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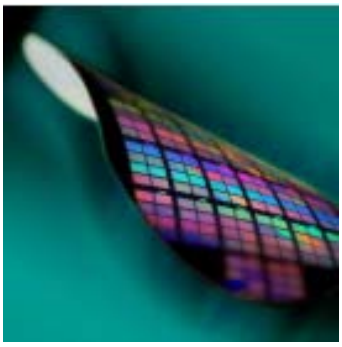
# Application Note No. 102

## Cutting of Thin Wafers with SYNOVA Laser-Microjet®



### Description of Product

Thin wafers are used in the semiconductor industry mainly for the manufacturing of smart cards, smart labels, RFID (Radio Frequency Identification) systems, stacked memory chips, anti-counterfeit devices, MEMS (Micro Electro-Mechanical Systems), implantable medical electronics, and memory for mobile phones. The primarily interest of thinning the wafers is to gain space and flexibility. Wafers become as flexible as metal foil as a result of the thinning process.

### Description of Material

Silicon is the basic material used to make wafers; its atomic structure makes this element an ideal semiconductor. Silicon is commonly mixed with other elements, such as boron, phosphorous and arsenic, to alter its conductive properties. The average thickness of thin wafers is between 25 and 150 microns.

### Description of Manufacturing Task

After the thinning process (grinding + etching), the microchips are diced into individual units. Due to the extreme thinness of wafers, the dicing and packaging processes require advanced technologies. The handling of thin wafers is quite critical.

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

Dicing performed by the means of diamond saw is not satisfactory. Thin wafers are easily damaged by mechanical forces and sawing causes high-residual stress, micro-cracks, and chipping. To partly overcome this problem, it is possible to thin the wafer after dicing (so called dicing-before-grinding). However, this technique entails additional processing steps and more costs. Furthermore, problems inherent in sawing, such as low cutting speed, inconstant cutting quality, and high consumption of saw-blades, are not removed.

### 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 pressurized water chamber. The geometry of the chamber and nozzle are decisive to coupling the energy-rich laser beam in the water jet.

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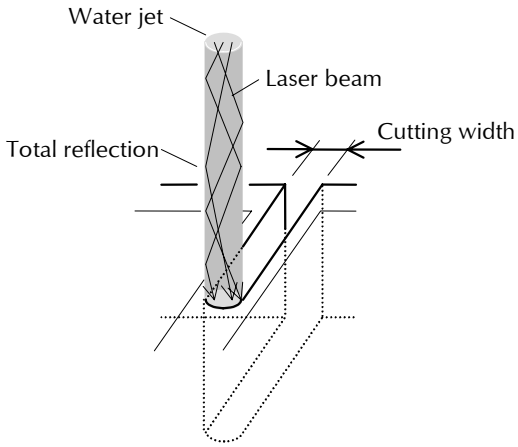
The low-pressure water jet emitted from the nozzle guides the laser beam by means of total reflection at the transition zone between water and air, in a manner similar to conventional glass fibers. The water jet can thus be referred to as a fluid optical wave-guide of variable length.

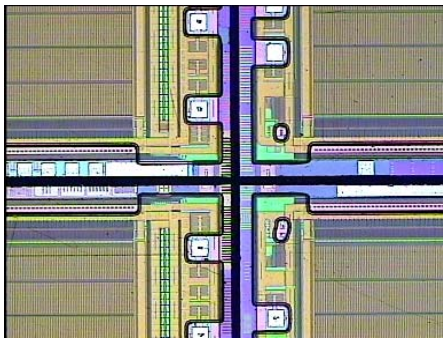
Because a pulsed laser is used, the continuous water jet is able to immediately re-cool the cut, resulting in only a very slight depth of thermal penetration. The result is a very narrow, parallel, burr-free, clean cut, without any thermal damage.




*Cutting with water jet guided laser*

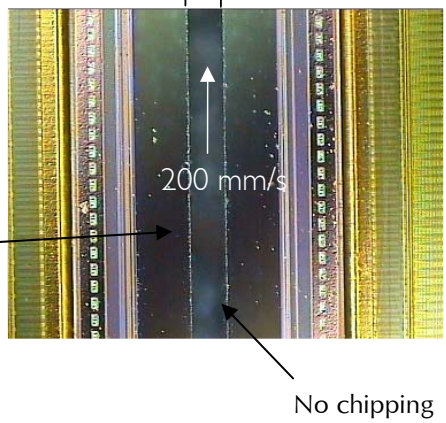
Solution with Laser-Microjet® Process

The Laser-Microjet®, or water jet guided laser, provides a suitable technique for the dicing of thin wafers. It enables excellent cutting quality free of mechanical stress, thermal damages, contamination, and chipping. The wafer is protected 100% against any deposition thanks to a water film covering the wafer. The dicing speed is between 200 mm/s (for a 50 micron thick wafer) and 50 mm/s (for a 200 micron thick wafer). The laser cuts in any direction and thus there is no empty return pass as it is necessary for sawing.



*A perfect cut of the dies*

By using a short pulse laser, a burr-free, clean cut can be reached. The average kerf width is between 30 and 50 microns. Thin wafers can be laser-diced on LaserTape®, which can be used as standard dicing tape. This picture shows the cutting quality of a 100-micron thick silicon wafer (memory chip). The Laser-Microjet® can cut thin wafers between 3 and 5 times faster than a conventional saw.



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## Benefits for the Customer

The customer now obtains the following advantages:

- Constant cutting quality
- No mechanical stress, force free
- No chipping
- High fracture strength
- Omni directional cutting
- Cutting of straight and round shapes
- Drilling, scribing, grooving, edge grinding, thinning, marking.
- Kerf width 25 - 80 micron
- Cutting speed up to 200 mm/s* in both directions (* for 50 micron thick wafers)
- Ideal for thin wafers
- Wafer thickness 25 micron - 5 mm
- LaserTape® can be used as standard dicing tape (available at Furukawa, Japan)
- No tool-wear
- Very few consumables, low running costs
- Cost saving of up to 1 Mio US$ per year

## Consequence of the Benefits

Because of the huge improvement in costs, quality, flexibility, and productivity compared to conventional sawing process, the Laser-Microjet® process will be the future choice for dicing thin wafers.

## Machine for Laser-Microjet®[1] cutting of thin wafers


Synova offers a state-of-the-art, clean-room compatible machine, especially adapted for the cutting of thin wafers. Optimum cutting parameters are preloaded. The machine designation is LDS 200. Cleaning unit and automatic loading system are available, too. The machine has a precision of +/- 3 microns, a processing area of 240 X 240 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 options 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.

 