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## **More Powerful Sources and Innovations Pushing EUVL Closer to Volume Manufacturing, Lithographers Conclude at International Workshop in Maui**

Maui, Hawaii -- Increasingly powerful plasma source based scanners that could be enhanced with optical innovations and improved resists are driving extreme ultraviolet lithography (EUVL) closer to manufacturability, according to technologists at a recently concluded EUVL R&D forum here.

The 2008 International Workshop on EUV Lithography, held June 10-12 at the Wailea Beach Marriott, brought together lithographers from North America, Europe and Asia for a multi-disciplinary look at new solutions for the technical challenges to bringing EUVL into high-volume semiconductor manufacturing.

The gathering was organized by EUV Litho, Inc., an organization dedicated to promoting and accelerating EUVL through workshops and education. Industry organization SPIE co-sponsored the Workshop and will publish its proceedings along with an audio recording of the workshop.

“Many of the presentations came from universities and national labs, which have been major sources of innovation for EUVL,” said Vivek Bakshi, President of EUV Litho, Inc. “Speakers focused less on commercial products and more on R&D, with an emphasis on how to make current technology work.”

Sergey Zakharov of NANO-UV described potential of raising xenon to the higher ionization stages of 17 to 25 to provide a 2 percent conversion efficiency (CE), which means that 2 W of EUV light are generated for every 100 W of energy input. If verified, the higher conversion rate makes Xe more competitive with tin (Sn) as the fuel for EUV light sources.

Sharp increases were reported in the power of LPP-based sources, with Gigaphoton’s 13 kilowatt (kW) CO<sub>2</sub> laser-based system the most powerful to date. Presenter Akira Endo said Gigaphoton couples this laser intensity with the 4% CE of Sn to produce significantly greater source power. Some researchers believe that integrated LPP sources can collect upto four times more power than its technology rival, discharge-produced plasma (DPP).

However, Juergen Kleinschmidt, representing XTREME technologies and Philips Extreme, argued that LPP may not realize that level of increased collection efficiency. Kleinschmidt noted that only DPP sources have been successfully integrated and revealed results of lab experiments showing that DPP sources can continue to provide more power in coming years via increased operational frequency. Others said that much of today’s DPP source power is still not utilized by scanners, making integration the main challenge today for increasing the throughput of the scanners.

Advances in optics and optical techniques to advance the capabilities of EUVL also were offered by presenters:

- Torsten Feigl of Fraunhofer described his lab's success in developing collector optics technology that can support the requirements of LPP-based sources.
- Patrick Naulleau of LBL showed designs based on diffractive optical elements to extract twice the EUV light from sources and deliver it to the wafer.
- Russ Hudyma of Hyperion presented a high numerical aperture (NA) obscured optics design that reportedly can take EUVL to the 9 nm node, considered by many to be the endpoint of the *International Technology Roadmap for Semiconductors* (ITRS). He also presented new optics designs that can help scanners use much more of available source power, decreasing heat generation and the resultant need for cooling. Such designs appear to be part of the solution to increasing scanner throughput.

Chemical resist suppliers demonstrated a strong commitment to developing improved EUV resists. New approaches include molecular resists and new polymer designs to address the challenges of resist sensitivity, line edge roughness (LER) and resolution. With the recently announced recalibration of resist sensitivities by Lawrence Berkeley National Laboratory (LBL) and the National Institute of Science and Technology (NIST), 10 millijoule (mJ) EUV resists now appear feasible.

However, LER will continue to be problematic for all lithography techniques as manufacturers print smaller and smaller features. Understanding the nature of LER requires the assessment of four parameters and not just one, according to well-known lithography expert Chris Mack, who taught a day-long class on LER fundamentals. Mack also outlined the experimental rigor needed to allow researchers to compare their results and permit new theories of LER to be verified.

In other discussions and events at the Workshop:

- Professor Padraig Dunne of University College Dublin called on governments, universities and industry to conduct a second round of collaboration aimed at creating a detailed roadmap for EUVL R&D. (Panelists from the Workshop plan to draft such a roadmap in coming months.)
- The second International Workshop on EUV Lithography is planned for summer 2009 in Hawaii, with specific dates and location will be announced later. More information on this year's Workshop is available at [www.euvlitho.com](http://www.euvlitho.com).

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