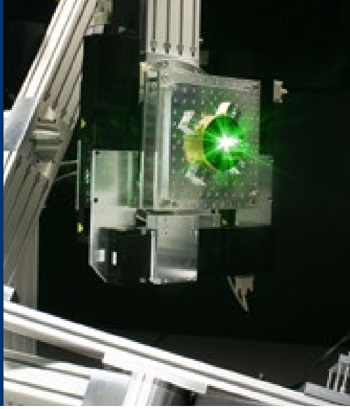
Fraunhofer IOF

FRAUNHOFER INSTITUTE FOR APPLIED OPTICS AND PRECISION ENGINEERING

SOLUTIONS WITH LIGHT

EXPERTISE IN OPTICAL SYSTEM TECHNOLOGY


SOLUTIONS WITH LIGHT

The Fraunhofer IOF conducts application oriented research in the field of optical systems engineering on behalf of its clients in industry and within publicly funded collaborative projects.

The target is to develop innovative optical systems to control light, from its generation to its application in the cutting-edge fields of

- Energy and environment,
- Information and communication,
- Healthcare and medical technology,
- Safety and mobility.

To achieve these goals, the Fraunhofer IOF covers the entire process chain, from system design to manufacturing prototypes of optical, opto-mechanical and opto-electronical systems.

In this context, the sustainable energy efficient use of light – "Green Photonics" – is of special interest for the Fraunhofer IOF, particularly with regard to the Fraunhofer innovation cluster.

- Light for carbon-neutral power generation,
- Light for energy-saving and resource efficient production,
- Light for controlling environmental and climate disasters,
- Light for safe nutrition and drinking water supplies.

The close cooperation with the Institute of Applied Physics (IAP) at the Friedrich Schiller University Jena is of particular importance to both, covering the scientific lead work and training young scientists.

OPTICAL SYSTEM TECHNOLOGY

Optical system technology facilitates the step from discrete optical, mechanical, and electronic components to complex optical, opto-mechanical, or opto-electronic modules and systems.

The Fraunhofer IOF and the IAP offer solutions extending from concepts with strong future potential to the development of technologies as well as manufacturing and measuring methods through to the construction of prototypes and test series for applications in the wavelength range from millimeter to nanometer.

Infrastructures at high technological level as well as highly trained employees are the basis for the successful implementation of research and development.

Research, development and services at the Fraunhofer Institute for Applied Optics and Precision Engineering focus on the following business areas.

BUSINESS FIELDS

Optical Components and Systems

We realize optical components and systems for the entire spectral range from EUV to THz and cover the entire process chain - design, manufacturing, system integration.

Precision Engineering Components and Systems

Key points in research and development are design, simulation, manufacturing, and assembly of optical and mechanical devices.

Functional Optical Surfaces and Layers

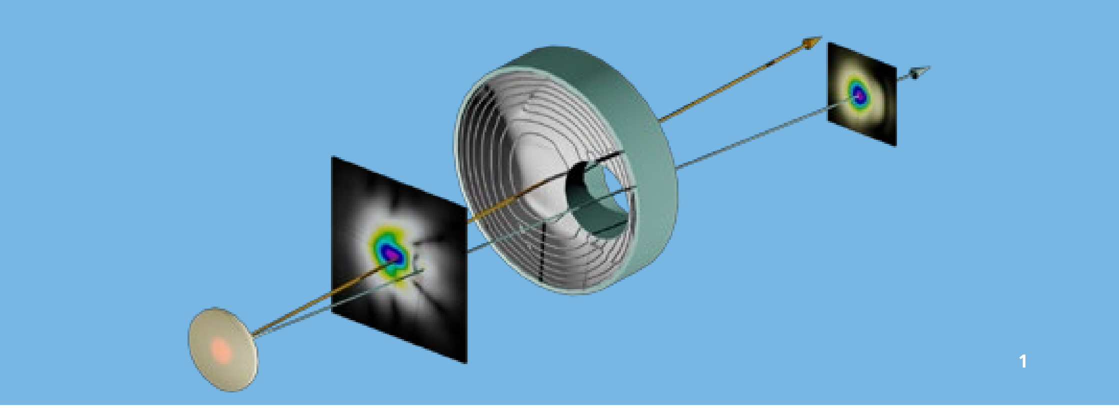
Surface functionalizations and multifunctional optical coatings on plastic, glass, ceramic, and metal for wavelengths from XUV to infrared are developed.

Lasers

The development of laser systems (especially fiber lasers) treating different wavelengths, ultra-short pulses, and power up to the kW range are focal points.

Photonic Sensors and Measuring Systems

For process-integrated quality assurance and 3D shape measurement via surface characterization up to THz imaging optical and opto-electronic measurement and sensor systems are developed.



DESIGN AND SIMULATION

Our core expertise and basis of all developments is optical and mechanical design as well as simulation and complex analysis of optical and opto-mechanical systems including thermal and thermo-optical effects. Extensive design and modeling tools enable simulation and optimization of systems for THz to X-ray range and from micro-optics to astronomical telescopes.

1 Semiconductor disk laser with an unstable resonator and a Gaussian shaped outcoupling distribution.

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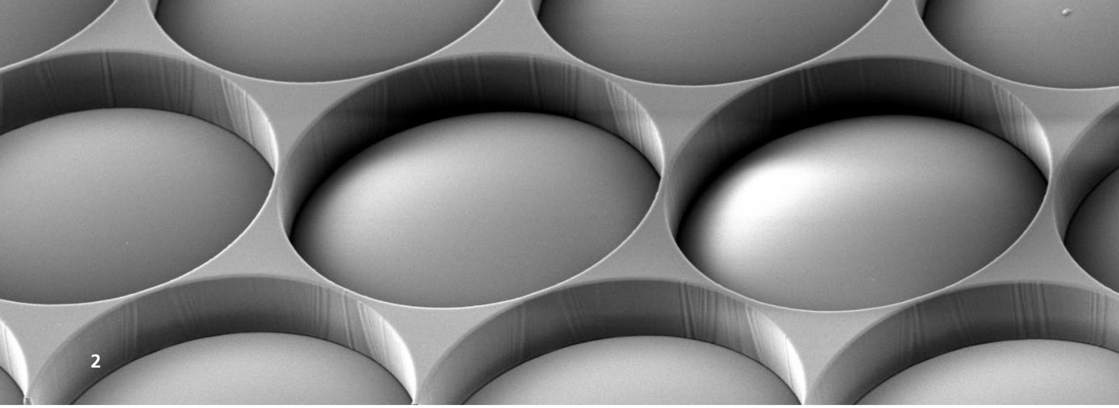

MICRO- AND NANOSTRUCTURING

2 Lithographically generated master structure combined of microlens array and binary structure.

The creation and replication of optical microstructures and nanostructures is the basis for modern, complex optical systems. The institute's technological basis consists of laser lithography, electron beam lithography, and reactive ion etching. These technologies enable the production and characterization of high-end micro-optical and nano-optical elements in highest resolution on substrates up to 12", including curved surfaces.

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COATING AND SURFACE FUNCTIONALIZATION

Functional coatings and surfaces are essential for innovative optical systems. The institute has strong expertises in design of optical multi-layer systems, development of coating processes, and characterization of surfaces and coatings. Particular interests lie on the areas ultrareflective coating systems for optics in the EUV and X-ray range as well as the functionalization of plastic surfaces.

3 Vakuum coating system SYRUS pro.

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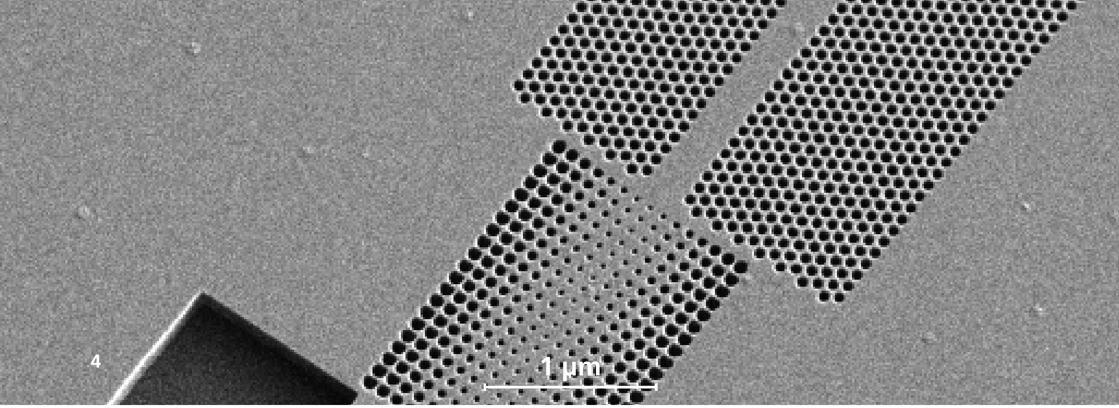

OPTICS AND PHOTONICS MATERIALS

4 A lens made of a photonic crystal structure.

Nano-structure technologies enable the development of new materials for optics and photonics such as photonic crystals and metamaterials, which opens up completely new applications in the fields of imaging, ultra-compact light sources, nanomicroscopy and optical nanomanipulation. Research in these materials is carried out at the Center for Innovation Competence "ultra optics®".

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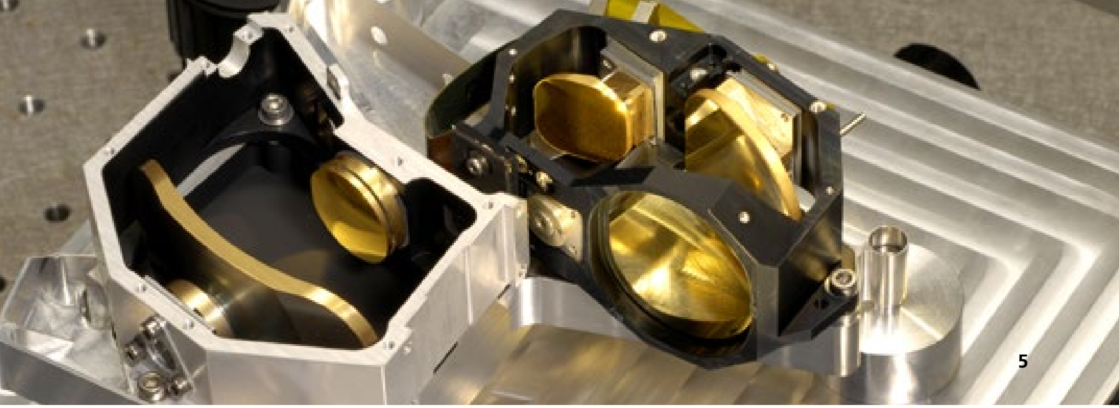

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ULTRAPRECISION MACHINING

We manufacture metal optics, plastic optics, microstructures, and molding tools for precision replicas in optical quality by using ultra-precise production technologies such as single-point diamond turning, fly cutting, micro-milling, and planning. We achieve deviations in form < 18 nm and microroughness < 1 nm for 500cm² large aspherical metal mirrors. Modern tactile and optical metrology are used to examine the manufacturing results.

5 Optical assembly of the athermal IR spectrometer for the space mission to Mercury MERTIS, consisting of ultra-precise metal mirrors.

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MICROASSEMBLY AND SYSTEM INTEGRATION

6 Screen printed actuator and electric contact structure.

The institute has extensive expertise in the development of technologies for the hybrid integration of various components with high precision for the assembly of complex opto-mechanical and opto-electronic microsystems and macrosystems. The expertise encompasses the creation of new solutions for assembly sub-processes such as positioning and alignment, joining technologies such as adhesive bonding, laser soldering, plasma bonding, laser splicing, and lens centering, all the way to system integration such as wafer-level assembly and the integration of optical systems for space applications.

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MATERIAL PROCESSING USING ULTRASHORT LASER PULSES

Ultra-short pulse lasers with pulse durations ranging from picoseconds down to a few femtoseconds have a tremendous potential for high-precision patterning of various materials, especially metals, glasses, semiconductors, and biological tissues.

7 Micro holes in stainless steel. Left: pulse duration 3.3 ns, right: pulse duration 200 fs.

Our Fiber-based ultra short pulse laser systems generate high pulse repetition rates at high power and excellent beam quality. Production processes require short process times which can be achieved by ultra short lasers.

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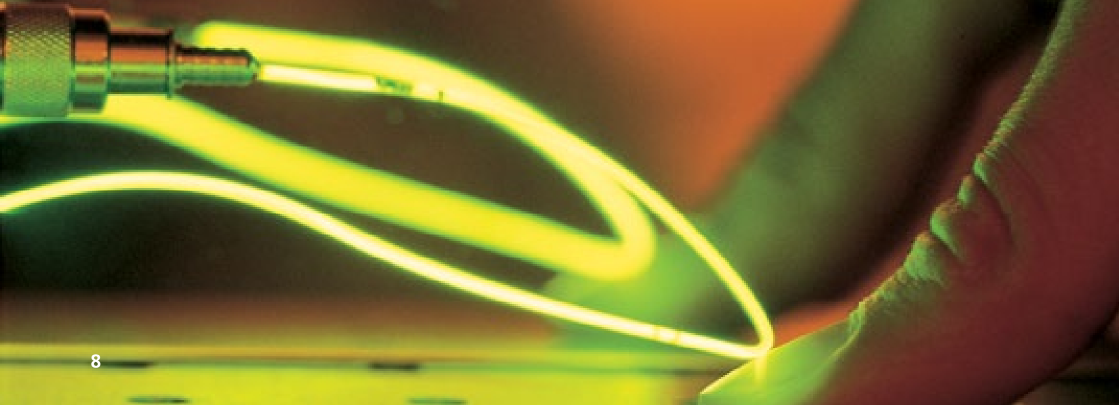

LASER DEVELOPMENT AND NON-LINEAR OPTICS

8 Ultra-short pulse fiber laser.

For the development of high-power fiber lasers with diffraction-limited beam quality we have expertise in fiber design, optic design, and thermo-optics, in fiber technology and production, in assembly and joining technology for fiber lasers and in developing efficient fiber couplers and beam guidance systems.

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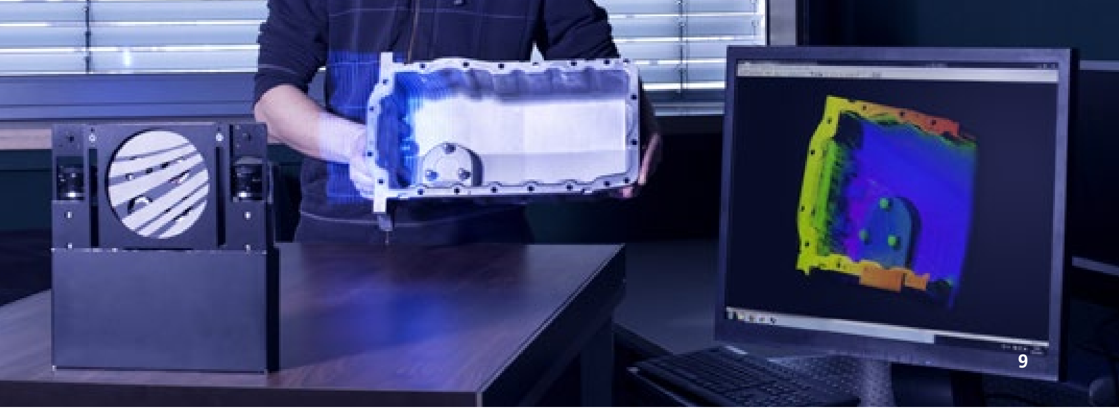

MEASUREMENT METHODS AND CHARACTERIZATION

Optical measuring methods and systems are developed to meet customer-specific requirements and institutes needs. Key areas include the analysis of nanostructures and microstructures of optical and non-optical surfaces and coatings, materials, components and systems, as well as 3D shape measurement. THz tomography and CT processes are developed for the spatial identification of substances and the metrical evaluation of inner structures.

9 3D measurement system with integrated LED based array projector.

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