REPORT: Stainless tube cutting by Laser-MicroJet®

for Anonymous

by Stephane Delahaye, Synova SA

OBJECTIVE

The Laser-MicroJet® technology has been tested for cutting slots into 250 µm thick stainless steel tubes. Trials were performed on 2 types of machine (LCS 150 and LCS 300) with different laser sources. Various cutting strategies have been performed, including the cutting with a one-pass strategy and a multi-pass strategy.

SAMPLES DESCRIPTION

15 samples were provided in order to carry out this first iteration.

SAMPLE	Material	Steel	
	Thickness	250	µm
	Quantity	15	pce

Release of application report			
Project Leader		Responsible Application Group	
Name:	Stephane Delahaye	Name:	Benjamin Carron
Date:	12.01.2015	Date:	15.01.2015
Visum:	SDE	Visum:	BC

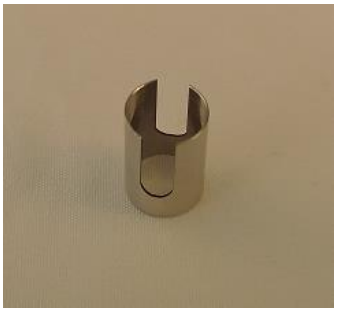

FIGURE 1: Macroscopic view of the final sample.

PROCESS: INSTRUMENT & TEST PARAMETERS

Major advantages of Laser-MicroJet® technology with regards to slots cutting are:

- Advantageous process rates
- Negligible contamination / re-deposition
- Negligible heat damage to the material
- Negligible burrs formation

For these experiments, the LCS 150 and LCS 300 combine with Nd:YAG laser have been selected as the most suitable machine configurations available in the lab.
The table below summarizes the machine configurations used for the experiments:

	**SYSTEM**	Machine type	LCS 150	LCS 300	*µm*
		Fixing system	Clamps	Rotary axis	*µm*
		Water pressure	350	350	*bar*
		Protect gas: Helium	0.9	0.9	*L/min*
		Working distance	12	12	*mm*
	**LASER PARAMETERS**	Laser type	L51G	L202G	
		Wavelength	532	532	*nm*

TABLE 1: machine configurations used for the experiments

THE RESULTS:

Four set of parameters were used for process speed optimization. Samples were fixed around a tube of smaller diameter to keep the roundness of the parts.

1. LCS 150/50W laser: Mono-pass strategy

Parameters	Sample1	Sample2	
Nozzle diameter	40	40	*µm*
Frequency	30	30	*kHz*

Average power	38	42	*W*
Power in the water-jet	~13	~15	*W*
Pulse width	~140	~140	*ns*
Speed	2.2	2.5	*mm/s*
Pass	1	1	
Overall speed	2.2	2.5	*mm/s*
Cutting Time (without loading unloading)	~9s*2 sides=18	~7.5*2 sides=15	*s*

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

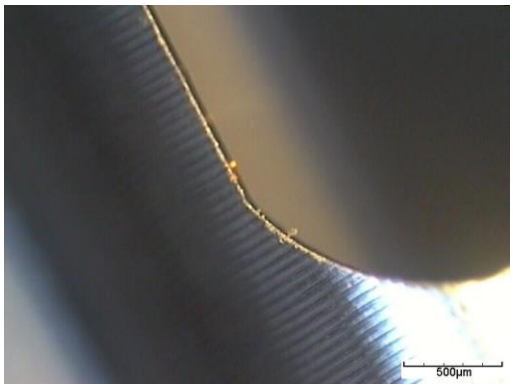

FIGURE 2: frontside view of the slot

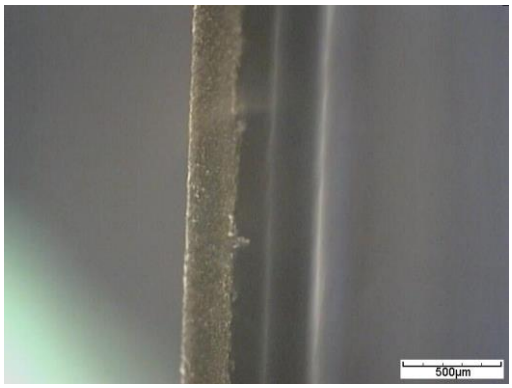

FIGURE 3: Side view of the slot

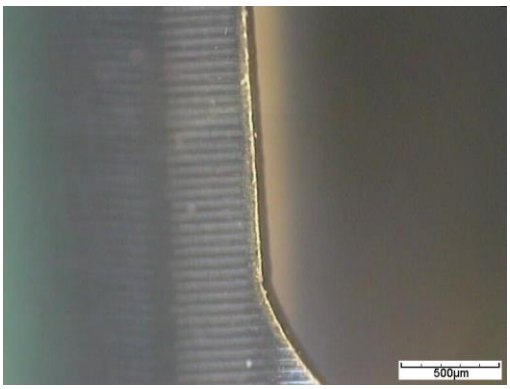

FIGURE 4: frontside view of the slot

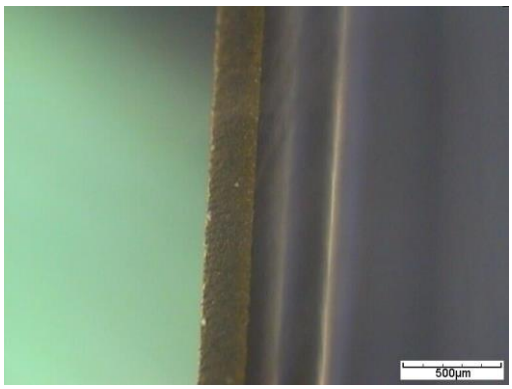

FIGURE 5: Side view of the slot

Note: the rotary axis which is used to turn the sample at 180° was not available on this machine

2. LCS 300/200W laser: Mono-pass strategy

Parameters	Sample3	
Nozzle diameter	60	*µm*
Frequency	28	*kHz*

Average power	40+40	*W*
Power in the water-jet	~52	*W*
Pulse width	~180	*ns*
Speed	3.8	*mm/s*
Pass	1	
Overall speed	3.8	*mm/s*
Cutting Time (without loading unloading)	~5.5*2=10	*s*

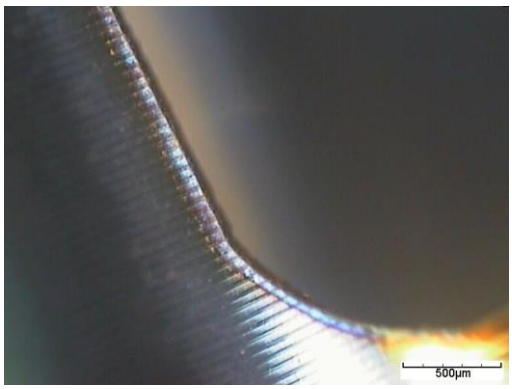

FIGURE 6: frontside view of the slot (more HAZ is visible)

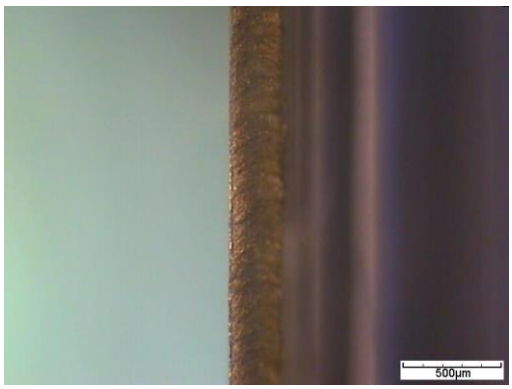

FIGURE 7: Side view of the slot

3. LCS 300/200W laser: Multi-pass strategy

Parameters	Sample3	
Nozzle diameter	40	*µm*
Frequency	28	*kHz*
Average power	40+40	*W*
Power in the water-jet	~52	*W*
Pulse width	~180	*ns*
Speed	11	*mm/s*
Pass	2	
Overall speed	5.5	*mm/s*
Cutting Time (without loading unloading)	~3.5*2=7	*s*

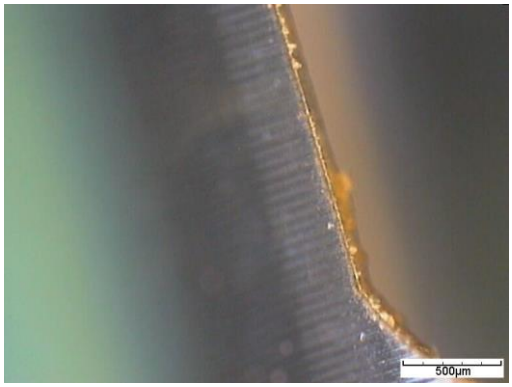

FIGURE 8: frontside view of the slot

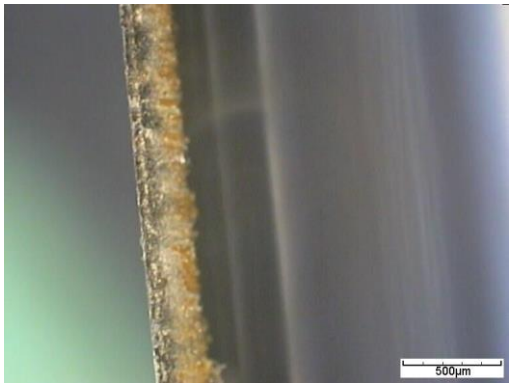

FIGURE 9: Side view of the slot

CONCLUSION

The cutting of stainless tubes was investigated on a SYNOVA LCS 150 and a LCS 300 machines. These machines are based on the MicroJet® technology and combines the advantages of a high energy pulsed fiber 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 particle contamination, advantages that are essential for cutting slots with high quality.

The tests show that:

- Slots can be processed in 250 µm thick steel tubes with overall good cutting quality
- The effective cutting speed can be even superior to 5.5mm/s depending on the cutting quality requirements. Indeed the overall cutting speed can still be slightly improved by increasing the average power but this may have a negative effect on the quality of the cut.
- More samples would be necessary to develop this process further.

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.