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The Future Of EUV And Technology

One of the great achievements of EUV is the revival of Moore’s Law which kickstarts an exciting period for future technologies, Moore’s law isn’t the same as any other law as it’s an observation made by Gordon Moore in 1965 and it states that, every two years the number of transistors on a chip doubles, which in simple terms means that the processing power of affordable computers will double every two years. Over the years Moore’s Law gradually started to come to end, as scientists and engineers were no longer able to double the amount of transistors on a chip every two years. However, with the development of EUV/EUVL, Moore’s law still holds true. As the development of EUV continues it expected that, it will transform the production of semiconductors. The semiconductor industry as a whole is beginning to invest in EUV as it looks to transition high end technology production form 193Nm to EUV. In the next few years the lithography market is expected to grow from USD 2.98 billion in 2018 to USD 10.31 billion by the end of 2020, at a CAGR (Compound Annual Growth Rate) of 28.16% [1].

The future for EUV seems to be bright with great investments from tech giants such as well known Intel, Samsung and many other huge firms. Intel on its own has committed over USD 4.1 billion with ASML, TSMC (Taiwanese Semiconductor Manufacturing Company) has invested another USD 1.4 billion while Samsung handed over USD 970 million. EUV is being funded by eleven different firm this includes Samsung, Intel, ASML, Toshiba and many more [2]. Thanks to these investments we are starting to see the first benefits from using this type of lithography, which is helping improve our current technology by making new products cheaper with the same capabilities and new more speedier components, for example in 2020 Samsung has reached a milestone in memory used for PC’s, the Korean firm has released the first 10nm DDR4 DRAM which is based on EUV. Using this next-gen lithography technique will help RAM producers get past many barriers, which will allow for greater performance, decrease time of production and better yields which means that there will be a smaller amount of defective chips being manufactured. Also the tech giant is planning on starting the production of super fast DDR5 RAM in 2021, which thanks to EUV will help bring computer memory to a completely new level when it comes to speed and efficiency, DDR5 RAM is being advertised to be 2x times faster then its predecessor which should be a major boost in performance. At the start of 2020 Samsung has also announced that the mass production of both 6nm and 7nm circuits will begin in Hwaseong, South Korea. TSMC is also predicted to begin the mass production of 7nm chips using EUVL and a new 5nm node technology is expected by 2021, these developments make TSMC the largest customer for ASML’s EUV scanner[3]. We are also seeing production facilities which are based on EUVL and are being built by companies such as Intel, Hynix and other tech giants. Intel will need EUV tools as it expands its fabs in Oregon, Israel, and Ireland. Besides, the chipmaker will need EUV scanners to equip its Fab 42 in Arizona. These factories will be used to produce chips using Intel’s [7 nm](https://www.anandtech.com/show/13683/intel-euvenabled-7nm-process-tech-is-on-track) fabrication process. SK Hynix will need EUV tools for its [new fab](https://www.anandtech.com/show/13129/sk-hynix-set-to-build-a-new-memory-fab) near Icheon, South Korea [5].

Obraz zawierający rysunek

Opis wygenerowany automatycznie

The above image is showing and increased demand in EUV scanners which are produced by ASML.

Source: <https://medium.com/@gaurav.k_57188/euv-lithography-future-of-lithography-8717acc78f80>

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Challenges Ahead Of EUV Lithography

Despite many of its advantages, EUV still isn’t perfect and faces many challenges which ASML must overcome if they want to be the leading manufacturers of semi-conductors. One of the major challenges associated with EUV is the need of a high power light source. The failure to produce a light source with sufficient power doesn’t allow an EUV scanner to go fast enough, this has been causing major delays which pushed EUV from one node to the next. Successful production of high power light would help improve the reliability of EUV and in turn make it more economically feasible.

Another very big roadblock for EUV lithography which slows down the technology from achieving its full potential and becoming successful in the field is the strong absorption of EUV radiation by all the materials that are used in an EUV scanner. Resists must be sensitive enough to capture the image, but at the same time high aspect ratio wafer structures require longer etch times and therefore better etch resistance from the photoresist. Thin resist layers are preferable because tall, narrow resist pillars tend to simply fall over. The downside is that thinner resists capture fewer photons and are more susceptible to erosion during the etch[4]. This means that both scientists and engineers need to consider alternatives for the materials that currently are in use. Current resists are chemically amplified and in turn each incident photon may generate photoacid materials. Each photoacid molecule, in turn, “deprotects” a resist polymer molecule, rendering it soluble in developer. The “sensitivity” of the resist is a measure of the number of photoacid molecules generated by each photon. Diffusion of photoacid molecules is key for successful amplification however, this can also cause image blur when diffusion occurs outside of the exposed area.

The shear size of EUV scanners is another factor which can be challenging for ASML, their scanners are said to be the size of a school bus (in reality they weight around 180 tonnes), this makes transport very troubling it takes 40 freight containers, 20 trucks and 3 cargo planes to ship just one scanner to chip manufacturers. Required utility resources for EUV are also very large and the required resources are 1500 L/min of cooling water, 532kW of electrical power and 6 gas lines for one 200W output[6], once these requirements aren’t met the productivity of the scanner begins to fall.

Due to many of the challenges that EUVL is tied with and being arguably the most complex piece of machinery in the industry, the technology hasn’t yet been extremely successful. Each year we are seeing a continuous growth in the sale of scanners manufactured by ASML and the tide is beginning to slowly turn for the technology. Many large IDM’S ( Integrated Device Managers) such as Intel, Samsung, TSMC and so on have seen potential in the technique which is being perfected by ASML and invested huge money into this specific lithography technique which forecasts a bright future for the technology. Hopefully more large IDM’s will decide join Samsung and TSMC to begin mass production of circuits with the use of EUV after they begin to see the successes of the technology.

[1]<https://www.marketsandmarkets.com/PressReleases/extreme-ultraviolet-lithography.asp>

[2] <https://www.forbes.com/sites/jimhandy/2012/08/27/whys-everyone-investing-in-asml/#974bf7435737>

[3] <https://medium.com/@gaurav.k_57188/euv-lithography-future-of-lithography-8717acc78f80>

[4] <https://semiengineering.com/euv-finally-arrives-now-what/>

[5] <https://www.anandtech.com/show/13904/asml-to-ship-30-euv-scanners-in-2019>

[6] Gigaphoton, Sematech Symposium Japan, September 15, 2010