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2010 EUVL Workshop Reveals Progress in Scanners, Sources & Mask Defects

Maui, Hawaii (28 June 2010) — Extreme ultraviolet lithography (EUVL) is the semiconductor industry's best bet for extending Moore's Law and its inherent advantages make it an increasingly preferable choice for next-generation patterning, ranking technologists agreed at the 2010 International Workshop on EUV Lithography.

Speakers at the just-concluded workshop described steady progress in source power, resist performance, mask defect reduction, line edge roughness (LER) and in addressing other major EUVL challenges. Obert Wood of GlobalFoundries was honored with a Lifetime Achievement Award for his work in pioneering EUVL research, which included a 33-year career at Bell Labs. Also, Lithography scanner maker ASML was recognized with an Outstanding Contribution Award for significant technical achievements in developing EUVL scanners.

"Although scanner throughput needs improvement, the remaining specs for beta scanners are expected to be met.," said Vivek Bakshi, organizing chair of the workshop and President of EUV Litho, Inc. "Based on the present data, it appears that 40 W of sources will be available this year and 60 W next year for integration in the beta scanners. These sources should provide sufficient throughput for beta scanners to allow chip-makers to develop processes for high volume manufacturing (HVM)."

Sponsored by EUV Litho, Inc. the workshop is an annual R&D-focused meeting that brings together top researchers to outline EUVL technical challenges and brainstorm solutions for them. The 2011 International Workshop on EUVL is planned for June 2011 in Maui.

During this year's June 21-25 meeting, ASML announced it had received six orders for its NXE:3100 beta scanner, and plans to ship the first tool this year and the others in 2011. Jos Benschop, ASML Vice President Research, also said his company is looking at options of multiple suppliers and both laser produced plasma (LPP) and discharge produced plasma (DPP) technologies for EUV sources for beta scanners. Benschop cited lower manufacturing costs, increased fab capacity, and extensibility to resolution below 5 nm as advantages that EUVL has over competing technologies. "EUV offers the best balance between cost, shrink and absence of design restrictions," he said. "It is the only cost-effective way to extend Moore's Law."

Benschop and other speakers also defined technical areas of focus to prepare EUVL for HVM. In addition to source power, Wood of GlobalFoundries listed these as mask pellicles, mask defect mitigation, mask flatness, and more precise targets for acceptable LER.

Source Development

Discussion on EUVL sources dominated the meeting, including details from supplier Gigaphoton on its recent announcement of 104 W of power at intermediate focus (IF). The company expects to increase the source lifetime through improved thermal load handling. The source currently offers 2.5 percent conversion efficiency (CE), 7 .9 kW CO_2 laser operation, 20 percent duty cycle, 1.04 millijoules (mJ) pulse energy at IF with a 100 K Hz operation frequency. Invited speaker Krzysztof M. Nowak of Komatsu described methods of improving the efficiency of a CO_2 laser system. A test system has verified a 21.2 kW beam (M2 of 1.5) from simulation. The system also can achieve 20 kW operation at a 100 percent duty cycle.

Next-generation EUV sources are expected to have wavelengths shorter than the current 13.5 nm, according to several papers presented at the workshop. Padraig Dunne of University College Dublin (UCD) spoke of LPP-produced terbium and gadolinium plasmas as EUVL sources with 6.5 – 6.7 nm wavelengths. If multilayer (ML) reflectivity at these wavelengths is low and higher power density is needed to produce the plasma at these wavelengths, another wavelength such as 8.8 nm may be a better choice, Dunne noted.

Mask Defects and Metrology

The state of EUVL mask defects and the metrology for measuring them was another deeply discussed area at the workshop. Invited speaker Kenneth A. Goldberg of Lawrence Berkeley National Laboratory (LBNL) reviewed research work on the mask defect inspection at various labs around the world

Goldberg said EUV wavelength penetrates deep into ML pairs and for that reason is important to mitigate buried defects in ML-based EUV masks. He also noted that the current defect density at 30 nm needs to improve by 13X.

Despite these caveats, Goldberg said “all of the best solutions” for mask defect inspection at the resolution of 22 nm and below can be found in actinic inspection technology, which reviews defects at wavelength of 13.5 nm, the same wavelength used for printing circuits.

Other presentations

- Invited speaker Toshiyuki Uno of Asahi Glass Co. Ltd. reported mask blank defect density of 0.05 cm^2 at a sphere equivalent volume diameter (SEVD) of 54 nm, and 0.12 cm^2 at 34 nm SEVD. Frontside flatness of 38 nm and backside flatness of 48 nm has been achieved for the mask blanks, with a new ruthenium-based film being used for the capping layer. This new material has better chemical and thermal durability than current ruthenium films, he said.
- Iwao Nishiyama of SELETE, in a keynote talk, described Japan’s contributions to the development of EUVL infrastructure and current status of technology development in the areas of source, mask, resist and optics in Japan.
- Longtime lithography consultant Chris Mack described the challenges of reducing LER, which he called “the ultimate limiter for EUV and 193i based lithography.” He

also outlined missing elements in current LER models: EUV resist exposure mechanism, base quencher, and development rate uncertainty, among other topics.

- Hiroo Kinoshita, University of Hyogo in Japan, noted that experimental results on defect printability show that the critical dimention of a phase defect is less than 100 nm^2
- Sergey Zakharov of NANO-UV and Debbie Gustafson of Energetiq described their company's development of high brightness EUV light sources for actinic mask defect metrology.

A related meeting of the EUV Source Technical Working Group (TWG), organized by EUV Litho, Inc. and UCD, is planned for Nov. 13-15, 2010 in Dublin, Ireland. This workshop will focus on 13.5 nm and shorter wavelengths for next generation EUV sources as well as technology for high brightness metrology sources at 13.5 nm, and will include experts from EUVL and soft X-ray areas. Interested persons are invited to contact Bakshi at vivek.bakshi@euvlitho.com or padraig.dunne@ucd.ie to submit abstracts for papers.

About EUV Litho, Inc.

EUV Litho, Inc. is an organization that promotes EUV Lithography via consulting, workshops and education. Our company organizes the annual International Workshop on EUV Lithography as well as EUVL short courses around the world. Dr. Vivek Bakshi is the founder and president of EUV Litho, Inc. Please visit our website www.euvlitho.com for information on our latest events.

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