

Ultra hard material cutting with improved LMJ technique

*Alexandre Pauchard, Grigore Suruceanu, Benjamin Carron, Notker Kling, Bernold Richerzhagen
Synova SA, Ch. de la Dent-d'Oche 1, CH-1024 Ecublens, Switzerland
Phone +41 21 694 35 00; fax +41 21 694 35 01; www.synova.ch
E-mail: info@synova.ch*

Ultra hard materials, such as polycrystalline diamond (PCD), cubic boron nitride (CBN) and tungsten carbide (WC), are widely used in the tooling industry, e.g. for the fabrication of inserts. Processing these ever-harder materials is an increasing challenge, in particular when thick samples have to be cut following complex shapes.

Machining technologies are required to cut discs and plates into inserts of various geometries such as triangles, rectangles or lozenges. Drilling is an additional process for fixing of the insert. Main requirements are: smooth edged surfaces, parallel walls, narrow cut for material savings, no burrs nor material changes due to heating, reasonable speed, and flexibility to realize any shape.

Legacy cutting technologies include diamond saws, electro-discharge machining and conventional dry laser cutting. The first technique suffers from important tool wear, is a rather slow process, induces costly material loss due to large kerfs, and limits the cutting shapes with straight lines cutting. EDM requires electrically conductive materials and is a slow process. Conventional dry laser cutting suffers from depositions, thermal damage, conical kerfs, and often requires post-processing treatments.

The water jet-guided laser technology (also known as Laser MicroJet[®] or LMJ) has proven to be an efficient technique in cutting ultra hard materials. It offers excellent cutting quality and good cutting speed. The process requires low water consumption, induces no tool wear, and offers reproducible quality. No post-treatment is necessary, and smooth edges can be obtained. In addition, the process produces no burrs nor heat damages.

One remaining issue however was the water nozzle lifetime, which was negatively affected by the high power levels required in these demanding cutting applications. Recent LMJ technology improvements have enabled a significant increase in the reliability of hard material cutting processes, in particular that of the nozzle lifetime. The thermal management inside the optical head has been greatly improved, and nozzle contamination has been reduced. A number of applications are presented that show the effectiveness of the LMJ process for hard material cutting.

CVD diamond tipped insert cutting was performed with 120W green laser operating at 532nm and 15kHz. The material thickness was 0.4mm. The nozzle diameter was 75 μ m. An overall cutting speed of 35mm/min has been obtained. Edges are sharp and perfectly clean. Neither recast nor thermal effects are visible on the inserts.

Thick, 5mm CBN inserts in WC discs were cut through using a 532nm laser at an average optical power of 140W and a repetition rate of 8kHz. The jet diameter was 66 μ m. Fast processing time and high aspect ratios were obtained. Neither burrs nor contamination were observed. The process proved to be very flexible in the shapes that could be obtained. It also offered high quality and clean edges, with no heat-affected zone (HAZ).

The LMJ process with 532nm laser was also used to cut 1.5mm thick CBN on 7mm WC discs. A cutting speed of 1.7mm/min was obtained.

In another application, 1.6mm CBN/WC inserts were cut using a 532nm laser at an average optical power of 128W. An overall cutting speed of 11.5mm/min was achieved.

Pure WC rods were cut using 140W green laser at 18kHz. The rod thickness was 1.42mm. Outstanding cutting quality was achieved with the LMJ process.

In conclusion, an improvement of the water jet-guided laser technology has made it possible to greatly increase the nozzle lifetime. The advantages of using the LMJ technology for hard material cutting are a higher throughput than standard diamond blades or electro-erosion, and superior quality to standard lasers. The process offers however the flexibility of traditional dry laser cutting, able to cut all patterns and geometries. The technology runs on low operating costs, as neither blades nor cooling liquid are required. It also offers the possibility to perform fast-prototyping runs.