

Mask Factory Automation Workshop
February 9, 2005
SEMATECH, Austin, Texas

Executive Summary:

On February 9, 2005, SEMATECH Lithography Mask Strategy held a Mask Factory Automation meeting at SEMATECH in Austin, Texas. A review of the Lithography Mask technology section of the International Technology Roadmap for Semiconductors was also conducted prior to starting the Mask Factory Automation Workshop. Thirty-nine persons attended the Mask Factory Automation meeting from seventeen companies. Six of the eight SEMATECH member companies attended. (Hewlett-Packard and TSMC were not present).

AMD gave a presentation on mask automation, describing lessons learned from the wafer fab perspective. The workshop participants received a factory automation overview and AEC/APC overview from the eDiagnostics group of the International SEMATECH Manufacturing Initiative. The group then heard presentations from IBM, Dupont Photomask and Intel on the topic of the automation stressing the perspective from the mask factory. Freescale and Texas Instruments gave presentations on what requirements the wafer factory lithography area needs to most efficiently work with the mask factory. Wes Erck from Wes Erck Consulting gave an update on the SEMI P-10 standard. To wrap-up the workshop presentations, Professor Charles Weber from Portland State University talked about the economics of photomask manufacturing.

The workshop participants then broke out into two groups. The groups were asked to answer these questions:

- What can the industry do to facilitate mask factory/tool/process automation?
- Is mask factory automation needed?
- What technology/method(s) could be implemented easily/cost effectively? ("any low hanging fruit")
- Where should the work be done?
- Who does the work?

After the breakout groups answered these questions, the groups recombined into the main meeting room and reviewed each group's results. The common themes were combined and then each person was given a chance to vote on their top choices.

Results from the breakouts:

- Is mask factory automation needed?
Both groups said: "Yes, mask automation is required."
- What can the industry do to facilitate mask factory/tool/process automation?
This question generated many ideas, so like topics were combined in a topic group and each person was given a set of votes they could distribute amongst the topic groups. The working group concept received the most votes. This

concept was expressed as a mask industry council, or a mask industry automation task force (narrower scope). Standards came in second, which extends to communicating the standards that could be implemented today in the mask factory/tool environment. There is a still a strong need for a unique identifier on mask blanks, which was voted into third place.

- What technology/method(s) could be implemented easily/cost effectively? ("any low hanging fruit")

One gap/problem that got many responses was a unique blank identifier such as bar codes on blanks or a laser scribe number. Leveraging the learning from the wafer factory automation experience was expressed in abundance. Leveraging the use of existing standards that are used today, such as the adoption of SECS/GEM into the mask infrastructure.

- Where should the work be done? / Who does the work?

An international working group is proposed that includes both the commercial and captive mask shops (factories). SEMATECH should coordinate the working group. Some suggestions for the group are to collect best practices, to look at EPIT models, and to help define the scope of activity. The tool suppliers should be involved. I300I guidelines would be useful (actual use of, or refer to methodology).

SEMATECH's Lithography Mask Strategy Program team will review the workshop output and develop some follow activity/proposals for mask factory automation as a potential project.

MASC Day 1 Agenda - Mask Automation Meeting

Wednesday, February 9, 2005

Location: SEMATECH Austin, F-C

Meeting Purpose: Review the ITRS 2005 updates for Mask Technology. Review and discussion regarding mask factory automation capabilities versus semiconductor factory automation, with focus on information automation. Semiconductor factory expectations of mask factory and mask product regarding automation.

Meeting Expected Outcome: Proposed changes to the ITRS Mask tables will be identified, and owners of necessary follow-up actions will be identified. Increase the dialogue and activity for improving automation at the Mask factory. Proposals for follow on activity.

7:30	Breakfast	
8:00	ITRS Update	Scott Hector
10:00	Break	
10:20	Automation Meeting Start	Patricia Gabella
10:30	Mask Automation: Lessons Learned from the Wafer Fab Perspective - AMD	E.Christenson/A.Haskins
11:00	Automation Overview	Brad Van Eck
	- Factory Automation Overview	
	- eDiagnostics Group at ISMI	
	- AEC/APC Overview	
12:00	Lunch	
12:45	Automation Perspective Mask Factory	
	- IBM	Tom Faure
	- DuPont Photomask	Blaine Woodbury
	- Intel	Adnan Amoura
14:15	Break	
14:30	Lithography/Wafer Fab Requirements	
	- Freescale	Mike Hamilton
	- Texas Instruments	Bob Bennett
15:30	SEMI P-10 Update	Wes Erck
16:00	Economics of Photomask Manufacturing	Prof. C. Weber
16:30	Breakout Directions	Patricia Gabella
	Breakout	All
17:30	Wrap-Up/Close	
18:30	Dinner	Zax Pints & Plates

APPENDIX – Notes from workshop

Mask Factory Automation General Discussion:

- Need a vision for place and go strategy
 - Note: KLA-Tencor did not attend the meeting
 - There is a volume difference between the semiconductor chip (wafer) manufacturing business versus mask manufacturing business
 - ? Do we have any ROI models?
 - Need a 3rd party list
 - Mask cycle time much shorter than wafers
 - Whether minutes or hours -> you can “fingerprint” a tool
 - Even long processes
 - can have predictor elements & can use predictor software
 - multi-variant analysis
 - within wafer variability
 - Mask yield 0 or 1 (tough requirement)
 - ? Maybe you should put together a mask council?
 - mask manufacturers have some unique areas vs. wafer fabs
- (ex: of SEMATECH models for councils...)
- yes group interested
 - Need a home to discuss this
 - low volume statistics (have they been/can they be applied to mask manufacturing?)
 - ?How to not start from scratch?
 - AEC/APC has exhibitors
 - ?Is list overwhelming?
 - ?Where to start?

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- -Barcodes on blanks – Needed!!!
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- Writers – drive standard formats
 - Japan driving a standard effort, is it useful?
 - Drive down to where the output is the same
 - ?Is SELETE standard driving a standard output?
- Example – OK flow
- Receive OASIS -> direct transfer to write tool -> P-10 picks up: standard job deck -> follow up
- Example – also OK flow
- Receive OASIS -> 1X fracture -> goes to write tool -> P-10 picks up: standard job deck -> follow up
- ?Quantify? Like cycle time

- 50% decrease in cycle time
 - ? Do you track productivity?
 - Off-line time analysis
-
- ?What amount of mask information goes to the wafer fab?
 - ?What do you do with this data?
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- PSU – uses steering committee member from merchant

Breakout Group Recombined
IS MASK FACTORY AUTOMATION NEEDED?
Data information automation
All agree

WHAT CAN THE INDUSTRY DO TO FACILITATE MASK
FACTORY/TOOL/PROCESS AUTOMATION?

Vote	Structured Brainstorming Ideas
18	<p><i>Working Group</i></p> <ul style="list-style-type: none"> ▪ Working together to define a coherent set of information reporting needs/standards to mask tool suppliers ▪ Convene industry working group that would communicate with capital equipment supply base on the need to implement SECS/GEM for mask process tools ▪ Insist on SECS/GEM compliance from all mask tool suppliers ▪ Drive standard requirements for tool communication on reticle tools ▪ AEC standards – enable supplier / customer ▪ Drive SECS/GEM compliance with equipment suppliers ▪ Experienced wafer fabs to provide ‘consulting’ service on implementation of automation and data management
16	<p><i>Standards</i></p> <ul style="list-style-type: none"> ▪ Standard Status request format (fab request of mask status) ▪ Drive best practice forums for data analysis ▪ Agree on interface standards ▪ Create unified specs on data automation in mask house
12	<p><i>Blank Unique ID</i></p> <ul style="list-style-type: none"> ▪ Blank ID per T7 idea
10	<ul style="list-style-type: none"> ▪ SEMATECH to require all supplier projects to support SECS/GEM ▪ Define and agree on requirements; Prioritize ▪ Put communication standards / protocol into tool purchase specs ▪ All new tool delivered to members to be SECS/GEM compatible
4	<ul style="list-style-type: none"> ▪ Foster JDP’s between tool suppliers, SECS/GEM specialists, mask

	<p>makers</p> <ul style="list-style-type: none"> ▪ Project idea – collect all data on all ebeam writer, analyze
2	<ul style="list-style-type: none"> ▪ Worldwide standardization, USA, Europe, Asia
2	<ul style="list-style-type: none"> ▪ Establish common classifications for tool and process failures
1	<ul style="list-style-type: none"> ▪ Find commonality with IC fab equipment and leverage ▪ Coordinate mask-shop specific investments
0	<ul style="list-style-type: none"> ▪ OASIS

WHAT CAN THE INDUSTRY DO TO FACILITATE MASK FACTORY/TOOL/PROCESS AUTOMATION?

Structured brainstorming ideas groups by topic:

- Working Groups
 - Form an mask industry automation task force
 - Form council to determine common needs and communicate to mask equipment suppliers
 - Working groups
 - Commit to factory automation for mask (like it is done for wafer, commit money and resources)
 - Join forces
 - Define common needs for mask factory automation software
 - SEMATECH conducts a benchmarking survey on status and needs
 - Generally open SEMATECH to all players – not just SEMATECH members
- Standards
 - Require equipment suppliers to meet automation standards
 - Standards
 - Standardization of specification
 - Implement standards
 - Do not block standards in belief to gain competitive advantage
 - Standardize data formats for design data sent to mask shops
 - Standardize data formats for job decks
 - Standardize data format input to mask writers
- Fab Learning
 - Leverage fab learning and solutions
 - Use wafer approaches
 - Prioritize learning from wafer automation – what would work cost
 - 3rd party experts (2/topic)
 - All players to be included to participate in round table discussion
 - Periodically share BKM in workshop like this
 - Use current best practices (i.e. Intel diva)
 - Dynamic mask scheduling based on wafer fab lot status
 - Identify mask house difference with fabs
- Customer Data Format
 - XLM delivery of mask quality results data to customer

- Download all data to data management system (like wafer fabs) for ease of use by process engineers.
- Comprehensive mask data management software
- Develop capability for wafer fabs to have database on mask quality; inspection reports, CD, registration,...
- Education
 - SEMATECH to develop a supplier training plan & tutorials

“LOW HANGING FRUIT”?

- Blank ID
 - Implement wafer standards for masks
 - Blank ID 3Xs; Blank ID; Unique blank ID
 - Standardize a location to put RF ID'S on blanks
 - Blank ID with laser scribe
 - Bar codes on blanks
 - Introduce blank ID
 - In standards
 - In products
- Leverage
 - Leverage the expertise and solutions from wafer fabs/third party suppliers
 - Mask suppliers copy/acquire SECS/GEM code from 3rd party outfits that service wafer fabs
 - Implement SECS/GEM
 - XML data starting
 - XML based result files
- Stand Alone Automation/Point Source
 - fault detection & collection ex: SEMY, Brookside
- RF-ID
 - Tracking by RF-ID
- Barter solutions
 - Horse trade solutions
- Vendor Data
 - Electronic vendor data
- Uniform Coordinate system
 - Define uniform coordinate system across
 - Blank inspection
 - Writers
 - Inspection
 - Metrology
- APC
 - APC data collection for tool health status
- DIVA
 - Auto defect inspection classification

- OEB standards
 - Implement a complete standard for job decks and writer format
 - Standard format for a ebeam
 - Common pattern data format
- Cross-reference
 - Cross reference 3rd party solution providers
- Commitments
 - Commitments by equipment suppliers for 5yr outlook
 - Common vendor data standards, SECS
 - Force tool suppliers to comply with
 - MEMS standards
 - GEM/SECS standards
 - SECS/GEM
 - Drive adoption of SECS/GEM by mask equipment supplier
- Eliminate unnecessary mask specifications

WHERE SHOULD WORK BE DONE? WHO SHOULD DO THE WORK?

- International working group – both commercial and captive shops
 - SEMATECH coordinate
 - Scope
 - Best practices/standards
 - Look at EPIT model
 - High profile champion
- Tool suppliers
- I300I guidelines would be useful