



Workshop Summary

The 2011 International Workshop on EUV and Soft X-ray Sources was held Nov. 7-11, in Dublin, Ireland to explore how to advance the performance of current and future EUV sources.

The plenary talk of the Workshop was given by Konstantin Koshelev of ISAN, who presented new concepts for EUV sources based on both laser produced plasma (LPP) and discharge produced plasma (DPP). Koshelev proposed using "mist" targets for LPP to increase power and conversion efficiency (CE) and reduce debris. (A few other papers in the Workshop showed the advantages of this approach over current droplet-based targets.) For DPP, he proposed using a tin jet target.

ASML roadmap

ASML presented the current status of LPP and DPP technology. Current power is < 10 W for EUV sources and by the end of 2Q 2012 it is expected to be in the 20-50 W range. ASML's roadmap foresees a shift to beyond EUV (BEUV) wavelength (6.x nm) for resolving half-pitch (hp) < 8 nm after 2018. ASML also said it has shipped its sixth NXE3100 system.

Supplier presentation highlights

Most research papers in the Workshop, which was attended by all major source suppliers and most source researchers, focused on LPP. Highlights included:

- Xtreme Technologies' latest performance data (30 W at 100% duty cycle)
- A novel way to heat LPP targets
- Composition of an ideal target for LPP
- Latest developments in high-power CO₂ lasers
- A detailed description of technical challenges that must be addressed for LPP to achieve higher CE and further improve debris control

A separate session on EUV source modeling explored the benefits of mist targets for LPP and CE for BEUV sources. Another session reviewed alternative concepts for high-power EUV sources.

6. X nm Sources

For next-generation BEUV sources, gadolinium (Gd) seems to be the leading candidate as it is more widely available. Its emission peaks at 6.775 nm +/- 0.15 nm. It appears that a dedicated program, such as ASML's Flying Circus for 13.5 nm, is needed to ensure all measurements are done in a similar manner.



Multilayer (ML) Optics for 6.x nm sources

Leading researchers from around the world provided data on ML development. Reflectivity of 49% for (La/B₄C) ML at 6.684 nm was presented by Yuriy Platonov of RIT. Eric Louis of FOM showed that for ten reflections, ML optics based on LaN/B allow five times more throughput than LaN/B₄C-based ML optics. It is probable that 6.78 nm with Gd as the source material will be chosen for BEUV sources.

Metrology source suppliers report high brightness

There were several presentations from suppliers for metrology sources, with two speakers presenting source brightness in excess of 100 W /mm²sr. Others expect that with improvements, they will reach similar or higher brightness in the near future.

Poster Session

Winning posters were determined in voting by attendees. First place went to Isaac Tobin of Trinity College Dublin for "Investigation of Spatial and Spectral Characteristics of EUV Emission from Laser Assisted Vacuum Arc." The second place award was shared by Thomas Cummins of UCD for "Investigating the Effects of Laser Power Density and Pulse Duration on the 6.7-nm BEUV Emission" and Takamitsu Otsuka of Utsunomia University for "Extreme Ultraviolet Source at 6.7 nm Based on a Low-density Plasma.

Soft X-Ray Sources and Microscopy

The performance and applications of EUV and soft X-ray sources, up to water window wavelengths, were discussed for microscopy and other uses. As soft X-ray and EUV sources are based on similar concepts, the Workshop created a synergistic opportunity for many source experts to share and discuss opinions on how to further source technologies in these wavelength regions.

Summary

Overall, forty excellent presentations were made during the Workshop, with proceedings to published soon at www.euvlitho.com.

The 2012 EUVL Workshop is planned June 4-8 in Maui and the *2012 Source Workshop* is scheduled Oct. 8-11 in Dublin. Please visit www.euvlitho.com for additional information.

####