REPORT: NiTi bit drilling by Laser-MicroJet®

for Anonymous

by Stephane Delahaye; Synova SA

TASK

The Laser-MicroJet® technology has been tested for drilling bit of NiTi. For this first feasibility test, the processing of these samples has been “optimized” to reduce the heat affected zone

SAMPLE DESCRIPTION AND PREPARATION

SAMPLE	Material	NiTi
	Dimension	~1 *m*
	Thickness	1700 *µm*
	Quantity	1 *pcs*

PROCESS: INSTRUMENT & TEST PARAMETERS

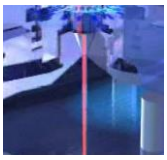
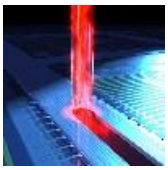
For these experiments, the LCS 300 machine equipped with a dual-cavity frequency-doubled Q-switched Nd: YAG laser and a rotary axis has been used as the machine configuration in our lab. It is a manually loaded machine, allowing cutting and drilling any kind of metal piece.

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

- Cutting of arbitrary shapes
- Low heat damage to the material
- limited slag/burr formation
- Good wall surface quality

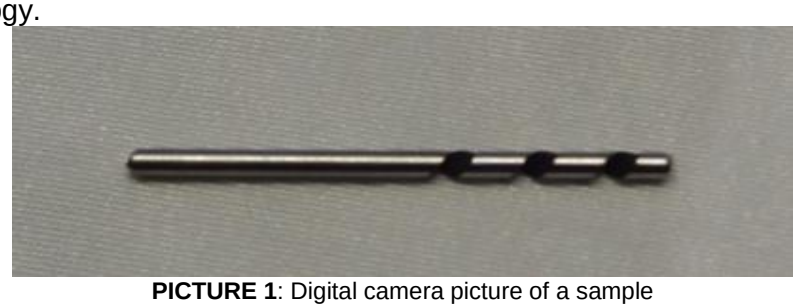
Release of application report			
	Project Leader		Responsible Application Group
Name:	Mr Stephane Delahaye	Name:	Dr Benjamin Carron
Date:	17.02.2014	Date:	17.02.2014
Visum:	SDE	Visum:	BC

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

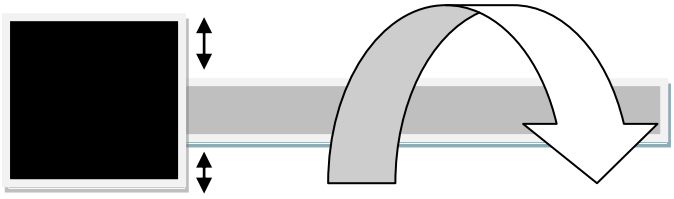
	**SYSTEM**	Machine type	LCS 300
	**MICROJET® PARAMETER**	Nozzle diameter	80 *µm*
		MicroJet® diameter	~64 *µm*
		Water pressure	250 *bar*
		Assist gas	He
	**LASER PARAMETER**	Laser type	L202G
		Wavelength	532 *nm*
		Pulse frequency	See results *kHz*
		Average power	See results *W*
		Pulse width	~150 *ns*
	**CUTTING PARAMETER**	Cutting speed	See results *mm/s*
		Number of passes	1
		Fixing system	clamps

RESULTS

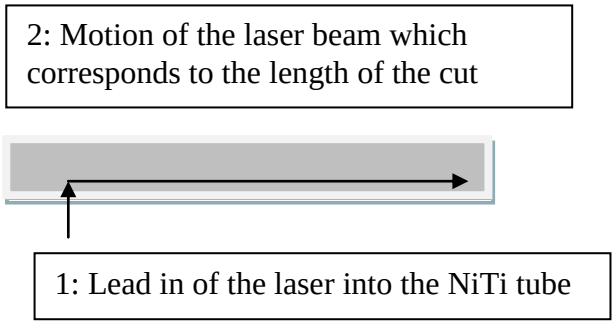
Three different cutting parameters have been used to process the samples.
The following microscope pictures give an overview on the quality obtained with the Laser-Microjet® technology.



PICTURE 1: Digital camera picture of a sample



PICTURE 2: Illustration of the angle of rotation (side view)



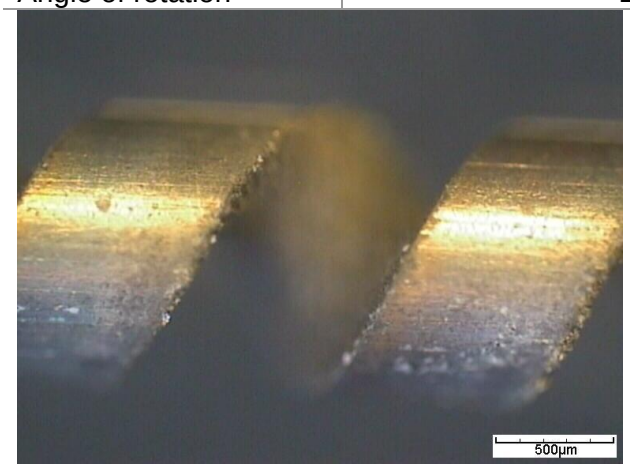
Motion of the laser beam (top view)

Note: sample and rotary axis are not strictly coaxial so the thread of the sample is not symmetric

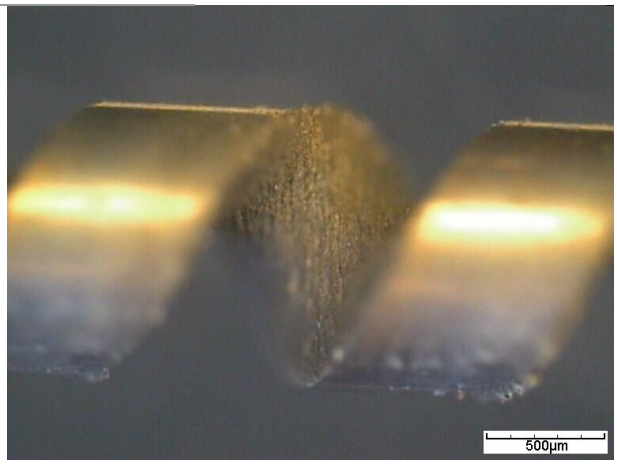
The first sample was performed by using both cavities of the double laser. Some burrs are visible on the frontside.

1. Sample A

Pulse frequency	20 (two cavities)	*kHz*
Average power	76 (38 into the water-jet)	*W*
Cutting speed	0.2	*mm/s*
Length of the cut	10	*mm*
Angle of rotation	2000	°



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

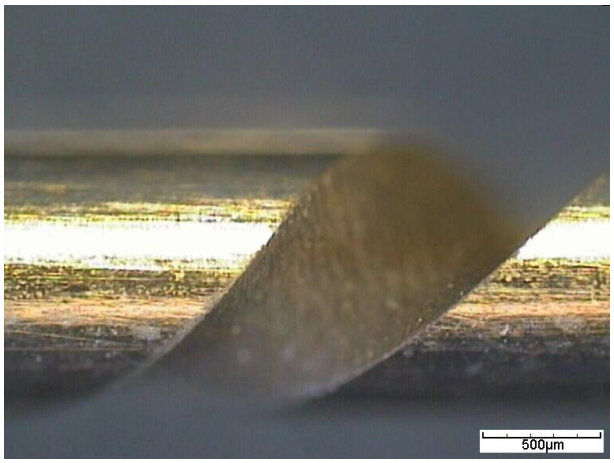


PICTURE 4: Microscope image of the bottom (dark field illumination)

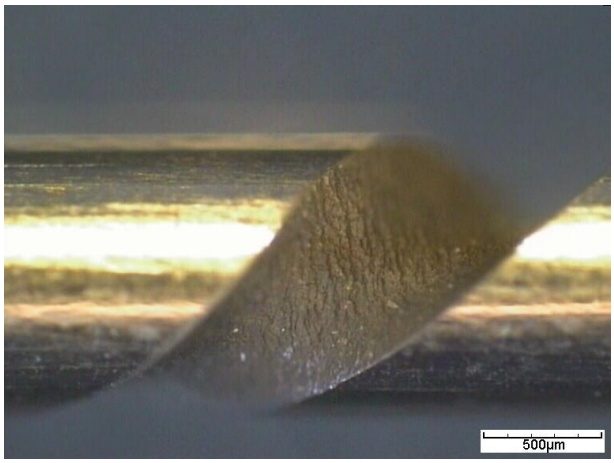
Sample B and C were processed by using only one cavity and a lower average power to improve the frontside quality.

2. Sample B

Pulse frequency	10 (one cavity)	*kHz*
Average power	37 (19 into the water-jet)	*W*
Cutting speed	0.15	*mm/s*
Length the cut	10	*mm*
Angle of rotation	1000	°



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

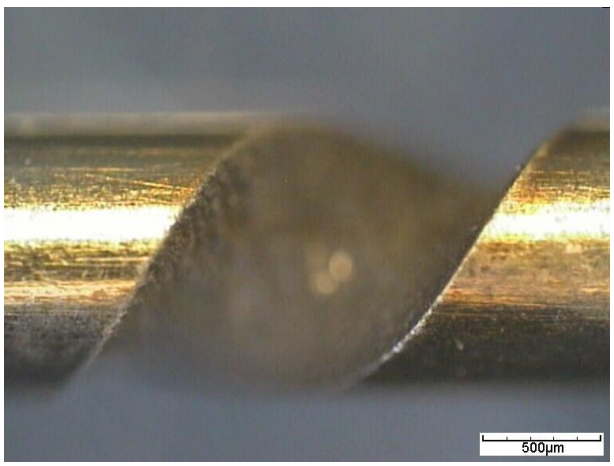


PICTURE 6: Microscope image of the bottom (dark field illumination)

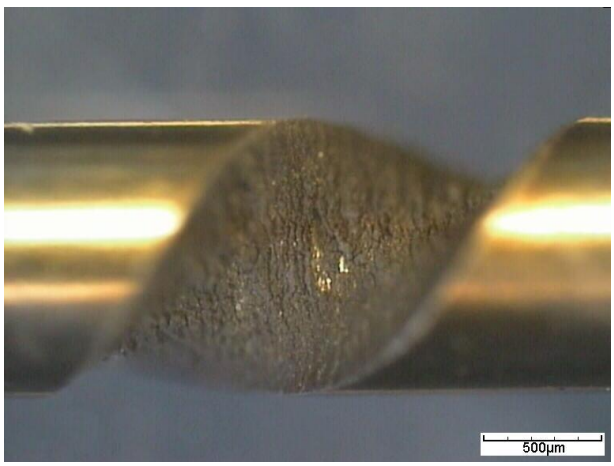
3. Sample C

Five samples have been processed with the same cutting parameters to test the process repeatability.

Pulse frequency	10 (one cavity)	*kHz*
Average power	40 (19 into the water-jet)	*W*
Cutting speed	0.15	*mm/s*
Length of the cut	10	*mm*
Angle of rotation	1000	°



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



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

CONCLUSION

The drilling of NiTi tubes was investigated on SYNOVA LCS 300 machine. 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 NiTi with high quality.

These tests show that:

- Very good frontside quality is achievable by fine tuning laser parameters.
- Some heat affected zone can be visible if the thickness of material which needs to be removed is too important. Indeed more average power is requested because a monopass-strategy is used.
- Dual cavity green laser allows faster cutting speed.
- Thread is not symmetric because the rotary axis and NiTi tube are not coaxial.
- Depth of the thread can be adjusted by changing the lead in position into the material
- Angle of rotation and length of the cut can be used to set the angle and the width of the threads
- Multi-passes strategy has not been successful for the processing of these first samples.

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