REPORT: Cutting of machining tools by Laser-MicroJet®

For Anonymous

by Synova SA, Mr. Florent Bruckert

1. TASK

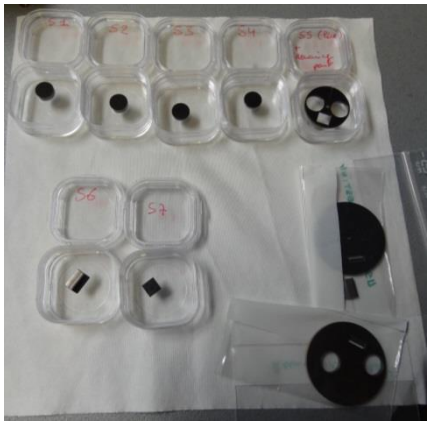
This application aimed at cutting 2 different substrates of PCD/WC with the Laser-MicroJet® technology.

The main purposes were to:

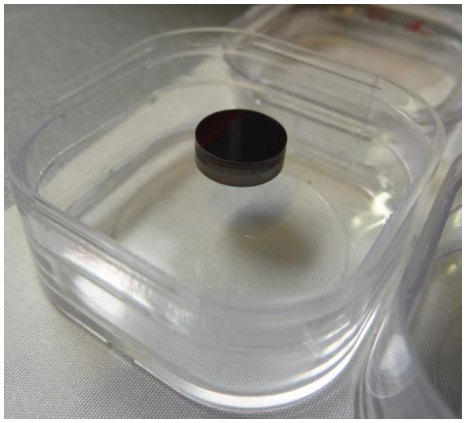
- Cut 10mm diameter disks in the two thicknesses
- Cut a parallelepiped rectangle with a clearance angle of 45°
- Cut the 2.0mm thick substrate in 1 pass.

2. TASK DESCRIPTION

Supplied Material	Thickness	Quantity
PCD / WC	2.0 mm	4
PCD / WC	3.2 mm	3

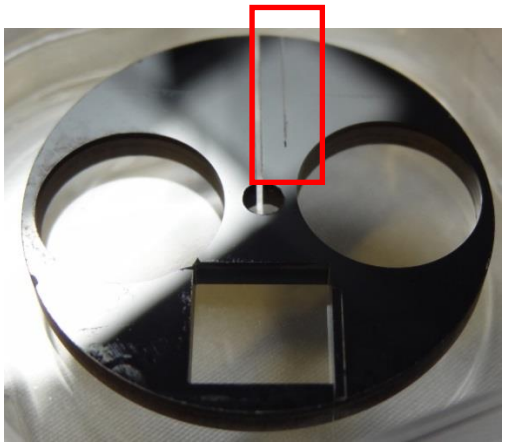


PICTURE 1: Macroscopic picture of the cut parts

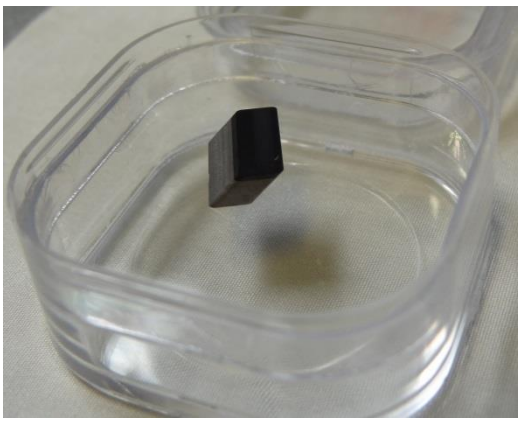


PICTURE 2: Picture of the sample S1

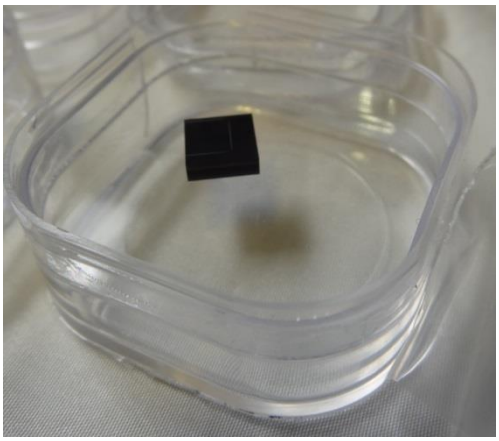
Release of application report			
Project Leader		Industry BU Responsible	
Name:	Mr Florent Bruckert	Name:	Dr Carron Benjamin
Date:	10.06.2014	Date:	
Visum:	FBR	Visum:	



PICTURE 3: Picture of the sample S5 (straight line)



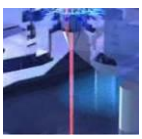
PICTURE 4: Picture of the sample S6



PICTURE 5: Picture of the sample S7

3. PROCESS: INSTRUMENT & TEST PARAMETERS

For this application, the LCS150, equipped with a frequency doubled, Q-switched, Nd:YAG laser, has been selected as the best machine configuration available in the lab. In the table below, the optimised processing parameters used in the experiments are summarised:

	**SYSTEM**	Machine type	LCS150	
		Fixture	Clamped	
	**MICROJET® PARAMETER**	Nozzle diameter	40	*µm*
		Water pressure	400	*bar*
		Working distance	11	*mm*
		Assist gas	He	
	**LASER PARAMETERS**	Laser type	L51G	
		Wavelength	532	*nm*

In order to optimize the cutting quality and the cutting speed, two sets of cutting parameters have been tested. They are summarized in the table below:

Set	Frequency [kHz]	Power (intern) [W]	Power (in the water jet) [W]	Pulse duration [ns]
P1	6	26	9.1	120
P2	6	28	9.8	120

TABLE 1: Sets of cutting parameter used

In the table below are shown the set of parameters used and the related processing parameters:

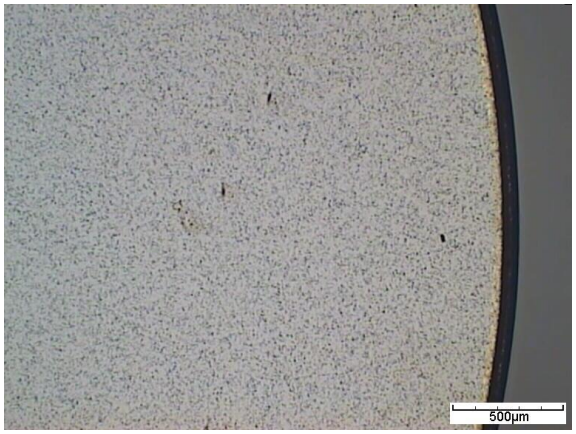
Sample Ref.	Parameter set	Material Thickness [mm]	Description	Motion speed [mm/s]	Number of passes	Process time [min-sec]	Effective cutting speed [mm/min]	Pic. Ref.
S1	P1	3.2	10mm Ø disk	10	379	20 min	1.57	2-6-7
S2	P2				351	18min30s	1.70	8-9
S3	P1	2.0			230	12min10s	2.58	10-11
S4	P2				231	12min07s	2.59	12
S5			Straight line	0.02	1	7min45s	1.20	3-13
S6		3.2	Rectangle: 3X10mm^2 angle=45°	10	700	29min	1.03	4-14 15-16
S7		2.0	Square: 5X5mm^2 0.1µm radius	0.015	1	30min	0.90	5-17

TABLE 2: Description of the processed samples

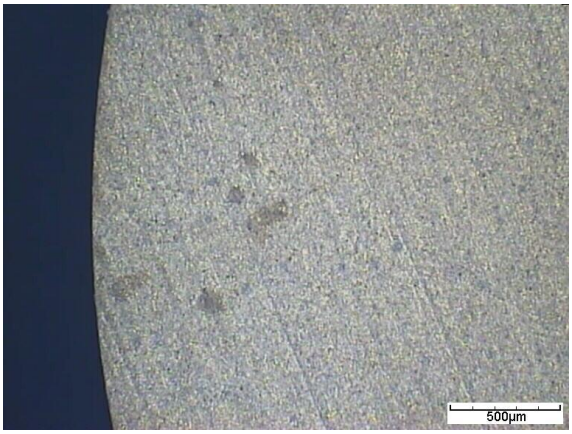
4. RESULTS

Picture 1, 2, 3, 4 and 5 show a macroscopic view of the processed samples.

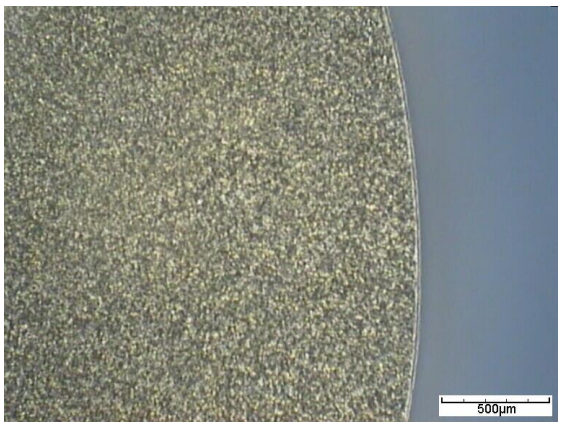
The following pictures show a microscopic view of the cut samples:



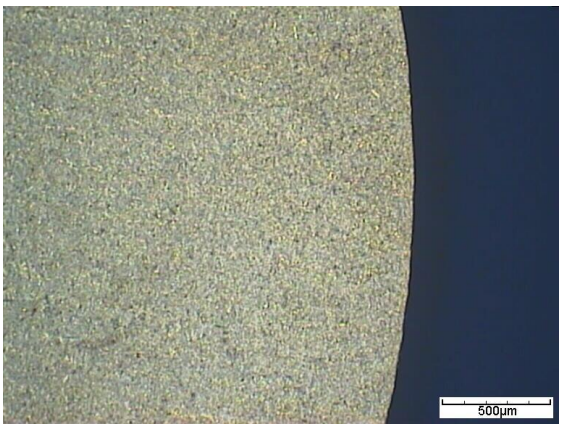
PICTURE 6: PCD/WC 3.2mm, set P1, front side view of S1



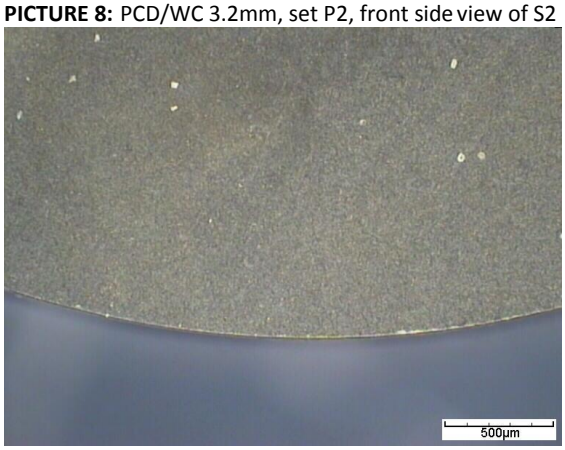
PICTURE 7: PCD/WC 3.2mm, set P1, back side view of S1



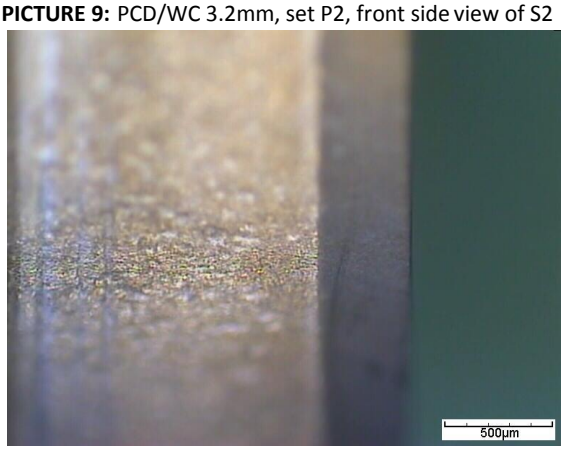
PICTURE 8: PCD/WC 3.2mm, set P2, front side view of S2



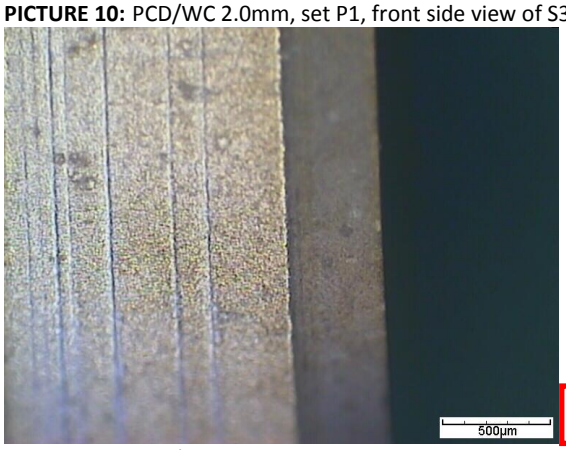
PICTURE 9: PCD/WC 3.2mm, set P2, front side view of S2



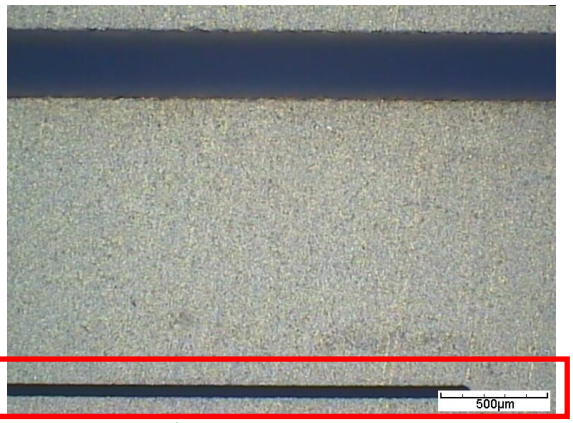
PICTURE 10: PCD/WC 2.0mm, set P1, front side view of S3



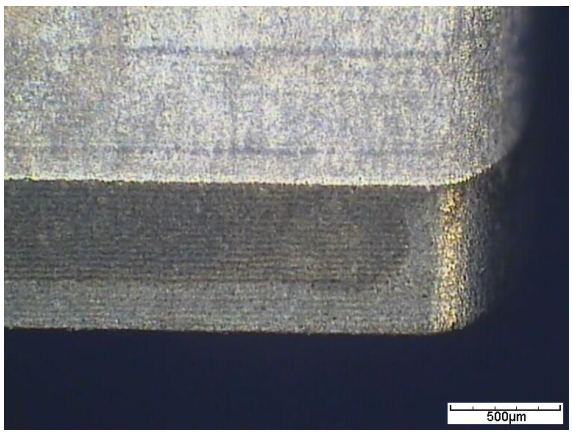
PICTURE 11: PCD/WC 2.0mm, set P1, edge side view of S3



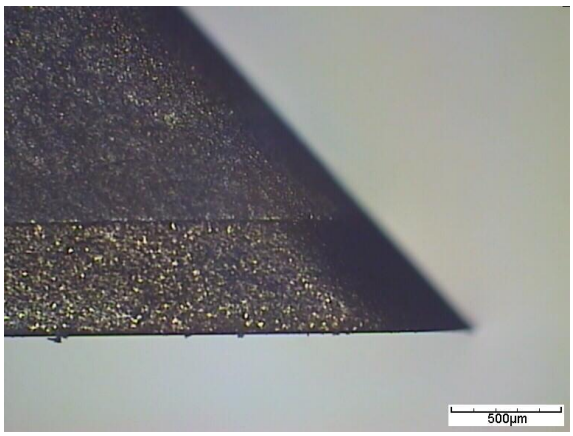
PICTURE 12: PCD/WC 2.0mm, set P2, edge side view of S4



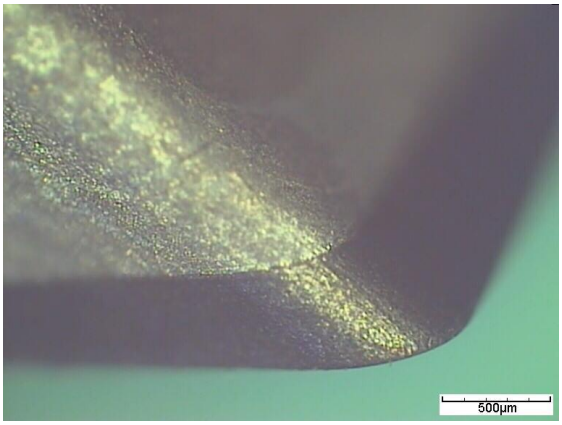
PICTURE 13: PCD/WC 2.0mm, set P2, back side view of S5
Top: cut by EDM, bottom: cut by LMJ



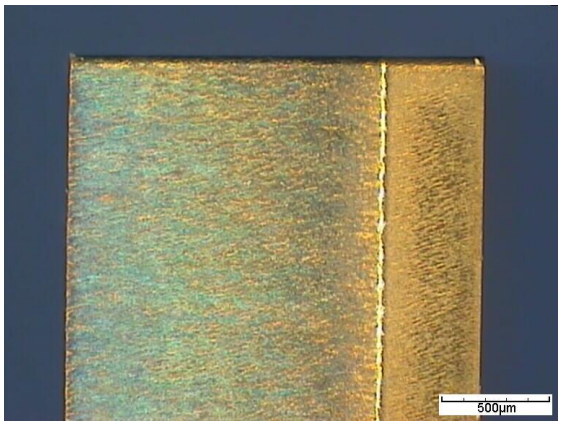
PICTURE 14: PCD/WC 3.2mm, set P2, edge side view of S6



PICTURE 15: PCD/WC 3.2mm, set P2, edge side view of S6



PICTURE 16: PCD/WC 3.2mm, set P2, edge view of S6



PICTURE 17: PCD/WC 2.0mm, set P2, edge side view of S7

Note 1: On Picture 6, we can note a defect at the top surface of the sample. The laser beam coupled in the water jet has followed the pattern but the part was already cut. It has resulted in a shift at the end of the cut. This problem can be solved by changing of fixture (waxing for example).

Note 2: The picture 12 shows some lines at the edge on the WC substrate. The cause is not clear in this case. Nevertheless, there is no doubt that this problem can be solvable with further developments.

5. CONCLUSION

The cutting of machining tools has been performed with a SYNOVA LCS 300. 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 processing machining tools with high quality.
These tests show that:

- The use of a 40µm nozzle brings an excellent cutting quality in terms of roughness and top/bottom angles.
- It is possible to cut with a clearance angle of 45°.
- A mono-pass strategy can be used on a 2.0mm PCD/WC substrate but the cutting speed has to be decreased compared to a multi-pass strategy.

We are open to further discuss your needs regarding:

- The edge roughness homogeneity.
- The cutting speed.

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.