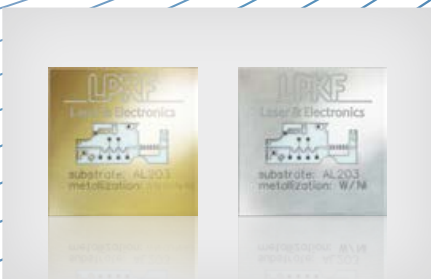
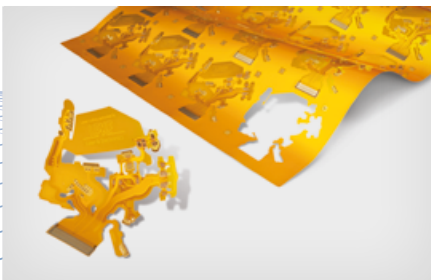


The Swiss Army Knife for the Lab Micro Material Processing with the LPKF ProtoLaser U4





Micro Machining in the Lab

LPKF ProtoLasers have been in use in leading electronics laboratories around the world for many years. The LPKF ProtoLaser U4 builds on this experience with numerous applications and expands the process window of its predecessors.

The application examples on the following pages represent typical applications of the globally unique UV laboratory laser. The system operates in a contactless manner, requires no tools or masks, and reduces the mechanical and thermal stresses on the workpiece.

UV Laser Source as a Versatile Tool

The LPKF ProtoLaser U4 uses a scanner-guided laser developed especially for use in electronics labs with a wavelength in the UV range of 355 nm. At this wavelength, numerous material groups can be easily processed with the laser – without the need for additional tools, masks, or films.

By laying the structuring fields next to each other (“stitching”), this system has a working area of up to 229 mm x 305 mm x 10 mm. With a laser spot size of about 20 μm , it can produce structures with a pitch of 65 μm (50 μm track and 15 μm space) based on FR4 with 18 μm of Cu.

The ProtoLaser U4 features three main improvements over the predecessor:

Stabilization in Low-energy Range

Intricate, sensitive processes require an extremely low laser energy level. The new UV laser source has been designed accordingly and is stable over a large range of energies. This is especially beneficial for applications with thin films or delicate materials.

Process Tracking

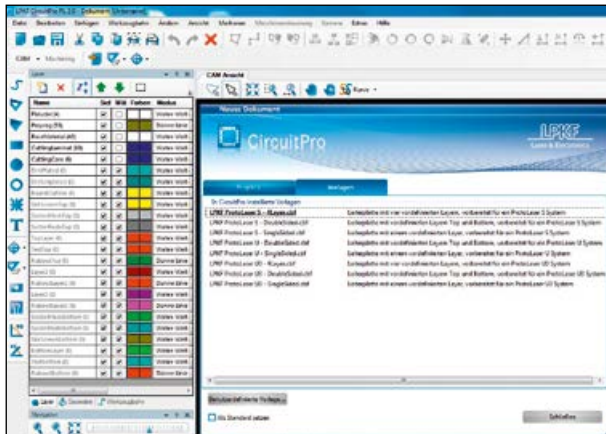
An integrated power meter determines the actual laser power in the focus position. This yields precise actual data for documentation of the production process.

Vision System

The LPKF ProtoLaser U4 uses a newly designed rapid vision system that has been optimized for laser micro material processing. Fiducials and geometric structures on the substrate can be detected.

- Easy to use
- Faster determination of machine data
- “Special areas” for higher precision
- Proven LPKF software basis

The user-friendly LPKF CircuitPro PL system software provides access to all important process parameters. Users can draw on a comprehensive parameter library for numerous common and exotic materials for their projects.

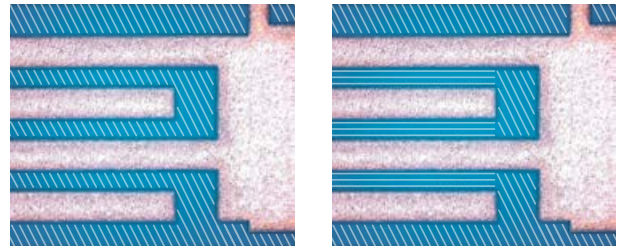


Faster Results on the Computer and the Laser System

LPKF's system programmers have done a good job. In developing the LPKF CircuitPro software, they put all of the procedures from predecessor programs to the test. The result is impressive: uniform, intuitive operation for all software variations, extensive automation of routine tasks, and optimization of calculation processes. Some calculations run on the same computers up to ten times faster than before. Even the practical processing time has been improved: thanks to new path routines, certain position changes and cutting operations are no longer necessary.

Special Areas

A great developmental leap was made with the introduction of “special areas” for CircuitPro PL. The software identifies areas in which fine structures are found and removes the copper layers between the tracks in a process that runs parallel to these structures. This process poses a much lower risk of damaging the substrate during rub-out than the former hatching process did. At the same time, it leaves delicate structures intact.



Left: the previous rub-out process; right: processing as a “special area.” Processing parallel to the track geometries leaves delicate structures undamaged and increases the precision.



Layout data are laid side by side seamlessly with design-based optimization

Island Hopping

Through “stitching” – seamlessly laying of scanning fields next to each other – laser systems can structure large boards. Up to now stitching has been restricted to quadratic fields.

The Software CircuitPro PL runs the boundaries along existing structural elements. This reduces the number of separate stitching steps required and improves the overall board precision.

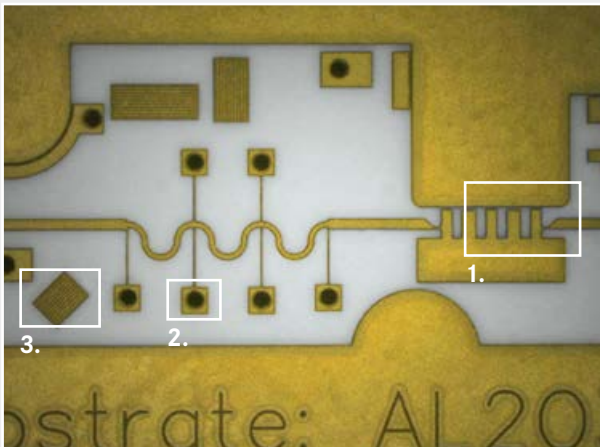
Application Areas

The results speak for themselves: the LPKF ProtoLaser U4 can process demanding materials with high reliability and precision.

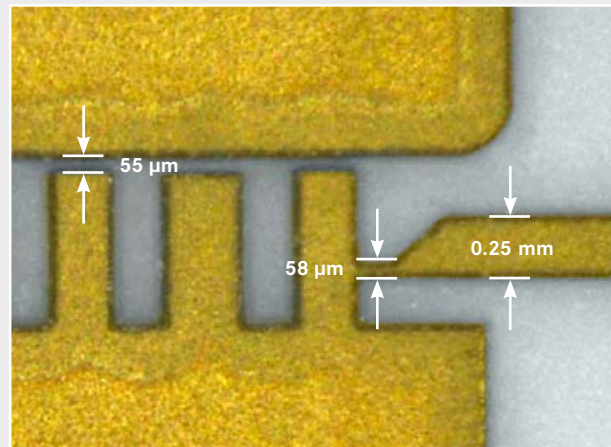
Ultrafine Structures on Challenging Substrates

Due to their electrical properties, hardness, and resistance to environmental factors, fired ceramics play important roles in demanding electronics applications.

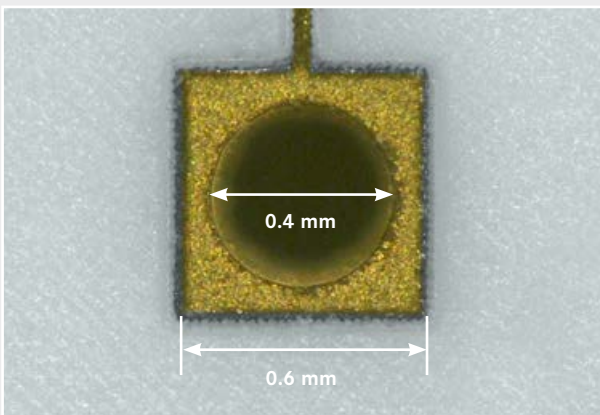
Structuring of sensitive metal layers on ceramic parts can be accomplished with high precision with the LPKF ProtoLaser U4 – as shown in the example to the right (figure to right in original size: 25 mm x 25 mm). A closer look at the structures impressively reveals the possibilities of the UV laser process.



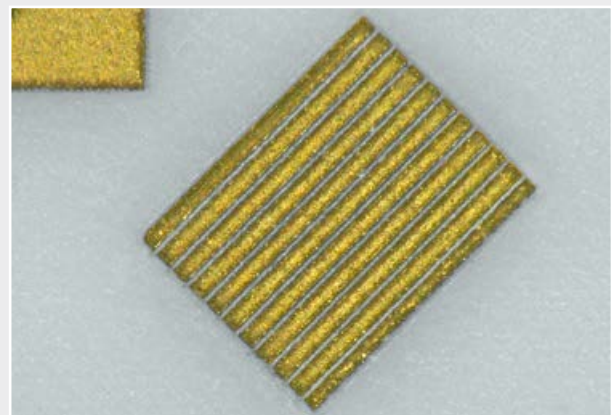
Some regions of the circuit require a closer look



1. The ProtoLaser U4 achieves a high detail resolution, even for complex geometries



2. Hole with a diameter of 0.4 mm in the ceramic substrate in the middle of the square pad

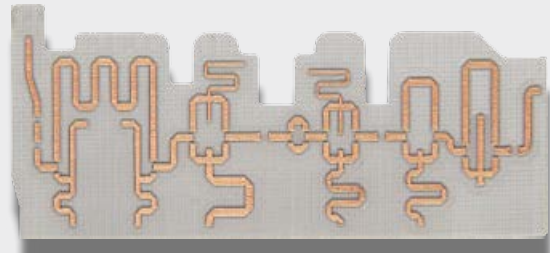
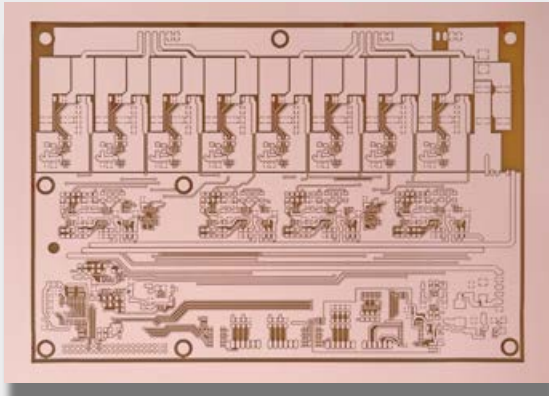


3. Ultrafine structures and gaps on ceramics: line/space of 50/15 μm at an angle of 135°

Processing Laminated Substrates

To produce a track on a base material such as FR4 with a fully coated surface, the ProtoLaser U4 forms insulating channels on both sides of the track. Any geometric shapes can be generated in this manner.

Due to the high precision achieved, this laser system is also ideal for RF applications and digital circuits.



Conventional PCBs on laminated substrates or RF circuits with high demands on geometry matching between layout and practice – both good examples illustrating the precision of the LPKF ProtoLaser U4

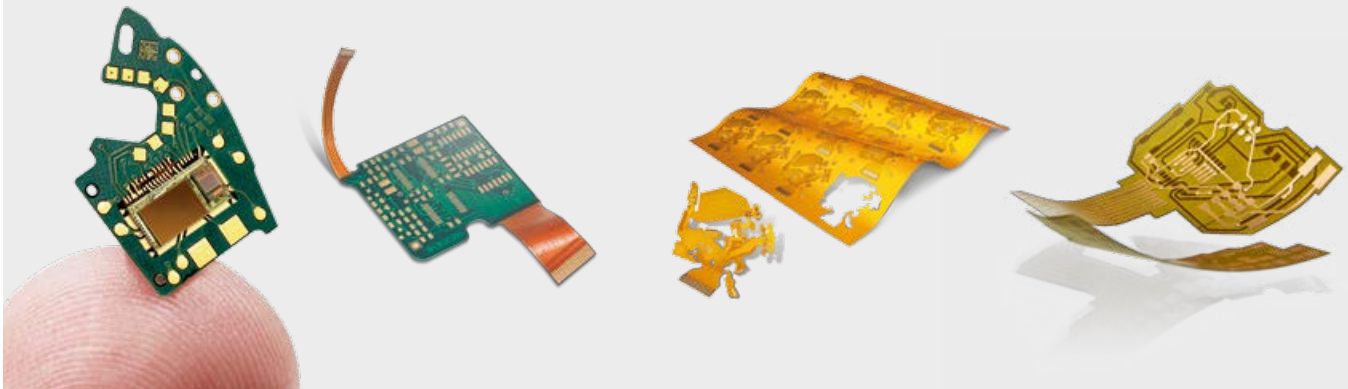
Depaneling and Drilling PCBs

Not only can the laser beam precisely remove metal surface layers, but it can also cut through the substrate material. The number of laser pulses required depends on the material – the CircuitPro PL CAM software has an extensive parameter library for many common materials.

The UV laser beam can cut individual PCBs out of larger panels via tab cutting or make full-section cuts through thin substrates without damaging any tracks or components near the cutting edge. The laser can also separate rigid sections from rigid-flex components or cut out pockets in multilayers. Laser drilling is actually cutting of circles of virtually any given diameter – and the LPKF ProtoLaser U4 has also mastered this task.

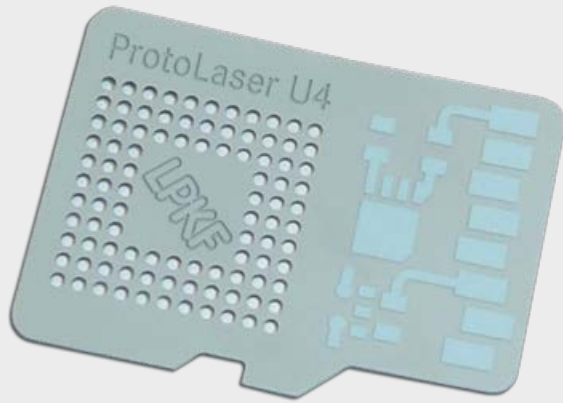
Structuring Double-sided Flexible Boards

The ProtoLaser U4 can do this, too: the Pyralux material (figure to the right) is coated with copper on both sides. The new stabilization enables double-sided ablation of the copper layers without damaging the substrate material.



Cutting, Drilling, and Structuring LTCCs

Low-temperature cofired ceramics (LTCCs) are thin ceramics. They are used in a green state, e.g., for multilayer circuits or, after being sintered, as robust component substrates. LTCCs are difficult to process due to their sensitivity to mechanical factors – and are hence perfect candidates for laser processing.

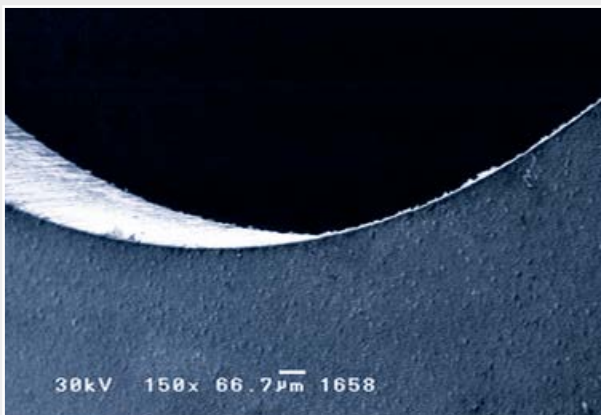


Delicate low-temperature cofired ceramics (LTCCs) can be reliably structured, drilled, engraved, and cut with the UV laser beam

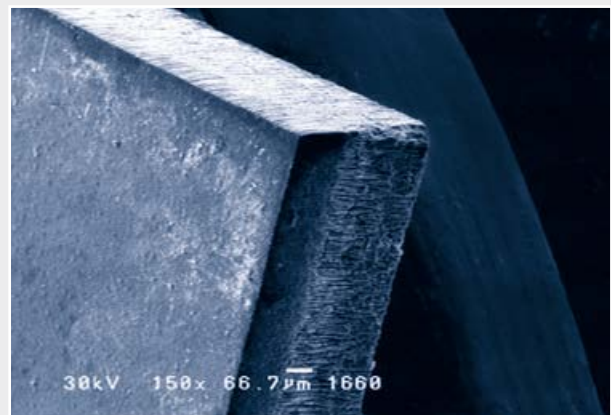
Processing Ceramics

The demands on processing for fired ceramics change fundamentally. The desired material properties complicate the processing of these parts. The UV laser beam in the ProtoLaser U4 can carve, drill, or cut any conceivable contours into these materials and components.

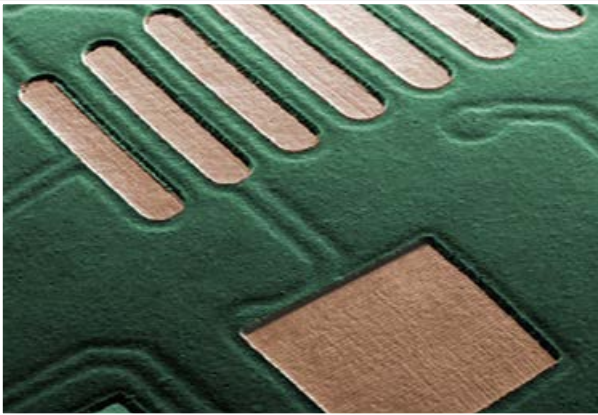
Laser structuring is performed with no physical contact and no limitations on the pattern that can be produced. With the ProtoLaser U4, prototypes, one-offs, and small batches can be made reliably, cost-effectively, and precisely.



Curved edges in Al_2O_3 – with outstanding cutting edge quality



Carving instead of full-section cutting: for faster production of straight cuts



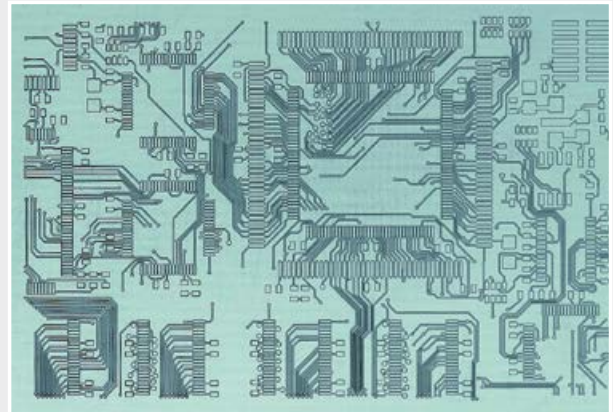
The laser creates openings in the solder mask above the closely spaced contact surfaces

Opening Solder Resists

Another widespread application is the creation of openings in solder resists. Regions with closely spaced electrical connections are completely covered with a solder mask. The laser precisely removes the solder resist above the fine solder pads and cleans the residue off of the copper surface.

Exposing Ultrafine Conductors

The UV laser can also expose ultrafine conductors. In this process, a part is coated with a photosensitive polymer (photoresist). The resist passages exposed by the laser remain in place after development. They protect the areas where the conductive tracks will later be situated during structuring in the etching bath. Thanks to the precise control of the process, tracks with widths of down to about 20 μm , approximating the laser spot size, can be produced.



The laser exposes an etch resist. In a further process, conductive structures with minimal spacings of down to 15 μm are produced.



A breath of air reveals the hidden TCO layers

Structuring TCOs/ITOs

The ProtoLaser U4 can process a wide range of material combinations as long as the absorption characteristics of the material to be structured and the substrate are different.

One example of these capabilities is the structuring of the invisible conductive layers (TCO/ITO layers) on glass to produce invisible sensors, antennas, or heaters.

PCB Prototyping with Worldwide Support

Users of LPKF prototyping laser systems can rely on global application centers in Germany, the USA, Japan, Korea and China for assistance. Application centers provide access to LPKF's many years of experience in laser material processing and offers expert consultancy on technical questions, new processes and applications. Along with structuring lasers, LPKF offers a wide range of systems and processes that make functional, close-to-production printed boards out of structured boards.

From Prototyping to Mass Production

If prototyping with LPKF laser systems produces good results – why not use them for mass production? LPKF's MicroLine family includes mass production-capable UV laser systems with different handling options for use in production. These systems are deployed throughout the world for depaneling delicate substrates, structuring LTCCs, and processing ceramics. The results of prototyping trials can be rapidly transferred to mass production systems. Additional laboratory lasers round out LPKF's product offering: from the ProtoLaser LDI for direct exposure of structures with sizes down to 1 µm and the ProtoLaser R with a picosecond source for processing ultrafine layers to the ProtoLaser 3D, which makes use of the LDS technique to generate tracks on three-dimensional plastic parts.

Technical Data: LPKF ProtoLaser U4

Laser class	1
Max. material size and layout area (X x Y x Z)	229 mm x 305 mm x 10 mm (9" x 12" x 0.4")
Laser wavelength	355 nm
Laser pulse frequency	25 kHz – 300 kHz
Structuring speed	200 mm/s (7.8"/s) on 18 µm / ½ oz Cu on FR4
Cutting speed	200 mm/s (7.8"/s) 0.5 mm (0.02") FR4*
Diameter of focused laser beam	20 µm
Minimum line / space	50 µm/20 µm (2 mil/0.8 mil), on laminated substrate (18 µm Cu)
Accuracy**	± 1.98 µm (± 0.08 mil)
Dimensions (W x H x D)	910 mm x 1650 mm x 795 mm (35.8" x 65" x 31.3"); height with open door 1765 mm (69.5")
Weight	340 kg
Electrical consumption	110 V – 230 V; 1.4 kW
Required compressed air supply	Min. 6 bar (87 psi), min. 230 l/min (8.12 cfm)
Required accessories	Exhaust unit, compressor, PC

* 70 repetitions

** Mechanical resolution scanfield

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