REPORT: Cutting of Alumina substrate and dicing of Gallium Arsenide Wafers by Laser-MicroJet®

for Anonymous

by Stephane Delahaye; Synova SA

TASK

The Laser-MicroJet® technology has been tested to reproduce the cutting of alumina substrates coated with gold and the dicing of GaAs wafers with the customer's machine.

SAMPLE DESCRIPTION AND PREPARATION

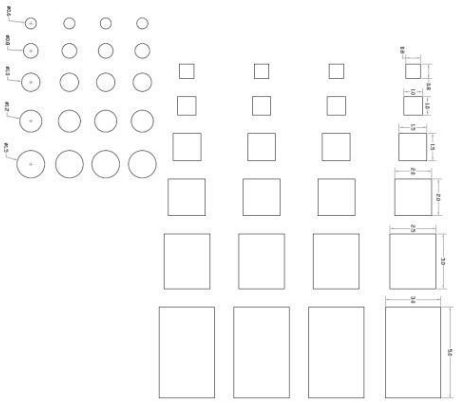
SAMPLE A	Material	Alumina plate (Al_2O_3)
	Dimension	50 x 20 *mm*
	Thickness	~381/254 *µm*
	Quantity	2 *pcs*
SAMPLE B	Material	GaAs
	Dimension	Ø76.2 *mm*
	Thickness	~200 *µm*
	Quantity	1 *pcs*

Release of application report			
Project Leader		Responsible Application Group	
Name:	Stephane Delahaye	Name:	D[r] Benjamin Carron
Date:	30.06.2015	Date:	02.07.2015
Visum:	SDE	Visum:	BC

RESULTS

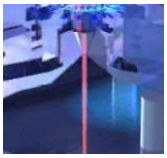
1. Alumina plates

The aim is to avoid any gold delamination. We use the same pattern as for the tests in 2013.



PICTURE 1: Drawing representing the cutting path for sample

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

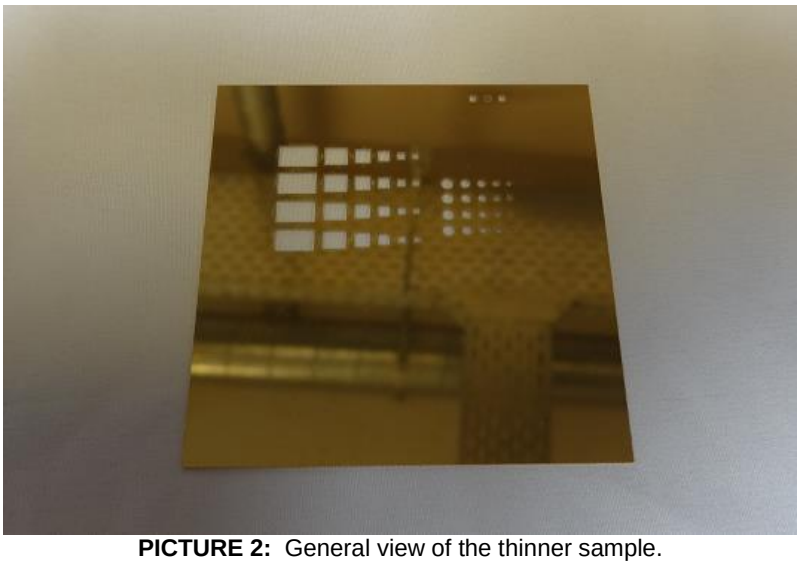
	**MICROJET® PARAMETER**	Nozzle diameter	60 *µm*
		MicroJet® diameter	~50 *µm*
		Water pressure	150 *bar*
		Assist gas	He
	**LASER PARAMETER**	Laser type	L101G
		Wavelength	532 *nm*
		Pulse frequency	12 *kHz*
		Average power	~32 *W*
		Pulse width	~280 *ns*

The 2 samples have been processed with the following cutting parameters.

Sample	**~254 µm (10 mils)**	**381 µm (15 mils)**
Number of passes	38	80
cutting speed [mm/s]	15	15
Overall cutting speed [mm/s]	~0.39	~0.19
Fixture	clamps	clamps

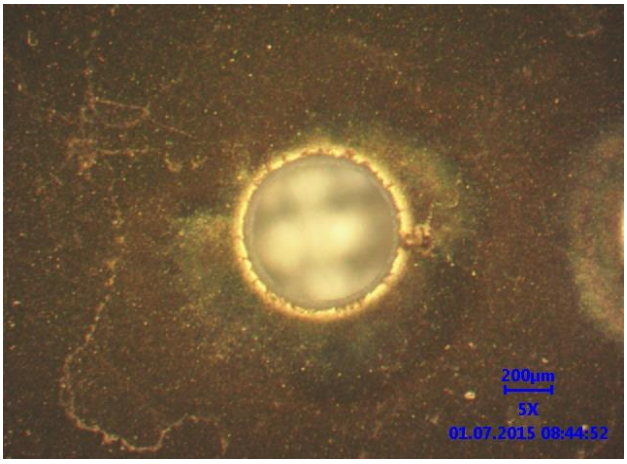
Overall cutting speed is similar to the one achieved in 2013. Using 20mm/s as cutting speed is also possible (with a very low impact on the overall cutting speed) but it seems that 15mm/s provides better results (less gold delamination).

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

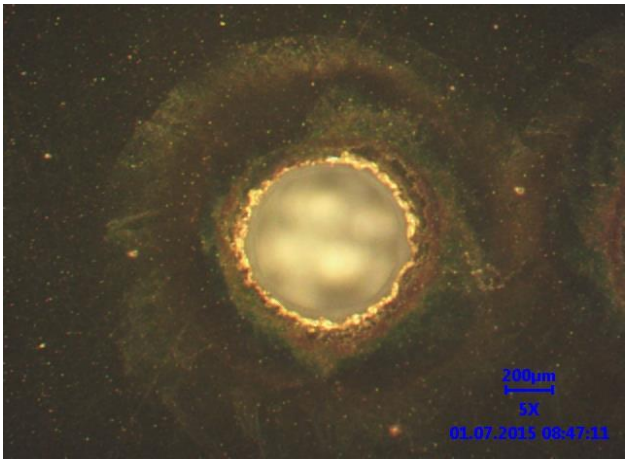


PICTURE 2: General view of the thinner sample.

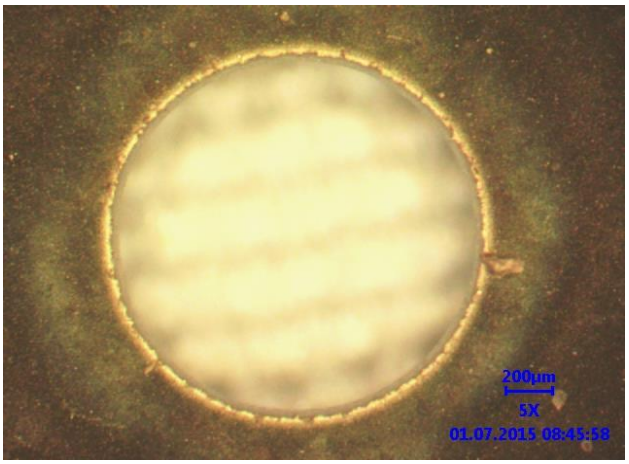
- **Matrix of circles**



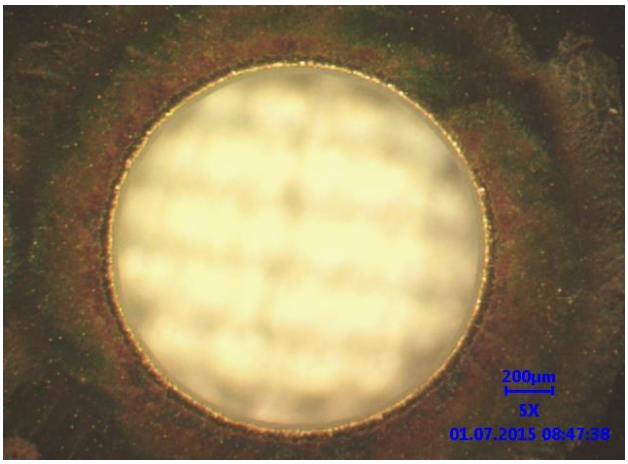
PICTURE 3: Frontside view of the smallest hole (ϕ 0.6 mm dark field illumination).



PICTURE 4: Backside view of the smallest hole (ϕ 0.6 mm dark field illumination).

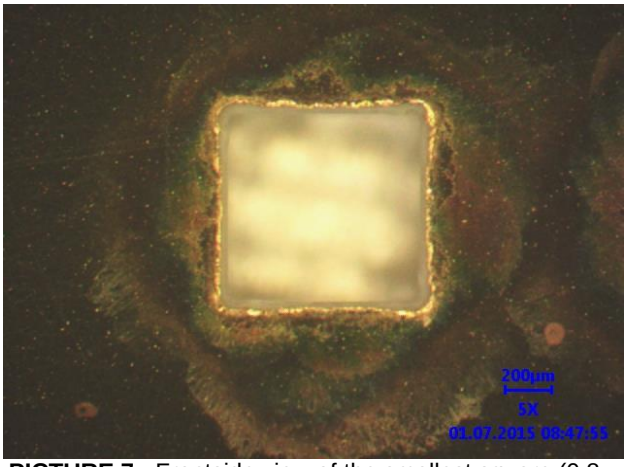


PICTURE 5: Frontside view of the biggest hole (ϕ 1.5 mm dark field illumination).

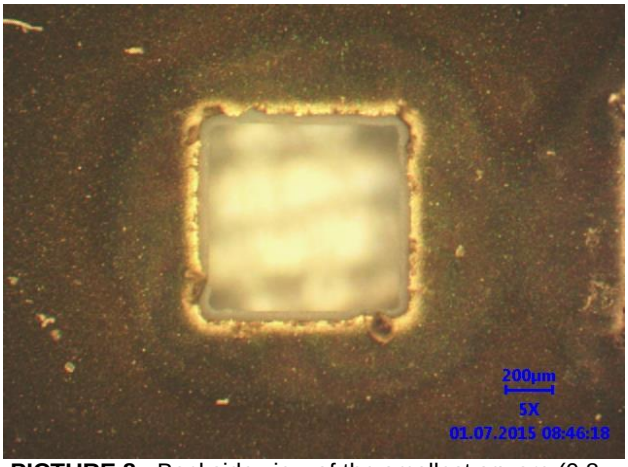


PICTURE 6: Backside view of the biggest hole (ϕ 1.5 mm dark field illumination).

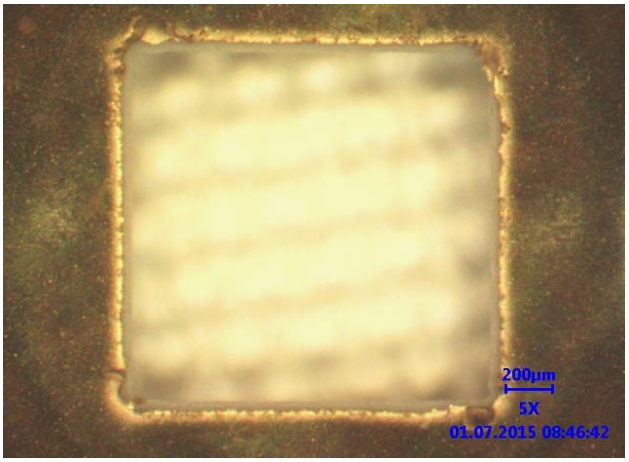
- **Matrix of rectangles**



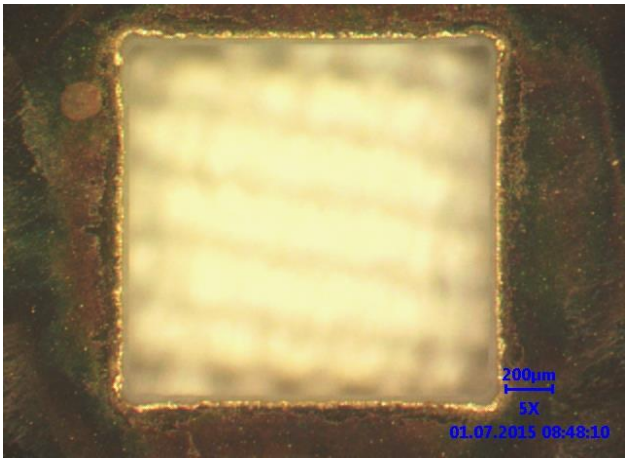
PICTURE 7: Frontside view of the smallest square (0.8 x 0.8 mm dark field illumination).



PICTURE 8: Backside view of the smallest square (0.8 x 0.8 mm dark field illumination).

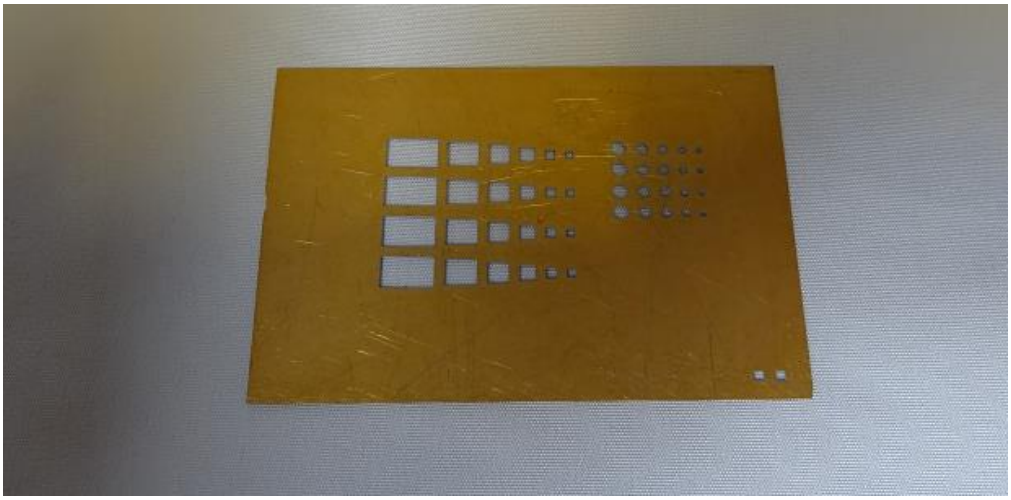


PICTURE 9: Frontside view of a bigger square (1.5 x 1.5 mm dark field illumination).



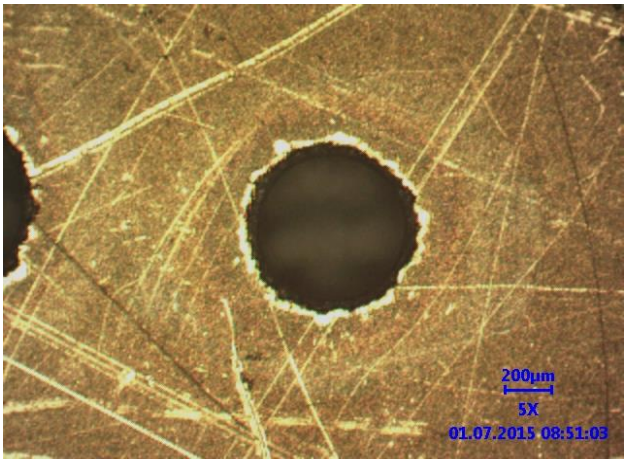
PICTURE 10: Backside view of a bigger square (1.5 x 1.5 mm dark field illumination).

On the second sample the same laser cutting parameters were applied:

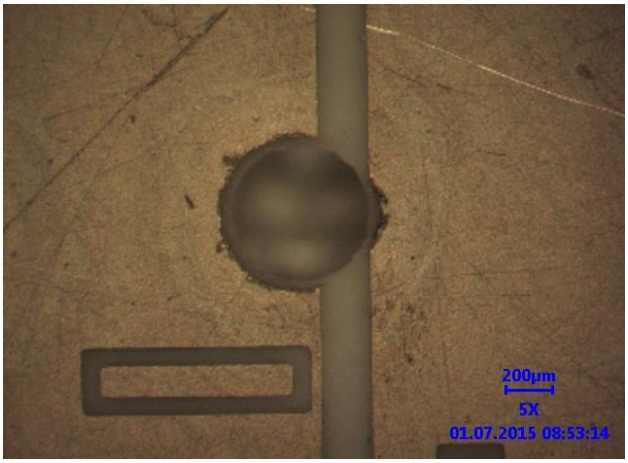


PICTURE 11: General view of the thicker sample.

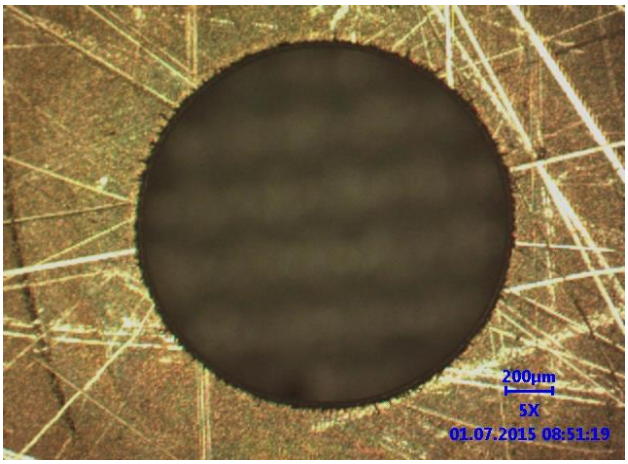
- **Matrix of circles**



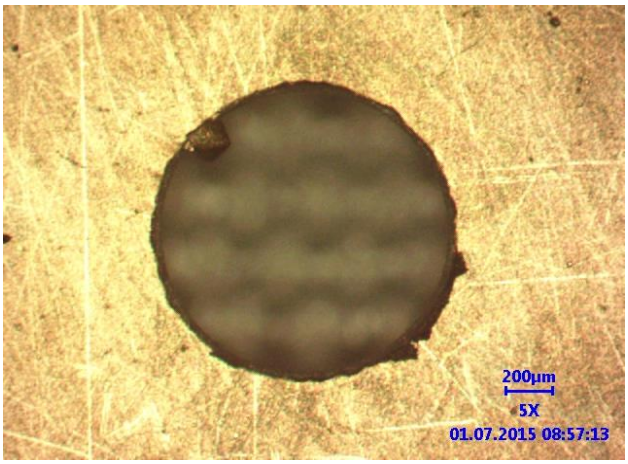
PICTURE 12: Frontside view of the smallest hole (ϕ 0.6 mm dark field illumination).



PICTURE 13: Backside view of the smallest hole (ϕ 0.6 mm dark field illumination).

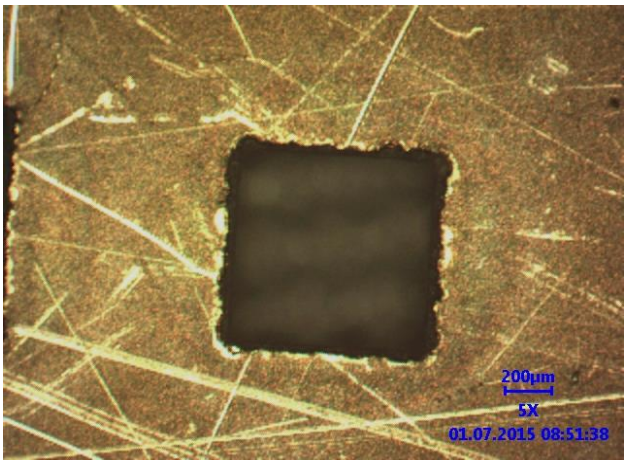


PICTURE 14: Frontside view of a bigger hole (ϕ 1.2 mm dark field illumination).

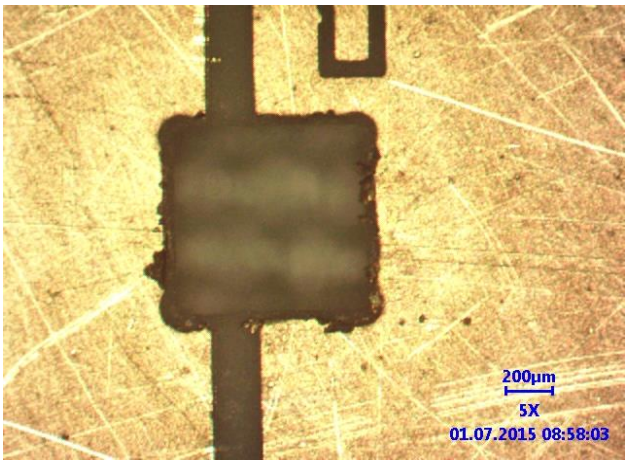


PICTURE 15: Backside view of a bigger hole (ϕ 1.2 mm dark field illumination).

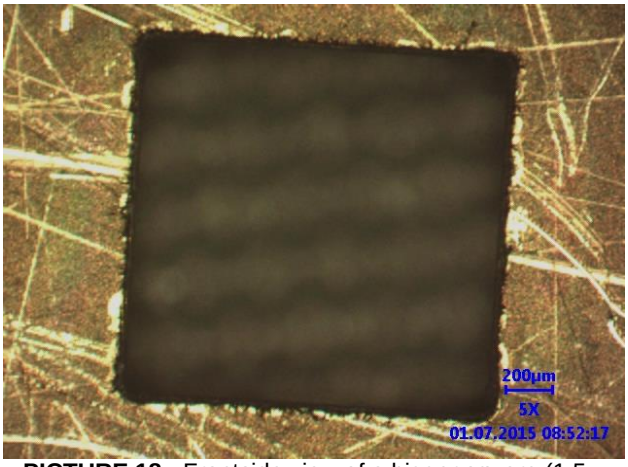
- **Matrix of rectangles**



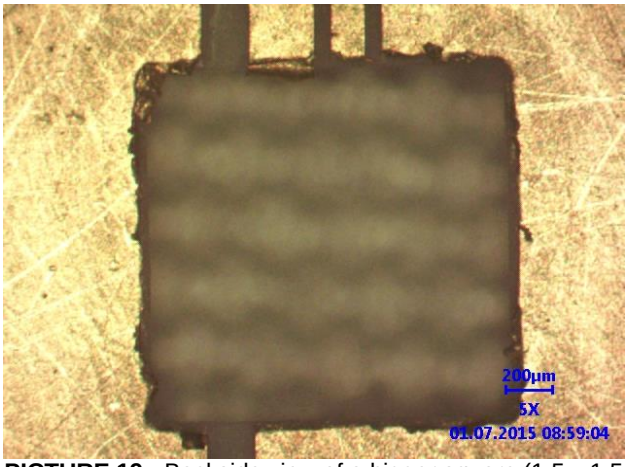
PICTURE 16: Frontside view of the smallest square (0.8 x 0.8 mm dark field illumination).



PICTURE 17: Backside view of the smallest square (0.8 x 0.8 mm dark field illumination).



PICTURE 18: Frontside view of a bigger square (1.5 x 1.5 mm dark field illumination).

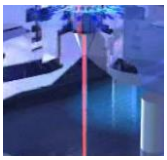
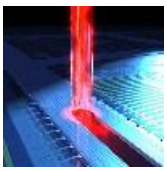


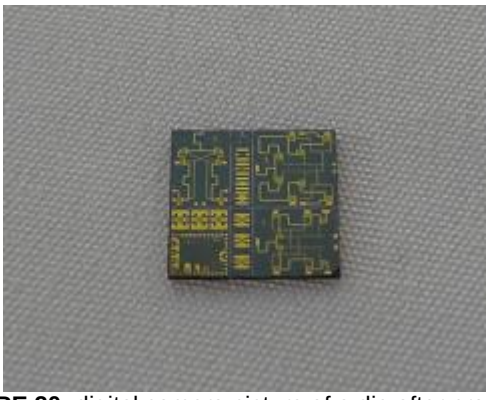
PICTURE 19: Backside view of a bigger square (1.5 x 1.5 mm dark field illumination).

As shown on the pictures, the delamination is very limited like reported in the previous report (132-5).

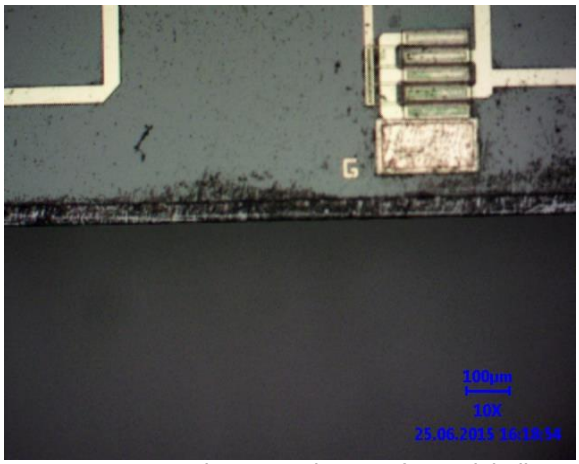
2. GaAs Sample

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

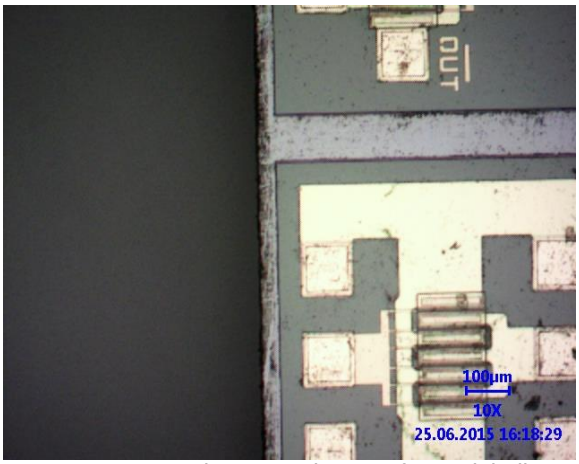
	**MICROJET® PARAMETER**	Nozzle diameter	30 *µm*
		MicroJet® diameter	27 *µm*
		Water pressure	350 *bar*
		Assist gas	He
	**LASER PARAMETER**	Laser type	L101G
		Wavelength	532 *nm*
		Pulse frequency	35 *kHz*
		Average power	~15 *W*
		Pulse width	~350-400 *ns*
	**CUTTING PARAMETER**	Cutting speed	6 *mm/s*
		Number of passes	1
		Overall cutting speed	6 *mm/s*
		Tape	ADWILL D-520



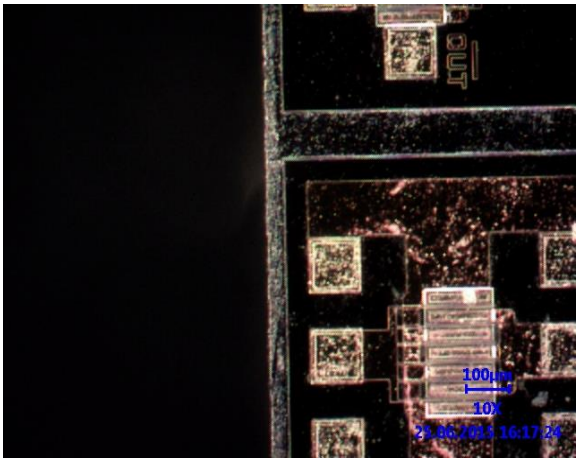
PICTURE 20: digital camera picture of a die after processing



PICTURE 21: Microscope image of a straight line (bright field illumination).



PICTURE 22: Microscope image of a straight line (bright field illumination).



PICTURE 23: Microscope image of a straight line (dark field illumination).

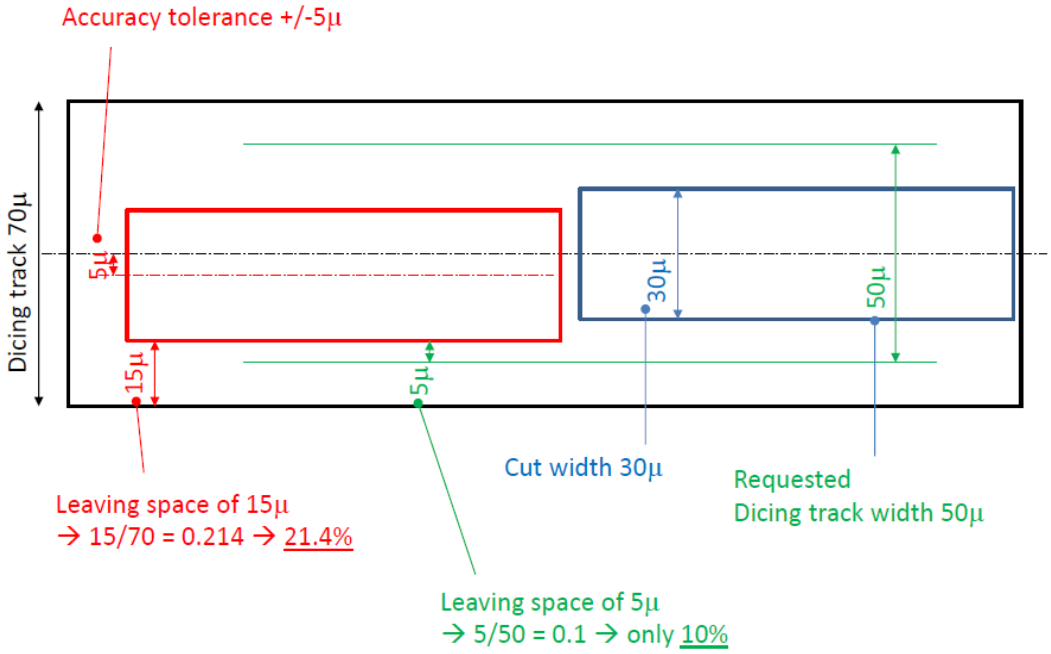
Notes:
It has not been possible to keep the samples cleaned and contamination near the cut is visible.

3. Precision and Accuracy Assessment

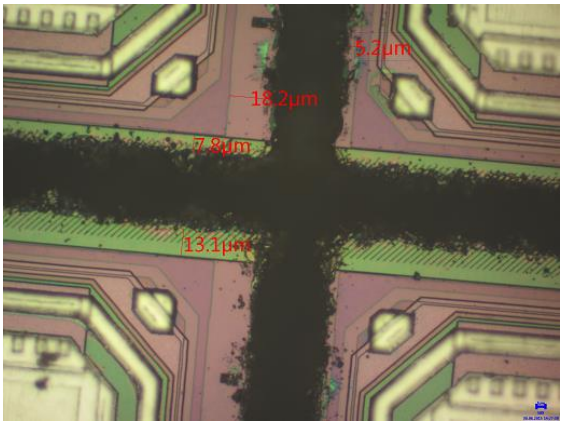
A 200mm silicon wafer was used to assess the machine precision/accuracy. Please note that the room temperature is not controlled by any air conditioning.

Laser dicing specifications are the following:

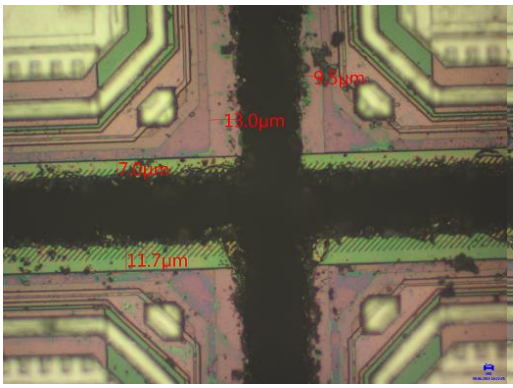
Accuracy: +/- 5 µm
Repeatability: +/- 1 µm



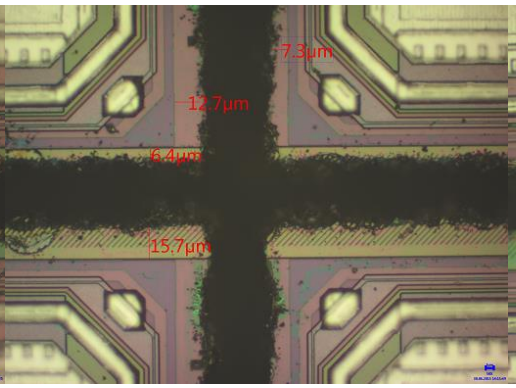
PICTURE 24: Laser dicing specification



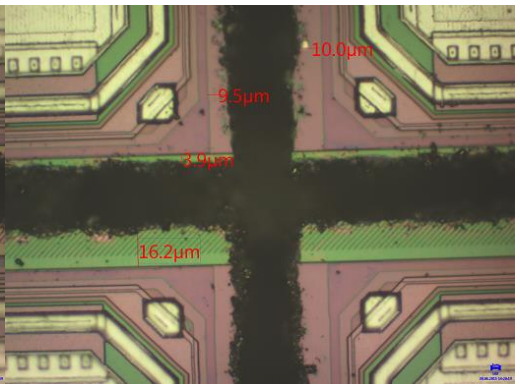
PICTURE 25: Upper part



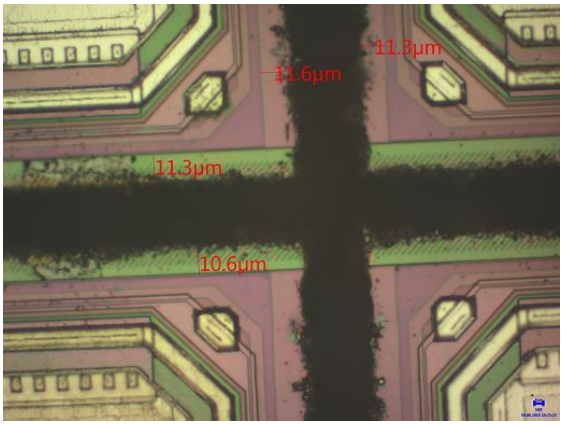
PICTURE 26: Left section



PICTURE 27: Center



PICTURE 28: Right section



PICTURE 29: Bottom part

Conclusion:

The dicing of a silicon wafer shows that the accuracy of the cut is >5 µm (~6-7 µm) for the upper and the right sections. This could be explained by the fact that the machine is located in a room where there is no air conditioning.

CONCLUSION

The cutting of alumina coated with gold and the dicing of GaAs wafers was investigated on SYNOVA LDS 300 M. 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 and cooling the edges, advantages that are essential for cutting with high quality.

These tests show that:

Sample A

- Very good cutting quality is achievable
- The delamination of the gold coating is minimal
- No chipping and no cracks have been observed
- Some discoloration is visible on the frontside for the thicker sample.

Sample B

The cutting quality is very good and similar as obtained in 2013. Nevertheless some deposition is visible near the cut.

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