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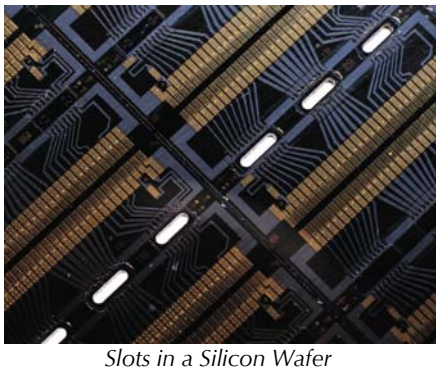
Application Note No. 107

Drilling and Slotting of Wafers with SYNOVA Laser-Microjet®

Description of Product

Wafers are used in the semiconductor industry for the manufacturing of integrated circuits. Wafers have to be drilled or slotted for different reasons, such as the manufacturing of stacked chips, fibre-optic switches, and ink jet printer chips.



Slots in a Silicon 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

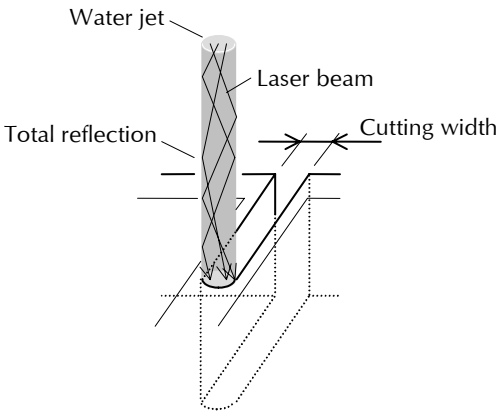
Generally, wafers are drilled or slotted before dicing or singulation. The size and the geometrical shape of holes and slots vary depending on the function or the purpose.

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

Holes in the size of more than 50 microns into Silicon wafers can be made by different methods, such as dry or wet etching, sandblasting, and laser machining. Up to now, those methods have not been fully satisfactory. Etching processes are slow, expensive, and require masks. Sandblasting is incompatible with clean room processing, the minimum diameter of holes is limited and the edges tend to be conical. Laser drilling creates slag and micro cracks. Therefore, there is a need for a new method of hole drilling, which combines high speed of laser drilling and high quality of etching.

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. 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.



Cutting with water jet guided laser

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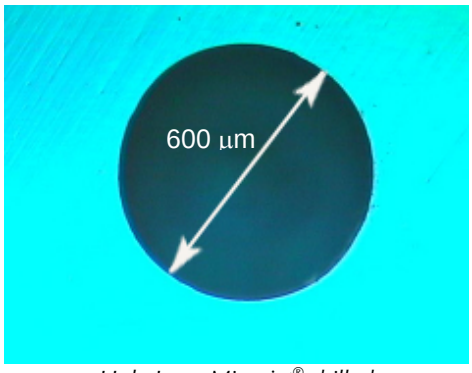
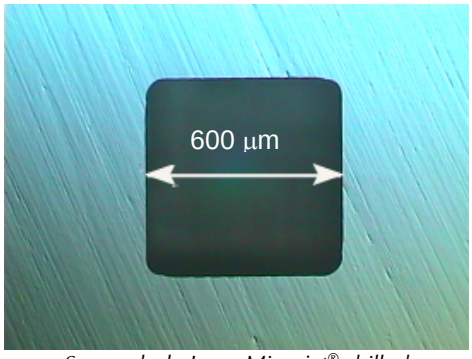
Solution with Laser-Microjet® Process

Silicon absorbs sufficiently the near-infrared, as well as visible, wavelength used with the Laser Microjet®. Holes can be drilled using the trepanation method (the CNC enables a circular movement) or the percussion method (the laser emits several pulses at the same location without movement of the axes).



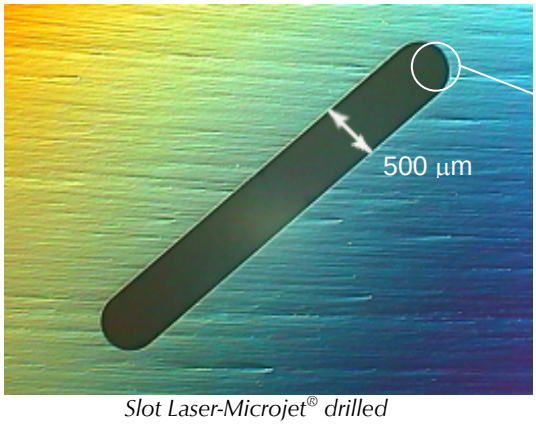
Hole Laser-Microjet® drilled

The trepanation method allows extremely high tolerances in the hole geometry, especially, if the process is applied at front- and back-side of the wafer. Percussion-drilled holes are made in a high repetition rate.

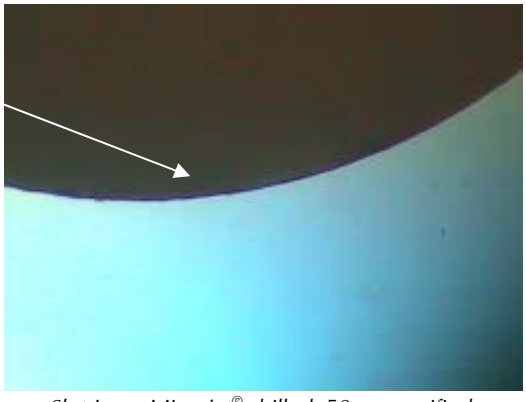


Square hole Laser-Microjet® drilled

The Laser-Microjet® can drill a hole or a slot in the wafer in between 1 and 10 seconds. There are no mechanical damage, slag, and burrs. The hole-diameter on front and backside is identical; therefore, the hole-edges are absolutely parallel.



Slot Laser-Microjet® drilled


Slot Laser-Microjet® drilled, 50 x magnified

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Benefit for the Customer

The customer obtains now the following advantages:

- Very high tolerances
- No mechanical stress, force free
- No chipping
- No mechanical damage, no cracks
- Any hole geometry is possible
- Machine can be used also for grinding, scribing, grooving, dicing, thinning, and marking.
- Hole geometry designed on CAD station
- Very fast process
- Ideal for thin wafers
- Wafer thickness 25 microns to 5 mm
- No tool-wear
- Very few consumables, low running costs

Consequence of the Benefits

Because of the huge improvement in quality, flexibility, and productivity compared to conventional drilling processes; the Laser-Microjet® process will be the future choice for the drilling and slotting of Silicon wafers.

Machine for Laser-Microjet®[1] Drilling and Slotting 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.

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.

Laser Dicing System 200

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.

