# REPORT: TS-PCD cutting by Laser MicroJet®

*for attention of* Anonymous

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## TASK

The Laser MicroJet® technology has been tested on TS-PCD materials. The goal of this new iteration is to cut 6 samples of TSDC-1 and TSDC-2 samples for wear tests.

## SAMPLE DESCRIPTION AND PREPARATION

| | | |
|---|---|---|
| **SAMPLE 1: TSDC-1** | Material | TS-PCD |
| | Wall thickness | 3.5 *mm* |
| | Quantity | 20 *pcs* |

| | | |
|---|---|---|
| **SAMPLE 2: TSDC-2** | Material | TS-PCD |
| | Wall thickness | 5 *mm* |
| | Quantity | 20 *pcs* |

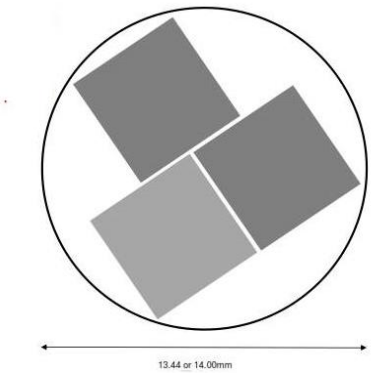



**FIGURE 1:** Illustration of the samples TSDC-1 and TSDC-2

Note: The samples were waxed on a ceramic plate and hold up with clamps.

| Release of application report | | | |
|---|---|---|---|
| Project Leader | | Responsible Application Group | |
| Name: | Stephane Delahaye | Name: | Benjamin Carron |
| Date: | 24.06.2014 | Date: | 24.06.2014 |
| Visum: | SDE | Visum: | BC |
| | | | |

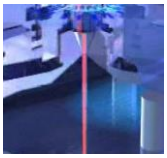
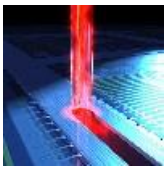
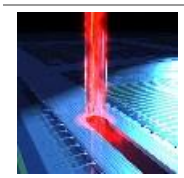
## PROCESS: INSTRUMENT & TEST PARAMETERS

For these experiments, an LCS 150 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 machine, allowing cutting and drilling any kind of materials.

Major advantages of the Laser MicroJet® technology with regards to your application are:

- Cutting of non-conductive materials
- Advantageous process rates
- Cutting of arbitrary shapes
- Low heat damage to the material

In the table below, the optimized processing parameters used in the experiments are summarized. Please note that the laser has one cavity, the process time could be reduced with the use of a double cavity laser.

| | | | |
|---|---|---|---|
|  | **SYSTEM** | Machine type | LCS150 |
|  | **MICROJET PARAMETERS** | Nozzle diameter | 40/50 *µm* |
| | | MicroJet diameter | ~32/40 *µm* |
| | | Water pressure | 400 *bar* |
| | | Assist gas | He (0.9 *L/min*) |
|  | **LASER PARAMETERS** | Laser type | L51G |
| | | Wavelength | 532 *nm* |
| | | Frequency | 6 *kHz* |
| | | Pulse width | 120 *ns* |
| | | Power | 30 (40 *µm nozzle*) *W*<br>33 (50 *µm nozzle*) |
| | | Power in jet | ~13(40 *µm nozzle*) *W*<br>~15(50 *µm nozzle*) |
|  | **CUTTING PARAMETERS Sample 1** | Working distance | 12 *mm* |
| | | Motion speed | 10 *mm/s* |
| | | Pass numbers | 500 |
| | | Process speed | 1.2 *mm/min* |
|  | **CUTTING PARAMETERS Sample 2** | Working distance | 12 *mm* |
| | | Motion speed | 10 *mm/s* |
| | | Pass numbers | 600 |
| | | Process speed | 1 *mm/min* |

## RESULTS

Different strategies were used to process the geometry. Indeed as we noticed some bridges on the sample backside for strategy 1 an optimization has been performed (strategy 2) to successfully cut your samples.

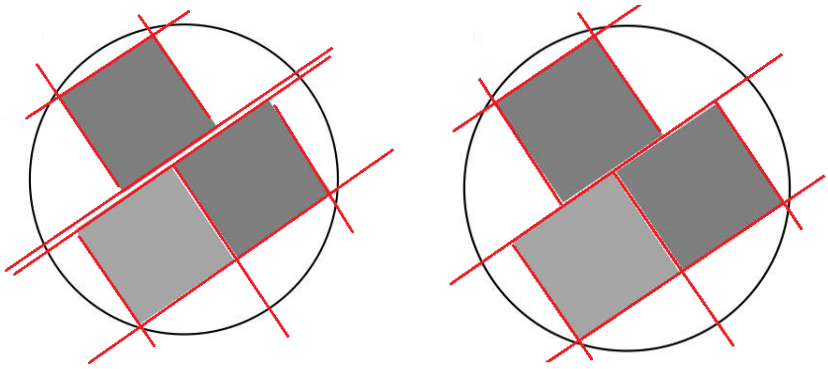
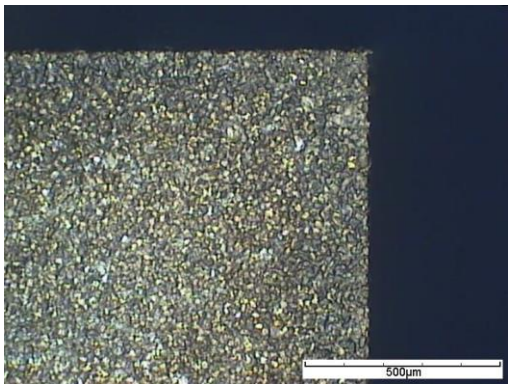


**FIGURE 2:** Strategy 1(with 40 and 50 $\mu m$ nozzle) and 2 (only with 50 $\mu m$ nozzle)

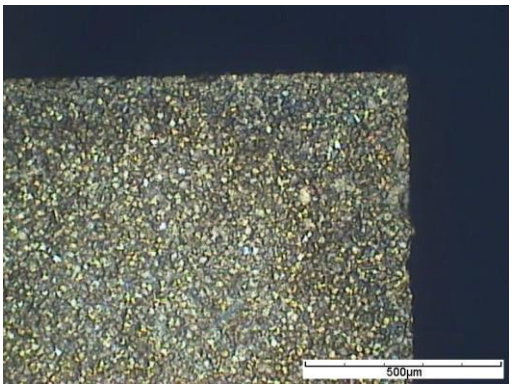
**PICTURE 1:** Digital camera picture of the samples

### 1. 3.5 mm thick samples

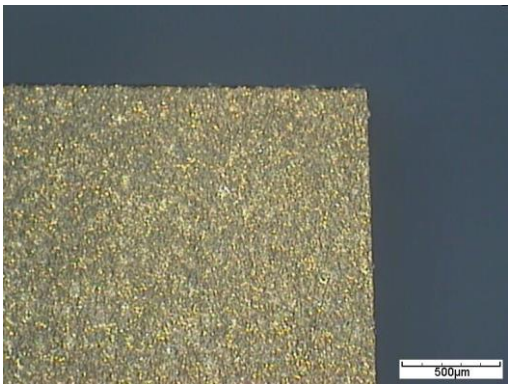
**Strategy 1: sample 1,2,3,4 (40 µm nozzle)**




**PICTURE 2:** Microscope image of the frontside (dark field illumination)

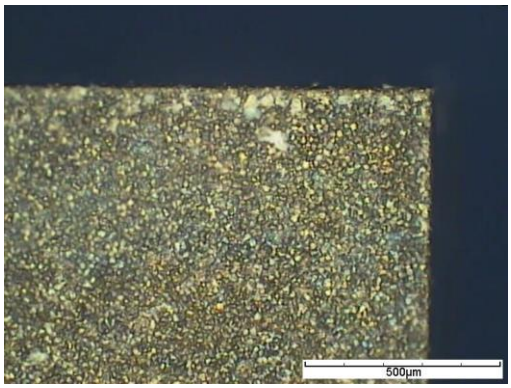



**PICTURE 3:** Microscope image of the backside (dark field illumination)

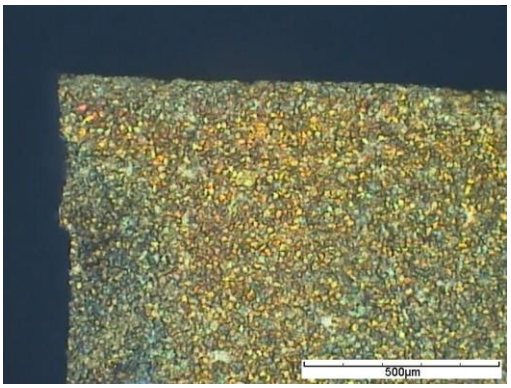



**PICTURE 4:** Microscope image of the sidewall (dark field illumination)

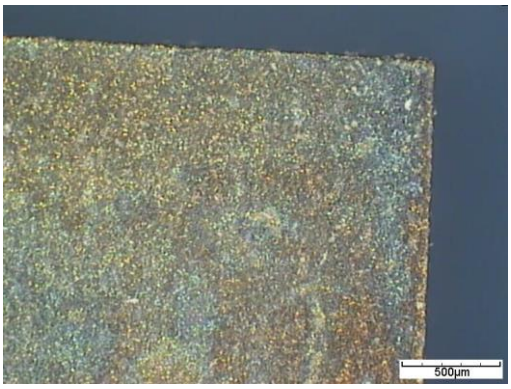
## Strategy 1: sample 5 (50 µm nozzle)




**PICTURE 5:** Microscope image of the frontside (dark field illumination)

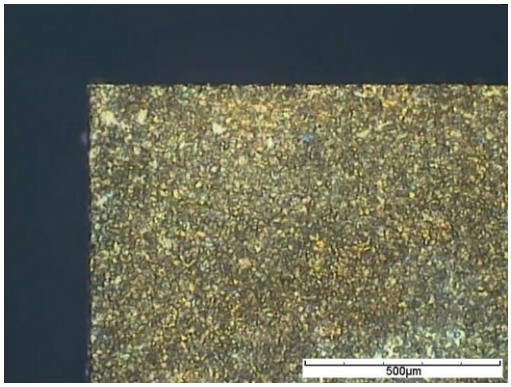



**PICTURE 6:** Microscope image of the backside (dark field illumination)

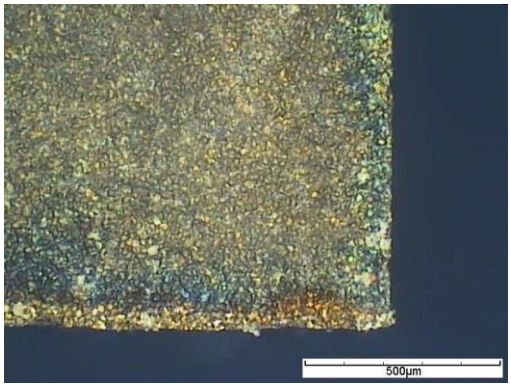



**PICTURE 7:** Microscope image of the sidewall (dark field illumination)

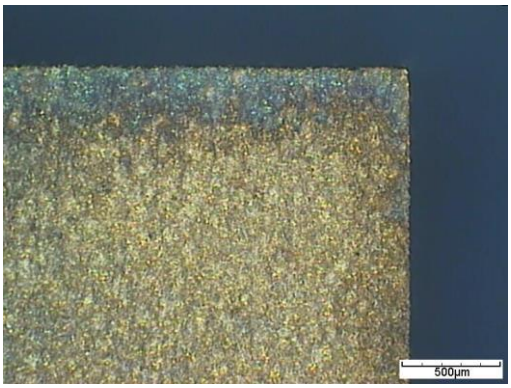
**Strategy 2: sample 6 (50 µm nozzle)**




**PICTURE 8:** Microscope image of the frontside (dark field illumination)




**PICTURE 9:** Microscope image of the backside (dark field illumination)

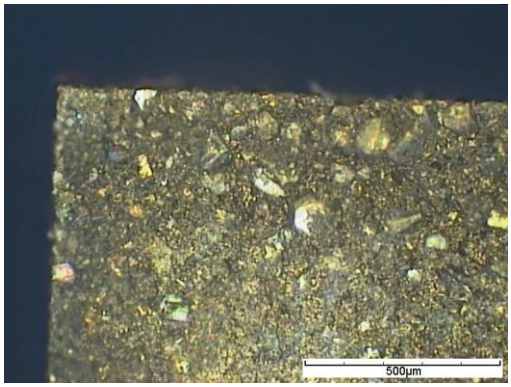



**PICTURE 10:** Microscope image of the sidewall (dark field illumination)

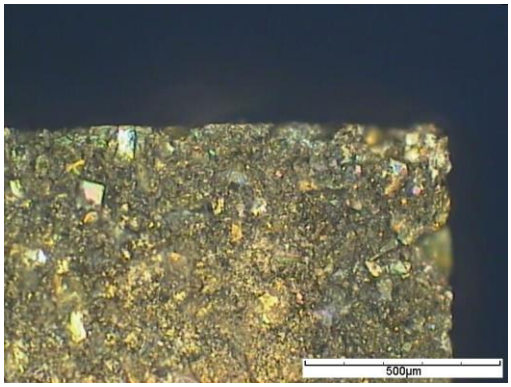
## 2. 5mm thick samples

As strategy 2 combined with a 50 µm nozzle shows good results this configuration has been used for the thicker samples.

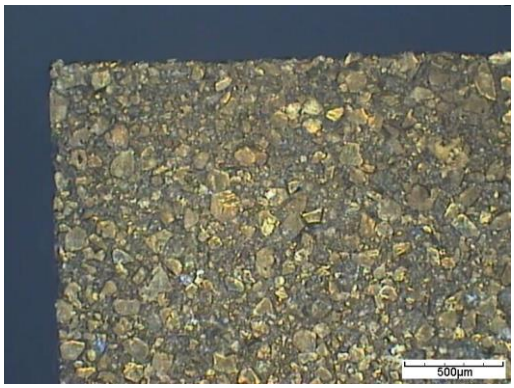
**Strategy 2: sample 9, 10 (50 µm nozzle)**




**PICTURE 11:** Microscope image of the frontside (dark field illumination)




**PICTURE 12:** Microscope image of the backside (dark field illumination)




**PICTURE 13:** Microscope image of the sidewall (dark field illumination)

Please note that one sample shows some chipping on the frontside because the sample moved during the cut.

## CONCLUSION

Cutting TS-PCD squares was investigated on a Synova LCS 150. This machine is based on the Laser MicroJet® technology and combines the advantages of a 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 and grooving hard materials with high quality.

This test shows that:

- Very good cutting quality is achievable for both types of samples.
- Frontside quality: 3.5 mm thick samples show no chipping while some minor chipping can be visible on 5mm thick samples due to the size of the grain.
- Backside quality: minor chipping is visible for both samples. It should be interesting to make some comparison with another fixing solution.
- Strategy, nozzle size and number of passes have been modified in order to avoid any bridges on the sample backside. We successfully demonstrate that strategy 2 combined with a 50 µm nozzle shows very good repeatability.
- Cutting speed can be optimised by using a double cavity green laser but cutting quality may suffer.

We thank you for your interest in our technology. We will contact you soon to receive your feedback and the analysis of these results and to discuss the further steps.