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Application Note No. 127

Synova Laser-Microjet: A Major Advantage in Edge Grinding and Singulation of Ultra-thin Wafers

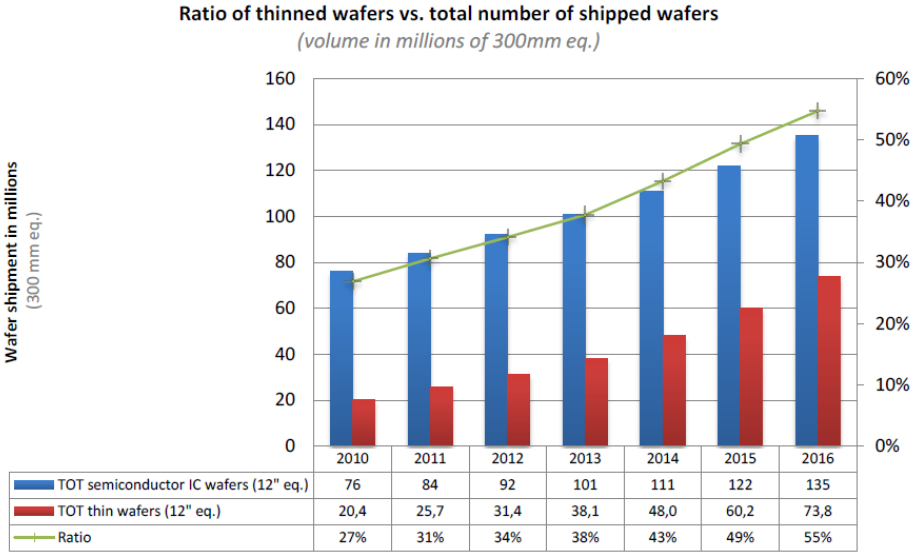
Summary

The Synova laser microjet technology provides a solution for edge grinding of ultra-thin carrierless wafers. As compared to usual grinding approaches which creates mechanical and thermal stresses, Synova's water jet guided laser provides a cost effective technique for edge cutting of thin wafers.

The Laser-Microjet delivers excellent cutting quality free of mechanical stress, thermal damages, contamination, and chipping.

Ultra-Thin Wafers

By 2015, more than 50% of all wafers processed in the semiconductor industry will be considered thin, as per a Yole Developpement recent study. Thin wafers are considered to be those with a thickness between 40 and 300 microns.



(taken from the Thin Wafer Handling and Processing report from Yole Developpement, October 2011)

Major technology drivers for thinner wafers include:

- The need for higher electrical performance in RF and LED packaging
- Overall dimensional profiles in novel 3D and MEMS assemblies
- Power devices with improved efficiency through the use of field-stop structures
- Improved camera performance through backside illumination.

These drivers have introduced changes to traditional wafer manufacturing practices whereby grinding is no longer the last operation before die singulation. Indeed, post-grinding processes such as ion implantation and metallization are common in such cases.

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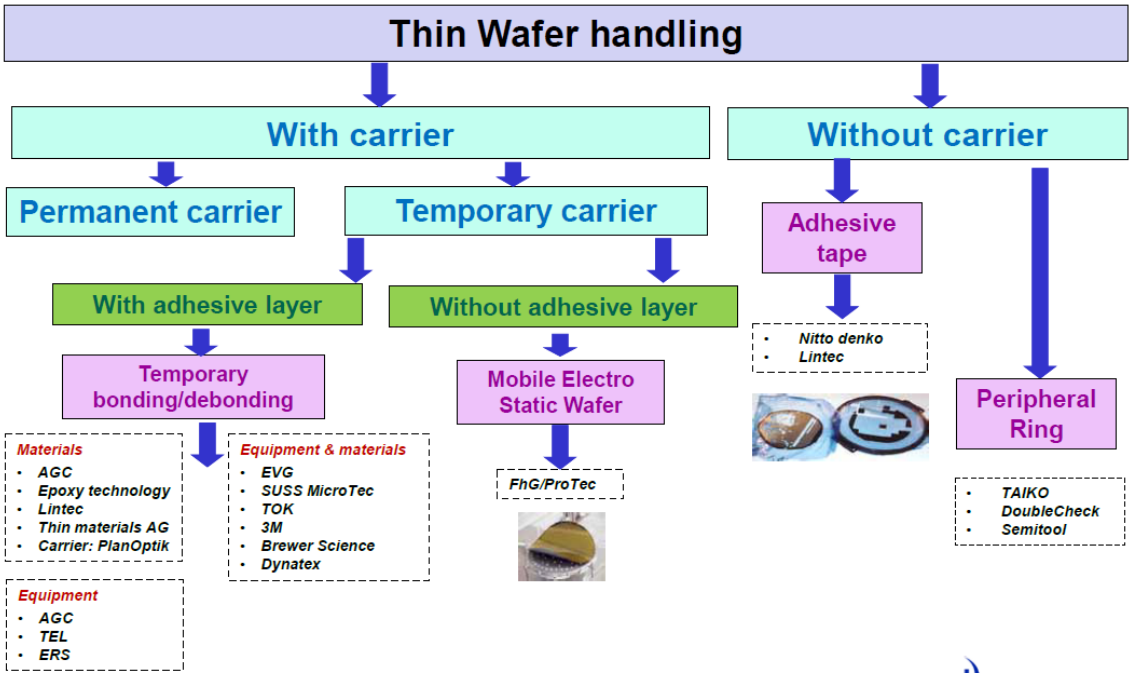
New Challenges

Handling of thin wafers through post-grinding processes introduce a significant number of new challenges as traditionally front-end processes such as vacuum deposition and ion implantation are now performed on these thin wafers. Handling is of particularly concern since the die breaking strength is greatly reduced. Indeed, die breaking strengths of a 200 microns thick wafer is only 7-8% of that of a standard 600-700 microns thickness.

Various approaches are under development to address the major quality and reliability concerns of such thin-wafer processes, as shown in the following diagram.



(taken from the Thin Wafer Handling and Processing report from Yole Developpement, October 2011)

In such cases, operations such as edge cutting of the peripheral ring or dicing of thin dies require the use of a Synova laser-microjet. Details will be provided in the following sections.

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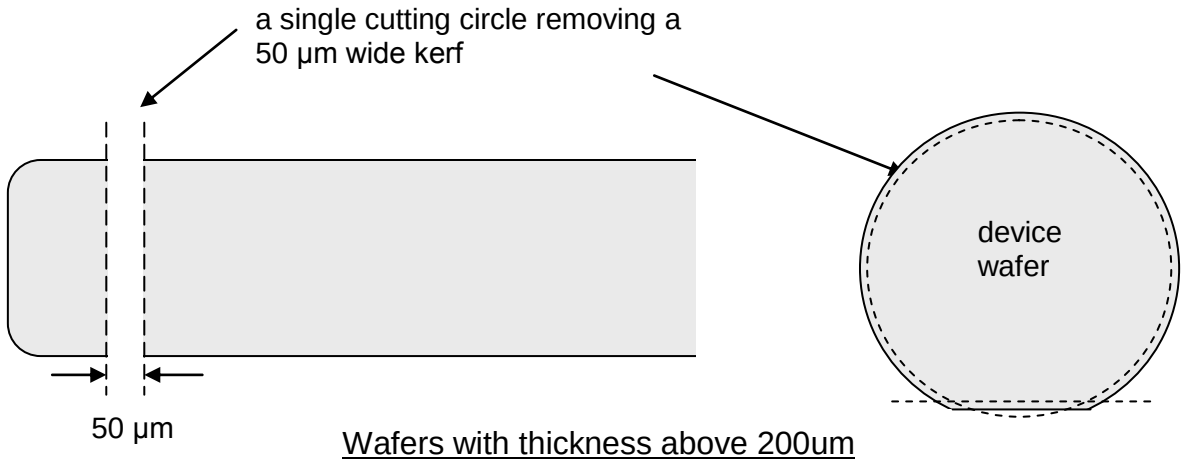
Synova Laser Microjet® for thin wafer processing

Wafer 200um thick and above

For wafers with thicknesses above 200um, the Synova Laser Microjet® avoids completely the process of edge grinding and replaces it by a downsizing process. A ring is cut on the edges of the wafers as shown in the diagram below. It enables excellent cutting quality free of mechanical stress.



Wafers with thickness above 200um

Wafer 200um thick and below

For ultra-thin wafers, the Synova Laser Microjet® offers singulation and dicing solutions for both carrierless (Taiko process) and carrier-based (ex: WSS) approaches. Details are provided in the following sections.

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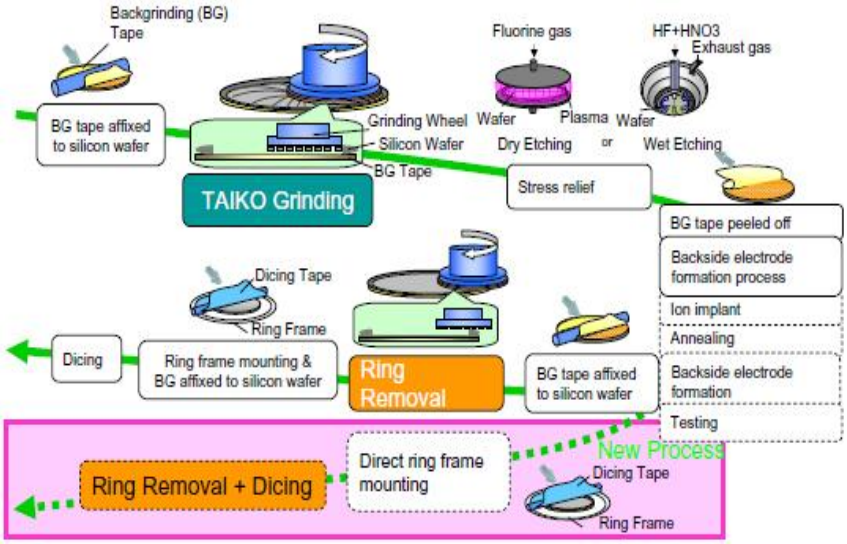
Synova Laser Microjet® inside the Taiko process

The TAIKO process is a wafer backgrinding method developed by Disco. This process method leaves a ring (approximately 3 mm) on the wafer outer edge and thin grinds only the inner area of the backside wafer. By leaving this edge ring, it is possible to reduce the risks of wafer breakage or edge chipping.

The Synova Laser Microjet® in used in the step 2 of the Taiko process illustrated in the second diagram below:



Taiko Process step 1 diagram

Synova Laser Microjet® can be used at this stage to cut the wafer (downsizing)

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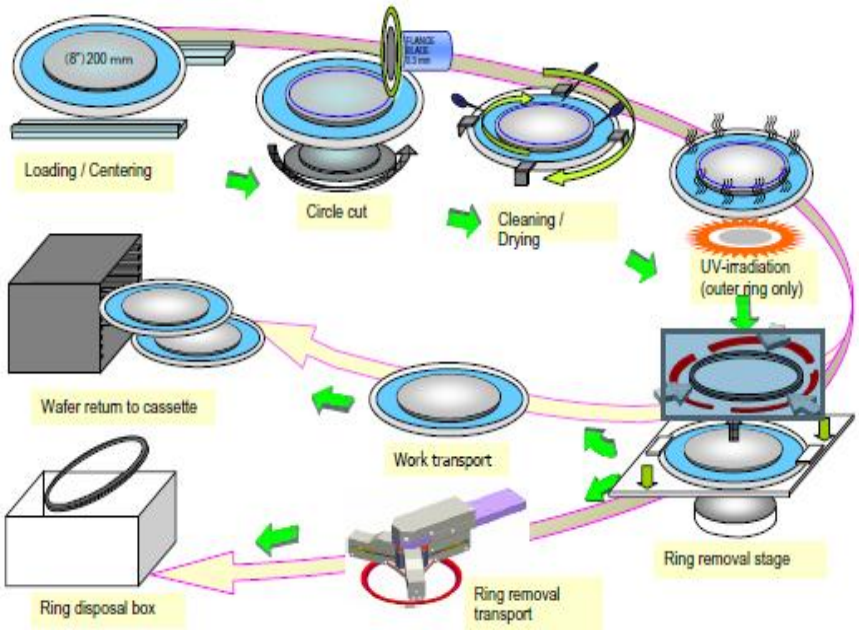

Taiko Process step 2 diagram

Synova Laser Microjet® for the WSS (Wafer Support System) process

A Wafer Support System (WSS) was developed to support the wafer during backgrinding and subsequent post-thinning processes.

The Wafer Support System (WSS) uses a UV-curable liquid acrylic adhesive, designed to support high-temperature processing to bond the wafer to a glass carrier. After thinning and other process steps, a unique thermal release process uses a laser to separate the wafer from the glass carrier. The cured adhesive layer is then easily peeled from the wafer, leaving a surface that is as clean as those provided by conventional backgrinding tapes. The system is engineered to minimize stress during grinding and high-temperature post-thin processes. This system combines 3M materials with specialized bonding, debonding, and carrier recycling equipment provided by several of the world's leading semiconductor equipment manufacturers, enabling high-volume manufacturing of ultra-thin wafers down to 20µm.

The Synova Laser Microjet® is used for the ring cutting in the step two as shown in the following process flow:

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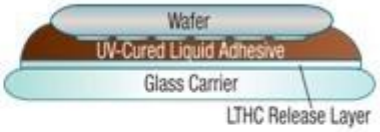
1) Mount (Spin coat UV resin on wafer; vacuum bond to support glass; UV irradiate)

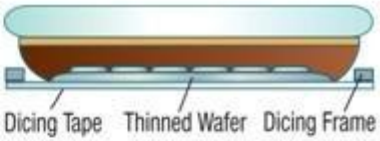


2) Backgrind using conventional grind methods.

Thinned wafer is fully supported after backgrind operation for safe handling.

Synova Laser Microjet can be used at this stage to cut the wafer (downsizing)

3) Bonded wafer stack is mounted to saw frame using standard wafer mounting systems.



4) Laser Irradiation – The laser debond creates micro voids in the LTHC layer allowing for separation between glass support and wafer.

5) Remove Support – After laser debonding, the glass support lifts off easily and is cleaned and recycled for multiple uses.

6) Remove Adhesive – Adhesive layer removes easily, leaving minimal to no residue.

WSS process

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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 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 fibers. *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.

Synova Laser Microjet® cut

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.

Customer Benefits

- *The customer now obtains the following advantages:*
- *Very flexible process*
- *No mechanical stress, force free*
- *No chipping*
- *No mechanical damages*
- *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*

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.

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Machine for Laser-Microjet® Grinding of Wafers : LGS

The LGS is a fully automatic laser edge-grinding system; its function is to remove the wafer edge that contains micro-cracks from back grinding. A simple MMI (Man Machine Interface) allows easy control of the machine

The LGS is equipped with a cassette-loading / unloading unit, a cleaning station and a manipulator which moves the wafers from one station to the next.

Example for a full automatic system with cassette-loading / unloading

Synova-Pretech Machine

