Accelerating the next technology revolution

The EUV Mask Infrastructure (EMI) Development Imperative

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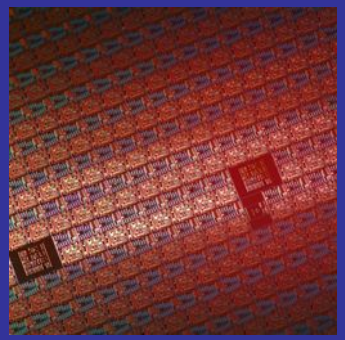
October 2010



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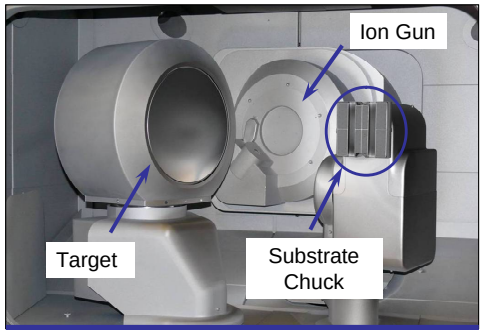
SEMATECH's EUV Mask Defect Reduction Strategy

- Objective:
  - enable commercially available defect-free masks to the industry at reasonable cost
- Resources:
  - Over $200M invested in development and 50+ engineers and scientists on staff, and active supplier collaborations
- MBDC (Mask Blank Development Center)
- RMDC (Resist & Materials Development Center)
- Infrastructure Creation
  - Create funding mechanism for critical mask tool development via a EUV mask infrastructure (EMI) consortium



Multilayer EUV Mask Blank DepositionTool

Lasertec M1350 / M7360

Sensitivity M1350 / M7360: 55 / 40 nm on substrate and 73 / 45 nm on multilayer

AGC
College of Nanoscale Science & Engineering, University at Albany, State University of New York
IBM
GLOBALFOUNDRIES
intel
SAMSUNG
SEMATECH
Veeco
ASML
DNP

Surface Profiler SPM

FEI FIB/SEM/EDX

Development of defect-free EUV blanks

Hamatech ASC 5500

SEMATECH's actinic capabilities

- EUV Micro Exposure Tools
  - Albany eMET with 22nm resolution, 6k wafers/year
  - LBNL MET with 18.6 nm resolution, 1500 wafers/year
  - EUV Alpha Demo Tool (ADT): 28-25nm resolution, ~600 wafers/year
- LBNL Actinic Inspection Tool
  - 0.35NA, 16nm (1x) mask imaging

EUV Defect-free Mask Strategy Concept

Objective	Approach	
Define what a defect is	Printability	SMT
Find them	Inspection	EMI
Eliminate as many as possible	Process Optimization	SMT
Mitigate the rest	Repair, Pattern shift	

SEMATECH Mask-related Oral Presentations this week

- Process Window of EUV Mask Defects On Wafer
  - Kwon, et al: Monday 14:20

- SEMATECH's EUVL Mask Defect Reduction Program, Defect Sources and Mitigation Strategies
  - Goodwin, et al: Wednesday 13:40

- Substrate, Blank, and Mask Cleaning Contribution to EUV Mask Defectivity and Lifetime
  - Rastegar, et al: Wednesday 15:00

SEMATECH Mask-related Poster Presentations this week

- EUVL Mask Blank Defect Inspection Capability at SEMATECH
  - Ma, et al
- Modeling growth of defects during multilayer deposition of EUV blanks by level set method
  - Jindal, et al
- SEMATECH's infrastructure for defect metrology and failure analysis to support EUV mask defect reduction program
  - Lin, et al
- EUV Actinic Mask Imaging with the AIT and a future to 8 nm and beyond.
  - Goldberg, et al
- Aerial images phase measurement with the AIT: a new dimension in mask metrolog
  - Mochi, et al
- Low defect EUVL mask blank deposition tool process characterization and modeling
  - Kearny, et al
- Cross-sectional Film Characterization of Exposure-induced Carbon Contamination on Patterned EUV masks
  - Fan, et al
- Implementing Dual-pod Handling Capability on a Film Deposition Tool for Defect-free EUVL Mask Blank Development
  - Sohn, et al

Infrastructure Creation: EMI

- 1Q 2009 – Discussions with suppliers on potential tool programs
  - THE PROBLEM: Suppliers emphasize low ROI – need for development support
- July 2009 – workshop at SEMICON West gives mandate to SEMATECH to create EUV mask infrastructure (EMI) consortium
- August – November 2009 – Working groups develop proposals
- February 2010 – Seven members plus SEMATECH establish the EMI (THE SOLUTION PATH)
  - Technical and Management Teams established

EMI Portfolio

- BI (Blank Inspection)
- PMI (Patterned Mask Inspection)
- AIMS (Aerial Image Metrology System)

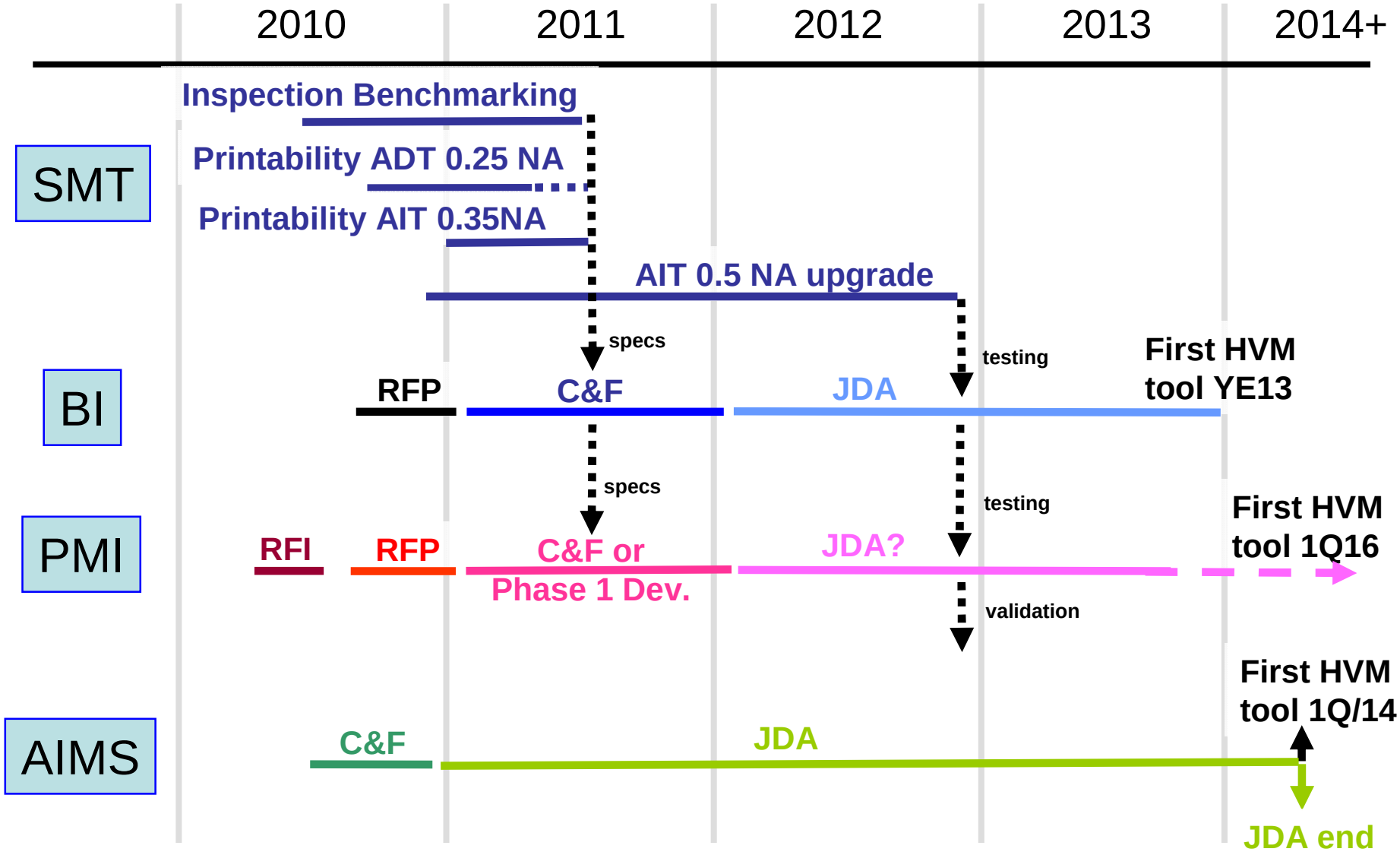
Program Phases	Exploratory (SEMATECH)	Concept & Feasibility (Supplier)	Development (Supplier)
Objectives	Groundwork, planning & consensus	Risk mitigation	Commercialization

EMI Project Status Update

- AIMS C&F phase of project launched
  - Work progressing on schedule since June start
  - Status presentation by Zeiss: Wednesday 14:20
- Blank Inspection Request for Proposals (RFP) initiated
- Patterned Mask Inspection Request for Information (RFI) completed and RFP initiated

EMI Project Schedule Overview: Scenario

(Scenarios based on best information available September 2010)



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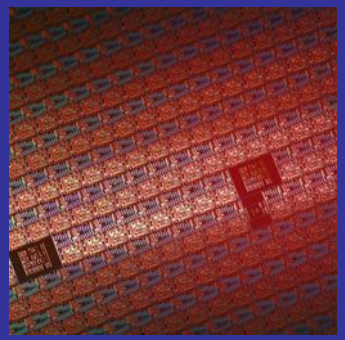
Project Summaries and Status



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Blank Inspection (BI) Plan Overview

- **Current capability and gap:**
  - 22nm HP: currently evolving commercial platforms are expected to fulfill this need.
  - Beyond 22nm HP: actinic inspection is necessary at some point in the mask process and BI is likely best option.

- **Approach:** Two part plan forward is proposed:
  - Benchmarking to define gaps and monitor closure
  - Concept study to characterize and mitigate technical risks and quantify financial risks

Blank Inspection Project Status

- EMI Members consensus plan and specifications completed.
- RFP (Request for Proposals) initiated on schedule.
  - Sent to supplier candidates August 17
    - 18 companies on the candidate list
    - Multiple supplier responses expected
  - Responses due November 1
- Target: development agreement in place with supplier partner 1Q11.

Patterned Mask Inspection (PMI) Plan Overview

- **Current capability and gap:**
  - 22nm HP: Tool suppliers' development plans provide high confidence of optical 19Xnm solutions for 22nm HP PMI.
  - Beyond 22nm HP: Significant development effort is necessary to optimize 19Xnm for ultimate limits and to create subsequent technology.
- **Approach:**
  - 22nm HP: No investment for development. Conduct benchmarking of evolving commercial platforms. Characterize printability data.
  - Beyond 22nm HP: Conduct concept study with one or more supplier partners to investigate feasibility of most promising concepts and characterize high-risk components.

Patterned Mask Inspection Project Status

- EMI Members consensus plan and specifications completed.
- RFP sent to candidate suppliers September 15th.
  - RFP structured as two parallel RFPs:
    - One for actinic photon-based solution
    - One for electron-based solution
  - Responses are due back from suppliers November 1.
- Target: development agreement in place with supplier partner 1Q11.

AIMS Plan Overview

- **Current capability:**
  - No EUV AIMS exists.
    - EUV small-field microscopes exist but do not emulate a scanner and are not suitable for high-volume mask manufacturing.
    - Defect and repair characterization by surrogate wafer inspection is possible but also not viable for high-volume mask manufacturing.

- **Approach:**
  - Complete C&F to detail design concept and mitigate high-risk tool elements.
  - Execute JDA to develop alpha and commercial tools with early access and preferential purchasing terms for EMI members.

AIMS Project Status

- Concept & Feasibility Study
  - Running on-schedule since June start with Zeiss.
  - Key Deliverables:
    - Project plan with schedule, resources, risks, costs
    - Design study with elements:
      - Optical system design and simulation
      - Software logical flowchart
      - Facilities requirements
      - Technical risks and mitigation plans
      - Commercial tool performance specifications
- Commercial Tool Development
  - Contract discussions ongoing in parallel with C&F.
  - Plan is to commence immediately after C&F completion.

Summary

- EMI is part of SEMATECH's overall strategy to provide a defect-free mask blank solution
  - Seven key EUV stakeholders plus SEMATECH working in EMI.
  - Management structure and technical teams active since Feb'10
- Technical Teams finalized plans and specs.
  - AIMS project running with C&F phase active at Zeiss. Plan to enter commercial development phase immediately after C&F.
  - BI and PMI projects completing exploratory phase with consensus plans and specifications done. Plan to enter C&F phase in early 2011.
- SEMATECH and EMI welcome all collaborative efforts to deliver needed EUV infrastructure as soon as possible