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Application Note No. 105

Cutting of Multi-Project Wafer (MPW) with SYNOVA Laser-Microjet®

Description of Product

Silicon Wafers are used in the Semiconductor industry for the manufacturing of integrated circuits. In the case of Multi Project Wafers (MPW), several designs from different customers and/or projects are combined onto one wafer. One mask contains the same layer of two or more different circuits. This approach allows the costs to be shared among several customers.

Multi-Project 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

Microchips are fabricated on silicon wafers and must be diced and packaged before use. The particularity of multi-project wafers is that the size of dies can be different. Therefore, the cut lines are not necessarily from one side to the other; this feature typically requires T-cuts.

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

Currently, dicing is done by means of a diamond saw. However, diamond sawing is generally unsatisfactory. This technique is slow, it causes high residual stresses, and chippings are created around the cuts. In addition, the sharpness of diamond tips quickly degrades and this demands frequent replacement, resulting in variable scribe performance and high running costs.

Because the dies are of different sizes, the saw would have to stop at a certain position in order to avoid cutting through a die. Thus, the street geometry is limited and some dies have to be first picked up before other dies can be cut. This makes the whole singulation process very slow and complicated. Consequently, there is a need for a new method of multi-project wafer dicing.

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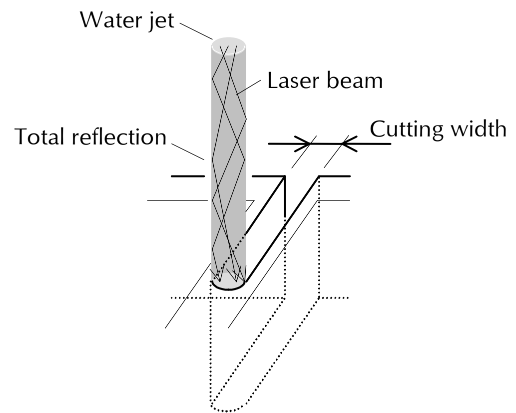
Water Jet Guided Laser Technique

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

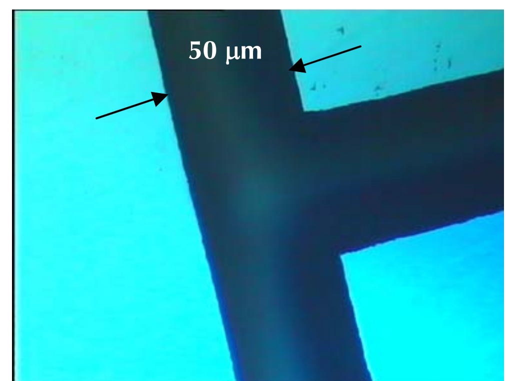
The water jet can thus be referred to as a fluid optical wave-guide of variable length. Because a pulsed laser is used, the continuous water jet is able to immediately re-cool the cut, resulting in only a very slight depth of thermal penetration. The result is a very narrow, parallel, burr-free, clean cut, without any thermal damage.

Solution with Laser-Microjet® Process

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

T-cut of a Silicon wafer

This picture shows a 50 µm wide kerf free of burr and chipping. This T-shaped cut was performed at the speed of 200 mm/s. The Laser-Microjet® enables omni-directional cutting and the cut can be stopped at any precise position. In addition, the wafer can be laser-diced on LaserTape®, which can be used as standard dicing tape.



T-cut of a Silicon wafer, magnified

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Benefit for the Customer

The customer obtains now the following advantages:

- Omni directional cutting, T-shaped cuts are possible
- Multi-project wafer can be diced completely without interruption for picking-up
- No limitation in die sizes, high flexibility
- More dies per wafer
- No mechanical stress, force free
- No chipping
- Cutting of straight and round shapes
- Drilling, scribing, grooving, edge grinding, thinning, marking
- Kerf width ranges from 20 to 80 microns
- Because the whole wafer can be diced completely, the productivity is improved
- Wafer thickness from 25 microns to 5 mm
- LaserTape® can be used as standard dicing tape (available at Furukawa, Japan)
- No tool-wear
- Very few consumables, low running costs

Consequence of the Benefits

Due to the fact that now any combination of die sizes on the same wafer can be cut with the laser dicing system compared to conventional sawing process; the Laser-Microjet® process will be the future choice for dicing of Multi-project wafers.

Machine for Laser-Microjet®[1] dicing of multi project 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. 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.

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