

Outlook for EUVL

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As we look forward to 2018 SPIE Advanced Lithography, EUVL will be once again at the focus of the conference. It's a good time to review the outlook for EUVL in the short and long term, and make a few predictions.

Short term

Feasibility of EUVL has now been proven for many years, and a leading chip maker will start inserting EUVL into commercial production starting this year. However, there are still some pending issues which will impact how quickly remaining chip makers start using EUVL in fabs. These are scanner uptime (mostly related to source), lack of commercial actinic patterned mask inspection tools, and readiness of EUV mask pellicles. 250 W sources and corresponding mask pellicles are almost ready for 125 wafers per hour throughput scanners, and we will find out about the latest status in San Jose. This year, I expect to see progress toward 90% uptime for HVM level EUVL scanners. All of this should end up speeding up adoption of EUVL for remaining leading-edge chip makers.

Long Term

For the long term, I see challenges in resist, actinic inspection, mask and mask pellicles and sources.

Readiness of commercial EUV resist will be a leading challenge for EUVL in future nodes. EUV resists work differently than current resists. They work via secondary electrons chemistry, and we need to figure out all the knobs to address random printing failures and micro bridging, which were reported last year. At EUV wavelength, stochastic effects become important and in addition to better understanding of secondary electrons dynamics, we need to address material inhomogeneities at the nanoscale for producing production level EUV resists. For over five years at SPIE, we have seen some great results in new types of resists from labs, but we need to see the same from fabs.



Commercial tools for actinic patterned mask inspection is a big gap that needs to be closed. Wafer inspection is now increasingly being used to detect defects on masks, but it is costly and inefficient. Wafer inspection itself needs to evolve and move beyond 193 nm to smaller wavelengths, in order to offer better resolution for coming generations. New types of EUV sources and corresponding optics are expected to play a part here.

I am not sure if current pellicle designs and materials are extendable all the way to 500 W. I believe that pellicle designs must evolve. I now see that source power may be able to get to 500 W in the future, but I am not sure what technology will provide power greater than 500 W – Sn LPP or FEL.

Predictions and What is New

I expect alternate suppliers for commercial actinic patterned EUV mask inspection to emerge soon. These tools will be powered by 13.5 nm plasma sources or HHG. Pellicle designs will evolve with new materials, and the challenge will be to test and integrate the best options into the scanners. E-beam inspection will gain but optical inspection will remain the primary workhorse, as work continues to take it beyond 193 nm to improve its resolution.

ASML shipped 10 scanners in 2017 and about twice that number are expected to be shipped in 2018. Some have been asking me if scanner optics or mask blanks supply will be the bottleneck as the number of scanners delivered are expected to double every year from 2018 onward. I expect some challenges in the supply chain as EUVL ramps up, but nothing glaring has come into sight yet.

In terms of breaking news, there are couple of items. First is the emergence of manufacturing strength, investments and progress in EUVL technology development by GlobalFoundries. They have a good technical and manufacturing team, and I expect them to make steady gains in the share of foundry business, as well in getting EUVL ready for their fabs.

In terms of new information, together with colleagues I have published a special section in SPIE JM3 with papers to address challenges for EUVL for the 3 nm node and beyond. (Link) Also, my new EUV Lithography textbook will be released during the 2018 SPIE Advanced Lithography Conference in San Jose, and the outline is now available. (Link) With contributions from industry leaders and lots of never before published information, I expect it to do very well. I will return after the meeting to provide an update on the status and challenges of EUVL.



