

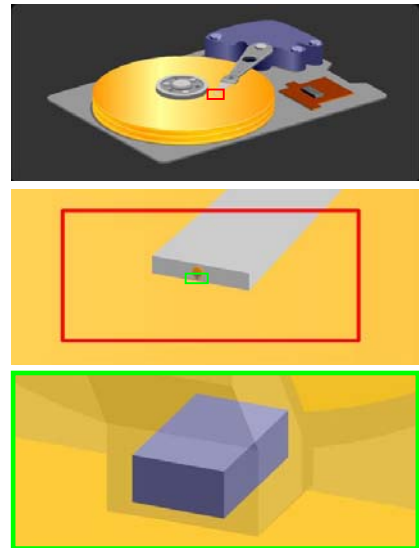
## Application Note No. 119

### Hard-Disk Drive (HDD) Read Head Substrate Dicing with Laser-Microjet®

#### Description of Product

Hard-disk drives (HDDs) are used to collect most of the data accessible by computers and workstations. The data are stored on the disk (called a platter), in form of permanently magnetized regions, or bits, which are written by an inductive head. Information can then be read with a magnetoresistive (MR) structure head. Thus, two physically-distinct heads are used for the write and read functions; this technology is known as the magnetoresistive head, and is commonly used in today's market place. Both heads are attached to sliders that maintain a consistent flying height above and below the rotating disk at an average distance of 10 nm.

Two important parts of the MR structure of the read head are a ceramic substrate and a thin-film component; the latter allows changes in the resistance as the magnetic fields switch, corresponding to the stored pattern of the disk. A sensor detects these differences in resistance, and this allows the bits on the platter to be read. These thin films are bonded onto very hard ceramic blocks that must be cut with very high accuracy.



#### Description of Material

The MR head substrate is made of ferromagnetic ceramic material, which has an extremely hard wear resistance and excellent magnetic properties. A typical MR substrate is AlTiC (or  $\text{Al}_2\text{O}_3\text{-TiC}$ ). The substrate thickness usually ranges from 200  $\mu\text{m}$  to 300  $\mu\text{m}$ .

#### Description of Manufacturing Task

Substrates for HDD read heads require machining after being sintered into bars or sheets. They have to be diced into very small units with very high precision and tight tolerances, since the read head will fly very close to the disk (average height of 10 nm).

#### Description of Conventional Manufacturing Process and Problem

Currently, diamond wheels are the most common process for read head substrate dicing. Although the technology is simple and mature, the method is not ideal. Significant problems are apparent, such as high mechanical (internal) stress, burrs, large kerf-width, lack of accuracy and low flexibility. Furthermore, this process has a high tool consumption rate, is a very slow process and requires large amounts of liquid coolant.

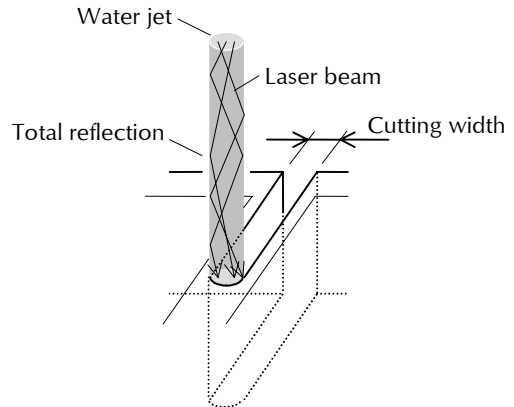
As conventional lasers are not able to meet the requirements of this application, HDD manufacturers do not consider this a viable cutting technology.

## Water Jet-Guided Laser Technique

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

The laser beam is focused through a nozzle while passing through a pressurized water chamber. The geometry of the chamber and nozzle are critical 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 fibers. The water jet can thus be referred to as a fluid optical wave-guide of variable length.



*Cutting with water jet-guided laser*

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.

## Laser-Microjet® Solutions

### 1. *Dicing with Laser-Microjet*

As a “cold” and “wet” laser, the Laser-Microjet is perfectly suited for high-precision cutting of HDD head substrates.

Accuracy is combined with speed. The cutting is entirely free of mechanical and thermal damage. It avoids any warping of the air-bearing pattern; the precision of the read head is increased, allowing a constant flying height above the disk.

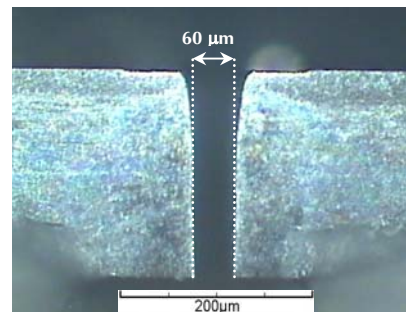
The process produces very smooth and straight edges, as well as burr-free cuts.

Parallel and narrow cuts can be obtained with small chamfers on the upper part of the piece, which allows a better functionality of the device.

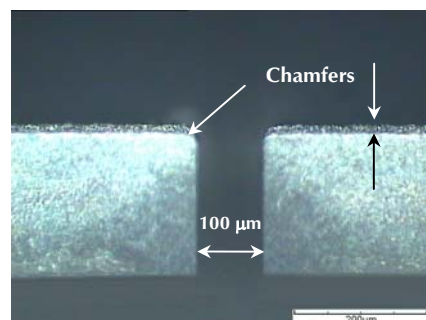
The Laser-Microjet can also process narrower kerf-width and higher throughput than mechanical saws.

### 2. *Laser-Microjet Post-processing*

Even if the diamond saw is chosen as the method for dicing the HDD substrate, the water jet-guided laser remains the perfect tool for this application as it releases the mechanical stress induced by the wheel. Additionally, edges can be treated by performing precise, small, regular and burr-free chamfers along the grooved bar.



*Microscope image of AlTiC cut with Laser-Microjet®; parallel walls and chamfers are clearly visible*



*Microscope image of AlTiC edge treatment with Laser-Microjet® (front view); it can treat both edges simultaneously*



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## Customer Benefits

Customers can obtain the following advantages using Laser-Microjet technology:

- ▶ High speed cutting
- ▶ Excellent cutting quality with narrow and parallel-cut walls, and smooth and straight edges
- ▶ No burrs or depositions maintaining a very smooth surface
- ▶ No mechanical damage; no warping of the air-bearing pattern or scratching of the substrate
- ▶ Post-treatment processing: chamfers are performed for stress releasing
- ▶ No heating of the parts or thermal deformation
- ▶ No contamination or re-deposition
- ▶ No chipping
- ▶ Constant results
- ▶ Very low running costs; no tool wear
- ▶ Higher throughput and productivity and better return on investment
- ▶ More ecologically conscientious process as particles are absorbed into the water for filtering

## Consequence of the benefits

Because of the significant improvements over diamond saws, and in particular, low mechanical stress on the material, the Laser-Microjet<sup>®</sup> process is proving to be the ideal method for cutting HDD head substrates today.

## Laser-Microjet<sup>®1</sup> Cutting System for HDD Head Substrate Applications

Synova offers a state-of-the-art, clean-room compatible tool—the LCS 300 laser cutting system—designed for the cutting of HDD head substrates.

This system has a precision of  $\pm 3$  microns, a processing area of 300x300 mm and a maximum axis velocity of 1000 mm/s. The system is equipped with a CCD camera and fast image treatment software, allowing automatic alignment and inspection. The operation interface is a flat color screen with touch panel, and the machine software is based on Windows 2000<sup>®2</sup>.

The LCS 300 can be connected to a LAN network for data transmission and tediagnostic services. Adapted CAM software can convert all DXF data, fast and easy, without any special knowledge or training.

Tool options are available, such as a chiller, alternative laser sources, a water treatment system, 2D-reference scales and transformers. The CE and S2 certified Synova machines are field proven and are used in production 24 hours per day.



LCS 300 Laser Cutting System

<sup>1</sup> Laser-Microjet<sup>®</sup> is an international protected trademark of Synova S.A., Switzerland.

<sup>2</sup> Windows 2000<sup>®</sup> is a trademark of Microsoft Corp., USA.