Micro and Nano Structuring
With Lasers

Fraunhofer ILT - Short Profile

The Fraunhofer Institute for Laser Technology ILT is worldwide one of the most important development and contract research institutes of its specific field. The activities cover a wide range of areas such as the development of new laser beam sources and components, precise laser based metrology, testing technology and industrial laser processes. This includes laser cutting, caving, drilling, welding and soldering as well as surface treatment, micro processing and rapid manufacturing.

Furthermore, the Fraunhofer ILT is engaged in laser plant technology, process control, modeling as well as in the entire system technology. We offer feasibility studies, process qualification and laser integration in customer specific manufacturing lines. The Fraunhofer ILT is part of the Fraunhofer-Gesellschaft.
MICRO AND NANO STRUCTURING WITH LASERS

High lateral resolution due to precise focussability down to a few micrometers, low heat input and high flexibility are main features of laser tools and processes for precision structuring and surface functionalization. With this properties the laser qualifies for numerous application fields like electronics, sensor technology, medical technology, fine mechanics and micro system technology. The Fraunhofer Institute for Laser Technology ILT is developing laser based micro and nano manufacturing technologies and production systems, which are selectively adapted to the customer specific applications.

Laser Ablation

The ongoing miniaturization of products in fine mechanics, electronics, medical technology and sensor devices requires components with structure sizes in the micrometer range and accuracies with less than one micrometer. Laser ablation processes provide appropriate manufacturing processes for micro machining of metals, ceramics and polymers. Using Excimer lasers, frequency converted Nd:VO₃ Lasers and ultrashort pulse lasers allow the exact machining of all types of materials with sub micron accuracies. For mass manufacturing of precise parts by hot embossing, injection molding and stamping, tools with structure sizes in the range of 5 - 10 µm with surface qualities < 200 nm can be produced. Since focused laser beams provide ultra high intensities, laser ablation of hard materials like tungsten carbide and diamond is possible with high accuracies. Using ultrashort pulsed lasers in the femtosecond and picosecond range laser ablation is an ideal alternative to conventional processes like EDM and High Speed Cutting with significant advantages in processing time and flexibility due to the elimination of processing tools.

Nano Structuring

Functional surfaces often require structures, which amplify the intrinsic properties of selected materials or which cause a specific effect only by their structure size. For optical functions, for example for surface or volume holographic gratings, for biological functions like cell guiding structures and analytical functions with specific molecule coupling areas, nano structures are necessary, which provide a reproducible functionality at low manufacturing costs. For these applications, a new laser interference technology has been developed to allow the production of periodic surface structures from 100 nm to 500 nm with high processing speeds. Using Excimer lasers and frequency tripled solid state lasers, this technology is ideally suited for nano structuring of metals and polymers.

Laser Fine Cutting

Laser fine cutting of precise metal parts is a well established process in industrial manufacturing of medical and fine mechanical parts. The contactless processing with cutting kerfs < 20 µm allows the manufacturing of very filigree parts, which cannot be produced by conventional technologies. With compact fiber lasers and new process principles, high processing speeds of up to 1 m/s and surface qualities in the micrometer range are possible. With this approach, laser cutting allows the manufacturing of precise parts as an alternative to conventional stamping processes with a significant increase of flexibility and reduced costs.

Laser Drilling

Drilling with laser radiation is used as a manufacturing technology at very small hole geometries, large aspect ratios and ultra hard materials, where conventional processes cannot be applied for. With new drilling technologies like helical drilling, related high speed optics and ultra short pulse lasers hole geometries in the range of a few 10 micrometers can be processed with drilling depths of up to 2 mm. For applications in filter technology and photovoltaics new laser drilling technologies are available with drilling rates of up to 3,000 holes/s. With new ultra short pulsed lasers and innovative multi photon absorption processes even hole geometries < 1 µm can be achieved. For structuring of dielectrical materials like glass and semiconductors hybrid processes can be applied, in which laser modification and subsequent etching are combined to produce structures with nanometer accuracy.

Facilities

- 100 fs Laser (P = 1,5 W, λ = 800 nm), 4-Axis Machine
- 500 fs Laser (P = 1 W, λ = 1043/522 nm), 5-Axis Machine
- 1,5 ps Laser (P = 50 W, λ = 1064/532 nm), 6-Axis Machine
- 7 ps Laser (P = 50 W, λ = 1030 nm), 8-Axis Machine
- 10 ps Laser (P = 5 W, λ = 1064 nm), 6-Axis Machine
- 10 ps Laser (P = 50 W, λ = 1064/532/355 nm), 6-Axis Machine
- 10 ps Laser (P = 50 W, λ = 1064/532/355 nm), 5-Axis Machine
- 10 ps Laser (P = 6 W, λ = 1064/532/355 nm), 5-Axis Machine
- 600 ps Laser (P = 67 mW, λ = 532 nm), Desktop-System
- 10 ns Laser (P = 36 W, λ = 532 nm) with Helical Drilling Optic
- 10 ns Excimer Laser (λ = 193 nm), 4-Axis Machine
- 20 ns Laser (P = 10 W, λ = 355 nm), 6-Axis Machine
- 40 ns Laser (P = 10 W, λ = 355 nm) with Interference Optic
- 0,7/1,5 µs Laser (P = 700/60 W, λ = 1030 nm, 5-Axis Machine
- Fiber Laser (P = 1000 W, P = 300 W, λ = 1070 nm), Cutting System
- Diode Laser (P = 500 W, λ = 800 - 980 nm), Hot-Embossing Machine

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1 Super hydrophobic surface micro-structured with picosecond laser.
2 Nanosctructured Hot-Embossing roll made of heat-treated steel (1.7225).
3 Light guiding structures made of micro lenses for a uniform light distribution.
4 Tool inserts for precision injection molding tool.
5 Micro sieve for filters with hole diameters < 20 µm and high transparency.
6 Laser cutted stent from stainless steel with detail geometries < 100 µm.