Source Workshop Presents Data on Readiness of 50 W EUV Sources to Support EUVL Scanners

Vivek Bakshi, EUV Litho, Inc.

The 2013 Source Workshop (Nov 3-7, 2013, Dublin, Ireland) brought together one of the world's largest annual gatherings of EUV source experts. I will focus on highlights of the workshop in this review.

In his keynote talk, Vadim Banine of ASML reminded the audience of the advantages of EUVL over double and quadruple patterning. He said that 50 W EUV sources have now demonstrated good dose control and are now available for deployment in the field. (ASML earlier this year acquired Cymer, a maker of high-power EUV Sources.) ASML also presented data on the feasibility of source power of 175 W at the first focus (720 W at source), and utilizing new, protective cap layers to give collectors six months of life.

Gigaphoton, the only other supplier of high power EUV sources, presented results of their development efforts. Although their source power is only 15 W with 2.5 % conversion efficiency (CE), their Sn laser produced plasma (LPP) technology has some key advantages for power scaling: dual wavelength pre-pulse, magnetic mitigation of debris and IR reduction technology for collectors, which they have developed with Rigaku. Collector rejection of IR radiation (10 μm from lasers) works with only 10% loss of reflectivity of collectors. Gigaphoton also showed that picosecond prepulse improves CE and reduces mists. High power lasers remain the drivers for source power scaling for ASML and Gigaphoton, and Gigaphoton is working with Mitsubishi on transverse flow CO_2 laser development and on an axial flow CO_2 laser development with Trumpf.

Mark Phillips of Intel in his keynote talk offered a balanced criticism of progress in EUV source technology. He said that 40-80 W of stable sources with master oscillator power amplifier (MOPA) technology and prepulse, linked to production level EUVL scanners (NXE 3300B), are needed to reestablish confidence in EUVL and process development. He expects these power levels to be available in the first half of next year, in keeping with the timeline of HVM insertion in 2017 by his company.

As Intel now expects that a pellicle will be needed for EUVL scanners, this position will help resolve the issue of choosing of actinic vs. e-beam technology for mask defect inspection, as only photon-based inspections can be used with a pellicle. This will hopefully result in an increased engagement between metrology source suppliers and mask defect inspection tool makers. Various makers of EUV sources for metrology application presented the performance of their sources, including Adlyte, Energetiq, Naextstream and NewLambda technologies. In an interesting paper, Serguei Kalmykov of Ioffe Institute, Russia demonstrated a 30-60 % increase in CE of Xe LPP sources via application of pre-pulse technology.

In other interesting results:

V. M. Krivtsun of RnD-ISAN /EUV Labs presented the concept of power scaling via increase of pulse energy, instead of the current option of pulse frequency for power scaling. His group also demonstrated

a closed tin system with tin jets at velocity of 5-15 m/s (max temperature of 350 C), with potential for power scaling for Sn LPP sources.

In another invited paper, Alexey Lopatin of the Institute for Physics, Russia presented his design of freestanding film elements for use as pellicles in an EUVL scanner. These films of merely 20 µm thickness have 84% transmission for EUV wavelength.

In the keynote on November 6th, Margaret Murnane, University of Colorado, Boulder, talked about coherent X-Rays from tabletop femtosecond lasers for applications in nanometrology. She discussed the ability to take high harmonic generation into the keV region and potential metrology applications in the Zepto (1E-21) and Yocto (1E-24) second physics!

Many excellent papers on multi-layer optics, modeling, BEUV, XUV sources and XUV Application were presented in the workshop and can be downloaded at the workshop's website at www.euvlitho.com.