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Flashes of light in a vacuum

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One of the biggest challenges of EUV lithography is how to generate light with the extremely short wavelength of 13.5 nanometers. To do this, the EUV light source has to deliver an output of a few hundred watts. That may not sound like much, but it turns out that EUV is an extremely difficult form of light to produce. The challenges involved can be hard to fathom, but one striking fact is that generating EUV light without a laser would require particle accelerators the size of soccer pitches!

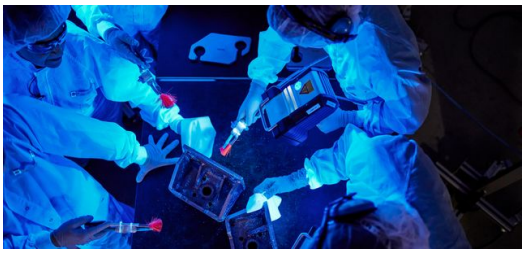
Which brings us back to the laser; the idea behind the laserbased fabrication process can be expressed fairly simply. Basically, a tin generator fires 50,000 droplets of tin a second (!) through a vacuum chamber and a laser pulse strikes the droplets as they shoot past. This is a kind of high-tech version of clay target shooting – and it generates a plasma in the vacuum that emits EUV light at the desired wavelength of 13.5 nanometers. A collector gathers up the EUV light and delivers it to the lithography system to expose the wafer. To produce the laser pulses, TRUMPF developed a one-of-a-kind beam source based on its CO2 laser technology – the TRUMPF laser amplifier. In five amplifier stages, this device boosts a weak laser pulse more than 10,000 times, outputting more than 30 kilowatts of mean pulse power. Pulse peak power can be as high as several megawatts.



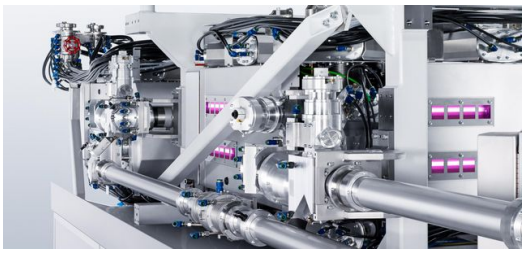
A mechatronics engineer installs a mirror mounting.



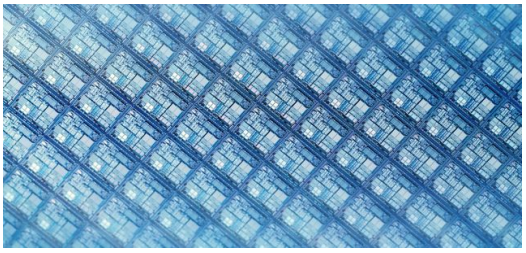
Light from CO2 lasers requires a vacuum. Leak tests are performed to ensure that no air from the outside penetrates the system.



Most of the system is disassembled and cleaned in order to remove any microscopically small particles before being dispatched. Such contamination could prevent the laser from operating correctly at the customer's site.



The excited mixture of gases in the CO2 laser glows red – this is where the high performance laser beam is produced.



Exposed transistors: EUV light can be used to create even tinier features on wafers. That makes the microchips far more powerful.

To achieve perfect results, the laser pulse must strike the tin droplet across as broad an area as possible. The tin droplet is smaller than the laser's focus spot, however, so the laser cannot transfer its full 30 kilowatts of power to the droplet when it hits it. The laser amplifier has a clever solution to this problem. It emits a pre pulse and a main pulse, one immediately after the other.

The pre pulse strikes the tin droplet with low laser power; the tin atoms ionize and the resulting plasma expands. The main pulse, following close behind, strikes the plasma cloud with the whole pulse power. Bull's eye!



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