REPORT: Silicon Wafer Cutting by Laser-MicroJet®

for Anonymous

by Stephane Delahaye, Synova SA

TASK

The Laser-MicroJet® technology has been tested on a blank silicon wafer. The goal was to use the layout provided by the customer to:
- Groove a recess (0.5 mm wide, 300 µm deep)
- Cut 8 extra notches (cut-outs), see Figure 1detail A
- Drill 8 through holes of 0.5 mm

SAMPLE DESCRIPTION AND PREPARATION

SAMPLE	Material	Blank Si wafer
	Dimension	300 *mm*
	Thickness	~500 *µm*
	Quantity	1 *pcs*

Only one wafer was provided for the tests.

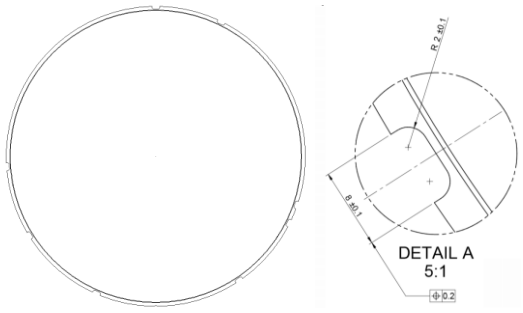


Figure 1: wafer layouts

Release of application report			
Project Leader		Responsible Application Group	
Name:	Stephane Delahaye	Name:	Benjamin Carron
Date:	12.01.2015	Date:	12.01.2015
Visum:	SDE	Visum:	BR

PROCESS: INSTRUMENT & TEST PARAMETERS:

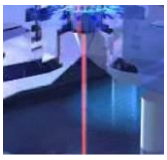
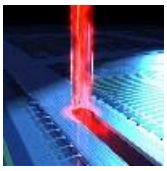
For these experiments, the LDS300 equipped with a frequency-doubled Q-switched Nd: YAG laser has been used as the machine configuration in our lab.

It is a manually loaded clean-room compatible machine, allowing to cut, drill, groove, scribe, trench, mark, or grind different kinds of materials.

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

- Cutting of arbitrary shapes
- Minimal chipping on frontside
- Negligible heat damage to the material
- Parallel and smooth cut walls

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

	**SYSTEM**	Machine type	LDS300
	**MICROJET® PARAMETER**	Nozzle diameter	60 *µm*
		MicroJet® diameter	~48 *µm*
		Water pressure	250 *bar*
		Assist gas	He
	**LASER PARAMETER**	Laser type	L101G
		Wavelength	532 *nm*
		Pulse frequency	25 *kHz*
		Average power	28 (grooving) *W* 36 (slots) 40 (holes)
		Pulse width	~200 *ns*
	**CUTTING PARAMETER**	Cutting speed	150(grooving) *mm/s* 40 (slots) 5 (holes)
		Number of passes	4(grooving) 45 (slots) 100 (holes)
		Total Process time	~26 *Min*
		Sample fixation	Vacuum chuck

PROCESSING RESULTS

A 60 µm nozzle was used to perform the three steps of the process. We started by grooving the recess (0.5 mm wide) by using a double-spiral path, as illustrated in Figure 2. The path first follows the blue arrows (inwards) and then red arrows (outwards), and is repeated 4 times to achieve a grooving depth of about 300 µm.
A 30µm step was used for the process. This value corresponds to the distance indicated by the black double arrow.

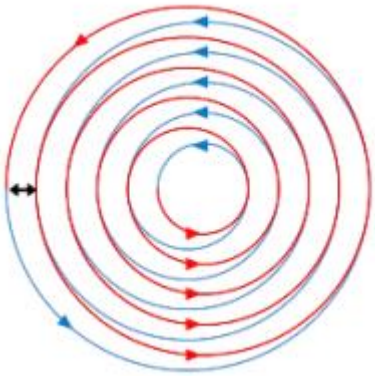


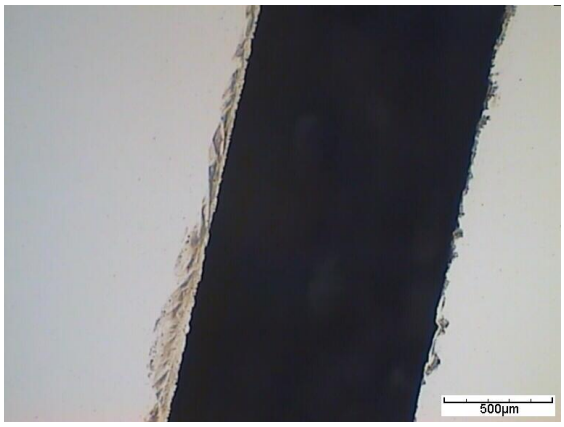
Figure 2: illustration of the path used for spiral drilling

Please note that the sample was only rinsed with DI water at the end of the process because our current cleaning station is not suitable for such wafer diameter.

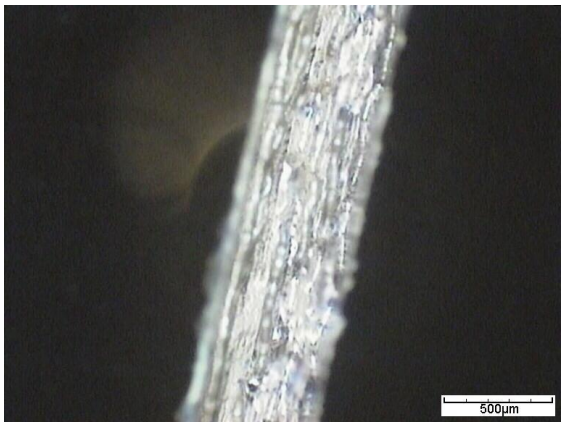
The following microscope pictures give an overview on the quality obtained with the Laser-Microjet® technology.

PICTURE 1: Macroscopic view of the final samples.

1. Recess

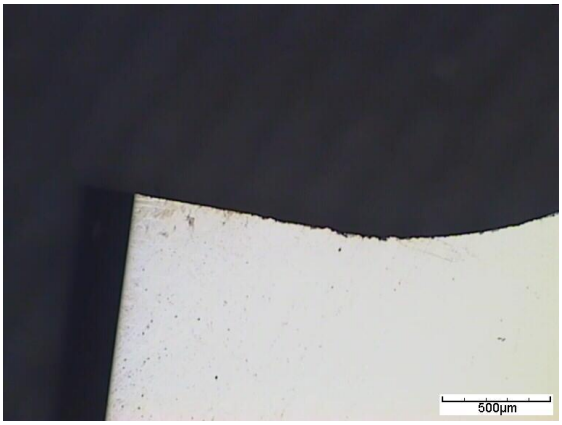


PICTURE 2: Microscope image of the frontside

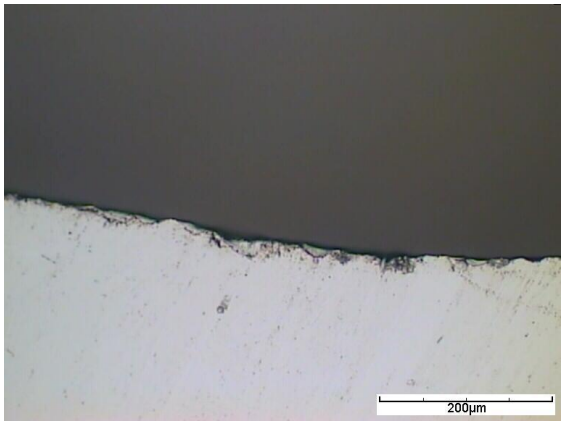


PICTURE 3: Microscope image of the frontside (Bottom view)

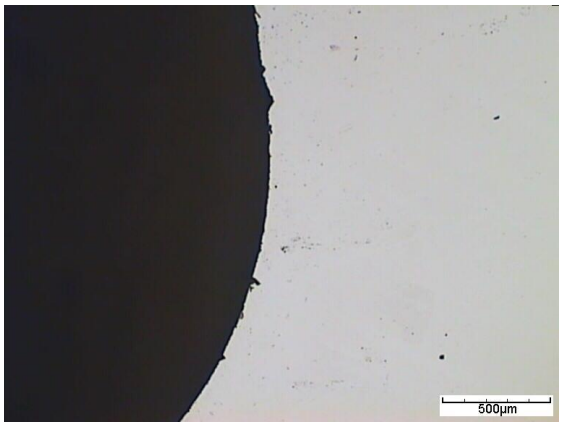
2. Slots



PICTURE 4: Microscope image of the frontside

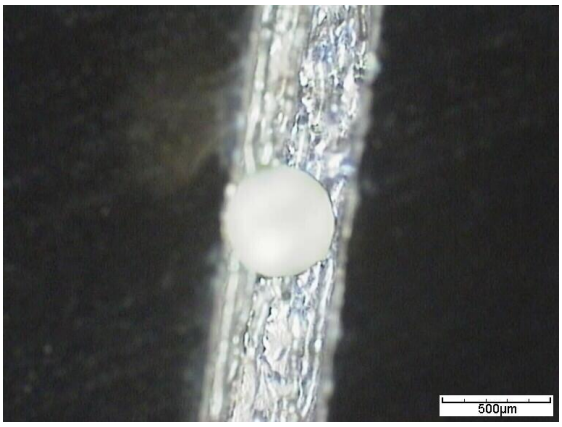


PICTURE 5: Microscope image of the frontside at higher magnification

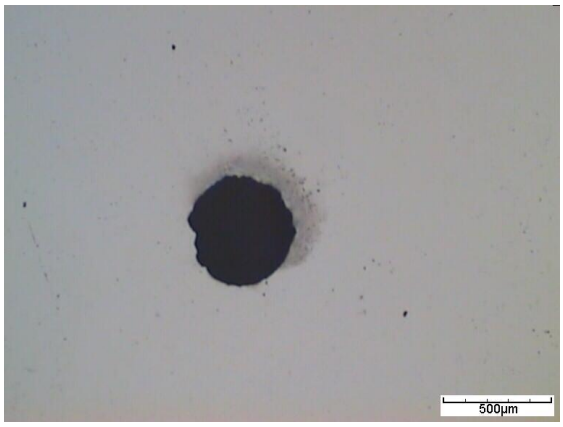


PICTURE 6: Microscope image of the backside

3. Holes



PICTURE 7: Microscope image of the frontside



PICTURE 8: Microscope image of the backside (some chipping is visible)

CONCLUSION:

The cutting of silicon wafer was demonstrated on SYNOVA LDS300. This machine is based on the MicroJet® technology and combines the advantages the high energy pulsed green 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 cutting of masks with high quality.

This first iteration shows that:

- Good cutting quality is achievable on the frontside while some minor chipping is visible on the backside.
- A shift is visible on the slots located around the recess. This is due to a shift in the reference positions which is used into the 3 NC-codes to process the sample.
- Further trials are necessary to ensure a good cutting quality if a passivation layer (SiO2) is added on the sample surface.
- Further development might be required if the quality of the groove needs to be improved.

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