LABORATORY GROWN DIAMONDS

FOR INDUSTRIAL APPLICATIONS

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<< Figure 1: NDE's laboratory grown diamonds. >>

Bakul Limbasiya, Director, New Diamond Era (NDE), was relieved when the second Synova LCS (Laser Cutting System) 150 machine arrived in his facility in August 2015.

The Synova LCS (Laser Cutting System) family of machines equipped with the patented Laser MicroJet combines the advantage of both water and laser cutting in one operation. This laser can slice hard synthetic diamonds for use as cutting tools with smooth edged surfaces.

Ever since NDE installed its first Synova LCS 150 system in 2012, the machine has been working on a 24-hour/7-day basis, machining synthetic diamonds for industrial applications.

NDE, based in Surat (India), has pioneered in the development and production of synthetic diamonds for industrial applications. After many years of research, Limbasiya's team succeeded in producing laboratory grown CVD (chemical vapour deposition) diamonds on a large scale (figure 1).

Diamonds, as well as synthetic diamonds, are the hardest material known and this property makes them ideal for use as inserts for cutting tools. They are, however, so hard that only laser systems can machine them to required profiles or shapes. Therefore, laser cutting machines play an important role in NDE's production process.

The Synova LCS 150 system, equipped with the patented Laser MicroJet, installed in NDE's manufacturing facility at Sachin, near Surat, provides distinct advantages over conventional laser cutting machines.

In the Laser MicroJet system, a laser beam, passing through a pressurised water chamber, is focused into a nozzle (figure 2). The low-pressure waterjet emitted from the nozzle guides the laser beam by means of total internal reflection at the water/air interface. The waterjet diameter ranges from 30 to 60 microns and the laser power required is less than 25 to 30 watts. While the principle looks simple, years of experimentation were required to fine-tune the process.

Parallel Beam for Added Cutting Depth

Unlike conventional laser cutting where thermal heating poses risks, the Laser MicroJet, between laser pulses, cools the surface of the synthetic diamond with a waterjet. This is effective 'cold laser cutting'.

In comparison to conventional 'dry' lasers, the Synova waterjet guided laser offers many advantages in synthetic diamond cutting.

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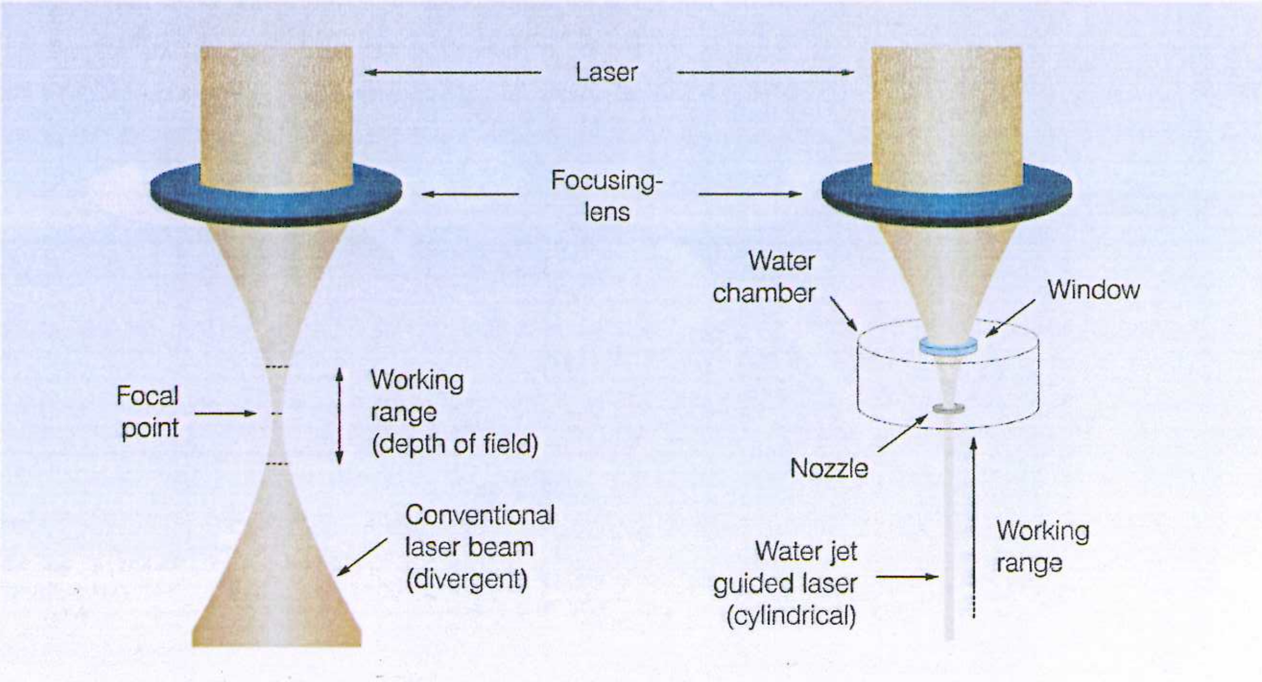
The most important advantage of the Laser MicroJet technology is the production of a cylindrical laser beam that can cut up to 25 millimetres deep with parallel kerf walls and minimal weight loss.

The technology behind the Laser MicroJet is based on creating a laser beam that is completely reflected at the air-water interface, using the difference in the refractive indices of air and water. The laser is, therefore, entirely contained within the waterjet as a parallel beam, similar in principle to an optical fibre.



<< *Figure 2: Comparison of beam shapes: Conventional vs. waterjet guided laser.* >>

This is not the case with conventional lasers where the focused laser beam has a limited working distance of just a few millimetres due to beam divergence. The beam converges at a focal point and then diverges. Therefore, a focus distance control is required and the working distance is short.

Thus, the Laser MicroJet's parallel beam is ideal for an NDE application requiring the slicing of laboratory grown diamonds into segments with thicknesses ranging from 0.3 to 1.2 and from 5 to 6 millimetres. The slices have to be absolutely parallel and the LCS 150 system has proven that it can deliver a degree of performance that is not possible with a conventional laser.

Moreover, the waterjet guided laser ensures a better surface finish.

This may be explained by the difference in the way a conventional laser works as compared to the Laser MicroJet.

The temperature in a conventional laser can reach 2000°C when the laser beam strikes the surface of the synthetic diamond. The synthetic diamond's molecular structure at this point is converted to carbon vapour, which is burned off. The result is carbon debris adhering to the surface.

By contrast, the Laser MicroJet uses the heat of the laser beam to cut while the waterjet provides a cooling effect. The hot carbon vapour generated during cutting is constantly being evacuated by the flow of water, resulting in a clean and smooth surface.

<< *Figure 3: NDE's LCS 150 system in operation.* >>

The NDE LCS 150 system (figure 3), with a table size of 150 x 150 millimetres, is equipped with a 3-axis CNC controller enabling the Laser MicroJet to cut extremely hard materials with precision along a predetermined path. The machine's optical head includes an optical fibre cable for laser beam transmission, a camera and a number of lenses.

<< Figure 4: Synthetic diamond tool inserts. >>

<< Figure 5: Bakul Limbasiya with Mahesh Kargar in the NDE Laser Shop. >>

Despite the sophisticated technology, the system's user-friendly software guides the operator on a step-by-step basis.

The machining capability of the 3-axis LCS system allows triangular, rectangular or other shaped inserts to be cut from synthetic diamonds. With the Laser MicroJet, it is possible to have the smooth-edged surfaces needed for cutting tools (figure 4).

"We have found that the Synova machine is delivering superior results compared to conventional laser cutting machines. The system has paid for itself," said Mr Nirav Patel, Head of NDE's Laser Department.

The challenge is to ensure that the machines work on a 24/7 basis. NDE relies on training its laser machine operators so that they understand the parameters needed to ensure that the Laser MicroJet delivers optimal performance. It also relies on SAI-Impex, Synova's agent for LCS systems for industrial applications.

"We found that NDE's machine operators and production team were quick to master the fine adjustments needed to align the laser beam so that the cutting performance is optimal," said Mahesh Kargar, director, SAI-Impex (figure 4).

With its experience in producing and machining synthetic diamonds, NDE is well positioned to expand its product range to other applications in the fast growing market for synthetic diamond products worldwide.

NDE has been a trailblazer in developing industrial applications for synthetic diamonds and Synova is proud to be associated in this venture.

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MAHESH KARGAR, DIRECTOR, SAI-IMPEå