Thin Wafer cutting with Laser Microjet® at Infineon - A Case Study. (P516)

Ochélio Sibailly, Rafal Romanowicz, Laetita Mayor, Bernold Richerzhagen
Synova SA, Chemin de la Dent d'Oche, 1024 Ecublens, Switzerland

ABSTRACT
For silicon wafer thickness' under 100 microns, wafer handling is extremely critical because of the brittleness of the material. The engineer's at Infineon found out that the fragility of this material is due to micro-cracks present all around the wafer's edge, that tend to propagate with any slight mechanical solicitation. They have therefore been looking for a long time for a cutting system gentle enough to process such expensive and difficult-to-machine wafers. With the Swiss water jet-guided laser technology they found a solution to their problem.

Laser Microjet® machines are today part of the Austrian chip manufacturer's production lines, where they are used to grind the wafer's edges, removing in this way the perturbing micro-cracks.
The overall challenges posed by thin wafer processing and the characteristics of Synova's technology that motivated Infineon's choice will first be reviewed. Results from the collaboration of Infineon and Synova will then be exposed.

1. INTRODUCTION

Over the past months, the Laser Microjet System developed by Synova SA, in Switzerland, has become ever more popular in the semiconductor industry. If its primary application is the efficient chipping-free dicing of silicon wafers, it has revealed itself to be also very attractive for less common operations. One of the most promising was developed and implemented for Infineon, the N° 5 in chip manufacturing.

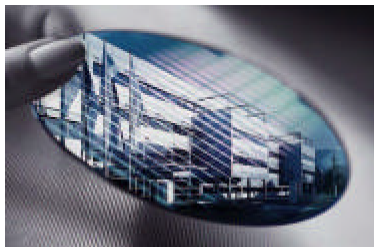

Figure 1: Infineon's Production Site in Villach, Austria

This application concerns the very specific domain of thin wafer processing (less than 100 ?m). The interest of thinning the wafers is to gain space and flexibility. The gain in space is, for example, important for multi-chip packages in mobile electronic devices. Mechanical flexibility of the chip is indispensable for Smart Cards and Smart Label applications.

The first processing steps of chip fabrication are carried out using standard thickness Silicon wafers (about 700 microns). Then, before wafer is completely finished, the wafer is mechanically ground to a thickness of less than 100 microns, followed by a chemical polishing step. During this mechanical grinding step, micro cracks form at the wafer's edge. After the thinning process several processing steps still need to be executed. The handling of the thin wafer during these process steps is extremely critical because of the micro cracks, and the wafer breakage rate is very high.
At this state the wafer is already very valuable because most of the process steps are finished, hence the money loss per wafer nearly equals the value of the final product.
As a result, it was paramount to find a method for detecting edge damage and eventually to remove the damage, in order to avoid the high wafer breakage rate. Infineon's engineers searched for a long time for a solution to this problem. Their requirements due to the specificity of the material were clear: the process should be completely automatic, and apply neither thermal nor mechanical constraints on the thin wafer, in order not to induce any stress which could lead to material destruction.

2. COLLABORATION WITH SYNOVA SA

The cause of the breakage problem are the micro-cracks that form all around the wafer border during thinning. So why not just remove them? Since to date no optical system is able to detect the cracks;

why not cut away the regions with micro-cracks around the edges of the wafer? The idea therefore germinated to use Synova's Microjet to literally grind the brittle edges of the thin wafers.
Indeed, the laser dicing system combining a laser source and a water jet had already proven its efficiency on thin wafers regarding precision and quality[1]. The efficiency of the system revealed itself to be just as high in grinding the edges as in cutting chips. After several tests by Infineon, the LDS 200 machine of Synova was selected, in order to process the edges of thin wafers for diameters of up to 8 inches.

Classical laser cutting may remove the edge too, but due to the thermal load of the wafer doing cutting new micro-cracks are generated in the Heat Affected Zone. Thus classical laser cutting is not an alternative.

The Laser Microjet? system has many indisputable advantages. First of all, the water jet absorbs the heat of the laser source, and carries away the molten silicon, thereby minimizing thermal stress and the formation of adhering particles (burrs). Since the entire process is automated and the cutting realized by the laser, the wafer is not subjected to unnecessary mechanical stress during the whole process. Furthermore, the precision of the machine allows the diameter to be reduced by very small increments (typically 50 ?m), minimizing the loss of precious material.

Last but not least, the machines can be utilized for the dicing of thin wafers as well. It is during the cutting of the thinnest wafers that the highest speeds can be achieved (The dicing speed is up to 200 mm/s for a 50 micron thick wafer, and 50 mm/s for a 200 micron thick wafer); the throughput rate can improved, thereby diminishing running costs.

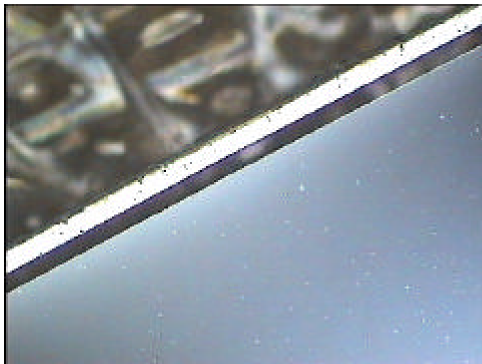

Figure 2: Details of Downsized Wafer, 70 microns Thick

3. THE FUTURE

Infineon's production lines for thin wafer production will soon be equipped with additional LDS 200 machines (figure 3). In a second step, these machines will be upgraded with an integrated edge damage detector, allowing the repair of wafer edges strictly at locations with visible cracks. The optical system already permits the recognition of damages as small as 50 ?m.

Figure 3: Synova's LDS 200 A Laser Dicing System

4. REFERENCES:

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MEET THE AUTHORS:

Ochélio Sibailly, Synova SA
After receiving her M.Sc. in micro-engineering from the Swiss Federal Institute of Technology Lausanne, she worked on different project related to the optimization of production systems. In 2003 she joined Synova as Communication Manager.

Dr. Rafal Romanowicz
Following his Ph.D. and M.Sc. in Micro-engineering at EPFL, he acted for 3 years as Managing Director of Sensile Technologies, a company specialised in industrial pressure sensors and fuel delivery logistics systems. He joined Synova in 2003 as Marketing Manager

Dr. Bernold Richerzhagen
After receiving his M.Sc. in mechanical engineering from Aachen Polytechnic in Germany (RWTH) and his PhD in micro-technology from the Swiss Federal Institute of Technology Lausanne, he became CEO of Synova SA in 1997. He is acknowledged as the inventor of the water jet-guided laser technology.