EUVL Source Workshop
October 29, 2001
Matsue City, Shimane Prefecture, Japan

Executive Summary
The third Extreme Ultra-Violet Lithography (EUVL) Source Workshop was held October 29, 2001 in Matsue City, Shimane Prefecture, Japan sponsored by International SEMATECH and ASET. Meeting chairs were Patricia Gabella of AMD/International SEMATECH and Glenn Kubiak of Sandia National Laboratory. The ASET chairs were Kazuya Ota of Nikon/ASET and Yoshi Gomei of Toshiba/ASET. 72 persons attended the EUVL source workshop, coming from lithography tool suppliers, EUVL source suppliers, semiconductor manufacturers, academia and consortia.

The lithography tool suppliers ASML and Nikon gave a presentation update on their EUVL source requirements. Eight EUVL source suppliers gave update presentations on their company's EUVL source efforts: Cymer, Gigaphoton, Innolite, JMAR, Philips, Plex, TRW, Xtreme; which includes both laser produced plasma for EUVL sources and discharge produced plasma for EUVL sources. Sandia National Laboratory gave an update presentation on discharge produced plasma technology under development there.

The meeting then split up into two groups for breakout to work on:

- Requirements update
- Reviewing developments in sources
- Critical issues, and identify top issues
- Thermal Management
- Next Meeting

The groups would like the tool suppliers to collectively clarify EUVL source requirements for required tool performance before the next workshop, scheduled for Q1 2002. More discussion, including more open discussion on the fundamentals of the source technology, definitions and common methods/terms to report out on source capability and how to show the rate of progress against required rate of progress – would help in reviewing developments in sources.
Group 2 voted on their top critical issues
(1) Increase EUV efficiency
(2) Heat removal, heat dissipation
(3) Debris & source element life; plasma resistant materials
Group 1 brought up the point that showing sustained operations of a source which included the critical issues (such a power, debris, stability) being monitored and documented was an important next step for EUVL sources.

Common themes in both groups were the ability to talk about source parameters using the same definitions, and same collection methods. Some of these definitions and methods are already developed, and the community would have

to adopt them (ex: ASML's definition of collectable power; ASML's source metrology "flying circus" effort and the metrology methods utilized).

The desire is to keep the EUVL source meeting frequency at two per year, one held in conjunction with the EUVL Workshop which is held in the fall of the year (and 2002 plans are underway). SPIE Microlithography is a good rallying point for another EUVL source workshop and the group recommended a weekend meeting, preferring the Sunday (March 3, 2002) of the start of SPIE Microlithography 2002.

Appendix
Flip Chart - Kubiak's breakout group (Group 2, Room 401)

1) Update Requirements
- ASML, Nikon & Canon to clarify and update requirements before Q1 2002 workshop
- Establish source metrology standards – Flying Circus was excellent start, but not all developers use the equipment/conventions: Work on this as part of Q1 2002 workshop

2) Workshop format - for better reviewing of developments in sources
- Some would like more discussion of issues, fundamental limits (include independent research community)
- Going forward, expectation is that source developers will have less revealing discussion of their solutions due to competition. Workshop should modify format to have developers focus more on showing specific progress toward pre-defined benchmarks without discussing "how". Also show rate of progress being made and establish what the rate of progress and learning needs to be to meet commercialization schedule.

3) Identify critical issues in source development
- Increase EUV efficiency
- Heat removal, heat dissipation
- Debris & source element life; plasma resistant materials
- Cost of ownership
- High volume manufacturability

?At what power/cost would an alternate to EUVL be used?

Voted on critical issue priorities:
#1 - Increase EUV efficiency
#2 - Heat removal, heat dissipation
#3 - Debris & source element life; plasma resistant materials

4) Was thermal Management covered adequately?
Not well-covered by presentations.
Must establish good benchmarks to measure progress

5) Next meeting
- 1-2 days Thurs/Friday before SPIE Microlithography – 8 votes
- 1 day, Sunday or Friday before SPIE Microlithography – 9+ votes
  - preferred Sunday before SPIE Microlithography
- 1-2 days not near SPIE Microlithography – 2 votes

Foils - Gabella's breakout group (Group 1, Room 501)

1) Critical Source Issues

- Maybe we should separate by LPP & DPP (did not do)
- Lifetime of collector mirror
- Larger collection mirror for large collection angle
- Sustained operations of a source: collective work (debris, power, stability, etc…)
  - Fully integrated source provides clean power at required operation specs
  - Concept of how to collect; debris…
- Fundamental understanding of plasmas that produce EUV (pre-competitive)
  - Spectra different for LPP & DPP
  - On the university side, little funding sources available for EUV source
- ?Is there sufficient funding for EUV source development?
- Power scaling
  - Order of magnitude away from requirements
  - Are the physics capable?
    - Note some think the physics are capable (physicist)
- Source and tool supplier dialogue
- Chip manufacturers -> thoughput required from tool suppliers will not be lowered
- Etendue / defined
  - Collectable power
  - Usable power into optical system
  - Definition
  - Could use ASML definition
- Can definitions and specifications be documented -> are we far enough along?
- Source meeting uniqueness -> what is trying to be accomplished? Other technical forums exist; How to approach integrated system
  - Review of what we know about the source? What conferences is it covered? Covered by SPIE Annual meeting, SPIE Microlithography & EIPBN (3 beams)
- Improved reporting on source parameters & definitions (pre-competitive)
- Can discharge be multiplexed?
- Meetings help keep up pace of competition
- Improved method
  - Collect supplier requirements
  - Collect source updates
  - (common language)

2) Next Source Meeting?x

- Do on weekend
- Saturday after SPIE Microlithography OK
- Could make summary talks shorter, since after conference

- Would like hardcopy at meeting
- CD-ROMs of meeting very useful

Vote by whole meeting at readout: hold next EUVL source workshop the Sunday of the start of SPIE Microlithography (March 3, 2002)

3) Is this meeting - meeting objectives?

- Useful meeting
- Organization with EUVL workshop -> many presenting essentially same thing tomorrow
- Panel discussions & how to generate open discussion