

EUVL R&D Forum brings together researchers to highlight roadmap to continue progress

New EUVL R&D forum, concluded last week in Maui, Hawaii was a great success as it brought together researchers from all disciplines within EUVL technology to brainstorm new ideas to current technical challenges and devise ways to bring EUVL to fabs sooner.

Sergey Zakharov of NanoUV presented potential of higher ionization stages of Xenon (17 to 25) giving 2% conversion efficiency (which means for 100 W input, 2 W will come out as EUV light). Current use of Xenon is based on the ionizations stage of 10, which gives conversion efficiency of 0.5- 1%, hence shift to tin as fuel to power EUV sources despite more challenges with handling of tin. Higher conversion efficiency claims for xenon will need to be verified in coming months. He believed that high energy electrons in his source of innovative design can generate such higher ionization stage for xenon. It was also pointed out by others that such higher ionization stages can also be generated in CO₂ laser based Xe LPP.

Recent sharp increase in the power of laser produced plasma (LPP) based sources was highlighted. Akira Endo of Gigaphoton discussed their 13 kW CO₂ laser, which is the highest power in the industry so far and explained that coupling of this laser power with 4% CE of Sn LPP source is the reason for such a great increase in the power of their LPP based sources. Integration of LPP sources still needs to happen which will also verify some claims of 4 x more ability to collect power for LPP based sources as compared to from competing technology of discharge produced plasma (DPP). Juergen Kleinschmidt, representing Xtreme technologies and Philips Extreme challenged such claims and gave his reasons on why such benefits of increased collection efficiency may not happen for LPP based EUV sources. As LPP and DPP plasmas are similar in properties but with different heating mechanisms to make EUV light, experiments need to understand how things may be different when power of these sources is increased to fulfill high volume manufacturing requirements. In defense of DPP, Jürgen pointed out that only such sources have been successfully integrated today and showed results of experiments from his labs which show that DPP sources can continue to provide more power in coming years via increase of its operation frequency. It was also pointed out by others that big part of power generated by DPP based EUV sources today is still not utilized by EUV scanners so integration is the main challenge today and not the source power. MIT researcher John Hybl showed how expertise in his lab can help suppliers keep interaction of laser and targets in check even at higher powers, based on their work done for star wars. Torsten Feigl of Fraunhofer showed success of his lab in developing collector optics technology that can support requirements of LPP based sources.

Many researchers from US, Japan and Europe got into details of physics of LPP based sources to address many fine points like, how different lasers differ in generation of debris from targets, conversion efficiency, power, out of band radiation etc, a discussion and information sharing that a R&D forum like this had hoped to generate.

Russ Hudyma of Hyperion presented high numerical aperture (NA) obscured optics design that can take EUVL based scanner to up to 9 nm node, considered by end of ITRS roadmap by many. Such extendibility of EUVL is the reason for industry's interest and investment in EUVL. He also presented new optics designs ideas that can help scanner use much more of source power, which if not used turns to heat, resulting in request for more source power and demand for cooling. It appears that new optics designs are needed in addition to other efforts to increase scanner throughput. Patrick Naulleau of LBL also showed his designs based on diffractive optical elements to extract twice the power from sources and deliver it to the wafer.

Workshop also demonstrated a strong commitment from resist suppliers to continue development of EUV resist. Jim Thackeray of Rohm and Hass pointed out increased efforts of his company on EUV resists development. New approaches including molecular resists, new polymer design were presented by suppliers to address challenge of resist sensitivity, LER and resolution. With the recent announcements of recalibration of resist sensitivities by LBL and NIST, it was noted that 10 mJ EUV resists are now a real possibility.

Line edge roughness (LER) will be an issue for all lithography techniques as we print smaller and smaller features. Chris Mack taught day long class to share his latest theory (fine tuned on flight to Maui) on fundamentals of LER. He explained why four and not just one parameter, as currently used, are needed to fully describe LER phenomenon and he also outlined experimental rigor needed to allow researchers to compare their results and allow verifications of new theories of LER.

Researchers from Europe, Asia and US discussed R&D funding to continue to drive EUVL research. Prof. Dunne of University College Dublin highlighted need for second round of interaction between government, universities and industry to create a detailed R&D roadmap and panelist plan to develop a draft of such roadmap in coming months.

Researchers educated audience on topics of optics, contamination, metrology and mask technology via review papers, outlined technical challenges and potential solutions. This was in addition to one day classes on EUV Lithography and EUV Physics that were taught preceding the workshop.

Workshop had 63 presentations with 37% presenters from Asia, 37 % from US and rest from Europe. Proceedings of the workshop, together with audio recording of the workshop will be published by SPIE. 2009 EUVL workshop is now planned for summer time in Hawaii, with dates and location to be announced soon.