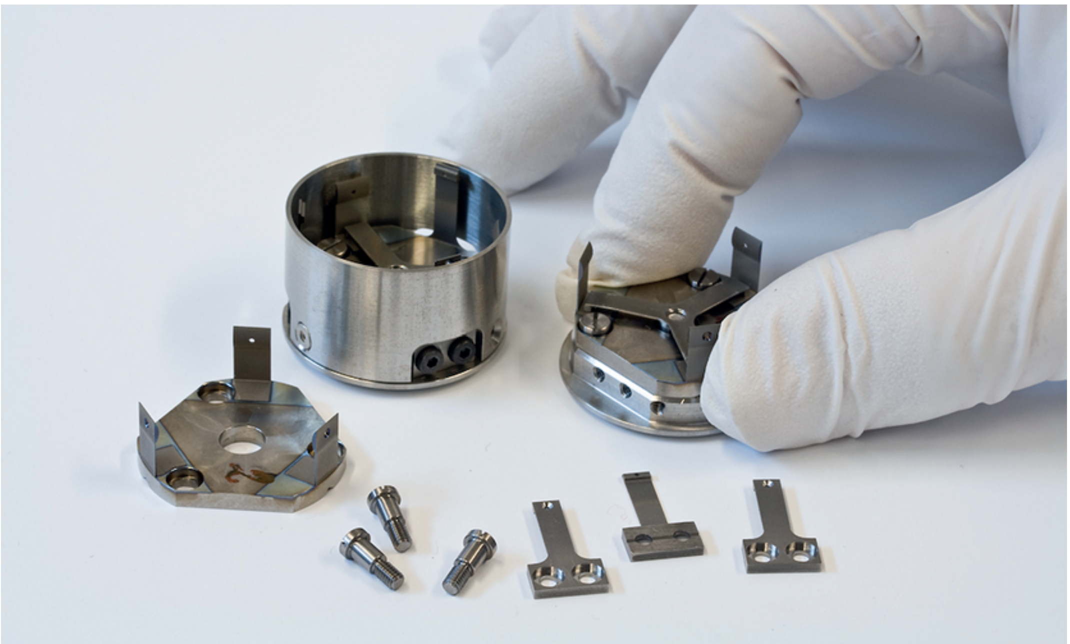
VERY ACCURATE, VERY RELIABLE



Parts of the molecular contamination monitoring system retro reflector

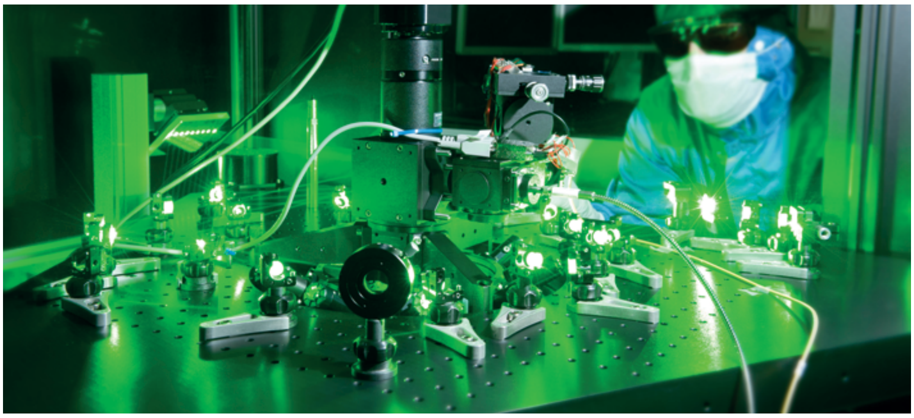
TNO innovation for life

Moore's law describes the stunning pace of innovation in the semiconductor industry: roughly every 1.5 to 2 years the amount of memory per surface area doubles. Something you can experience through your own mobile phone or computer during the years; they have become increasingly smaller, but at the same time faster, better, and more versatile. Metrology at TNO combines many different disciplines such as mechanics, optics and electronics to create innovative solutions for the challenges related to Moore's law and for challenges in other demanding markets.

The features or critical dimensions of a memory cell have to become smaller and smaller, which introduces a cascade of challenges: the wavelength of the light used for writing the features shifts from visible to the (D)UV (Deep Ultra Violet), the opening angles (NA = Numerical Aperture) of the optics become larger, the sensitivity for focus (DoF = Depth of Focus) becomes more critical, polarisation of the light plays a more important role, and particle and molecular contamination becomes more critical because less and smaller particles are allowed. TNO has contributed to these challenges by the development of several sensors. TNO has built sensors to measure:

- the polarisation state of the light;
- the height of the wafer to keep it in focus;
- particle scanners to measure particle contamination on wafer and reticle blanks;
- ellipsometry based sensors to monitor molecular contamination in real time.

TNO also develops complete opto-mechanical 'engines' for other markets. Recent projects vary from new concepts for maskless lithography to equipment for optical freeform surface shape measurement, Laser Interferometer Space Antenna (LISA), Optical Coherence Tomography (OCT), and delay lines for the Very Large Telescope Interferometer (VLTI) in Chile. Although the applications differ significantly, most projects have in common that the boundary conditions are very challenging: either in nanometer-range accuracy, ultra clean vacuum, and/or picometer-range stability. Each development is tailored to the requirements of the customer. A project may contain, for example, feasibility or trade-off studies, prototyping or breadboarding, and final production (especially for small series like in case of satellite hardware).



Rapid Nano allows for quick detection of particles; currently TNO aims at detecting particles smaller than 20 nm

TECHNOLOGIES

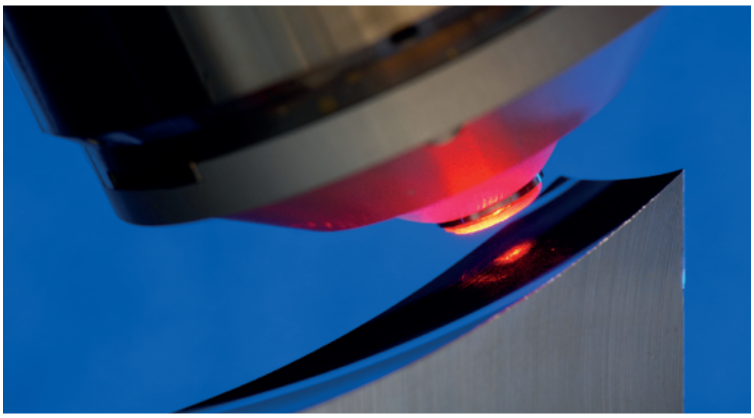
Most of the examples given above are based on the phase of light for their measurement principle. In general, the examples can be split up in two technologies: polarimetry (e.g. ellipsometry) and interferometry (e.g. OCT).
Polarimetry measures the vibration direction of the light beam under investigation. This can be compared with turning a skipping-rope through a barred fence: the person on one side makes a circular movement, at the other side of the fence a vertical oscillation remains.
Interferometry uses the interference between two or more beams as a measure for parameters such as distance. This can be compared with throwing a stone in the water, which causes a ripple effect. The interference can be observed when the original ripple and the ripple reflected back from the riverside wall meet each other and create their own pattern.

A technique that can be used in combination with interferometry is adaptive optics (deformable mirrors). One of the fields of applying adaptive optics is large telescope astronomy. Telescope images are disturbed by the earth's atmosphere. The amount of disturbance is measured using interferometry. The interferometry data is used to determine the amount of mirror deformation that needs to be applied to correct for the disturbance. TNO has excellent knowledge on developing light-weight and very stable deformable mirrors, as well as on controlling these mirrors.

ADVANTAGES

TNO has expert knowledge on optical design, mechanical design, systems engineering, and contamination control. We combine this knowledge with supporting technologies like electronics and software design. All these required disciplines are located under one roof, understanding each other's strengths and limitations. TNO can crossover these different technologies to other markets, creating state-of-the-art and surprising solutions.

TNO has excellent domain knowledge within the semiconductor and space markets. We work in close collaboration with world leading organisations like ESA and ESO in the space domain, and ASML and Carl Zeiss in the semiconductor domain.



The NANOMEFOS measurement machine, developed by TNO, TU/e, and VSL, is a unique measurement instrument for measuring the absolute form of aspherical and freeform optical surfaces (mirrors as well as lenses) without physical contact

TNO

TNO is an independent innovation organisation that connects people and knowledge in order to create the innovations that sustainably boost the competiveness of industry and wellbeing of society.

TNO works for a variety of customers: governments, the SME sector, international companies, service providers, and non-governmental organisations. Working together on new knowledge, better products, and clear recommendations for policy and processes. As a 'knowledge broker', TNO advises her customers on finding the optimum solutions that are geared precisely to the questions they have.

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