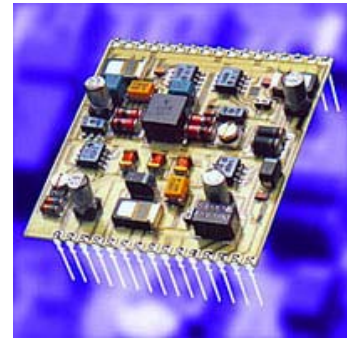


Application Note No. 112

Cutting, Scribing, Drilling of Hybrid Ceramics with SYNOVA Laser-Microjet®

Description of Product

Hybrid ceramics is characterized by excellent dielectric properties with very good thermal stability and thermal conductivity. It also offers excellent value for high performance and high miniaturization circuitry. Hybrid ceramics is intensively used, in the production of printed circuit boards and electronic components, by market leaders in wireless, automotive, medical, broadband communications and test instrumentation electronics.



Description of Material

Alumina (Al₂O₃) is normally used as basic material; it has high mechanical solidity and excellent electrical and thermal properties. In addition, metal conductors, resistors, dielectric and glass layers are normally applied by screen-printing technology and fired between 500 °C and 800 °C. Alumina, ZrO₂, Beryllium Oxide and Aluminium Nitride are commonly processed by laser.

Description of Manufacturing Task

Preparation of hybrid ceramic substrates includes cutting them to size, scribing, grooving, and drilling holes (vias) in them. New circuit designs often require thinner ceramic substrates, smaller vias (holes), closer via locations, denser circuit patterns and multi layer interconnects. Engineering ceramics require extreme accuracy of design.

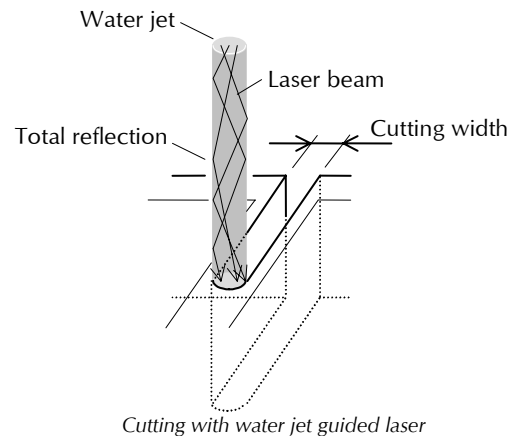
Description of Conventional Manufacturing Process (State of the Art) and Problem

Conventional methods, such as dicing saw, punch or ultrasonic cutter, are not able to achieve complex and quality processes; they are very slow and have high running costs. Punch typically becomes unusable between 0.008 and 0.015-in diameter; furthermore small diameter punches wear and break too easily. Conventional CO₂ laser provides significant benefits but is still problematic. Users have experienced material cracking, formation of a brittle recast layer, and edges of bad quality.

Water Jet Guided Laser Technique

In 1993, scientists at the Institute for Applied Optics at the Swiss Federal Institute of Technology Lausanne succeeded in creating a water jet guided laser, called by its inventors Laser-Microjet®.

The laser beam is focused in a nozzle while passing through a pressurised water chamber. The geometry of the chamber and nozzle are decisive to coupling the energy-rich laser beam in the water jet.

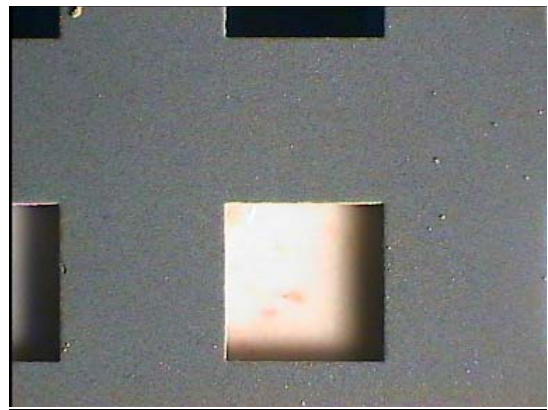
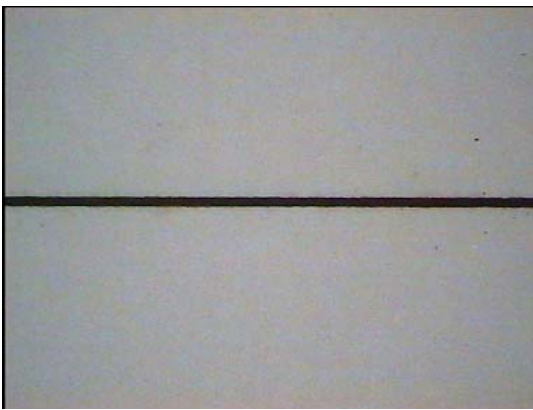


The low-pressure water jet emitted from the nozzle guides the laser beam by means of total reflection at the transition zone between water and air, in a manner similar to conventional glass fibres. The water jet can thus be referred to as a fluid optical wave-guide of variable length. Because a pulsed laser is used, the continuous water jet is able to immediately re-cool the cut, resulting in only a very slight depth of thermal penetration. The result is a very narrow, parallel, burr-free, clean cut, without any thermal damage.

Solution with Laser-Microjet® Process

A quality and clean cut as well as a smooth and flat surface can be achieved. A wide range of ceramic thickness can be processed. During scribing, the depth is very regular, and the water jet prevents any thermal damage. Laser-Microjet® can precisely cut, drill or scribe a wide variety of materials to your specification. In comparison with the conventional laser, the difference is at the very least remarkable.

These following pictures show the excellent cutting quality:



Benefit for the Customer

The customer obtains now the following advantages:

- ▶ No chipping or cracking
- ▶ Smooth, flat bottom surface of kerf
- ▶ No burrs or slags, no re-deposition/contamination
- ▶ No thermal damage or material changes
- ▶ No formation of craters on the edges of the groove
- ▶ Smooth vertical walls
- ▶ Formation of vias without drill wear or breakage, at a very high speed
- ▶ Excellent tolerances
- ▶ Possibility of cutting/drilling before and after firing
- ▶ Narrow and parallel cuts (35...60µm)
- ▶ Very low running costs, no tool wear
- ▶ Any cutting geometry possible (2D)

Consequence of the Benefits

Because of the huge improvement in costs, quality, flexibility and productivity compared to conventional CO₂ laser process, the Laser-Microjet[®] process will be the future choice for hybrid ceramics applications.

Machine for Laser-Microjet[®]

Synova offers a state-of-the-art, clean-room compatible machine, especially adapted for ceramic substrates processing. Optimum cutting parameters are preloaded.

The machine designation is LCS 300. Cleaning unit and automatic loading system are available, too. The machine has a precision of +/- 5 microns, a processing area of 300 x 300 mm and a maximum axis velocity of 1000 mm/s. The system is equipped with CCD camera and fast image treatment software, allowing automatic alignment and inspection. The operation interface is a 15-inch flat color screen with touch panel, the machine software is based on Windows NT^{®2}.

The machine can be connected to LAN network for data transmission. The integrated modem allows telediagnostic service. Adapted CAM software can convert all DXF data, fast and easy without special knowledge.



A complete list of option is available such as chiller, alternative laser sources, water treatment system, 2D-reference scales, and transformers.

The CE and S2 certified Synova machines are field proven and used for 24h production.

¹ Laser-Microjet[®] is an international protected trademark of Synova S.A, Switzerland.

² Windows NT[®] is a trademark of Microsoft Corp, USA.