REPORT: Grooving for Si Wafer by Laser-MicroJet®

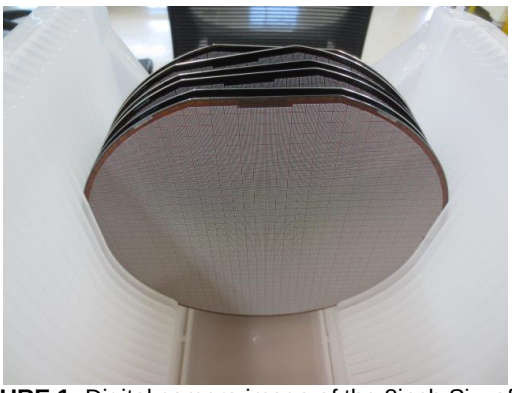
for Anonymous

by Andrew Chung, Synova SA

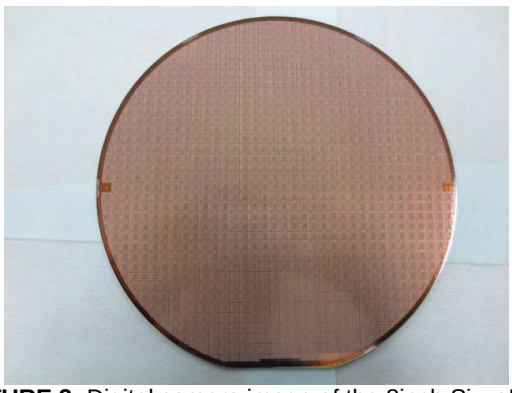
TASK

This test is to process the wafer which has a mixed metal layer to more than 30 µm-depth. This should be done fast without burr and delamination on the metal layer.

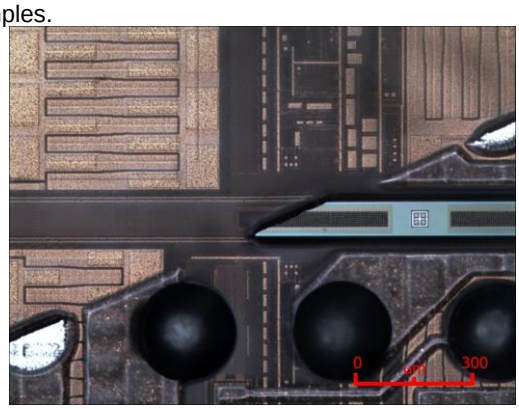
SAMPLE DESCRIPTION AND PREPARATION



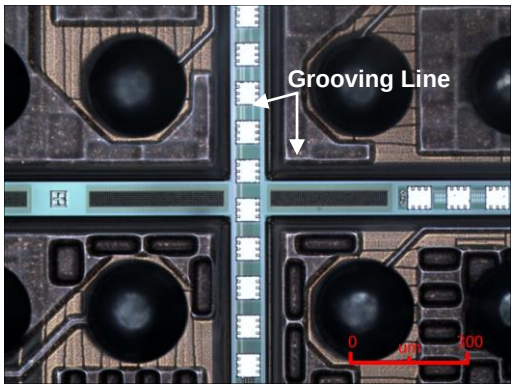
PICTURE 1: Digital camera image of the 8inch Si wafer Samples.



PICTURE 2: Digital camera image of the 8inch Si wafer.

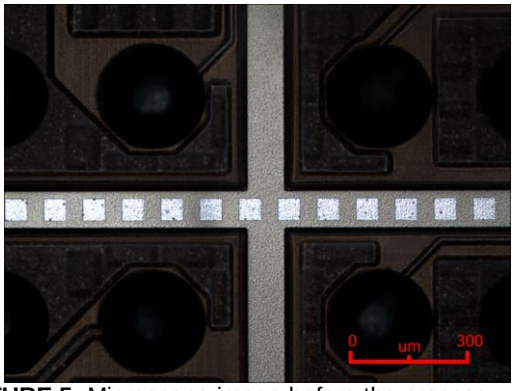


PICTURE 3: Microscope image before the process.

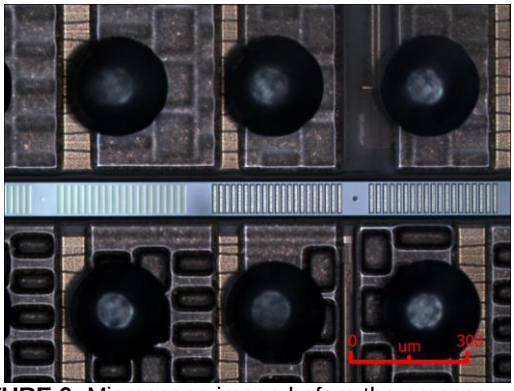


PICTURE 4: Microscope image before the process.

Release of application report			
Project Leader		Responsible Application Group	
Name:	Andrew Chung	Name:	Benjamin Carron
Date:	06.May.2013	Date:	08.May.2013
Visum:	ACH	Visum:	BC



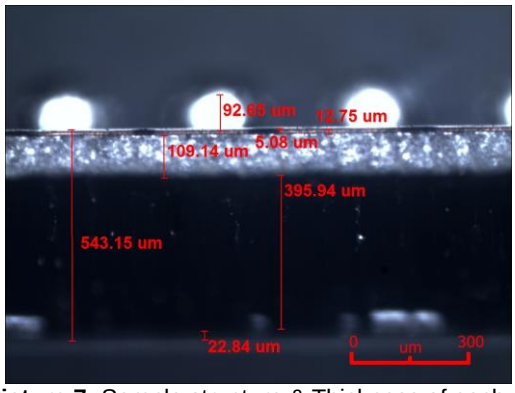
PICTURE 5: Microscope image before the process.



PICTURE 6: Microscope image before the process.

The above pictures are the microscope images of grooving line before the process.
As you see the pictures, each different pattern is formed on grooving line.
You can realize that each material & layer is different.
We confirmed that this pattern is composed of four different layers.

▪ SAMPLE STRUCTURE & THICKNESS



Picture 7: Sample structure & Thickness of each materials.

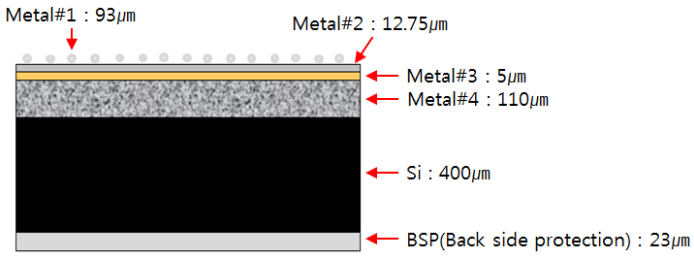


Figure 1: Sample structure & Thickness of each materials.

SAMPLE	**Quantity**	1ea (Sample) 5ea (Trial)

The information received from the customer is wrong after checking it by using a microscope.
Metal layer is actually thick and the sample is composed of each different layer.

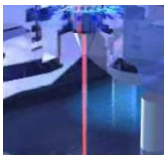
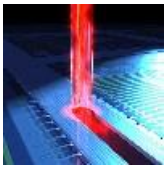
▪ PROCESS: INSTRUMENT & TEST PARAMETERS

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

It is a manually clean-room compatible machine, allowing to cut, drill, groove, scribe, trench, mark, or grind wafers of any kind of semiconductor material.

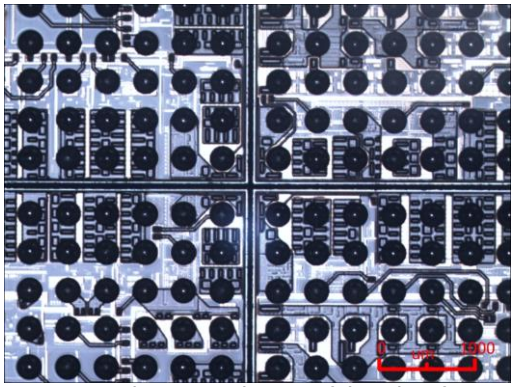
Major advantages of Laser- Microjet® technology with regards to your application are:
- Cutting of arbitrary shapes
- No chipping on front side, minimal chipping on backside
- Negligible heat damage to the material
- Parallel and smooth cut walls
- No slag/burr formation

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

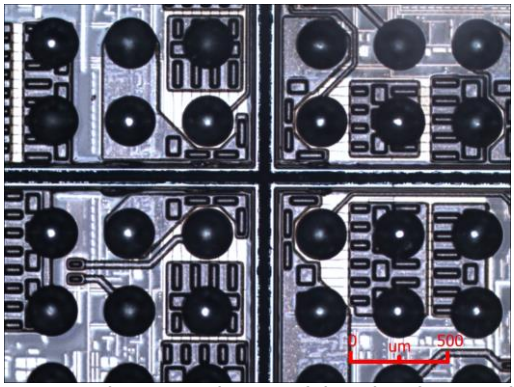
	**SYSTEM**	Machine type	LDS300M
	**MICROJET® PARAMETER**	Nozzle diameter	40 *µm*
		MicroJet® diameter	36 *µm*
		Water pressure	500 *bar*
		Assist gas	He
	**LASER PARAMETER**	Laser type	L51G
		Wavelength	532 *nm*
		Pulse frequency	30 *kHz*
		Average power	33.4 *W*
	**CUTTING PARAMETER**	Cutting speed	260 *mm/s*
		Number of passes	2
		Overall speed	130 *mm/s*
		Sample fixation	8” vacuum chuck

▪ PROCESSING RESULTS

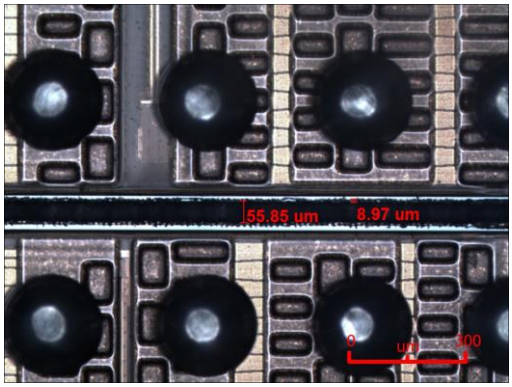
The following microscope picture give an overview on the quality obtained with the Laser-Microjet® technology.



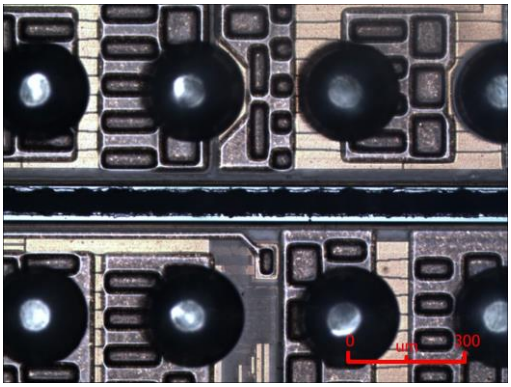
PICTURE 8: Microscope image of the Si wafer Sample. (bright field illumination; top view)



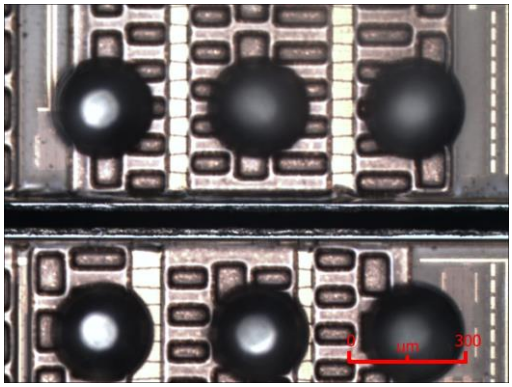
PICTURE 9: Microscope image of the Si wafer sample. (bright field illumination; top view)



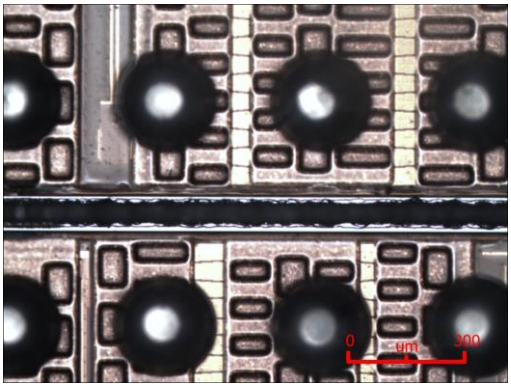
PICTURE 10: Microscope image of the Si wafer sample. (bright field illumination; top view)



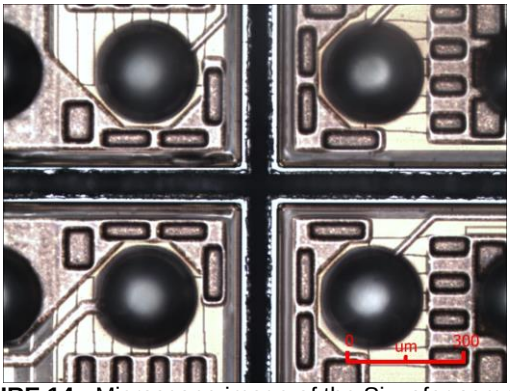
PICTURE 11 Microscope image of the Si wafer sample. (bright field illumination; top view)



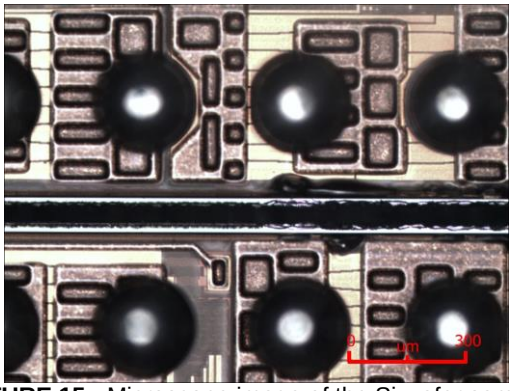
PICTURE 12: Microscope image of the Si wafer sample. (bright field illumination; top view)



PICTURE 13: Microscope image of the Si wafer sample. (bright field illumination; top view)



PICTURE 14: Microscope image of the Si wafer sample. (bright field illumination; top view)



PICTURE 15: Microscope image of the Si wafer sample. (bright field illumination; top view)

The result is that the processing quality is different according to the position of grooving Line.
The point which has four layers is not done well when we have the processing condition suited for the point which has one layer, and vice versa.
Delamination occurs on the metal layer for high peak power when we have short pulse.
We don't have this when we have long pulse. But we can see burr & splash. This is relatively uniform in shape compared to the test with long pulse.

The table below summarizes the Anonymous expectations and our results

	What are your priorities? (please put a cross)	Quantified expectations or improvements
• Speed/throughput:	X	More than 400 mm/s
• Kerf-width:	X	Less than 50 µm
• Burr-free:	X	Less than 15 µm
• Depth control:	X	More than 30 µm
• Contamination/particles:		
• Heat-damage free:		
• Chipping/Cracks:	X	Less than 10 µm
• Edge Roughness:		
• Tolerances:		
• Fracture strength:		
• Other:		

▪ Conclusion

The grooving of Si wafers were investigated on SYNOVA LDS300. This machine is based on the 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 Si wafer grooving with high quality.

These tests show:

1. Quality is different according to the processing point. This could be for the different material & thickness of the layer.
2. Burr & splash size is less than about 20 µm and the chipping size is about 20 µm.
3. The total speed of grooving processing is 130 mm/s. The process was done by 2 passes.
4. Grooving depth is from 40 µm to 70 µm deep. This is for the thickness of the layer & each material.
5. There is no delamination on the metal layer.

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