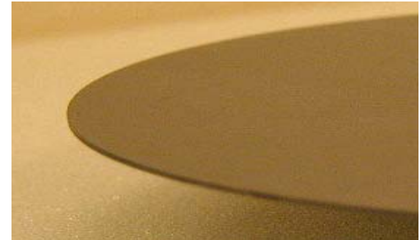
SYNOVA
SYNOVA S.A.
Chemin de la Dent d'Oche
CH-1024 Ecublens
Tel: + 41 21 694 35 00
Fax: + 41 21 694 35 01
info@synova.ch
www.synova.ch

Application Note No. 106

Edge Grinding of Wafers with SYNOVA Laser-Microjet®

Description of Product

Wafers are used in the semiconductor industry for the manufacturing of integrated circuits. Wafer shaping involves a series of precise mechanical and chemical processing steps, such as edge grinding, that are necessary to turn the ingot segment into a functional wafer.



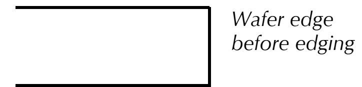
Edge grinding of non-processed wafer

Description of Material

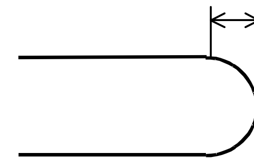
Silicon is the basic material used to make wafers; its atomic structure makes this element an ideal semiconductor. Silicon is commonly mixed with other elements in order to modify its conductive properties. The average thickness of wafers is between 25 and 1500 microns.

Description of Manufacturing Task

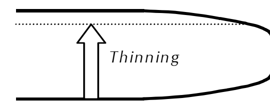
The edges of wafers are ground in order to render the wafer robust for further handling and enhancing resistance to mechanical stress situations. Several shapes are required depending on the manufacturing process and the use of wafers.

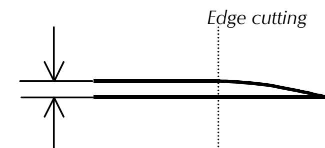


Edge rounding of about 0.3 mm



After the edge-grinding step, wafers are frequently thinned with the aim of gaining space and flexibility. The thinning step often causes micro-cracks in the edges, resulting often in wafer losses; consequently the edges have to be cut off.





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

Generally, edge grinding is performed by the means of grind wheels; different grinding grain sizes are used depending on the final shape and roughness specifications. This mechanical technique causes several problems such as chipping, micro-cracks, mechanical stress, and high residual stress. Furthermore, this process is slow and inflexible. Thin wafers, in particular, are easily damaged by the mechanical forces of the grinding wheels. Thus, there is a need for a new method of edge grinding.

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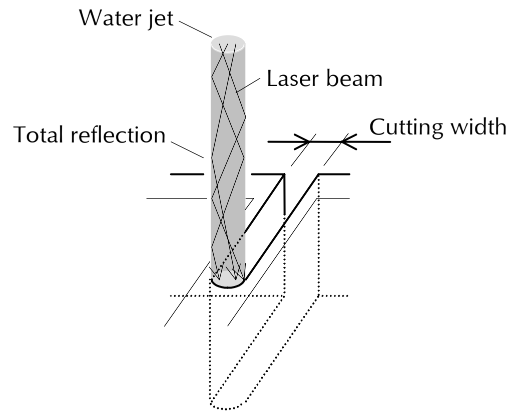
www.synova.ch

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.



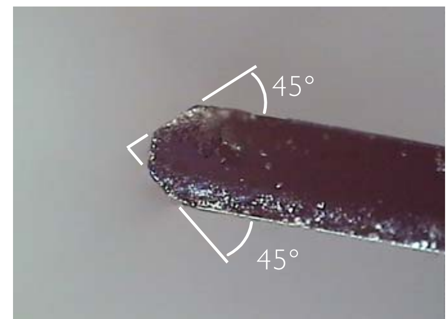
Cutting with water jet guided laser

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

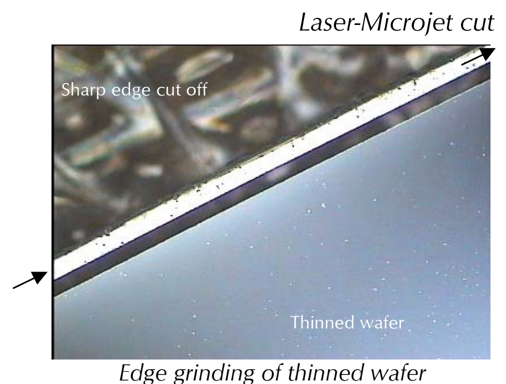
The Laser-Microjet®, or water jet guided laser, provides a suitable technique for the edging of wafers. It enables excellent cutting quality free of mechanical damages, micro-cracks, and chipping. The cutting speed ranges from 50 mm/s to 200 mm/s depending on the thickness.

The Synova laser cuts in any direction and thus any contour of edges are possible. Edges can be designed on a CAD computer and the process is very flexible.



Wafer after edge-trimming

The water jet guided laser provides a suitable technique for the cutting of thin wafers. It enables excellent cutting quality free of mechanical stress, thermal damages, contamination, and chipping.



Reduce of wafer Breakage to zero

Edge grinding of thinned wafer

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Benefit for the Customer

The customer now obtains the following advantages:

- Very flexible process
- No mechanical stress, force free
- No chipping
- No mechanical damages
- Grinding of any edge profile possible
- Machine can be used also for drilling, scribing, grooving, dicing, thinning, marking.
- Flat- or notch cutting on same machine
- Very fast process
- Ideal for thin wafers
- Wafer thickness from 25 microns to 5 mm
- No tool-wear
- Very few consumables, low running costs
- Important cost saving

Consequence of the Benefits

Because of the vast improvement in costs, quality, flexibility, and productivity compared to conventional grinding process, the Laser-Microjet® process will be the future choice for edge grinding of sliced wafers and thinned wafers.

Machine for Laser-Microjet®[1] Grinding of 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.

Laser Dicing System 200

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®[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.

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[1] Laser-Microjet® is an international protected trademark of Synova S.A, Switzerland.
[2] Windows NT® is a trademark of Microsoft Corp, USA.