REPORT: Friction ring segment cutting by Laser MicroJet ®

for attention of Anonymous

by Ronan Martin, Synova SA

TASK

The Laser MicroJet® technology has been tested for cutting a slot in steel rings with friction material on the inside. While previous tests had already shown that we could achieve a high quality, the aim of these new tests was to increase the cutting speed as much as possible, with a target of 10s or less.

SAMPLE DESCRIPTION

Eight samples were provided, as described below:

STEEL RING	Material	Metal: Friction material:	C35 steel resin, aramid fibers, carbon particles
	Thickness	Metal: Friction material:	1.4 — 2.2 *mm* 0.5 — 0.6 *mm*
	Quantity		8 *pcs.*

It can be noticed that the thickness is not constant.

Release of application report			
Project Leader		Responsible Application Group	
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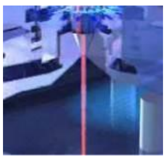
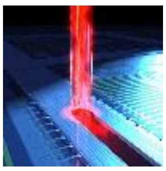
PROCESS: INSTRUMENT & TEST PARAMETERS

For these experiments, an LCS 150 equipped with a dual-cavity frequency-doubled Nd:YAG laser has been used as the machine configuration in our lab. This machine allows cutting most ceramics and any kind of metal.

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

- Low heat damage to the material
- Excellent wall surface quality

The table below summarizes the optimized processing parameters used in the experiments. Two different nozzle diameters were eventually used, leading to very similar results.

	**SYSTEM**	Machine type	LCS 150	
		Optical head type	Compact	
		Fixture	Clamps, with inserted spring to open the ring when cut through	
	**MICROJET® PARAMETERS**	Nozzle diameter	70 *µm*	80 *µm*
		MicroJet® diameter	58 *µm*	66 *µm*
		Water pressure	350 *bar*	
		Assist gas	He: 0.9 *L/min*	
	**LASER PARAMETERS**	Laser type	L202G	
		Wavelength	14 *kHz*	
		Pulse frequency	532 *nm*	
		Internal power	2 x 70 *W*	*2 x 75 W*
		Power in jet	103 *W*	*111 W*
		Pulse width	200 *ns*	180 *ns*
		Inter-pulse delay	300 *ns*	
	**CUTTING PARAMETERS**	Working distance	10 *mm*	
		Motion speed	40 *mm/s*	
		Number of passes	Total passes: 40 Passes to cut through: 30±1	
		Cutting time	Total cutting time: 12 *s* Time at cut through: 9.5 *s*	

We used a spring to prevent the part from closing after being cut through. It also allows seeing when the part is cut through on the videos we made. After careful inspection of these videos, we could count exactly the number of required passes to cut through the ring, and it turns out that we had more margin than we thought when we were running the tests.

After cutting, we cleaned the samples for a couple of minutes in an ultrasonic bath with a standard product, which easily removed all the dirt.

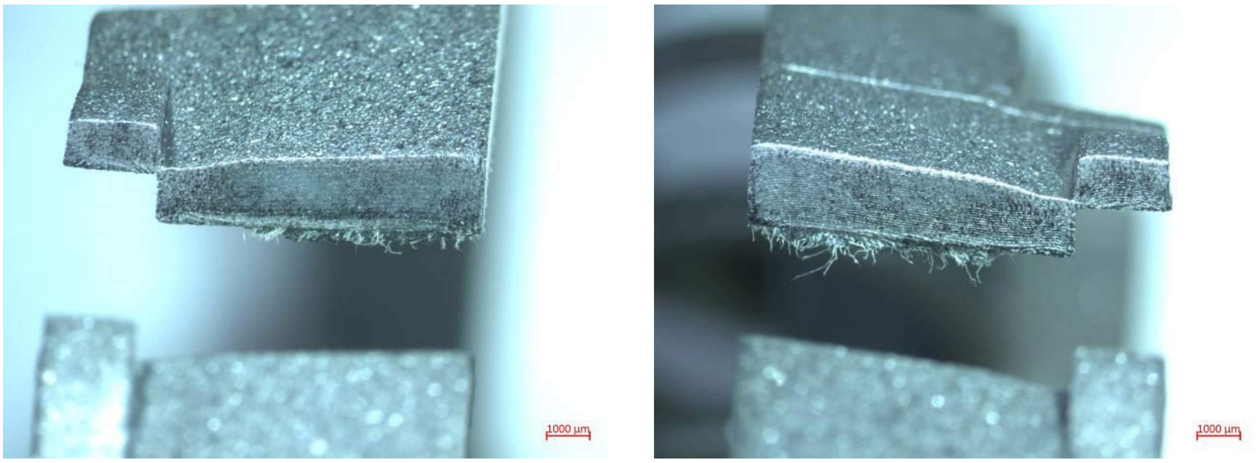
RESULTS

Three of the rings were cut without damage on the cut wall, which could occur with a shift of the part at the end of the cut. This should be solved by the support that you will send us. The first part was cut with a 70µm nozzle, while the others were cut with an 80µm nozzle. The results with these two nozzle types are nearly identical.

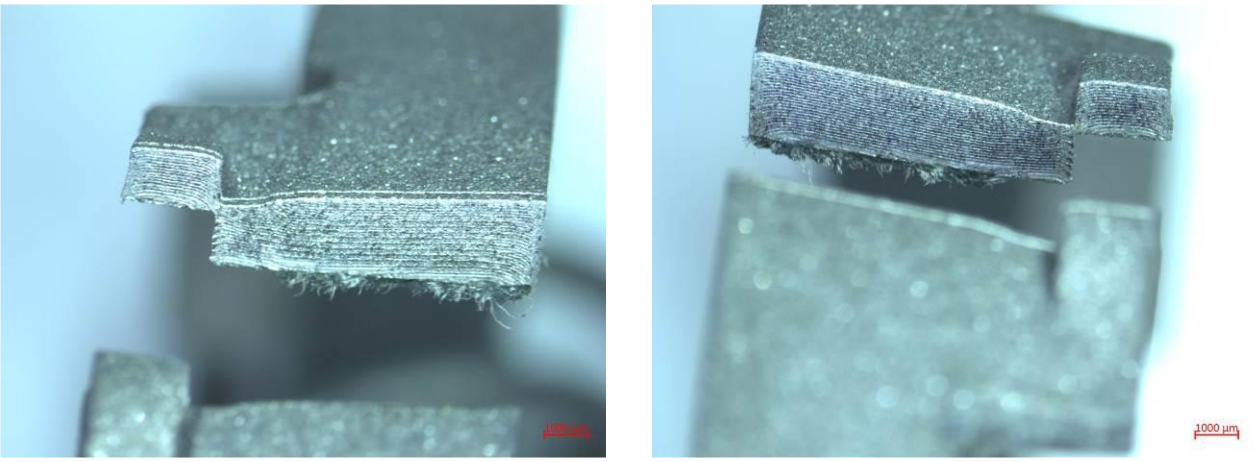
The tests on the final parts have taught us that cutting the step present on the profile becomes more difficult at high motion speeds. In order to further optimize the cutting time, we had indeed tried to increase the motion speed on the thinner part of the sample, but it turned out that it was not efficient. Using a different strategy to optimize the process time would therefore be preferable (for example: both decreasing the number of passes and decreasing the motion speed on the thicker part ; or keeping the speed constant but adjusting the length of the motion during the process in order to cut only where necessary).

PICTURE 1: Camera picture of a cut ring

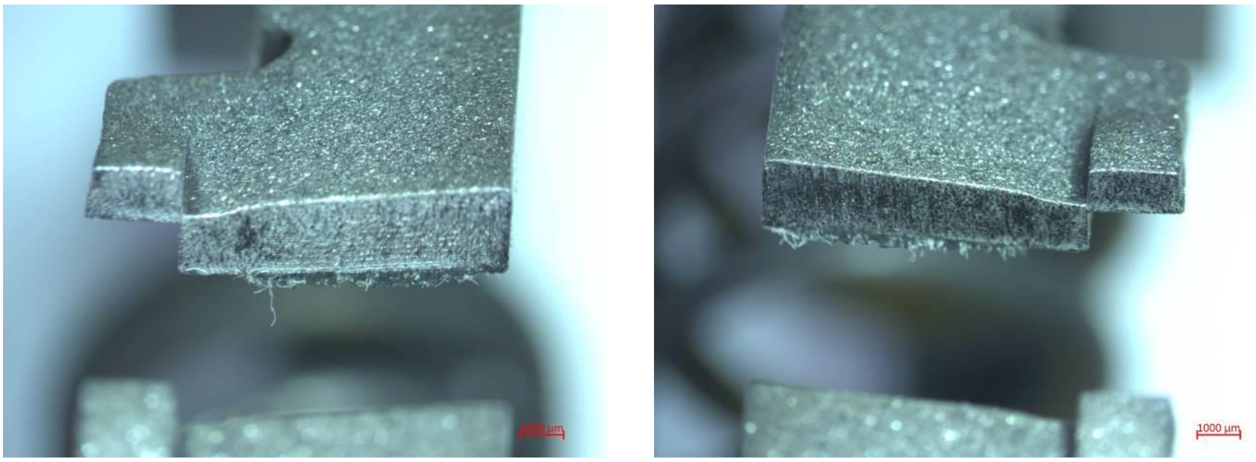
The microscope pictures below show in more detail the quality that was obtained. The quality is similar to the one observed in the first samples. Some fibers hang out of the friction material, but the ring seems not affected by heat.



PICTURE 2A&B: Microscope images of the cut walls of a ring cut with a 70µm nozzle



PICTURE 2C&D: Microscope images of the cut walls of a ring cut with a 80µm nozzle



PICTURE 2E&F: Microscope images of the cut walls of another ring cut with a 80µm nozzle

CONCLUSION

The cutting of friction ring segments 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.

These tests have shown that:

- The technology can reach a cutting time of about 10s, which is the target ;
- The quality remains good with these new parameters.

We thank you for your interest in our technology and we hope that 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.