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ACCELERATING THE FUTURE

Wanted: More Photons for EUV Lithography

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Astrileux is the first place winner of the iMatSci Materials Research Society competition in 2016 and the Semicon West Silicon Innovations forum in 2015 and the best start-up award at the Electron, Ion and Photon Beam conference 2018. Astrileux is currently nominated for the 2019 World Materials forum prize.

The remarkable power of today's computers is in large part a reflection of Moore's Law – the observation that the number of transistors in a dense integrated circuit doubles approximately every two years. Improved patterning optics and reduced patterning wavelengths have enabled transistor sizes to keep shrinking. Next-generation technology may well enable artificial intelligence and machine learning through conventional computing, and potentially through neuromorphic paradigms, bringing to reality transformative applications such as self-driving cars and smart buildings. Today's integrated circuits rely on multiple-patterning deep ultraviolet (DUV) lithography using light at 193 nanometers (nm). Multiple exposures increase costs. To manufacture affordable next-generation technology in high volumes, chipmakers will need single-exposure extreme ultraviolet (EUV) lithography using light at 13.5 nm. Today's EUV technology works with light at 13.5 nm, generated from laser-powered plasma sources. Light at this wavelength is especially challenging, as extremely high-precision quality control and characterization are needed in the materials, equipment, and components used in lithography tools. Unfortunately, such high-power light sources could each consume up to 2.5 megawatts of power. As the number of lithography tools increases, their energy consumption may reach 22 billion kilowatts per year. So there is a critical need to deploy energy-efficient lithography tools that can help create affordable, sustainable next-generation electronics.

Since IC manufacturing rate directly correlates with energy consumption, EUV lithography tools need to provide viability in terms of wafer throughput, reliable performance, and wafer yields. However, as the number of tools scale, relatively little has been done to address the energy consumption per tool. In fact EUV lithography tools are highly inefficient with a projected system efficiency of 1E-5%. The current industry focus is to develop a laser power plasma lightsource, capable of delivering 1kW of 13.5 nm light at the intermediate focus (IF), focal point at the entrance to the scanner, output of the lightsource. Future generations of EUV lithography may need more than 1kW or more at the IF to meet wafer throughput requirements driven by the world expanded economic growth. More photons are needed than ever before, not just to deliver more light to the wafer but to overcome on wafer issues related to stochastics, and line edge roughness.

The semiconductor chipmaker market is experiencing massive consolidation as only the top three chipmakers (Intel, Samsung and TSMC) will be able to afford EUV. New fabs are likely to cost in excess of $10 Bn. EUV lithography tools will cost more than $150 M each, potentially $300M. More than $25Bn has been spent on bringing about EUV manufacturing readiness.

The industry has developed significant infrastructure to deploy next-generation EUV technology at the 7 nm node and smaller. Astrileux's materials technology complements the existing infrastructure, increasing the rate of manufacture of chips, enabling the deployment of energy-efficient next-generation electronics production platforms, which will help bring down the cost of EUV and increase its accessibility in the marketplace.