Water jet guided laser tool machining

A cool solution for the hardest challenges: When it comes to machining cutting tool inserts made of materials like PCD, CVD, MCD and natural diamond, the **HYBRID LASER MICROJET METHOD** delivers performance and quality that can more than compete with conventional techniques like spark erosion or laser machining.

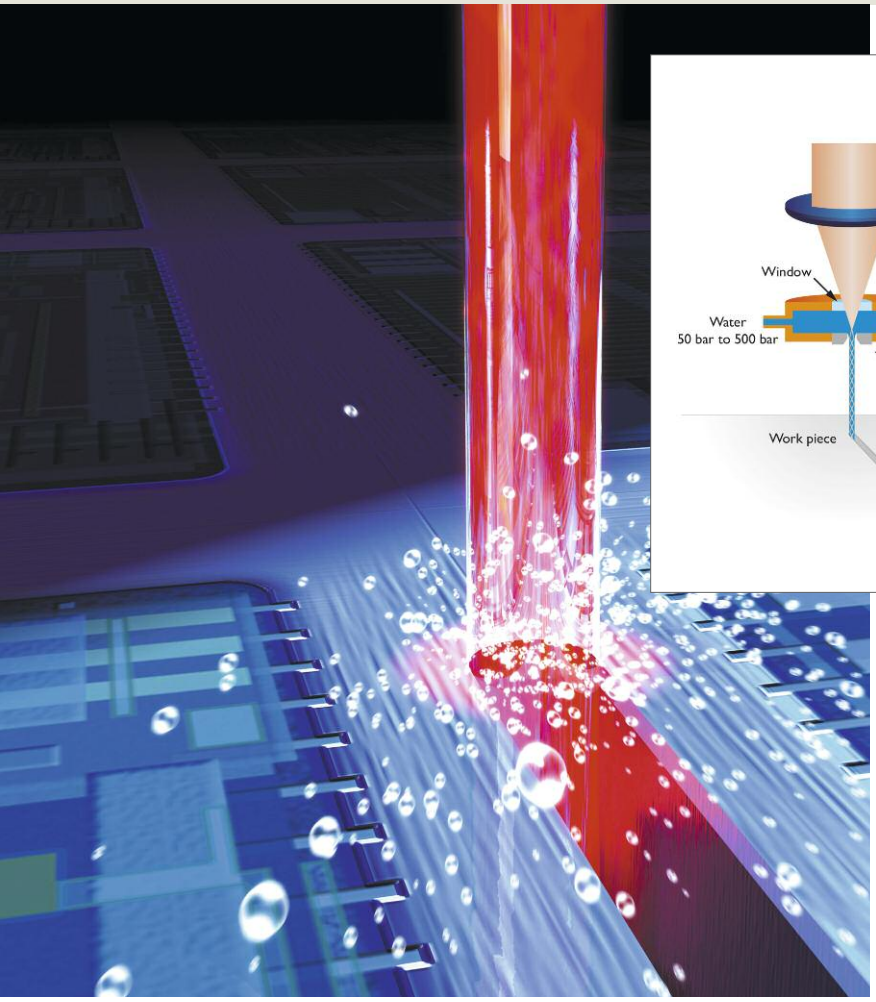

Figure 1. Laser MicroJet from Synova: The method uses a water jet guided laser (MicroJet Laser) that is capable of cold cutting edges in three-dimensional shapes

NITIN SHANKAR

In the Laser MicroJet method developed by the Swiss company Synova, the laser beam is focused in a nozzle and guided within an ultra-thin water jet at low pressure, allowing it to carry out precise machining operations such as cutting, edge grinding, drilling or scoring **(Figure 1)**. The water jet emitted from the nozzle at low pressure guides the laser beam by total internal reflection at the water/air interface and acts in a similar way to a conventional optical fibre. This produces a »cold and clean« laser that avoids all well-known problems such as heat damage, distortion and lack of precision **(Figure 2)**.

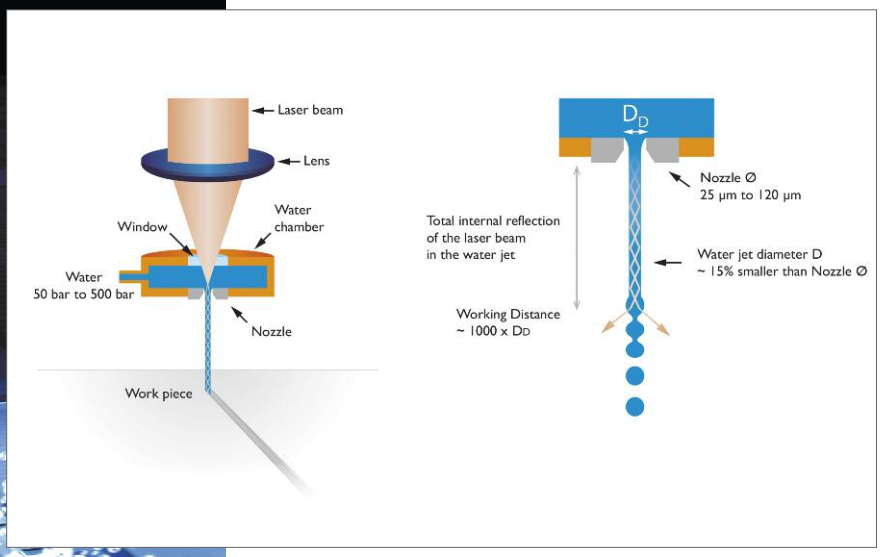

Figure 2. The Laser MicroJet principle

Functioning and advantages of Laser MicroJet

In addition to the beam shaping optical system, the optical head also contains a camera to adjust the nozzle opening for the laser beam and a light source. There is also a camera for positioning the part to be machined. The laser beam is first collimated in the optical head and then focused in the nozzle opening through a quartz window. This window separates the

> CONTACT

MANUFACTURER
Synova SA
CH-1024 Ecublens
phone: +41 21 694 3500
info@synova.ch
www.synova.ch

Figures: Synova

Figure 3. Laser MicroJet cutting is perfect for tool machining. It normally takes just a few minutes to cut a tool insert

optical system in the machining head from the water-filled nozzle chamber. In this section, water is fed into the nozzle through several channels perpendicular to the laser beam with rotational symmetry, so that an ultra-fine water jet emerges from the nozzle. Close to the nozzle, the laser beam is injected into the water jet and is guided within the jet by total reflection. The typical beam diameter is between 30 and 80 µm and the usable working length is generally approx. 1000 × D, in other words 30 to 80 mm. This gives the Laser MicroJet method a key advantage: It delivers a parallel laser beam, which greatly simplifies precision machining. The ablation rate remains almost constant over the full depth, which means that the material thickness is only of secondary importance.

The laser pulses in the nanosecond range and an optical cable is used to transmit the laser beam to the optical head, which is equipped with various lenses. The water jet emits red light, stimulated by the green laser, and strikes the surface of the part, which is moving horizontally on a coordinate table. It normally takes just a few minutes to cut a tool insert **(Figure 3)**.

A second crucial advantage comes into play here: The Laser MicroJet system is not based on expensive ultra short pulse laser sources, but can use robust, established, more powerful and more economical industrial lasers, which also enable the LMJ method to achieve a significant speed advantage. At the same time, efficient cooling by the water jet ensures that the cutting edge quality is at least as good as with other methods.

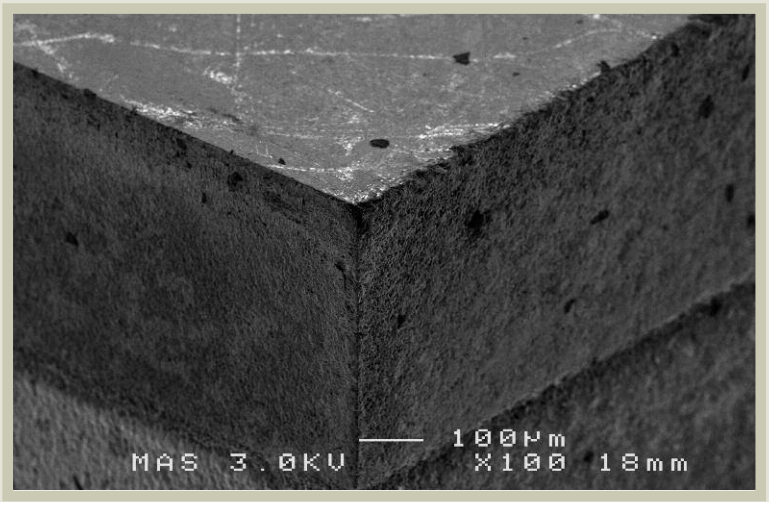

Figure 4. Sample cut: with Laser MicroJet on the left and using spark erosion on the right

Hard machining jobs made easy: top cut surfaces without cavities

For the machine tool industry, the LMJ cutting system also has key advantages over spark erosion as it delivers an exceptional cutting quality that conventional techniques simply cannot match. The result is a cutting edge with minimal roughness of the cut surface (R_a = 0.2 µm) and no cavities on the edge.

Figure 4 shows the cut on a PCD (polycrystalline diamond) tool insert after machining with the LMJ method compared to spark erosion. The LMJ method can also be used on other hard materials such as silicon carbide and CVD (chemical gas phase infiltration) without exposing them to heat, contamination (deposits or chips) or deformation. Customers also benefit from considerable economic advantages such as an increased manufacturing yield and lower unit costs.

Unlike EDM, LMJ can also be used on non-conductive materials. Machines with 5-axis systems also enable micro-machining of three-dimensional

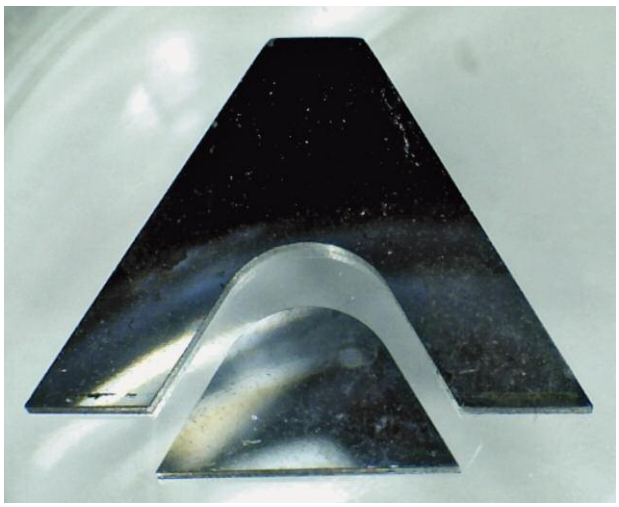

Figure 5. CVD insert with circular edge

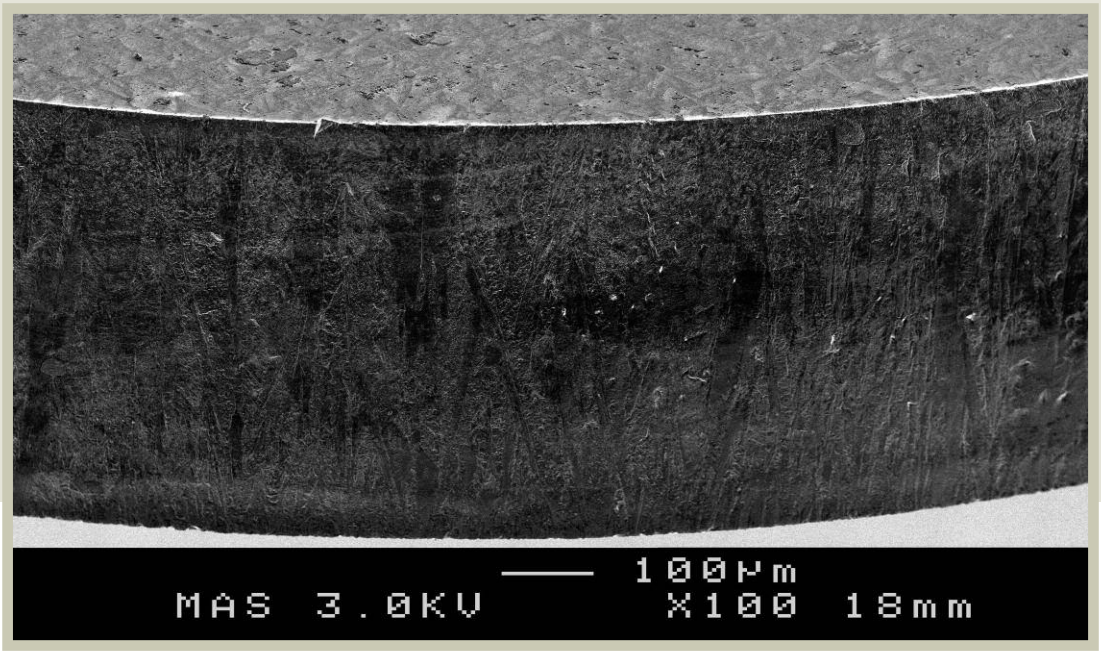

Figure 6. CVD insert at 100 times magnification

CNB (polycrystalline cubic boron nitride) and ceramic parts, such as a circular insert cut out of a 0.5 mm thick CVD sheet **(Figure 5)**. **Figure 6** shows the edge quality at 100 times magnification, and the clean structure of the cut surface is clearly visible.

Figure 7. The compact and flexible ›DCS 150‹ from Synova is primarily used in micro machining, for example in production of cutting tools made of ultra-hard materials

»Made in Switzerland«

Synova supplies turnkey laser cutting systems for the machine tool and micro-machining industry **(Figure 7)**. These machines have working surfaces of 150 × 150 to 300 × 300 mm^2. They are generally equipped with 3-axis CNC controllers that enable the Laser MicroJet system to cut the workpiece according to a previously specified cutting scheme.

There are also two 5-axis machines for finishing of diamond tools – one for large tools with multiple inserts (250 × 200 × 300 mm^3) and a small, compact version for tools with a diamond insert (150 × 50 × 100 mm^3). The machines come complete with operator software based on equivalent spark erosion machines so it is familiar for users. Both machines incorporate a totally new machine platform developed in conjunction with machine tool manufacturers, enabling users to enjoy the maximum benefits of the Laser MicroJet method. They have already been sold to key customers and are set to be delivered by the end of this year. ■ MI110329

AUTHOR

NITIN SHANKAR is an independent business consultant and freelance business journalist based in Ecublens/Switzerland;
nitin@vtx.ch

Figures: Synova