REPORT:

Wafer Edge Trimming by Laser-MicroJet®

for Anonymous

by Samuel Obi, Synova SA

TASK

The Laser-MicroJet® technology has been tested for trimming the edge of 730µm thick silicon wafers. The goal was to remove 60µm of silicon on a 1mm wide area. See figure 1 below.

SAMPLE DESCRIPTION AND PREPARATION

SAMPLE	Material	Fully patterned silicon wafers
	Dimension	Ø200 *mm*
	Thickness	730 *µm*
	Quantity	5 *pcs*

In total, 5 wafers out of a lot of 25 were processed. All wafers were mounted on semiconductor standard frames with UV-curable tape for handling, processing, cleaning and shipping.

Release of application report			
Project Leader		Responsible Application Group	
Name:	Samuel Obi	Name:	Benjamin Carron
Date:	31.01.2012	Date:	31.01.2012
Visum:		Visum:	

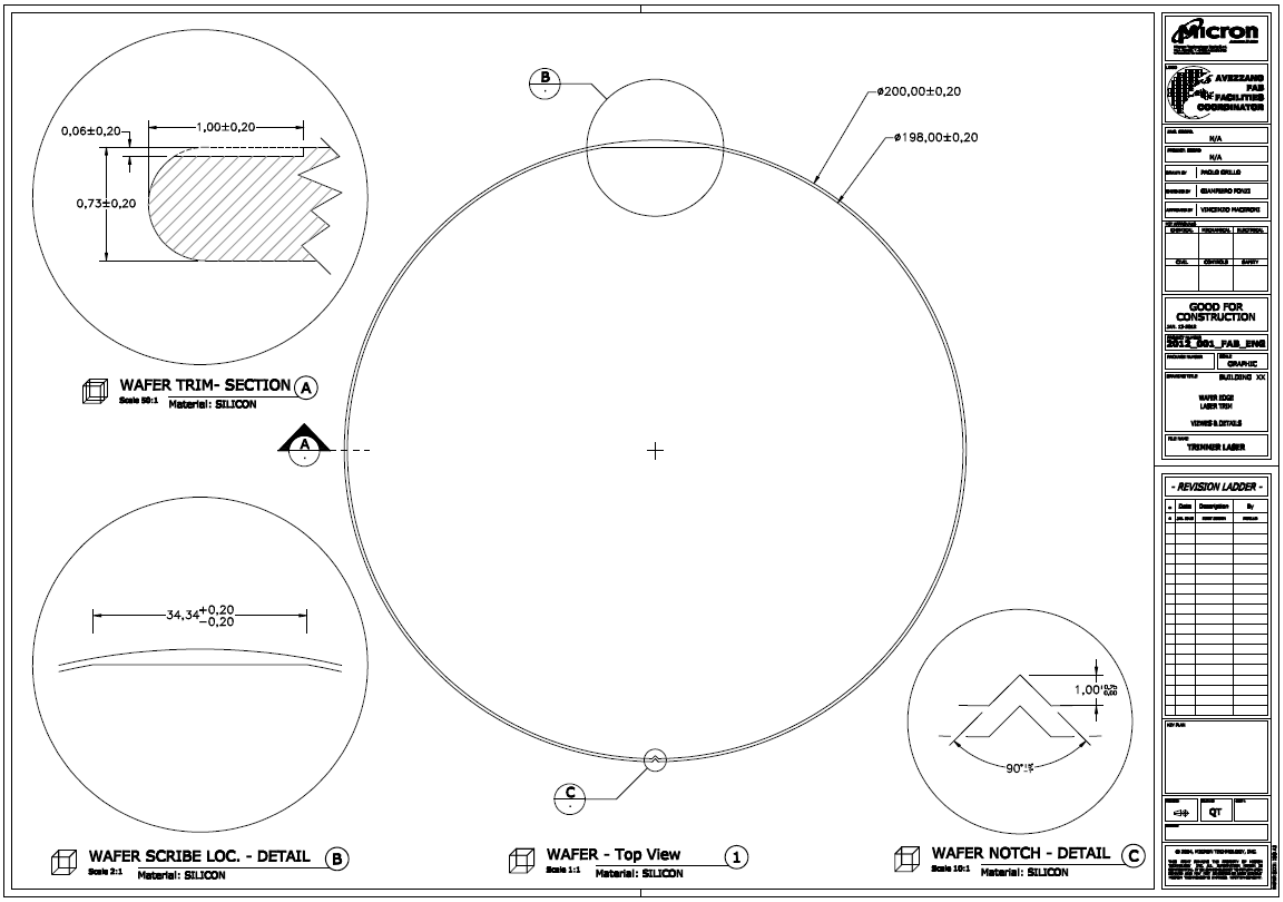


FIGURE 1: Layout of the full 200mm diameter wafer for edge trimming as requested by the customer. A 1mm wide zone is removed around the edge. The 1mm zone also follows the shape of the notch. Opposite the notch, a flat is formed by removing a wider area of 2.5mm.

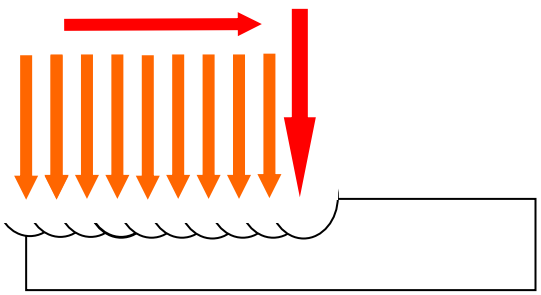


FIGURE 2: To remove a surface of silicon, several lines are cut next to each other. Starting form outside the wafer surface, these lines form a spiral. The distance in between the lines is around half the line width (25µm).

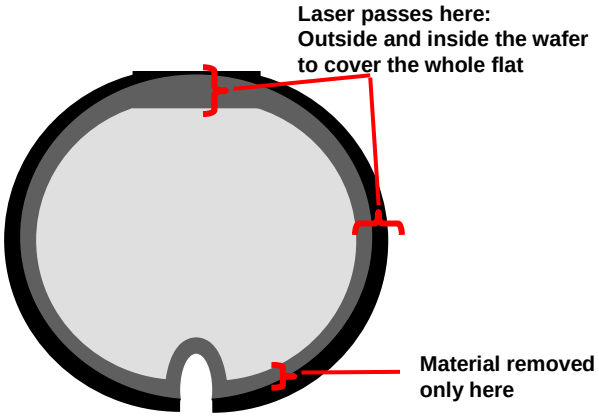


FIGURE 3: In order to remove the wider zone of the flat, the total cutting area was increased outside the wafer to 2.5mm in total (dark on the drawing). Only in the gray area the material is removed finally.

PROCESS: INSTRUMENT & TEST PARAMETERS

For these experiments, the LDS 200 M equipped with a frequency-doubled Q-switched Nd:YAG laser has been selected as the most suitable machine configuration.

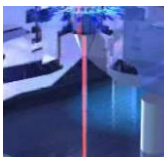
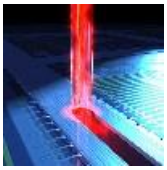
This machine is based on the Laser-MicroJet® technology and combines the advantages of the high energy pulsed laser with a hair-thin water jet. While the laser is used for material ablation, the water jet is used for guiding the laser light, cooling the edges and preventing the sample from particle contamination, advantages that are essential for machining of silicon with high quality.

It is a manually loaded clean-room compatible machine, allowing to cut, drill, groove, scribe, trench, mark, or grind wafers of any kind of semiconductor material. Please note that Synova is also supplying customized fully automated machines capable of handling bare wafers in cassette-to-cassette operation.

Major advantages of Laser-MicroJet® technology with regards to your application are:

- Advantageous process rates
- Excellent fracture strength
- Cutting of arbitrary shapes
- No chipping
- Negligible heat damage to the material
- No slag or burr formation
- No contamination or re-deposition

In the table below, the processing parameters used in the experiments are summarized:

	**SYSTEM**	Machine type	LDS 200 M
	**MICROJET® PARAMETER**	Nozzle diameter	50 *µm*
		MicroJet® diameter	45 *µm*
		Water pressure	350 *bar*
		Assist gas	He
	**LASER PARAMETER**	Laser type	L51G
		Wavelength	532 *nm*
		Pulse frequency	40 *kHz*
		Average power	25 *W*
	**CUTTING PARAMETER**	Cutting speed	130 *mm/s*
		Number of lines	100 (1 spiral)
		Distance between lines	25 *µm*
		Process time per wafer[1]	8.5 *min*
		Tape[2]	Lintec ADWILL D611

[1] Pure cutting time, not counting loading, unloading and alignment
[2] The UV-tape has been cured before shipping

RESULTS

The following pictures give an overview on the quality obtained with the Laser-MicroJet® technology:

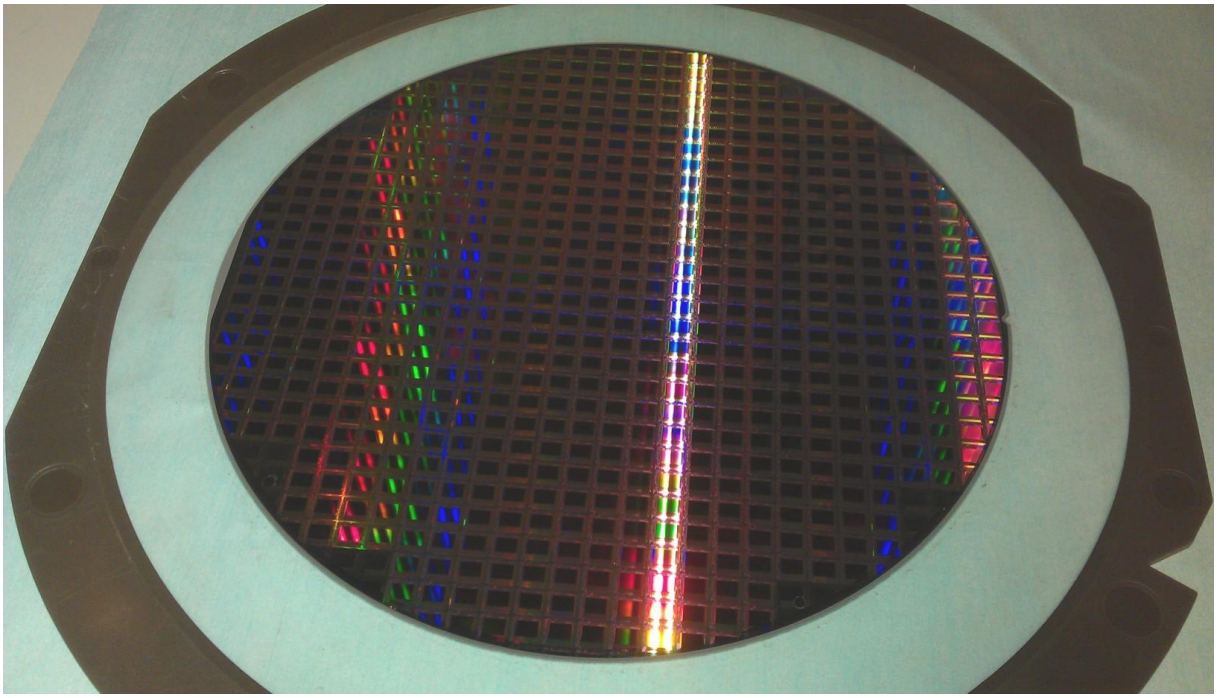


FIGURE 4: Photograph of a full wafer after edge trimming. Notch on the right, flat on the left side of the picture.

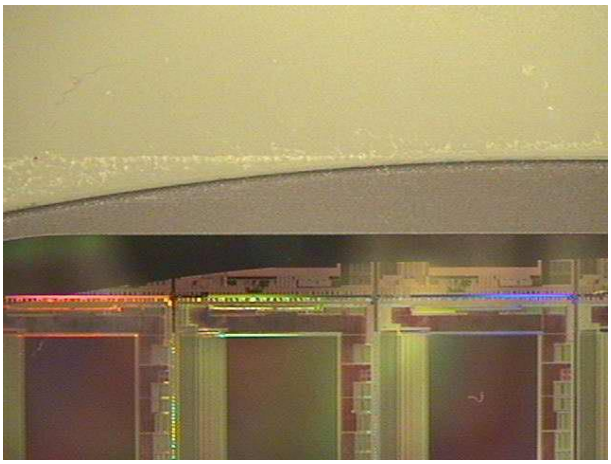


FIGURE 5: Photograph of the edge around the flat area. The trimming is up to 2.5mm wide.

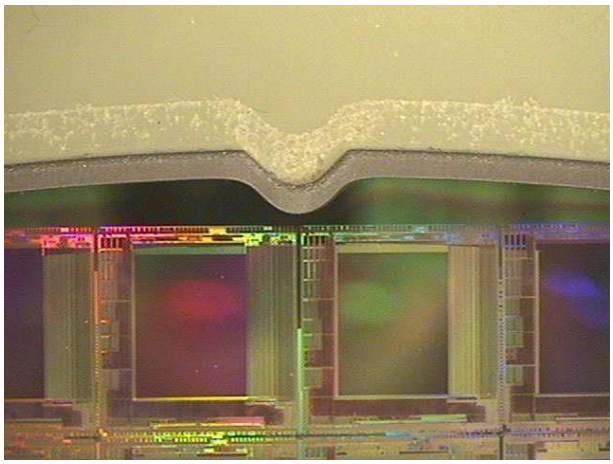


FIGURE 6: Photograph of the edge around the notch area. The trimming follows the notch shape.

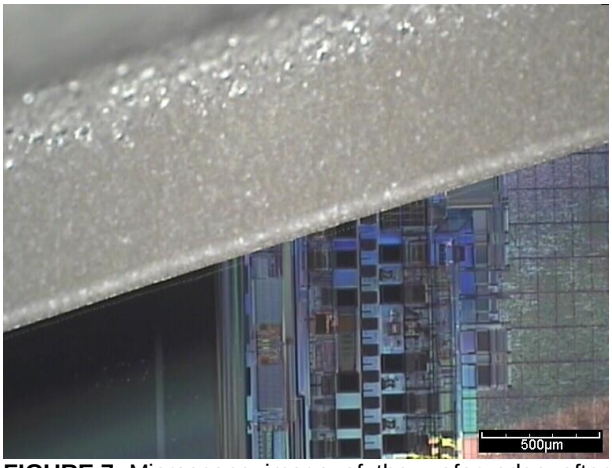


FIGURE 7: Microscope image of the wafer edge after trimming. The final edge is sharp and clean.

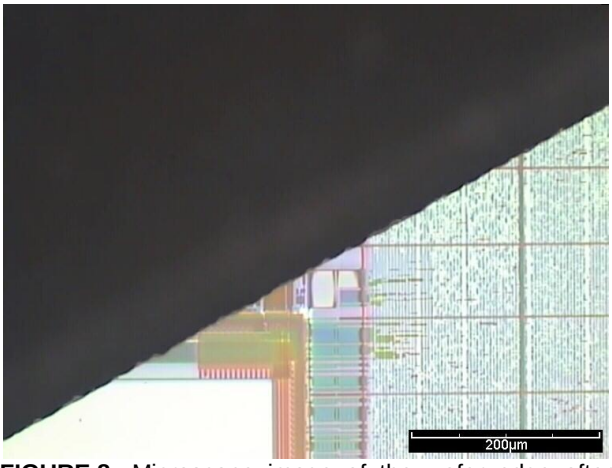


FIGURE 8: Microscope image of the wafer edge after trimming (bright field imaging).

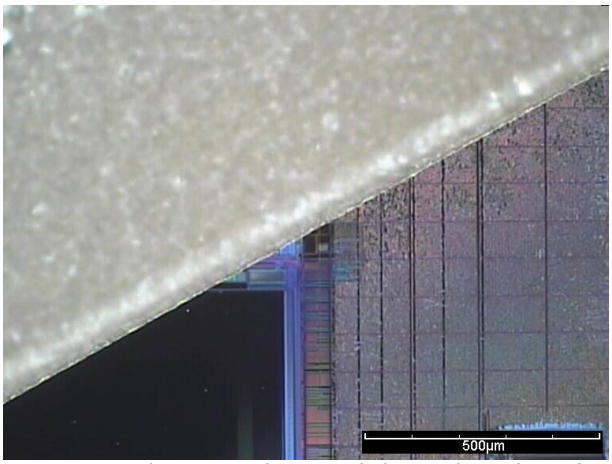


FIGURE 9: Microscope image of the wafer edge after trimming. Focus on the new top edge.

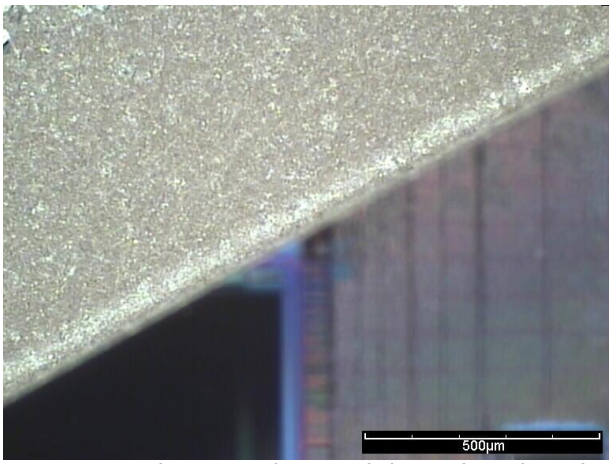


FIGURE 10: Microscope image of the wafer edge after trimming. Focus on the lower surface (60µm deep).

FIGURE 11: Microscope image of the wafer edge after trimming: Flat

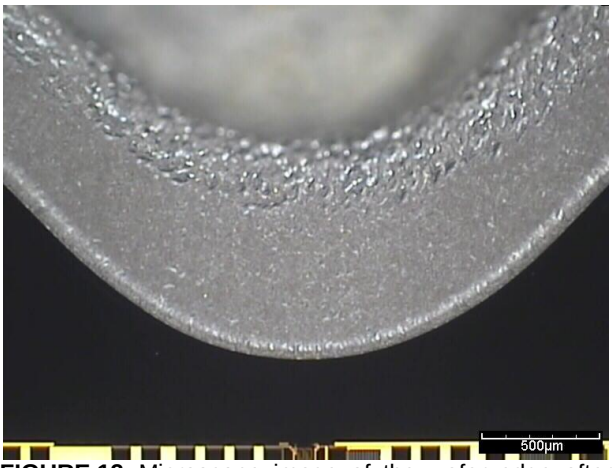


FIGURE 12: Microscope image of the wafer edge after trimming: Notch

CONCLUSION

Trimming the edge of silicon wafers with the Laser-MicroJet® technology (LMJ) was investigated on the Synova LDS200M. The LMJ is ideally suited for such an application, because the ablation rates in silicon are very high, while the mechanical impact of the process is negligible. The continuously running waterjet also keeps particles from sticking to the wafer.

Our results are summarized in the table below: we achieved excellent quality standards without chipping, delamination or contamination. The shape of the trimmed area is perfectly controlled; a flat is created and the notch is reproduced. The surface in the trimmed zone is also very regular and flat.

The cycle time for one wafer given here (8.5 minutes) can be significantly reduced by optimizing the cutting program. With the cutting approach currently used, the laser spends a lot of time outside the wafer area (See figure 3). By writing a dedicated program for this application, cycle times can at least be dived by half.

	Customer priorities	Synova results and comments
• Speed / throughput:	5000 wfrs/week	Cycle time: 8.5min (see note above)
• Kerf-width:	1mm	1mm
• Burr-free:	yes	No burrs
• Depth control:	x	Measured around 60µm
• Contamination/Particles:	Less than 50 pcs up to 0.2 µm	No contamination by silicon particles
• Heat-damage free:	x	No heat damage
• Chipping/Cracks:	free	No chipping
• Edge Roughness:	not relevant at now	Excellent edge quality
• Tolerances:	1 mm +/- 10 µm	High tolerances
• Fracture strength:	not evaluated at now	Very high fracture strength

We thank you for your interest in our technology and we hope our results meet your requirements. Our sales team will contact you soon to obtain a feedback about the analysis of these results and to discuss with you the further steps.