

Application Note No. 101

Cutting of Ferrite Cores with SYNOVA Laser-Microjet®

Description of Product

Ferrite Cores are also known as Soft Ferrite Cores. Their cycles of magnetic fields change in the same path as the electrical current, hence the magnetic fields created are a thousand-fold stronger than other mediums. Ferrite Cores are critical components in electronic machines. They are widely used in high frequency transformers, horizontal output transformers, deflection coils, energy-saving lamps and other inductance components and parts.

There are different types of core: EE, EI, ER, Pot Cores, Toroidal Cores, Tubular Cores and Deflecting Coil Cores, etc.



Ferrite Cores

Description of Material

Ferrites are dense, homogenous ceramic structures made by mixing iron oxide with oxides or carbonates of one or more metals such as zinc, manganese, nickel or magnesium. But the most basic alloys are the Nickel Zinc class¹ (NiZn) and the Manganese Zinc class² (MnZn).

Description of Manufacturing Task

Cores are sintered and some which will be assembled require machining. Some core sets require gaps with tight tolerances in their flux path. This can be accomplished by grinding a pot core's centre post, an E core's centre leg or by cutting a slit in a ring core.

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

Because of the extremely hard, brittle, and abrasive nature of the ceramic material, diamond wheels are commonly utilized for machining operations. However, this method requires large amounts of liquid coolant and a high tool consumption rate. In addition, the process is slow and very thin gaps cannot be realized.

Lasers have the potential to provide significant benefits over sawing but they still induce problems such as heat damages, contamination, cracking, low speed, formation of a brittle recast layer and edges of bad quality.

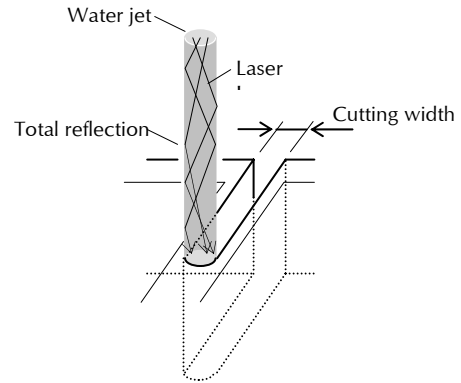
¹ a permeability range from 20 to 800 μ

² a permeability range above 800 μ

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.

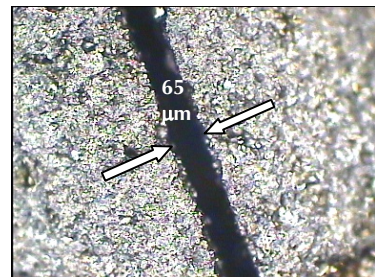
Machining with Laser-Microjet® Process

The absorption of the infrared laser radiation in the Ferrite material is excellent. The water jet is able to guide the laser energy to the bottom of the slit, thus parallel and very narrow slits are possible. The water jet prevents any thermal damage. It is worth mentioning that quality cutting is not reached at the expense of speed.

This 10x5x5 mm ring core was cut with the 50 µm diameter water jet and the gap is 65 µm wide. This cutting was made at a speed of 100 mm/s without any burrs.



The Laser-Microjet® moves rapidly back and forth over the surface until the core is cut. The cutting is very clean and no oxidation or heat affected zone is observable.



Benefit for the customer

The customer obtains now the following advantages:

- ▶ High cutting speed
- ▶ Excellent tolerances and surface finish
- ▶ No thermal damage or material changes
- ▶ No mechanical stress
- ▶ No burrs nor depositions, very smooth surface
- ▶ Narrow and parallel air gaps (28 to 100 µm)
- ▶ Any air gap geometry possible :
- ▶ Constant results
- ▶ Very low tolerances in inductance
- ▶ Online control of inductance possible
- ▶ Very low running costs, no tool wear
- ▶ Significantly reduced post-processing
- ▶ Higher productivity / better return on investment
- ▶ More ecologically conscientious process, because particles are absorbed in the water for filtering



Consequences of the benefits

Because of the huge improvement in costs, quality and productivity compared to any other conventional process, the Laser-Microjet® process will be the only choice for air gap cutting of Ferrite cores in the future.

Machine for Laser-Microjet®³ Cutting of Ferrite Cores

Synova offers a state-of-the-art, clean-room compatible machine, especially adapted for the cutting of Ferrite cores. Optimum cutting parameters are preloaded. The machine designation is LCS 300.

The Ferrite cores are cut on carriers. Automatic loading systems for these carriers can be obtained as well.

The machine has a precision of +/- 3 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 colour screen with touch panel, the machine software is based on Windows NT®⁴.

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.



Laser Cutting System LCS 300

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

The Synova machines have been repeatedly field proven and are being used for 24h industrial production.

³ Laser-Microjet® is an international protected trademark of Synova S.A., Switzerland.

⁴ Windows NT® is a trademark of Microsoft Corp., USA.