facilities
- Programs
- Summary
The NYS Center of Excellence in Nanoelectronics

- **The College for Nanoscale Science and Engineering**: The first college in the nation for the education of the 21st century high tech workforce in nanosciences.

- **Albany NanoTech**: National and international R&D resource for the academic & industrial nanoelectronics communities.
- 750,000 sq. ft cutting edge facilities (with 65,000 sq. ft 300 mm Wafer Cleanrooms).
- Over $2.4B in programs underway at the CNSE facilities (in addition to the brick and mortar above).
- Partners include SEMATECH, IBM, AMD, Micron, Infineon, AMAT, Tokyo Electron, ASML
- Over 600 personnel on site, 1600 people by end 2007 with current programs
ANT’s Strategic Partnerships with Industry

- **SEMATECH North**
  - $403M program announced 7/02
  - Focus on EUV Lithography Infrastructure

- **TEL Technology Center America (TTCA)**
  - $300M program announced 11/02
  - Focus on equipment and process technology R & D

- **International Multiphase Prog. for Lithography Science and Engineering (IMPLSE)**
  - $400M program with ASML, IBM & ANT, announced 1/05
  - Focus on 193 nm immersion and EUV

- **IBM R&D Center**
  - $450M program announced 1/05

- **International Nanoelectronics VENTure (INVENT)**
  - $600M program with IBM, AMD, Infineon, Micron & ANT, announced 7/05
  - Focus on 193 nm immersion and EUV

- **AMAT-IBM-ANT**
  - $300M program announced 9/05
  - Focus on materials, process, and equipment technology
## Exposure Tools at ANT

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
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<tbody>
<tr>
<td>ASML AT:1150i</td>
<td>193 nm Immersion, NA 0.75</td>
</tr>
<tr>
<td>ASML AT:1200B</td>
<td>193 nm Dry, NA 0.85</td>
</tr>
<tr>
<td>ASML XT:1700i-P</td>
<td>193 nm Immersion, NA 1.2</td>
</tr>
<tr>
<td>ASML EUV Alpha Demo</td>
<td>EUV, NA 0.25</td>
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The EUV Resist Test Center supports development of resists meeting production requirements. The EUV RTC can also support mask development.

The EUV RTC will accelerate EUV resist development by providing processing infrastructure to resist researchers.

Exitech MS-13 EUV Microstepper

Rohm & Haas MET 1K
SEMATECH North
EUV Mask Blank Development Center

- Advanced Cleans Lab
- EUV Reflectometer
- Ion Beam Deposition
- Pod Washer
- Advanced Defect Inspection (2006)
- Lasertec M1350
- Optical microscope
- FIB/SEM
- Advanced Cleans (2006)
- Interferometer/Phase Contrast Microscope
- Atomic Force Microscope
- Mask defect Tool
- X-ray Reflectivity

Total area = 655 m²
Accelerating the development of defect free EUV mask blanks in collaboration with commercial mask blank and equipment suppliers.
<table>
<thead>
<tr>
<th>Timing</th>
<th>Event</th>
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<tbody>
<tr>
<td>Q1 – Q4 2005</td>
<td>Integration of Alpha Demo #1</td>
</tr>
<tr>
<td>Q1 2006</td>
<td>First data on imaging, overlay, throughput</td>
</tr>
<tr>
<td>Q2 – Q3 2006</td>
<td>Installation of tool in Albany</td>
</tr>
<tr>
<td>Q4 2006</td>
<td>INVENT/IMPLSE commence development work</td>
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### Alpha Demo #1 Full-field EUV Scanner Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tbody>
<tr>
<td>NA Range</td>
<td>0.15 – 0.25</td>
</tr>
<tr>
<td>Imaging -- dense lines</td>
<td>40 nm</td>
</tr>
<tr>
<td>-- iso lines</td>
<td>30 nm</td>
</tr>
<tr>
<td>-- contacts</td>
<td>55 nm</td>
</tr>
<tr>
<td>Flare</td>
<td>16%</td>
</tr>
<tr>
<td>Overlay</td>
<td>15 nm</td>
</tr>
<tr>
<td>Throughput</td>
<td>6 wph</td>
</tr>
</tbody>
</table>

CDU = 10% resolution  
Throughput is at 5 mJ/cm²
INVENT Program EUVL Plans

- **Resists**
  - Goal: Develop resist process for <=32nm node
  - Approach: Screening & characterization of promising commercial resists on Alpha Demo

- **Reticles**
  - Goal: Understand defect issues and lifetime under storage & exposure conditions
  - Approach: Establish methodologies for reticle cleans and metrology with suppliers

- **Process**
  - Goal: Assess EUVL process technology including RET & tool performance on imaging & overlay
  - Approach: Integrate EUVL tool in process flow

- **Tool**
  - Goal: Determine EUVL Alpha Demo tool performance and reliability
  - Approach: Work closely with ASML to meet INVENT member-specified tool performance
CNSE takes delivery of compact high power EUV source for advanced EUV research

- **EUV Source Schematic**
  - Electrodeless Z-Pinch™ EUV Source
  - 10W in 1% BW (20W in 3.5% BW)
    - Continuous into $2\pi$ with Xenon
  - 1 kHz repetition rate (controllable)
  - Controllable source size and power

- **Magnetically Confined Z-Pinch Region**
- **Inductively Coupled Plasma Loops**

- **View of visible light from Z-Pinch**
Compact Source Programs

- Development of actinic metrology methods
- Exposure induced resist outgassing characterization
- EUV mask imaging microscope
  - High resolution and stepper emulation modes
  - Mask contamination in the presence of introduced hydrocarbons
    - Effect of contamination on mask performance
    - Effectiveness of mask cleaning procedures
ANT Strategy to Address EUVL Critical Issues*

1. Availability of defect-free mask.
   - SEMATECH North MBDC
   - Mask Imaging Microscope R&D using Energetiq source
   - INVENT & IMPLSE program activities

2. Lifetime of source components & collector optics.
   - INVENT & IMPLSE program activities

3. Resist resolution, sensitivity & Line Edge Roughness
   - SEMATECH North RTC
   - INVENT & IMPLSE program activities

* Source: 3rd International Extreme Ultra Violet Lithography Symposium
• Albany NanoTech has six ongoing industrial consortia and 65,000 square feet of 300 mm wafer cleanroom.

• Albany NanoTech will take delivery of a high NA 193 nm immersion system and an EUV alpha tool in 2006.

• Albany NanoTech consortia and infrastructure have been developed to address lithography and other processing technologies to prepare for the 32 nm technology node and beyond.

We hope to see you all in Albany soon!
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