TruMicro:

Power meets precision.
Great results on a small scale.

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The Power of Choice

The TRUMPF Group is a cutting-edge global leader for industrial lasers and laser systems. We offer the most comprehensive portfolio of laser technologies in the world. This includes technologies for welding, soldering, cutting, drilling, ablating, marking, and microprocessing, ensuring that we have the right laser for every application. By means of systematic research and development, we are further expanding our advantage in this area to the benefit of our customers.

The short- and ultra-short pulsed lasers of the TruMicro Series enable microprocessing with an optimum combination of quality, productivity, and profitability. Whether used for structuring, ablating, cutting, or drilling, lasers have become an indispensable microproduction tool.

The TruMicro Series features short-pulsed lasers with pulse durations in the nanosecond range – known as nanosecond lasers – as well as ultrafast lasers with pulse durations in the picosecond and femtosecond range – known as picosecond and femtosecond lasers. The TruMicro product lines cover average output powers from a few watts all the way up to the kilowatt range, with unmatched peak powers. This proven performance combined with lowest costs of ownership in the industry results in unbeatable costs per part.

TRUMPF’s ultra-short pulsed laser was among the winners of the German Future Prize 2013.

Visit us on YouTube.
www.youtube.com/trumpftube

Discover the endless possibilities of TRUMPF laser technology in the video “The Power of Choice”: www.trumpf.info/6v1cuw
TruMicro Series 2000
Fiber-based, compact picosecond lasers, optimized for maximum efficiency at average output power.

TruMicro Series 5000
Picosecond and femtosecond lasers with high average output power and high pulse energy based on disk laser technology for microprocessing at highest productivity.

TruMicro Series 7000
High-power fiber-guided nanosecond lasers based on disk laser technology, optimized for large-area material processing.
Cold material processing.

Ultra-short pulses.

Using laser pulses that last only a few pico- or femtoseconds, it is possible to efficiently process materials with virtually no thermal and mechanical effects. The pulse duration determines the duration of energy input into material. Pico- and femtosecond pulses are short enough to rapidly vaporize the material without any heat transferred to the surrounding material. This is commonly referred to as “cold processing”. For most materials, the ideal pulse durations for cold processing are between 1 and 10 ps.

In contrast to longer pulse durations in the nanosecond range, material heats up locally well above the melting point before the material evaporates. Residual molten material forms around the processed site, which subsequently hardens as burr or induces thermal shocks. Such processes can be successfully exploited, for example when ablating coatings from metals or glass while leaving the substrate unaffected.
Keep the flow.

Cardiovascular stents are medical implants that keep coronary blood vessels open. The decisive factor when manufacturing these stents is to achieve burr-free cut surfaces and edges. Depending on the size and location of the stent the implants are made of steel, nitinol or bioresorbable polymers. Nitinol is a shape memory alloy that always returns to its original shape after mechanical or thermal impact. In addition, nitinol stents are being better tolerated by the patient’s immune system.

Picosecond lasers enable nitinol stents to be manufactured without the need for subsequent reworking thereby significantly increasing the yield. Only with ultra-short pulse technology did it become possible to manufacture bioresorbable stents from extremely heat-sensitive polymers.
Our expertise in glass.

Durable and robust.

Chemically hardened glasses are used as extremely damage-resistant protective covers and as robust carrier substrates in the display industry. Hardened glass reduces the risk of scratches and other damage to the surface. In order to save weight and enable compact, slim designs, the glass covers for smartphones are becoming ever thinner.

Picosecond laser cutting is currently the only non-damaging and flexible tool for cutting chemically hardened as well as non-hardened glass. The laser cuts the glass after the hardening process and delivers outstanding edge quality. Unlike with mechanical methods, you can also use this cutting process for flexible 2D and 3D geometries. For this wear- and contact-free process a picosecond laser is the ideal tool.
Finely detailed colored markings.

Picosecond lasers can produce markings below the surface of even the thinnest glass substrates. The ultra-short pulses enable the individual dots to be placed so close together that they cannot be distinguished separately by the naked eye. In this way, it is possible to create filled-in areas of color in glass with a thickness of only a few hundred micrometers. By selecting the right process parameters, it is even possible to create a rainbow effect by using the ultra-short laser pulses to modify the diffraction properties of the glass. Thanks to the localized energy input, the amorphous structure of the glass remains intact.

Corrosion-resistant markings.

The annealing effect of laser processing causes metals to change color, resulting in darkened areas of different shades extending to almost black. If these markings are created deliberately using ultra-short laser pulses, the darkened areas remain corrosion-free, because the heat input required to structure the surface is extremely low. Corrosion-resistant markings are required in numerous industrial applications, ranging from medical implants and surgical instruments to automotive parts and household goods. There are virtually no limits to the type and shape of these markings. The possibilities include serial numbers, Data Matrix codes for product traceability, micro-engraved security features no wider than a few micrometers, and complex filigree graphics.
Our expertise in sapphire.

Transparent and resistant.

Sapphire is a material with very interesting properties: It is extremely resistant to chemicals, extremely hard, and highly transparent for visible light. For decades it has been used as a protective glass for luxury watches and in the chemical industry.

In the manufacture of light-emitting diodes (LEDs), sapphire is used as a substrate on top of which the light-emitting layers are grown. This makes it possible to produce efficient light-emitting diodes in high quantities at low cost. The growing demand for LEDs is leading to an increase in the supply of low-cost sapphire. This low-cost sapphire makes new applications economically viable: One example is that today sapphire protects high-resolution cameras in smartphones.

The very properties that make sapphire attractive for many applications make it a very difficult material to machine using conventional methods. However, with the TruMicro Series 5000 you can achieve a quality that requires no post-processing. Moreover, the high average power of the picosecond lasers ensures maximum productivity.
A material for high performance.

Ceramics are high-performance materials. Favorable electrical insulation properties and high temperature resistance make ceramics such as aluminum nitride, aluminum oxide, silicon nitride, and zirconium oxide popular materials for a wide variety of applications. Ceramics are an integral part of modern mobile phone antennas and high-performance light-emitting diode packages.

Drilling and cutting thin ceramics is a picosecond laser specialty, enabling you to obtain very small high-quality geometries. The holes impress with their cylindrical shape, smooth inner walls, and minimal debris. Thanks to the high output power of TRUMPF picosecond lasers, you can achieve high productivity rates for drilling, as well as for scribing and breaking.

Microholes drilled into 0.2 mm thick ceramic material.

Laser engraved ceramic substrate.

Ultra-fine microstructure in ceramic material.

TruMicro Series 5000: Laser processing of ceramics. www.trumpf.info/x4mhd6
Multi-layered and compact.

Modern printed circuit boards (PCBs) are constructed of several layers, making them especially compact. PCB substrates are made either of organic material reinforced with glass fiber for maximum mechanical stability or else of flexible polyimide films. Copper-lined holes connect the tracks across the different levels. This requires holes to be drilled with diameters often less than 100 µm.

These requirements stretch established production methods to their limits. With a picosecond laser, however, you can process PCBs in just a single operation. The high peak powers allow you to obtain the required geometry and quality at extremely high productivity rates.

TruMicro: Laser drilling of printed circuit boards. www.trumpf.info/l9xawi

Laser drilled printed circuit board.

Microhole drilled into printed circuit board substrate.

Laser drilling a printed circuit board with a picosecond laser from the TruMicro Series 5000.
Highly accurate laser structuring.

The laser is an important tool in the manufacture of thin-film solar cells and modules. It is increasingly replacing mechanical methods on account of its quality and productivity advantages. An example of this is the structuring of CIGS cells. CIGS stands for the elements used: copper, indium, gallium, sulfur, and selenium. These solar cells require higher demands from the laser process compared to nanosecond laser structuring of other thin-film materials. When heat is input, their molybdenum layer tends to form cracks and in extreme cases to delaminate. In addition, the photoactive CIGS layer reacts extremely sensitive to excessive heat input. All this makes pico-second lasers ideal tools for processing CIGS cells, as they narrow the track width significantly while at the same time minimizing the heat input. The resulting gain in surface area makes the solar cell much more efficient and thus a better value.

Laser edge deletion instead of sandblasting.

In order to protect thin-film solar modules against corrosion and short circuits in the long run, the coating system is removed at the edge of the module. The solar module is then hermetically sealed in a lamination process, providing protection from weather conditions lasting decades. Laser processing with the TruMicro Series 7000 offers decisive advantages over conventional sandblasting. Eliminating costs related to purchasing and disposing of blasting media is one such advantage. Another is the extremely high ablation rate offered by TruMicro 7000’s processing characteristics. Unit costs are much lower than those of conventional methods.
Simple, strong connections.

To reduce their vehicles’ fuel consumption and CO₂ emissions, car manufacturers are increasingly turning to lightweight construction techniques. To save weight across the board, new production methods and various new materials are growing in importance. Hybrid metal-polymer composites, for instance, combine the strength and rigidity of metals with the low weight and design freedom of polymers. The TruMicro Series of high-power nanosecond lasers can join metals and plastics perfectly without additional materials such as bolts, rivets, or adhesives. Metal pretreatment and joining are performed separately, enabling processes to be optimized and allowing your manufacturing resources to be deployed more flexibly.

In micro-scale interlock, the TruMicro laser creates a rough surface on the metal. The nanosecond pulses melt the surface, and material is evaporated. The ejected material solidifies immediately, leaving behind a deeply undercut, rough surface. The molten plastic in the joining zone is pressed onto the metal and flows into the cavities. As the material cools, the metal and plastic fuse together, creating a very reliable connection.
Efficient coating removal.

In response to expectations that modern cars should consume less and less energy, auto manufacturers are turning to lighter materials. Hot formed steel technology is useful here, as it increases the strength of components while also making them lighter. The high-strength steels used are typically coated with aluminium-silicon (AlSi) for corrosion prevention. To obtain optimum weld strengths, the aluminum in the AlSi coating must be removed prior to welding.

Beam shaping and repetition rates make the high-power nanosecond lasers of the TruMicro Series 7000 ideally suited to ablating large areas of coating systems. The coating removal works most efficiently with square fibers and line foci. Moreover, the operating principle of the high-power nanosecond lasers permits constant pulse duration over the entire range of the repetition rates. This means that the pulse energy and pulse frequency of the laser can be adapted to the beam shape, resulting in ablation rates that perfectly match the feed rates in the subsequent welding operation.
TruMicro Series 2000

Simply flexible.

The TruMicro Series 2000 is characterized by a light, compact design. Its fiber technology creates an ideal platform for ultra-short pulsed lasers with low average power. With peak powers of 0.5 MW, these lasers are used in processes for which cold material processing is productive even at low average powers. Cutting films and ablating thin coatings are excellent examples. The variable settings of burst technology enable the number and frequency of pulses to be selected separately for optimally adapted processes.

For maximum process stability over the entire output range, multiple loop feedback control paired with a patented fast external modulator guarantees the programmed parameters for every single pulse. And of course the space-saving lasers in the TruMicro Series 2000 also offer all the interfaces that are required for industrial applications.


1 Light, compact design for easy integration.
2 High beam quality for absolute precision.
3 Very flexible and high process stability.

Corrosion-resistant marking.
<table>
<thead>
<tr>
<th>Technical data</th>
<th>TruMicro 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
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<tr>
<td>Average laser power</td>
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<td>Max. pulse energy</td>
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<tr>
<td>Pulse duration</td>
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<td>Repetition rate</td>
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</table>

Subject to alteration. Only specifications in our offer and order confirmation are binding.
TruMicro Series 5000

Fast and economical.

Impressive features of the picosecond lasers from the TruMicro Series 5000 are extremely short pulse durations of below 10 ps and high pulse energies of up to 250 µJ. These picosecond pulses vaporize material so fast that no heat affects are discernible. Their patented two-stage laser-power regulation with an external modulator guarantees constant beam parameters and optimum output stability over the entire output range. Peak powers are as high as 40 MW.

TruMicro 5000 Femto Edition uses the industry-proven TruMicro Series 5000 platform and offers pulse durations in the femtosecond range. This gives you peak powers of several hundred megawatts.

With the TruMicro Series 5000, you can process virtually any kind of material – from semiconductors to metals and from dielectrics to plastics. These lasers deliver a total cost of ownership which is unequaled in the industry.

TruMicro Series 5000:
Benefits at a glance.

1. **High beam quality for absolute precision.**

2. **Maximum productivity and profitability.**

3. **Highly stable for optimum, reproducible results.**
## Technical data

<table>
<thead>
<tr>
<th></th>
<th>TruMicro 5025</th>
<th>5050</th>
<th>5070</th>
<th>5080</th>
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<th>5250</th>
<th>5270</th>
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<td></td>
<td>&lt; 10 ps</td>
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<td><strong>Beam quality</strong></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>M² &lt; 1.3</td>
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<td><strong>Repetition rate</strong></td>
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<td></td>
<td>200–1000 (^{(i)}) kHz</td>
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<td></td>
<td>515 nm</td>
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<td><strong>Beam quality</strong></td>
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<td></td>
<td></td>
<td>M² &lt; 1.3</td>
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<td><strong>Repetition rate</strong></td>
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<td></td>
<td></td>
<td></td>
<td>200–1000 (^{(i)}) kHz</td>
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\(^{(i)}\) Depending on performance class.
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TruMicro Series 7000

Built for maximum performance.

The high-performance short-pulsed lasers from the TruMicro Series 7000 are capable of stripping coatings swiftly and over large areas as well as drilling and cutting at maximum throughput. With pulse energies of up to 80 mJ, you achieve enormous ablation rates at excellent efficiency levels. The disk laser technology used combines short pulses and high pulse energies even at high frequencies. You can vary the repetition rate of the lasers independently of the pulse duration in order to optimize your processes.

By means of scanners, large areas can be ablated with highest efficiency. The beam is guided through a flexible laser light cable for easy integration into workstations. This means you can also set up the laser unit separately. Thanks to the high beam quality of the lasers, you can cover large areas and use round, square, or rectangular fibers for beam guidance. This enables you to increase your ablation rates significantly.

TruMicro 7050: Laser cleaning.
www.trumpf.info/4lxjy

TruMicro Series 7000:
Benefits at a glance.

1. High output power for maximum productivity.
2. Higher process efficiency through flexible beam shaping.
3. Fiber-guided for very easy integration.
## Technical data

<table>
<thead>
<tr>
<th></th>
<th>TruMicro 7050</th>
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<th>TruMicro 7240</th>
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<td>343 nm</td>
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<td>20–100 kHz</td>
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Beam guidance components.

Ultra-short laser pulses are not only extremely short but also reach outstanding values in other parameters such as pulse energy and output power. To ensure that despite these peak intensities the pulses of light are focused precisely on the workpiece, special beam guidance and shaping components are required.

TRUMPF supplies beam switches, deflectors, beam expanders and polarization optics optimized for use with ultra-short pulsed lasers. Multifunctional beam monitoring can also be provided.
Easy integration into manufacturing processes.

For lasers and a manufacturing system to work well together, you need the right interface. From the very start of product development, we place the utmost emphasis on ensuring that our lasers will be easy to integrate. And this is why TRUMPF always has the right interface for your needs.

The laser can be integrated into an existing programmable logic controller (PLC) via a galvanically isolated pin assignment or a parallel interface. Thanks to linearized output control, the laser power can also be varied via an external real-time interface in the voltage range of 0 to 10 V. A range of field bus interfaces, including Profibus, EtherCat and DeviceNet, allow easy communication by means of standardized protocols. You can expand the internal laser control system via adapter card with customized interface protocols.

TruMicro lasers permanently survey and log all relevant laser parameters like cooling water temperature and pump diode current. If parameters reach a predefined threshold the system will provide a warning message. The lasers also possess an OPC/UA interface (Object Linking and Embedding for Process Control Unified Architecture). This new generation of OPC interface expands communication between the laser system and the manufacturing automation system. Not only can machine status data be exchanged, it can also be embedded in semantic relationships and processed. This equips you with production control fit for state-of-the-art requirements.

Easy integration thanks to optimum interface architecture.
TRUMPF Laser Application Center.

An informed decision.

The Laser Application Center (LAC) is part of our service promise: to be an experienced partner for our customers throughout the world. The LAC develops fundamentals for your specific application, from the initial feasibility study to production support. It boasts outstanding facilities, including state-of-the-art analysis equipment and electron microscopes.

We have established application laboratories for you across the globe – with highly qualified engineers and advanced system technology. Because it is important to us that you always have access to the right partner in the right place – with the right technology for the work you do. All you have to do is send us your sample parts and your individual requirements. We carry out tests with lasers from our varied product portfolio and present you with a selection of possible quality grades and processing times along with suitable process parameters. This ensures that you obtain the optimum results for each of your applications.
Service all the way.

We support you with tailored services over the entire lifecycle of your laser: We ensure that your new microprocessing laser is ready for use and productive within no time. We maintain the laser and retrofit new options upon request. We train you and your employees so that you can extract the maximum potential from your microprocessing laser. Our engineers optimize laser parameters on-site if required and help you to increase the speed and quality of your production processes.

Unique teleservice.

All TruMicro lasers are equipped for remote support via teleservice by TRUMPF’s technical service teams. They possess a variety of sensors in the laser head and power supply unit, which measure hundreds of values. On request, our service experts can perform a rapid diagnosis and resolve most issues right away via remote access.

Worldwide service network.

TRUMPF offers you a global service network. Our service staff is on-site in over 40 countries to look after your needs.

Our spare parts quality promise.

All new or reconditioned components supplied through our after-sales service are fully guaranteed for one year, and replacements are delivered free of charge. Even beyond the regular warranty period, the TRUMPF Xchange program offers generous reductions on all high-value components replaced through our after-sales service.

Even beyond the regular warranty period, we replace high value components of our TruMicro lasers at reduced prices. Moreover, TRUMPF’s award-winning spare parts logistics team is available around the clock. Parts are usually delivered within 24 hours.
TRUMPF is certified according to ISO 9001:2008
(for additional information see www.trumpf.com/en/quality)