PRESS RELEASE

This is how the optics of the future are created – from glass to final assembly

Lasers make lenses: Laser-based optics production to solve the issues of the future with great precision

Whether in medical technology, quantum technology or semiconductor production, optical systems are an integral part of many high-tech applications. To ensure that lenses, mirrors and other components meet the highest requirements, manufacturing needs processes that combine precision, efficiency and flexibility. The Fraunhofer Institute for Laser Technology ILT develops tailor-made solutions for precisely this purpose, solutions that consist of a few highly efficient and extremely productive individual steps. Laser-based optics manufacturing enables the industry to produce dimensionally accurate and functional components with low roughness, from prototypes to series production, from microlens arrays to macro-optics, from spheres to free-form optics.

At Fraunhofer ILT in Aachen, lasers are not just used for cutting or welding; they take over the complete production of optical components. With selective laser-induced etching (SLE), for example, components such as lenses can be processed on the front, back and edges in a single clamping operation.

Another method the institute uses is laser ablation. In this process, a precise laser beam removes material in a targeted manner. In this way, highly complex shapes such as aspheres or free-form optics, which are used in cameras or sensors, for example, can be created from simple, inexpensive blanks such as spherical glass bodies.

"With our laser processes, we shape optics directly – without detours, without reclamping – and can do so quickly and cost-effectively," says Dr. Edgar Willenborg, who has played a key role in developing the field of optics production at Fraunhofer ILT. "We achieve maximum efficiency, especially when more than just simple spheres are required."

Shaping is followed by finishing: Lasers polish surfaces that are still rough from previous processing. The laser heats the surface so sensitively that the smallest irregularities melt away, within a few seconds and without mechanical contact. Willenborg and his team are researching laser beam figuring (LBF) to meet particularly high requirements in terms of shape accuracy. This involves the targeted ablation and

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correction of the smallest form deviations in nanometer layers – i.e. millionths of a millimeter – which is crucial for high-performance optics, for example.

In addition to shaping and polishing, Fraunhofer ILT also develops processes for the assembly of optical systems. These include the precise bonding or soldering of components so that they remain stable under load and function reliably over a long period of time.

"Whether aspheres, freeforms or classic lenses, we show that laser-based processing not only works, but also makes economic sense," explains Christian Vedder, head of the Surface Technology and Ablation Department.

Versatile areas of application – from research to series production

Laser-based optics production at Fraunhofer ILT is not only technologically exciting, it also demonstrates what is possible in practice. The processes developed can be used wherever medium precision, high efficiency and automation are required, for example in medical technology, where the smallest lenses are needed for endoscopes or diagnostic devices, or in quantum technology, where complex structures are created from glass that guide and manipulate light. Such optical components also play an important role in the semiconductor industry, for example in the production of the tiniest structures on microchips.

Another advantage: The technologies can be flexibly adapted, depending on the material, shape or quantity. Whether a single piece for a research laboratory or a larger series for industrial applications, the combination of different laser processes creates a modular system that can be precisely tailored to the application.

In addition, there are supporting processes such as laser-based marking and labeling of optical components or the separation of glass, for example in wafer-based production. In this way, all steps along the value chain can be mapped, from the initial idea to the finished product.

"Our technologies are particularly in demand when conventional processes reach their limits, for example with aspherical optics and complex geometric shapes made of glass," says Edgar Willenborg.

Research and collaboration – thinking ahead together in optical manufacturing

The demands placed on optical components are constantly increasing, in terms of precision, complexity and quantity. At the same time, there is a growing need for flexible, cost-effective solutions that can be quickly adapted to new applications.

In an interdisciplinary team at Fraunhofer ILT, more than 15 scientific employees are constantly developing new approaches to make the laser-based production of optical components faster, more versatile and even more precise. This is not just about basic research, but above all about how it can be transferred to industrial production.

Close cooperation with industrial partners is an important part of this work. Together with companies from various sectors, the researchers test new processes and process chains, adapting them and making them usable for production. This often results in tailor-made solutions for specific tasks.

In the future, it will not only be a matter of refining existing processes, but also of developing new materials and designs. By combining digital production-oriented optical design and laser-based manufacturing methods, the institute is making completely new designs possible. This can result in components that would be very difficult or impossible to produce using conventional methods, such as particularly compact or integrated optics for portable devices or use in space.

The integration into automated production processes and the connection with modern measurement technologies will also be further expanded. This means that quality and efficiency can be combined even better, in line with sustainable and future-proof production.

"By combining digital design and laser-based manufacturing, we will be able to make much more in the future, especially individualized products," Edgar Willenborg is certain. In the near future, the Aachen-based research institute wants to meet the highest precision requirements with the process chain for laser-based optics production. Lasers are the perfect tool for this.

Interested parties can find out more about "Smart Optics Manufacturing" at LASER World of PHOTONICS from June 24 to 27, 2025 in Munich at the joint Fraunhofer booth (Hall A3, Booth 431).

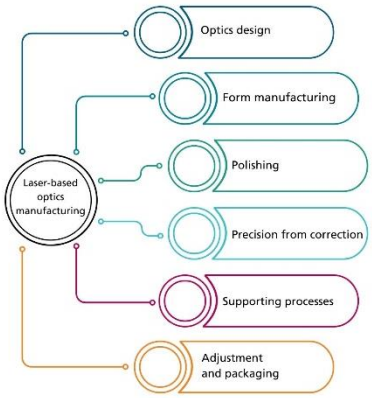

Image 1:
From design to finishing to assembly, from draft to final inspection: the new laser process chain for optics at Fraunhofer ILT in Aachen.
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Image 1:
"The fact that we can map all these steps in-house is a major advantage for our partners. They don't just get individual process steps, but a complete, integrated solution," explains Dr. Edgar Willenborg.
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Image 3:
A new generation of optical components is being developed at Fraunhofer ILT – faster to manufacture, precisely shaped and exactly matched to the application.
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