REPORT: Carbon-fiber composite cutting by Laser-MicroJet®

for Anonymous

by Mr Stephane Delahaye; Synova SA

TASK

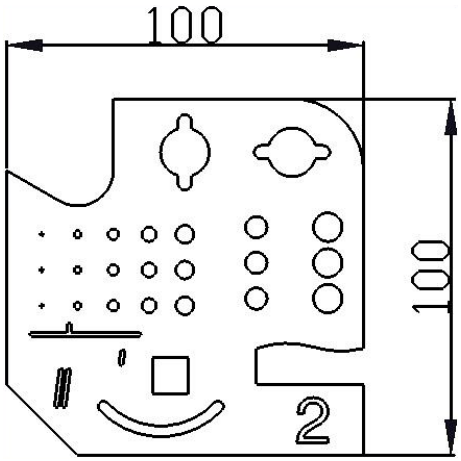
The Laser-MicroJet® technology has been tested for the cutting of carbon-fiber composite. The main focus of these first tests was to check the feasibility of the process.

SAMPLE DESCRIPTION AND PREPARATION

2 different carbon-fiber composites were available for the tests.

SAMPLE A	Material	CARBONNE THERMOPLASTIQUE PPS
	Dimension	~97*103 *mm*
	Thickness	~2850 *µm*
	Quantity	1 *pcs*
SAMPLE B	Material	CARBONE EPOXY
	Dimension	~115*180 (with holes) *mm*
	Thickness	~1100 *µm*
	Quantity	1 *pcs*

Release of application report			
	Project Leader		Responsible Application Group
Name:	Stephane Delahaye	Name:	Dr Benjamin Carron
Date:	14.05.2012	Date:	14.05.2012
Visum:	SD	Visum:	BC



PICTURE 1: Drawing used for the tests

The plates were fixed with clamps.

Note: Size of the drawing was reduced by 40% as the samples provided by the client were too small.

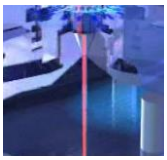
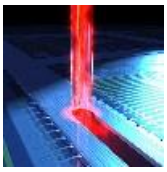
PROCESS: INSTRUMENT & TEST PARAMETERS

For these experiments, the 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 to cut, drill, groove, scribe, trench, mark, or grind a wide range of materials.

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

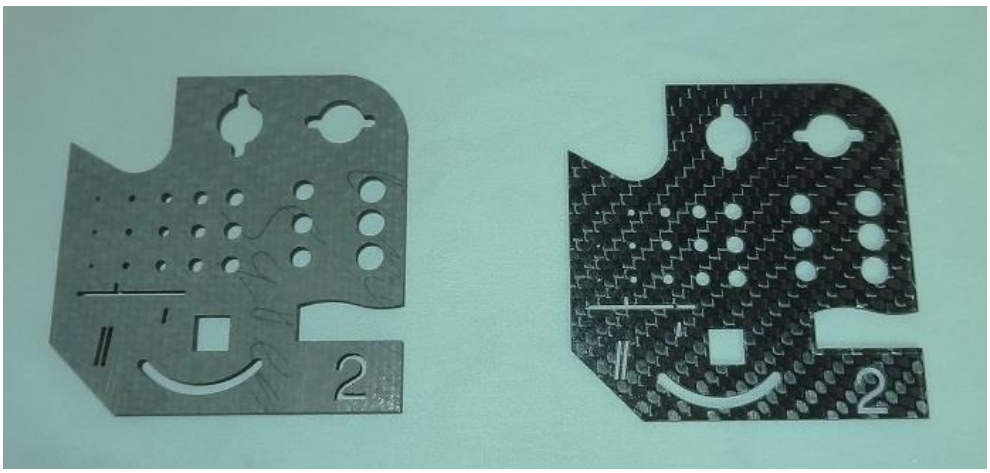
- Cutting of arbitrary shapes
- Negligible heat damage to the material
- Parallel and smooth cut walls
- Advantageous process rates
- Minor delamination of the surface

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

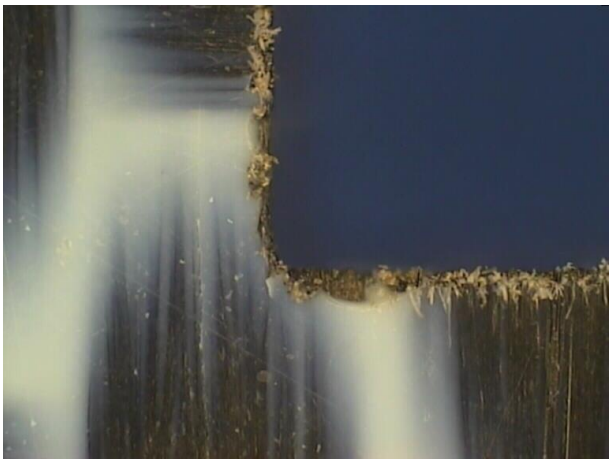
	**MICROJET® PARAMETER**	Nozzle diameter	60 *µm*
		MicroJet® diameter	~48 *µm*
		Water pressure	300 *bar*
		Assist gas	He
	**LASER PARAMETER**	Laser type	L101G
		Wavelength	532 *nm*
		Pulse frequency	14 *kHz*
		Average power	~50 *W*
	**CUTTING PARAMETER**	Cutting speed	100 *mm/s*
		Number of passes	Sample A: ~120 Sample B: ~80
		Overall speed	Sample A: ~50 *mm/min* Sample B: ~75
		Fixing system	clamps

RESULTS

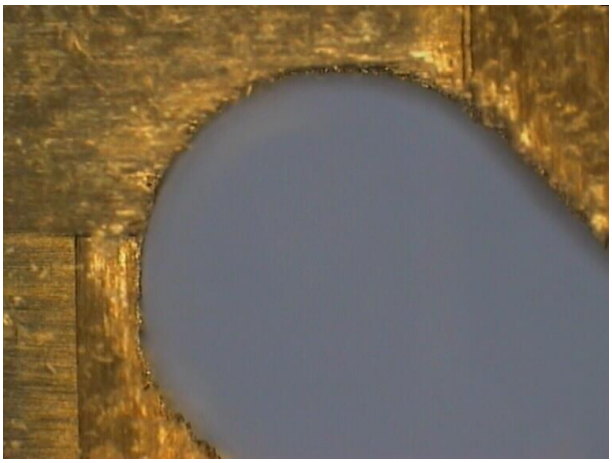
The following microscope picture give an overview on the quality obtained with the Laser-Microjet® technology.



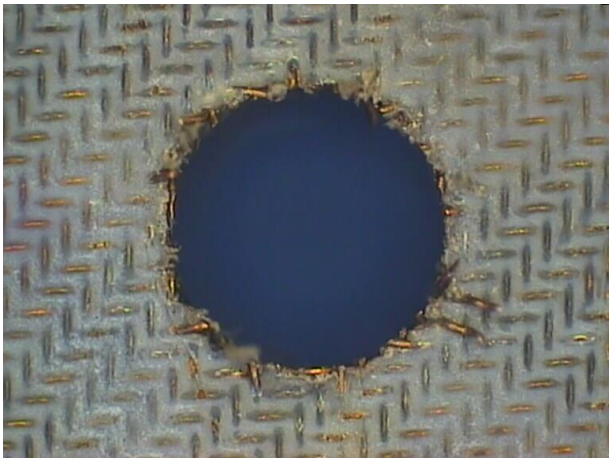
PICTURE 2: Digital camera pictures of the 2 samples



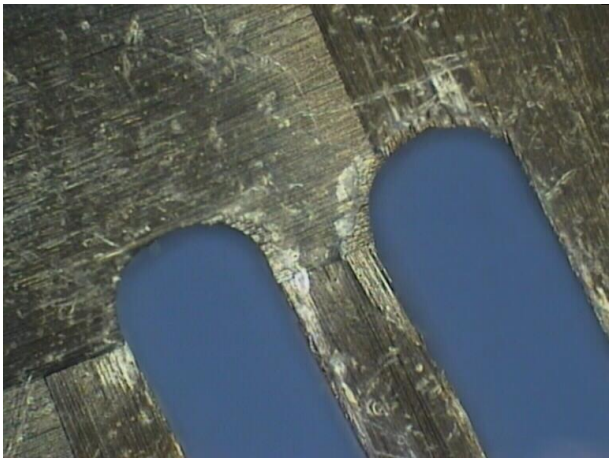
PICTURE 3: frontside of sample A
(dark field illumination)



PICTURE 4: frontside of sample B
(dark field illumination)

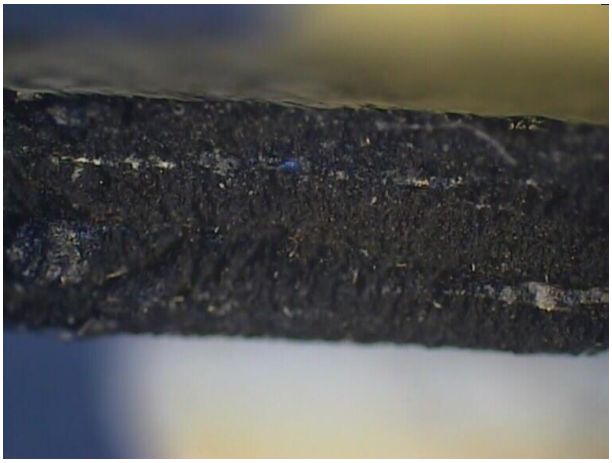


PICTURE 5: backside of sample A
(dark-field illumination



PICTURE 6: backside of sample B
(dark-field illumination)

PICTURE 7: cut wall of sample A
(dark-field illumination)



PICTURE 8: cut wall of sample B
(dark-field illumination)

The table below summarized Anonymous expectations and our results:

	What are your priorities? (please put a cross)	Quantified expectations or improvements
Speed / throughput:	1m/min minimum	Up to ~75mm/min depending on the thickness and geometry
Kerf-width:	Minimum	
Burr-free:	No burnt particles	Limited
Heat-damage free:	Do not alterate mecanical properties	Limited heat damage
Edge Roughness:	Defects of +/- 0.03mm	The cut walls seem smooth to the naked eye
Tolerances:	Outer contour + / - 0.1mm Inner parts + / -0.05mm (dimensions et positions)	Can not be checked as the drawing size was reduce but technology can match the requirements
Other:	No delamination	Delamination is visible on sample A and is limited on sample B

CONCLUSION

The cutting of Carbon-fiber composite was investigated on SYNOVA LCS 150. 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 the cutting of Carbon-fiber composite with high quality.

These tests show:

- The feasibility of the process
- Various geometries can be cut and the overall quality is good especially on sample B (carbon epoxy) where delamination is limited.
- Quality can be improved by optimizing speed/ laser beam intensity for each geometry and size.

These first results appear promising and depending on your requirements, we could try in a further step to minimize the delamination and the heat damage, or to increase the cutting speed.

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