REPORT: Dicing and drilling SiC Wafers by Laser-MicroJet®

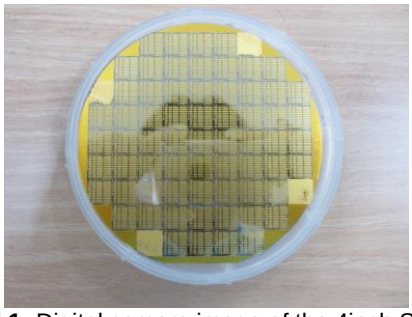
for Anonymous

by Andrew Chung, Synova SA

TASK

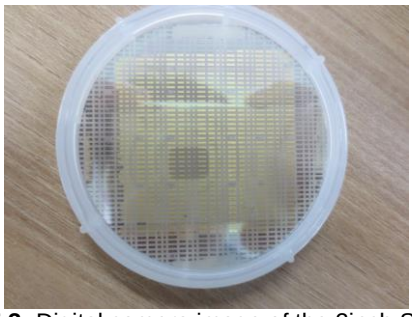
The purpose of the test is to cut Sic Wafer and eliminate Glue from the back side of UV tape as requested. The additional purpose is the via hole drilling of the SiC wafer back side.
In case of Si & GaN wafer, etching process can make via hole, but SiC wafer is hard.
Full drilling doesn't need to be done when doing the drilling process. First, 450µm-depth drilling process is done. Next, we need to decrease etching rate; and then an etching process.
Need to make the sample by doing the above two jobs. And then UV curing will be done.

SAMPLE DESCRIPTION AND PREPARATION

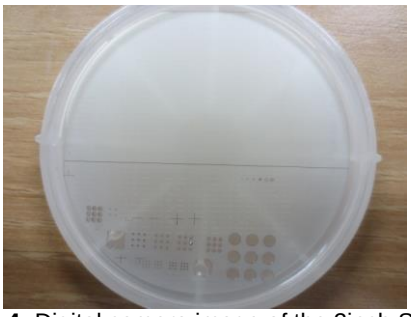


PICTURE 1: Digital camera image of the 4inch SiC Sample. (Dicing process)

PICTURE 2: Digital camera image of the SiC piece samples.(Dicing process)

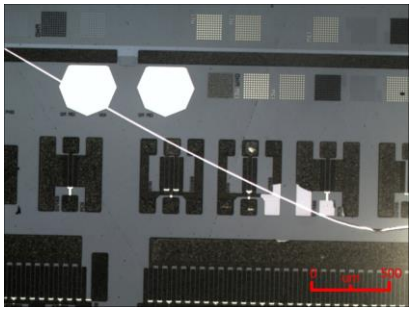


PICTURE 3: Digital camera image of the 2inch SiC Sample. (Drilling process)

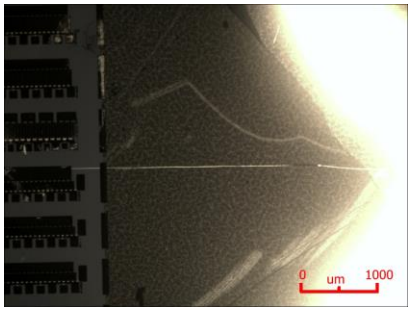


PICTURE 4: Digital camera image of the 2inch SiC Sample. (Drilling process)

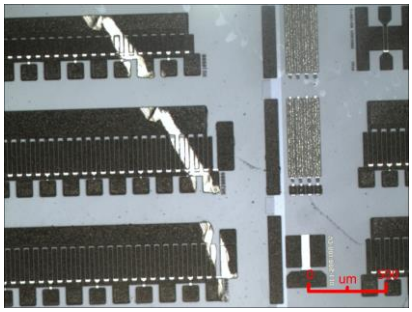
Release of application report			
Project Leader		Responsible Application Group	
Name:	Andrew Chung	Name:	Benjamin Carron
Date:	23.04.2013	Date:	24.04.2013
Visum:	ACH	Visum:	BC



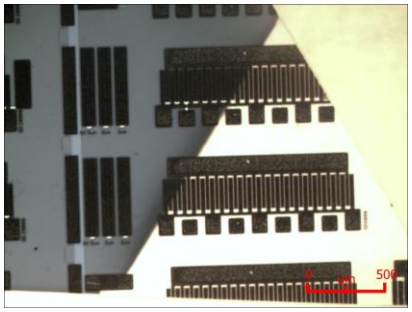
PICTURE 5: Microscope image before the process. (Scratch is seen partly.)



PICTURE 6: Microscope image before the process. (Scratch is seen partly.)



PICTURE 7: Microscope image before the process. (Pattern Delamination of Metal at the upper side is seem partly.)



PICTURE 8: Microscope image before the process. (Metal evaporation is not good partly.)

About the picture 1 & 2, the sample is for dicing.
The picture 3 & 4 show the 450µm -depth drilling of the back side. The sample is 2 inch-SiC wafer and the hole size is 50µm
The picture 5 & 6 is the image of the microscope before the process. Cracks is seen partly at the edge.
The picture 6 & 7 show the delamination of the pattern in part. It also shows the evaporation of the metal is not perfect.
Micro-crack is a lot seen around the edge of SiC wafer. So we think that edge trimming before the dicing process could stop cracks spread.

▪ SAMPLE STRUCTURE & THICKNESS

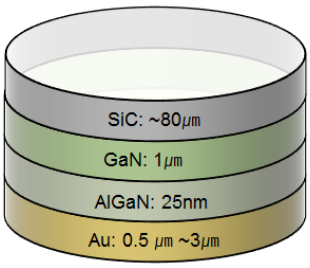


Figure 1: Sample structure & Thickness (Dicing Sample)

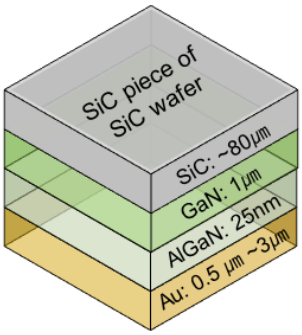


Figure 2: Sample structure & Thickness (Dicing samples)

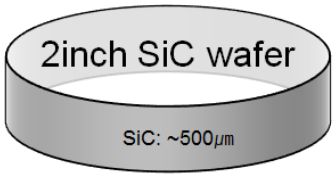
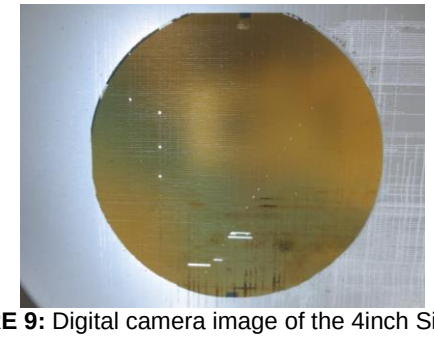


Figure 3: Sample structure & Thickness (Drilling Samples)

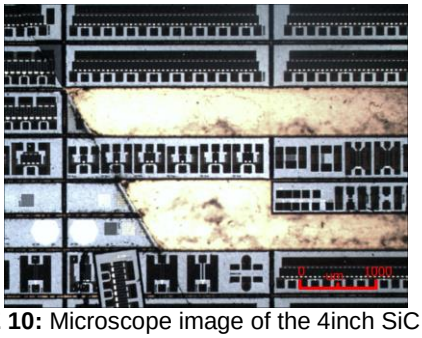
SAMPLES	Quantity	Dicing	1 x 4 inch SiC wafer
			9 x Pieces of SiC wafers
		Drilling	2 x 2 inch SiC wafers

▪ EXPLANATION ABOUT SAMPLES AFTER PROCESSING

▪ The dicing processing for SiC Wafer

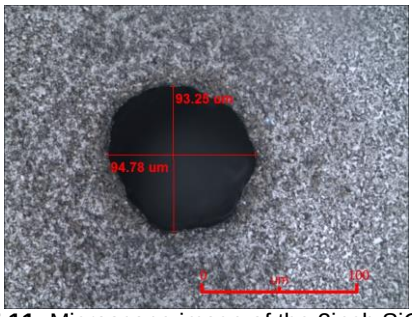


PICTURE 9: Digital camera image of the 4inch SiC Sample.

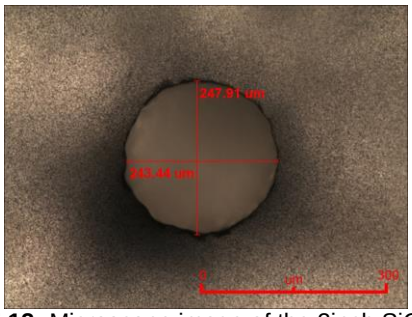


PICTURE 10: Microscope image of the 4inch SiC Sample.

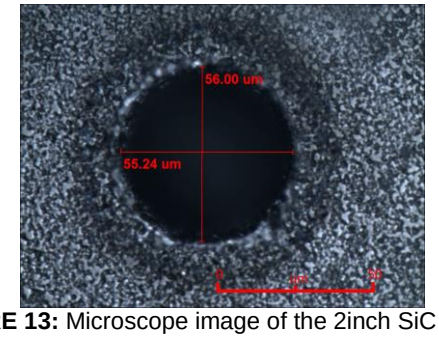
The picture 9 & 10 are ones after processing the SiC wafer that has cracks.
As you see, the part that has crack shows chip flying away.



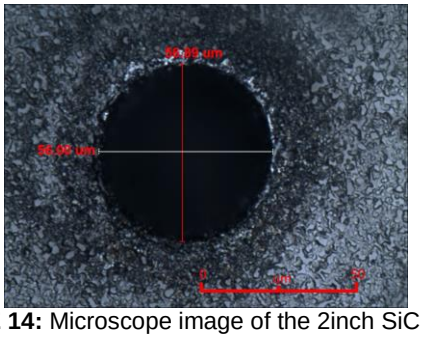
PICTURE 11: Microscope image of the 2inch SiC Sample.



PICTURE 12: Microscope image of the 2inch SiC Sample.



PICTURE 13: Microscope image of the 2inch SiC Sample.



PICTURE 14: Microscope image of the 2inch SiC Sample.

As requested, we did the test by using 30 & 40µm nozzles. Finally, sample was made by using a 30µm nozzle.
The picture 11 & 12 shows the process done by moving X-Y axis stage.
The picture 13 & 14 shows only laser beam was used, not moving X-Y axis stage.
As you see the above picture, we couldn't make 50µm-hole when moving the stage.
Over than 200µm size could make round shapes.
We could meet 50µm-hole when using only laser beam, not moving the stage. But we see HAZ and burr. Close to round shapes, but it makes a little difference of the shape.

▪ Process: Instrument & Test Parameters

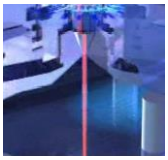
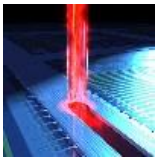
For these experiments, the LDS300 equipped with a frequency-double Q-switched Nd:YAG laser has been used as the machine configuration in our lab.

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

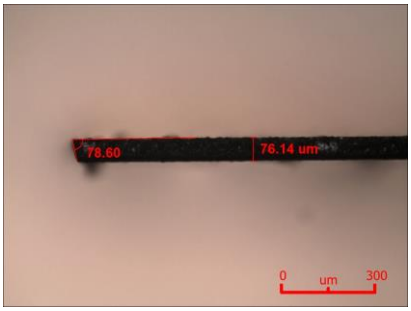
In the table below, the optimized processing parameters used in the experiments are summarized:

▪ Dicing condition of SiC Samples

	**SYSTEM**	Machine type	LDS300M			
			Dicing		**Drilling**	
	**MICROJET® PARAMETER**	Nozzle diameter	40	*µm*	30	*µm*
		MicroJet® diameter	35	*µm*	27	*µm*
		Water pressure	250	*bar*	250	*bar*
		Assist gas	He		He	
	**LASER PARAMETER**	Laser type	L51G			
		Wavelength	532*nm*			
		Pulse frequency	10	kHz	10	*kHz*
		Average power	5.7	*W*	15.4	*W*
	**CUTTING PARAMETER**	Cutting speed	50	*mm/s*	*Not moved*	
		Number of passes	10		10	
		Overall speed	5	mm/s	*Not moved*	
		UV Tape	Lintec D-520T			
		Sample fixation	8" vacuum chuck			

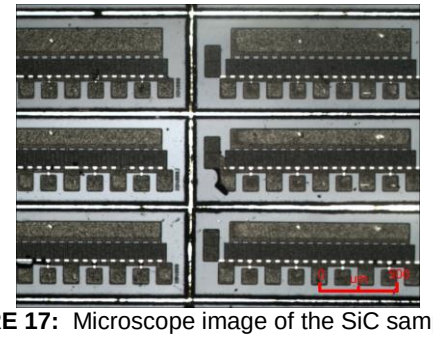
▪ Processing Results

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

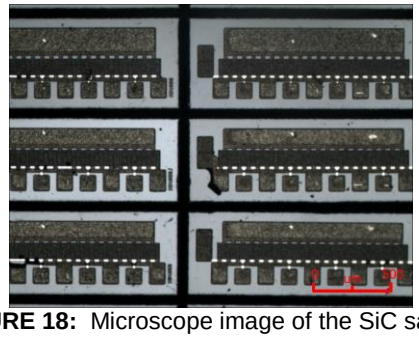


PICTURE 15: Microscope image of the SiC sample. (bright field illumination; cross-section view)

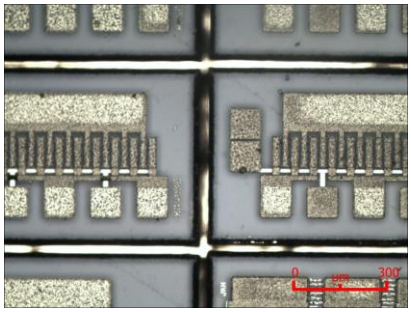
PICTURE 16: Microscope image of the SiC sample. (bright field illumination; top view)



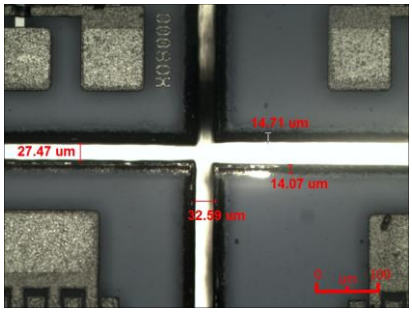
PICTURE 17: Microscope image of the SiC sample. (bright field illumination; top view)



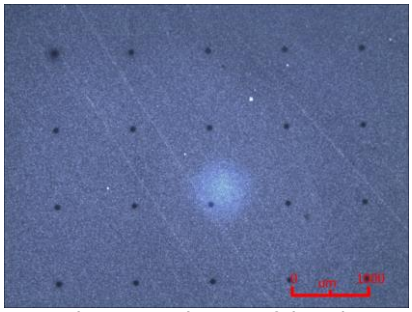
PICTURE 18: Microscope image of the SiC sample. (bright field illumination; top view)



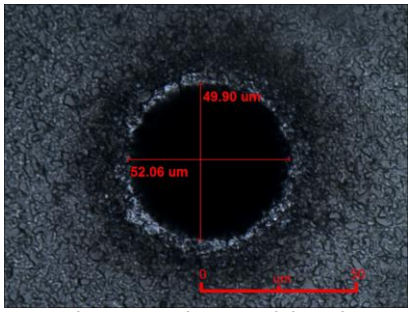
PICTURE 19: Microscope image of the SiC sample. (bright field illumination; top view)



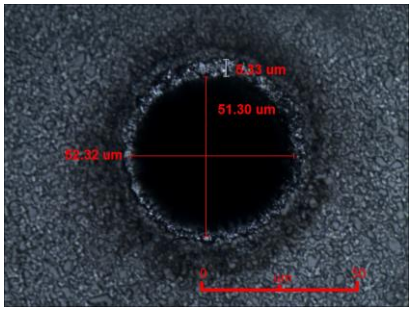
PICTURE 20: Microscope image of the SiC sample. (bright field illumination; top view)



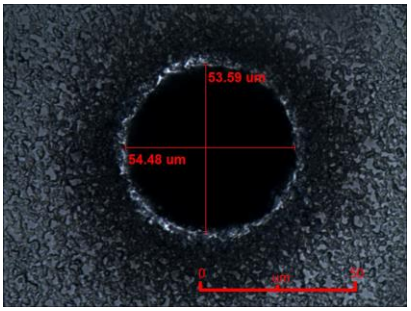
PICTURE 21: Microscope image of the SiC sample. (bright field illumination; top view)



PICTURE 22: Microscope image of the SiC sample. (bright field illumination; top view)



PICTURE 23: Microscope image of the SiC sample. (bright field illumination; top view)



PICTURE 24: Microscope image of the SiC sample. (bright field illumination; top view)

The table below summarizes Anonymous expectations and our results

	What are your priorities? (please put a cross)	Quantified expectations or improvements for the dicing	Quantified expectations or improvements for the drilling
Speed/throughput:	N/A	50mm/s	Does not moved
Kerf-width:	<50 µm	<40 µm	<50 µm
Burr-free:	Burr-free	About 15 µm	<10 µm
Heat-damage free	N/A	Not has	<30 µm
Contamination/particles:	N/A	Some particles	Some particles
Front chipping/Cracks:	No chipping / cracks	No chipping / No cracks	No chipping / No cracks

CONCLUSION

The dicing & drilling of SiC 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 SiC wafer dicing & drilling with high quality.

These tests show:

1. The chipping of the front side was not found under the fractography for the dicing process.
2. Burr & Splash size after the process was less than 15 µm for the dicing process.
3. We didn't move the stage when drilling. So we confirmed that burr size was less than 10µm and HAZ was about 30µm.
4. We can see a little difference of the hole shape.
5. UV Tape is well removed from SiC Wafer after UV Curing. Glue does also not remained.

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.