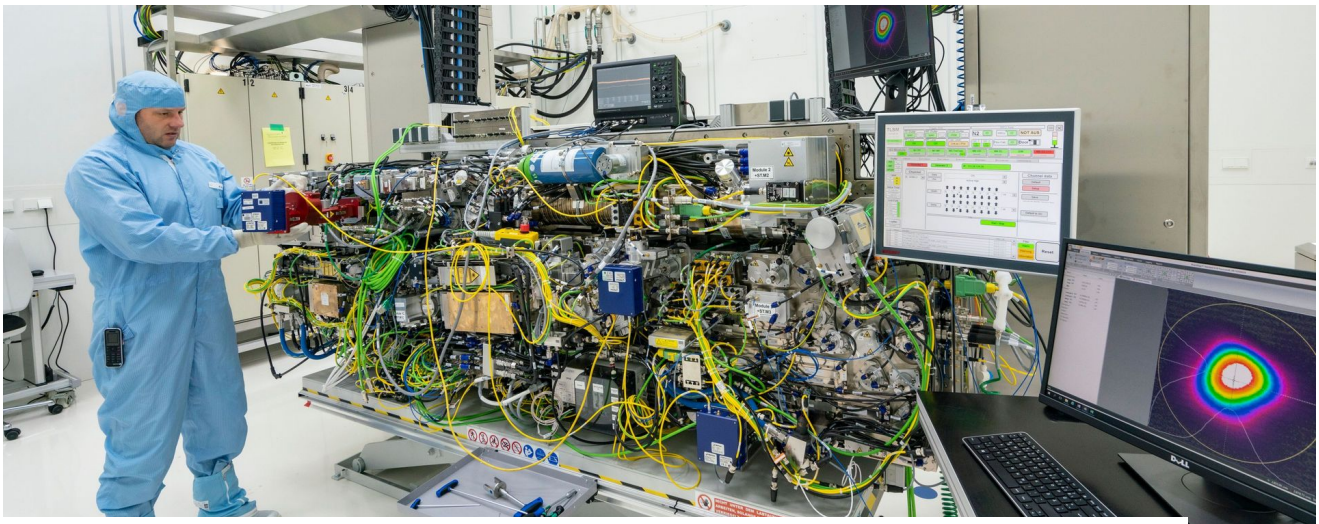


ATHANASSIOS KALIUDIS

Behind the scenes of microchip production

Be it smartphones with turbo data transfer and face recognition, smart data glasses, artificial intelligence or driverless cars – high performance superchips are what's needed for the megatrends of tomorrow. The key to producing these chips has three letters: EUV. A look behind the scenes at the advanced technology of EUV lithography.

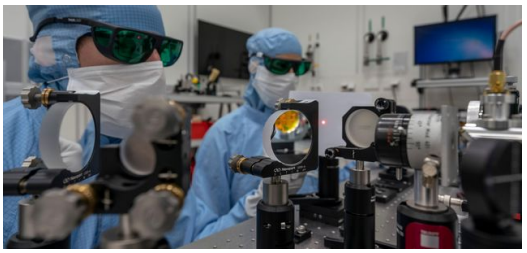
What EUV lithography is:

The life of a microchip starts in an optical lithography system. Today most of these systems use ultraviolet light (UV) to fabricate billions of miniature structures on thin silicon wafers. Together these structures form an integrated circuit known as a chip. The unrelenting drive of the semiconductor industry for ever more powerful microchips means that chipmakers must pack even more structures onto a chip, thereby making the chip faster and more powerful while simultaneously lowering the production costs. To do this, they need lithography systems that use EUV light. EUV stands for extreme ultraviolet light and has a wavelength of only 13.5 nanometers. A human hair in comparison has a width of about 30,000 nanometers.

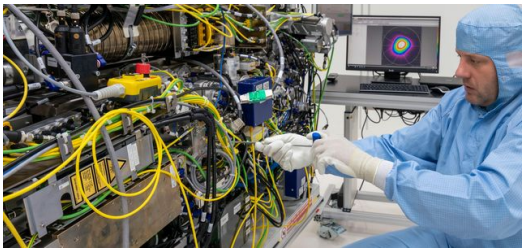
How EUV lithography works:

A lithography system is essentially a projection system. The light is projected through a blueprint of the pattern to be transferred. The optics transfer the pattern to the silicon wafer that is coated with a light-sensitive chemical. When the unexposed part is etched away, the pattern is revealed. The tricky thing about EUV light is that it is rapidly absorbed by everything, even by air itself. An EUV system thus has a large high vacuum chamber where the light is guided by a series of ultra-reflective mirrors until it reaches the wafer.

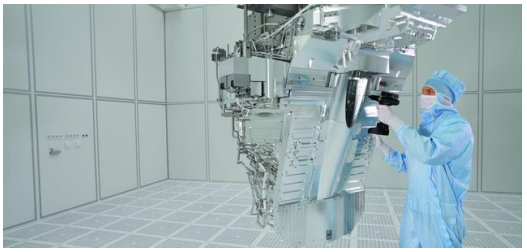
Commissioning of a TRUMPF EUV laser system in an installation bay. – TRUMPF



Mirror assembly in the TRUMPF clean room for production of the EUV laser system. – TRUMPF



TRUMPF employee in the clean room assembling the EUV laser system. – TRUMPF



EUV optics system from Zeiss. – Zeiss

A Zeiss system grinds and polishes a mirror for EUV production. – Zeiss

ASML employees in the clean room of the company in Veldhoven, Netherlands. – ASML

ASML employees working on a new generation of the EUV lithography system NXE3400B. – ASML

The biggest challenge is the fact that EUV light is difficult to generate. This is because at 13.5 nanometers we are very close to atomic dimensions. To generate EUV light, a high power laser from TRUMPF strikes the droplets of tin in a vacuum chamber as they shoot past – 50,000 times a second! It generates a plasma that emits EUV light at the desired wavelength of 13.5 nanometers. Collectors then gather the EUV light emitted by the plasma, focus and deliver it to the lithography system for the chip exposure.

Why EUV lithography is necessary:

Previous UV lithography systems were technologically improved more than many people would have imagined possible, yet the industry had to reach deep into its bag of tricks to make the chip structures even smaller. Think of it this way: If

somebody were to write their name with a highlighter in smaller and smaller handwriting, they would eventually reach for a different pen. EUV lithography provides the industry with a kind of fineliner pen for this. With this finer resolution, chipmakers are now capable of producing smaller, faster and more powerful chips, while the complexity of the manufacturing process and the costs stay within the framework.

Who the makers of EUV lithography systems are:

The protagonists of EUV systems are TRUMPF who develops and produces the EUV-light-generating laser and ZEISS who develops and produces the high-precision optics that collect and focus the EUV light. And then there is the Dutch company ASML from Veldhoven who is the mechanical engineer that integrates all of these components into one machine that weighs 180 metric tons and consists of more than 100,000 parts, 3,000 cables, 40,000 screws and requires more than 2 kilometers of hoses. A machine of superlatives.

ATHANASSIOS KALIUDIS
広報担当者（TRUMPFレーザ技術）

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