Five Axes Do It Better — Laser Drilling in the µm Range

Numerous industries require processing in the micrometer region: Applications range from ultra-fine bore holes for fine mechanics or automotive-industry injection nozzles all the way to electronics-industry micro-structuring and fabrication of textile-industry spinning nozzles. Now a 5-axis micro-machining system delivers a true technological leap with maximum flexibility and entirely new possibilities to develop and execute processes superior to typical percussion drilling, spiral drilling and trepanning.

Laser drilling increasingly outshines traditional methods such as electric discharge machining (EDM), electrochemical machining (ECM) or mechanical drilling. As laser drilling is contact-free, wear-free, highly precise, and extremely fast, it requires minimal heat input and no process medium. And last but not the least, extremely tiny diameters and high aspect ratios are achievable.

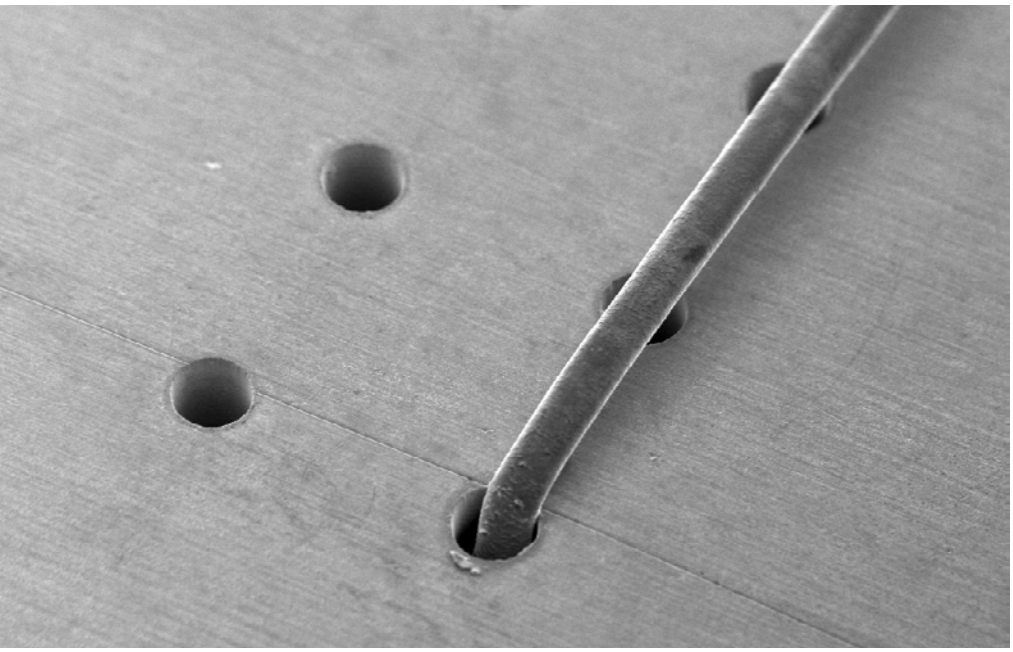
Lasers can remove nearly any kind of solid material, including hardened steel, cemented carbides, ceramics and composites—regardless of material properties such as electrical conductivity or hardness. And with this removal method, even sensitive materials such as glass and polymer film can be processed with negligibly low defects.

Dr Ing Patricia Weber
Project Manager
SCANLAB AG
info@scanlab.de

DIGITAL VERSION

To access this article online scan the QR Code OR visit our website and type the article headline in the SEARCH box

Five Axes



Source: SCANLAB AG

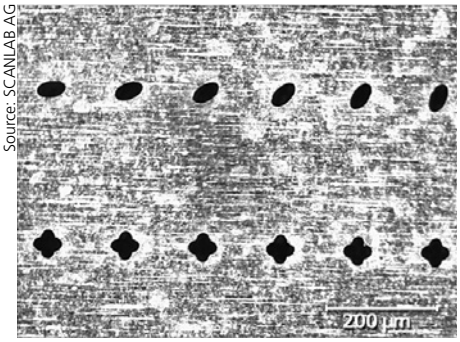
SEM pictures of 100 µm diameter bore holes (entry side, shown with a human hair) in steel of 200 µm thickness..

When implemented as scan solutions, laser drilling offers outstanding flexibility and automation capabilities, as well as phenomenal miniaturization potential via spot sizes adjustable down to mere micrometers. Ultra-fine bore holes are achievable in the sub-millimeter range (e.g., trepanning for diameters ≥ 40 µm with high aspect ratios, or percussion drilling for diameters ≥ 20 µm, always limited in miniaturization by the minimal adjustable focus spot size) with sharp edges at bore entrance/exit holes, and short process times.

New scanner-based micro-machining system

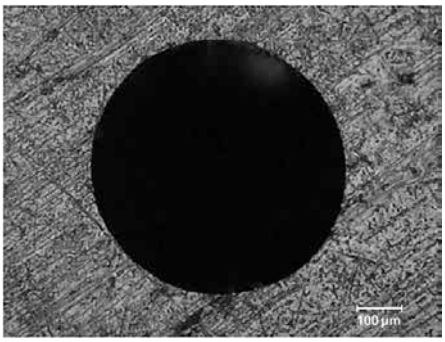
Many industries—from automotive, electronics and photovoltaics to watchmakers and textile-industry toolmakers—require processing in the micrometer region: In conjunction with USP lasers, diverse materials such as glass, hardened metals, ceramics and plastics can be processed burr-free and molten-free.

Source: SCANLAB AG



Flexible geometries in steel: ellipse x = 190 µm, y = 110 µm.

Source: SCANLAB AG



Zoom of bore holemachined in steel of 600 µm thickness.

There are no longer limits to creativity, as a new micro-machining system newly defines the prior limits. Laser-scan-system OEM manufacturer SCANLAB AG is introducing a 5-axis micro-machining subsystem. Designed for ultra-short-pulse (USP) lasers, precSYS enables highly dynamic and precise fabrication of flexibly definable geometries.

The system can, for example, create bore holes with positively/negatively conical or cylindrical walls, as well as round or elliptical entries/exits accompanied by high aspect ratios (small bore diameter with simultaneously large depth). Bore-hole creation is both precise and long-term stable. The possibility of rotary motion, coupled with flexibly adjustable angles of laser incidence, enables fabrication of free geometries for bore holes far finer than 80 µm. Stringing together ellipses or circles, allows more complex geometries to be achieved using a modular approach. On the software side, direct movement along the contours of complex geometries is currently implemented.

"Initial feedback from customers who have tested precSYS has been consistently positive," says CEO, SCANLAB AG, Georg Hofner. "All users particularly praised the wide-ranging freedom in fabrication strategies, as well as the high-quality processing results and quick installation thanks to stable system construction."

5-axis system's principle of operation

precSYS positions the focal spot in 3D onto workpieces with precise AOI tracking (angle of incidence). Progression of focal motion as angles of incidence and laser beam intensities can be varied. High-end scan technology and low moving masses ensure highly dynamic processing with trepanning or precession frequencies up to 500 Hz (30,000 rpm).

Advanced digital encoders, control algorithms and optimized servo control enable contour-true, speed-independent processing with maximum precision. Due to the ability to position the laser beam in 5 axes, the system offers the highest flexibility for process development, beyond typical percussion drilling, spiral drilling and trepanning.

Processing results – put under the microscope

The precSYS is laid out to rapidly machine fine hole diameters in the sub-millimeter range with high aspect ratios. In combination with ultra short pulsed laser beams and adaptive process management, perfectly sharp edges can be achieved at cylindrical hole entries and exits, with smooth wall surfaces.

User friendly control software with 3D visualization

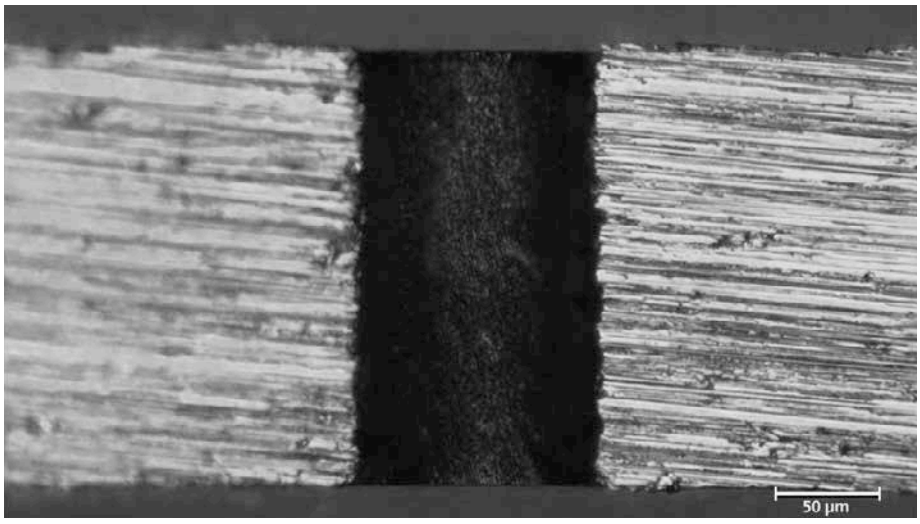
A graphical user interface (GUI) facilitates straightforward creation and testing of micro-machining jobs. The intuitive software interface with 3D job visualization helps to generate, select and simulate processing jobs. The job designer additionally allows varying the diverse process parameters and compensating workpiece tolerances. Drill sequences can be easily defined. The software facilitates the management of one or several systems for series production. Factory calibration enables description of laser motion directly in metric units within precSYS's cartesian image field coordinate system. Control and remote communication are via Ethernet.

Designed for automated series manufacturing

The system has full industrial suitability. It features modular construction, water cooling and a sealed, gas-purged beam path. This contributes to the high precision results of USP-laser processing and ensures a long life of the optical components. This makes precSYS a low-maintenance product with resilience against fluctuating temperatures, ablation particles, dust, etc. It is precisely factory-pre-calibrated and can be equipped with optional automatic fine alignment. The system offers two observation ports for process-monitoring add-ons.

It contains integrated sensor control and an embedded PC. The standardized interface for XML data exchange allows straightforward remote connectivity to PLCs, and thus integration into modern automated manufacturing environments. Hence, it is fully open to all the requirements of factory automation and modern IOT architectures (internet of things, industry 4.0). Test systems are available upon request. precSYS series production is scheduled for early 2016. MMI

Source: SCANLAB AG



Cross-section of a 230 µm bore hole in steel of 200 µm thickness.