

# **EUVL -**

## *Remaining challenges and preview of topics for the 2015 SPIE EUVL Conference*

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With the 2015 SPIE Advanced Lithography (AL) conference around the corner, some people have asked me what remaining EUVL challenges need to be addressed to ensure it will be ready for mass production later this year or next. Here are my thoughts on this topic and what I expect to hear at the conference.

The short answer is that we need to see a continued increase in reliable EUV source power in field and address the lack of readiness of EUV mask infrastructure in order for EUVL to be production-worthy in 2016. We expect to hear a lot on these two topics at the SPIE conference. The long-awaited breakthrough in source power was announced in summer 2014 ([link](#)). The availability of 50 W source on a long-term basis in the field was a major announcement and morale booster for the EUVL community. Since then, we have seen data for 80 W sources in labs ([Link 1](#) [Link 2](#) [Link 3](#) ). I expect to hear that 100 W sources are now available in labs and I expect reliable 100 W+ in field in 2015. Many now believe that FEL-based EUV sources will drive power beyond 250- 500 W. Although there will be one paper on this topic in the SPIE meeting, one can look elsewhere for additional coverage on this topic ([link](#)).

Delay in the readiness of EUV Mask infrastructure is now the focus of chipmakers. Although Mask defect density has come way down (thanks to SEMATECH's efforts over many years), it still needs to improve to meet manufacturing requirements. As there is only a single supplier of mask blank deposition tools, the most progress in defect reduction may come from mask repairs and by avoiding the addition of defects during manufacturing with the help of pellicles and mask cleans. Lack of readiness of actinic mask inspection tools remains a big gap, so let us see what progress we hear on this topic at the conference.

At last year's SPIE AL meeting, there were many announcements for high absorbing EUV resists –with the implied promise of reduction in source power requirements ([link](#)). However, I did not see them making way into the EUV product development lines, as most of the development results last year were still with resists with sensitivity of 20 mJ or higher. I look forward to seeing if any of the high absorbing EUV resists proved to be production worthy.



This year started for me with the analysis of what has worked and what has not for EUVL. Lack of readiness of metrology sources is the key reason for the delay in readiness of actinic mask defect inspection tools, and the lack of support for the development of metrology sources by research consortia has not helped. There are several metrology source suppliers - Adlyte, Energetiq, Ushio and Zplasma, plus many others - who have come and gone or are standing on the sidelines. Even a small portion of a consortium budget to engage and encourage these metrology source suppliers would be a very welcome and wise move that would result in readiness of the critical element of mask defect inspection tools. The industry's present position that metrology source suppliers must engage directly with inspection tool makers, has not worked well. Inspection tool makers are keeping a position that they will buy a metrology source when it is ready, but metrology source suppliers lack the resources to launch major efforts to produce high brightness sources on their own. Hopefully, this year someone will point out that the delay in readiness is a consequence of the industry's decisions and they are fully capable of addressing this issue, by strengthening this weak link.

I believe that in the near term, EUVL extension will come via multiple patterning and not via high NA options (which comes combined with a need to go to larger 9" masks) and the 6.x nm option now has been largely put on the back burner. I will report back here in this blog what I hear at the SPIE AL conference. And yes, if you have been wanting to ask detailed questions about EUVL, you are welcome to take the EUVL short course that I will be teaching with my colleagues Patrick Naulleau (LBNL) and Jinho Ahn (Hanyang University) at this conference ([Link](#)) and then again during the EUVL Workshop in June ([link](#)).

