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APPLICATION REPORT

Report No: 123-4
Sample No: 2.2.1077

CONFIDENTIAL

REPORT: Synthetic Monocrystalline Diamond Cutting by Laser-MicroJet®

for Anonymous

by Michael Pavius; Synova SA

TASK

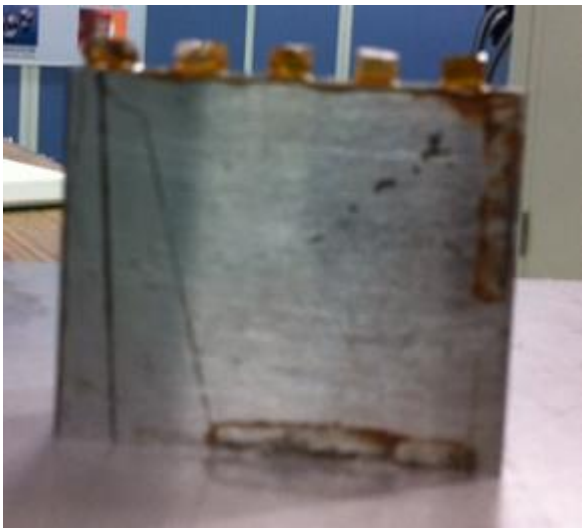
The Laser-MicroJet® technology has been tested for cutting of synthetic monocrystalline diamond.

2 different kinds of samples were provided:
- On sample 1, the goal was to cut 2 mm thick slices
- On sample 2, the goal was to cut 1 mm squares and 0.6 and 0.8 mm wide stripes

SAMPLE DESCRIPTION AND PREPARATION

SAMPLE 1	Material	Synthetic monocrystalline diamond
	Thickness	3800-6000 *µm*
	Quantity	5 *pcs*

Release of application report			
Project Leader		Responsible Application Group	
Name:	Michael Pavius	Name:	Dr Benjamin Carron
Date:	14.03.12	Date:	15.03.12
Visum:		Visum:	



SAMPLE 2	Material	Synthetic monocrystalline diamond
	Thickness	800 *µm*
	Quantity	36 *pcs*

PROCESS: INSTRUMENT & TEST PARAMETERS

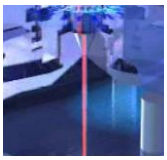
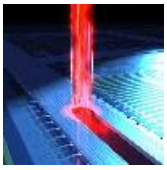
For these experiments, the LCS150 equipped with a frequency-doubled Q-switched Nd:YAG laser has been used as the machine configuration in our lab.

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
- No chipping on front side, minimal chipping on backside
- Negligible heat damage to the material
- Parallel and smooth cut walls

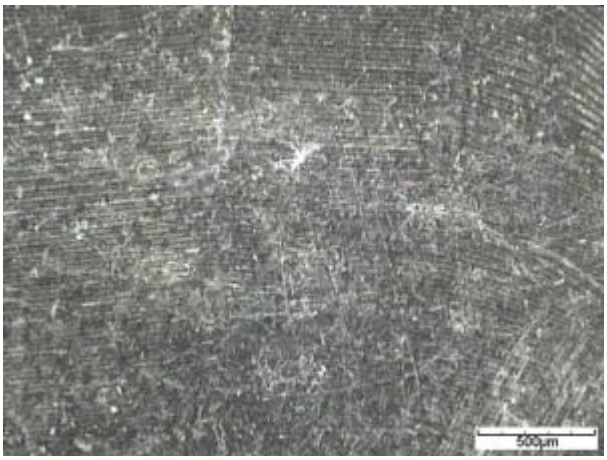
In the table below, the optimised processing parameters used in the experiments are summarised:

	**SYSTEM**	Machine type	LCS150
	**MICROJET® PARAMETER**	Nozzle diameter	50 *µm*
		MicroJet® diameter	42 *µm*
		Water pressure	300 *bar*
		Assist gas	He
	**LASER PARAMETER**	Laser type	L51G
		Wavelength	532 *nm*
		Pulse frequency	6 *kHz*
		Average power	30 *W*
		Pulse width	~125 *ns*
	**CUTTING PARAMETER**	Scanning speed	5 *mm/s*
		Time	
		Sample 1	5-10 *min*
		Sample 2 (square)	<1 *min*
		Fixture	
		Sample 1	waxed
		Sample 2	glued

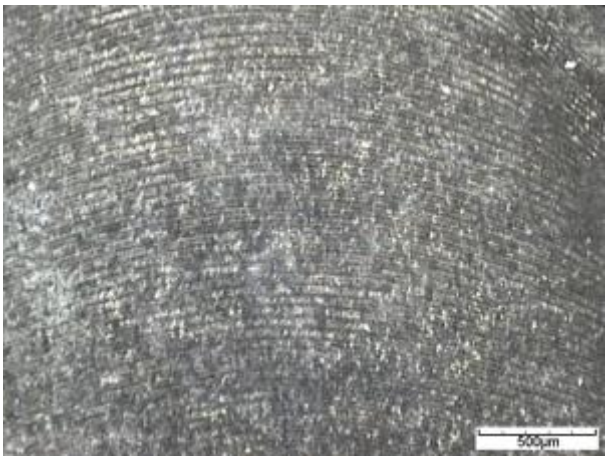
RESULTS

SAMPLE 1

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



PICTURE 1: Microscope image of cut diamond (dark field illumination; cross section view)

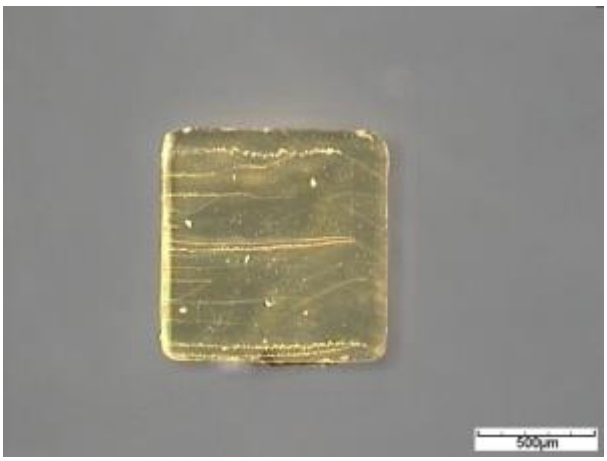


PICTURE 2: Microscope image of cut diamond (dark field illumination; cross section view)

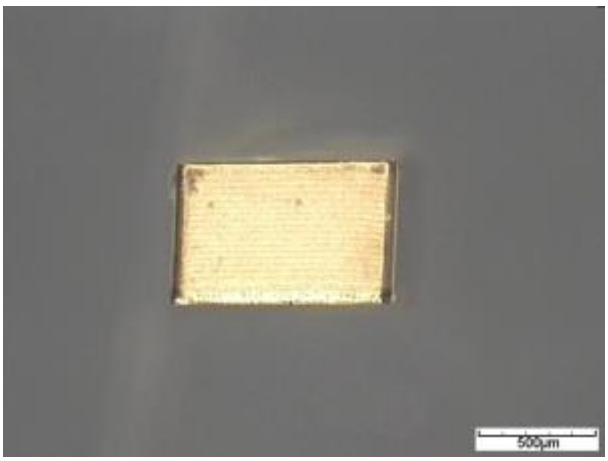
The quality of the cuts is very high (neither chipping nor cracks) and the sidewall is very smooth.

SAMPLE 2

We were only able to cut some 1 mm squares.
Indeed the glue used for sample 2 is not strong enough which resulted in movement of the samples during the cut of the stripes.
The following microscope pictures give an overview on the quality obtained with the Laser-Microjet® technology.



PICTURE 3: Microscope image of cut diamond (dark field illumination; frontside view)



PICTURE 4: Microscope image of cut diamond (dark field illumination; cross section view)

Again, the quality of the cuts is very high (neither chipping nor cracks) and the sidewall is very smooth.

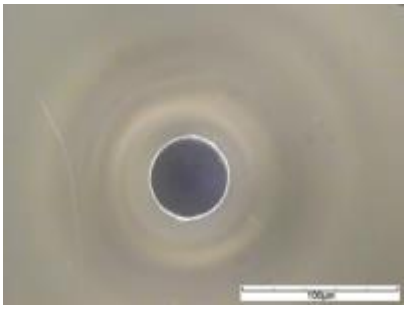
	Customer's requirements	Results obtained
• Depth control:	Must cut through	Samples were cut through
• Edge Roughness:	Sidewall as smooth as possible	Very smooth. Though it is not possible to measure roughness

CONCLUSION

The cutting of synthetic monocrystalline diamond was investigated on SYNOVA LCS150. 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 cutting diamond with high quality.

Our results are:

- We successfully cut 2 mm thick slices from 3.8 to 6 mm thick synthetic monocrystalline diamonds (sample 1)
- We successfully cut 1 mm square out of 0.8 mm thick synthetic monocrystalline diamonds (sample 2)
- The quality of the cuts is very high and the sidewall is very smooth for both samples.
- The nozzle used for those tests was still in excellent shape (see picture below).



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