REPORT: Magnet ring cutting by laser MicroJet®

for Anonymous

by Florent Bruckert, Synova SA

OBJECTIVE

The Laser-MicroJet® technology has been tested for cutting ferrite rings
The aim was to create a helicoidally opening in the magnetic rings into 6 parts with a 3 (X, Y, B) or 4 (X, Y, Z, B) machine. You can see the requested pattern on Figure 1 and one of the processed parts on Figure 2.

SAMPLES DESCRIPTION

SAMPLE	Material	Ferrite	
	Thickness	6	mm
	Quantity	8	pce

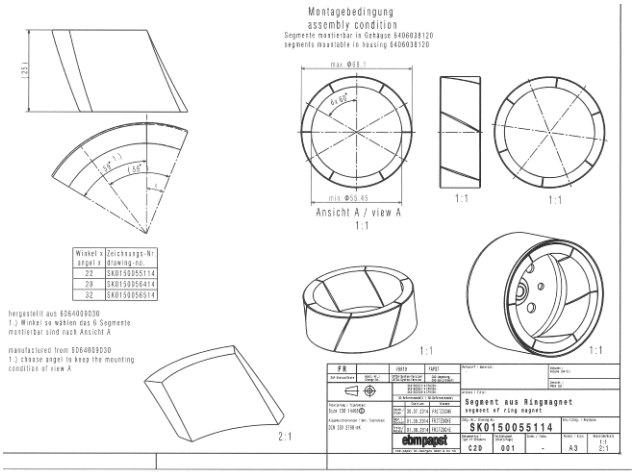


FIGURE 1: Drawing showing the requested cutting pattern

Release of application report			
Project Leader		Responsible Application Group	
Name:	Florent Bruckert	Name:	Benjamin Carron
Date:	26.06.2015	Date:	26.06.2015
Visum:	FBR	Visum:	BC

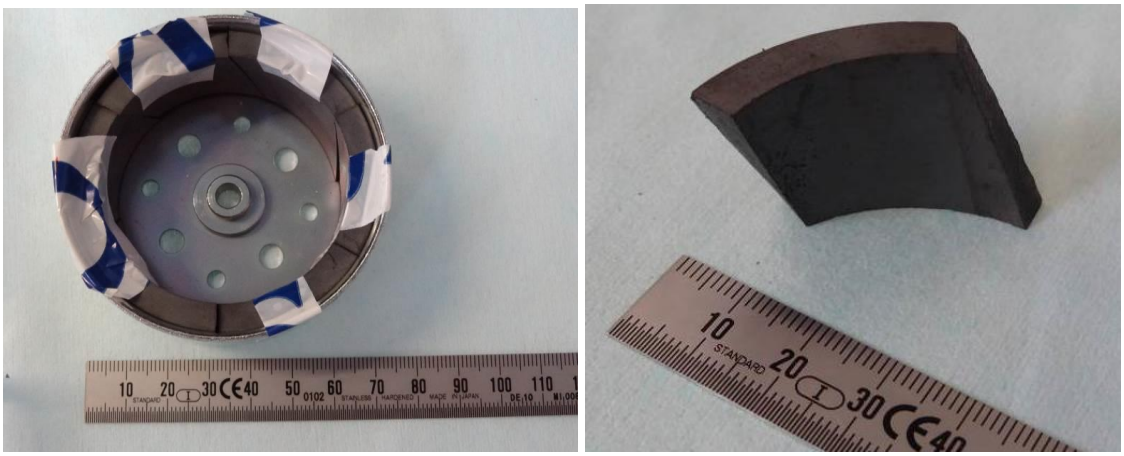


FIGURE 2: Pictures showing a whole sample cut in six parts (left) and one of these parts (right).

FIGURE 3: Picture of the 7 magnet rings cut (+1 for development)

PROCESS: INSTRUMENT & TEST PARAMETERS

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

- Advantageous process rates
- Negligible contamination / re-deposition
- Negligible heat damage to the material
- Parallel wall cut
- Low kerf width

For these experiments, the LCS300, Nd:YAG laser, has been selected as the most suitable machine configuration available in the lab.
In the tables below, the optimized processing parameters used in the experiments are summarized:

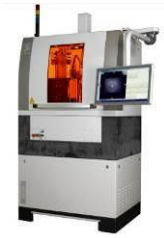
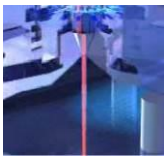
	**SYSTEM**	Machine type	LCS 300	
		Fixing type	Specific holder or clamped (see Figure 4)	
	**MICROJET® PARAMETERS**	Nozzle diameter	60	*µm*
		kerf width	65	*µm*
		Protect gas: Helium	0.9	*L/min*
		Water pressure	250	*bar*
		Working distance	17	*mm*
	**LASER PARAMETERS**	Laser type	L51G	
		Wavelength	532	*nm*
		Repetition Rate	13	*kHz*
		Pulse width	~ 200	*ns*
		Power in jet	29	*W*
	PROCESS PARAMETERS	Motion speed	30	*mm/s*
		Number of passes	260	*Passes*
		Pulse width	~ 200	*ns*
		Power in jet	29	*W*
		Process time per line	4min40sec	
		Process time per sample	26min40sec	

FIGURE 4: Pictures of a cut ring on (left) and out of the specific holder (right)

Different samples have been processed according to the customer needs. The main difference is the angle to apply on the B-axis all along the 29 mm long straight line (collinear to the Y axis).

Angle (to apply on the B axis)	Quantity of processed rings
22.5 °	3
25.5 °	1
28.5 °	1

RESULTS

The following pictures show the resulting quality that you can obtain thanks to the Laser Microjet® technology.

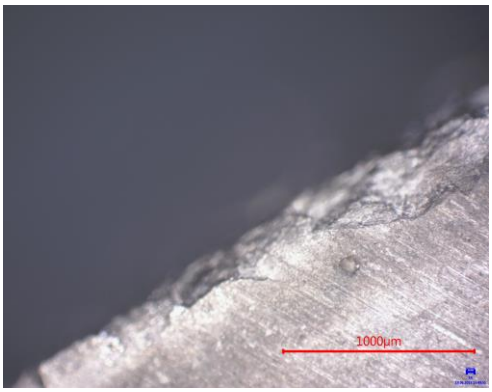


FIGURE 5: front side view

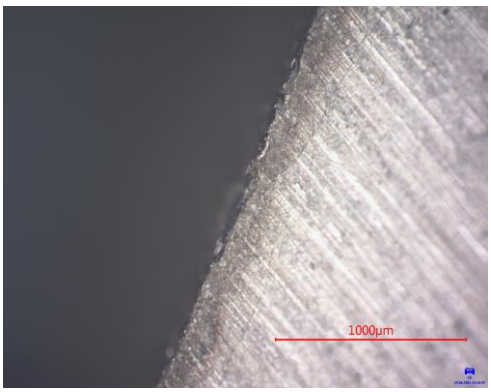


FIGURE 6: back side view

Some defects (mostly waves) have been noticed on the cutting edge.
According to experimentations, it reveals that the edge quality is correlated to the B axis movement (1 B-increment leads to a Y movement each 3 µm if we consider a circumference of 200 mm).
A straight line strategy (so without rotary axis) has been tested and the resulting edge quality is clearly much more homogeneous. This difference is shown on Figure 7 to Figure 10.

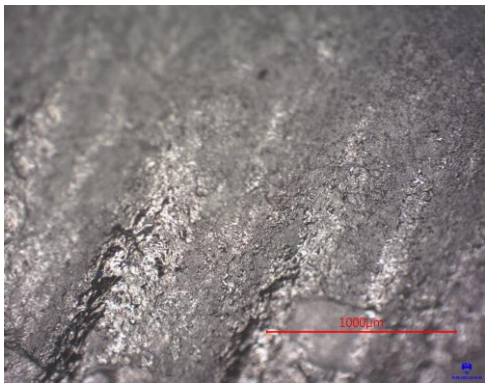


FIGURE 7: edge view, sample cut with the B axis

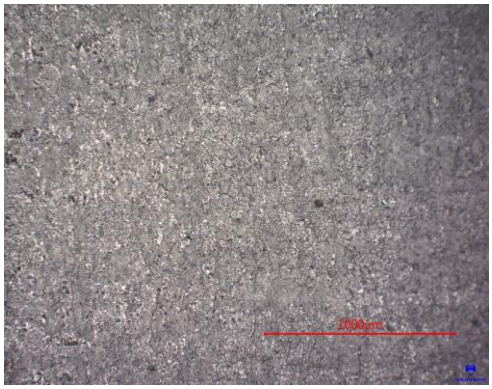


FIGURE 8: edge view, sample cut without the B axis

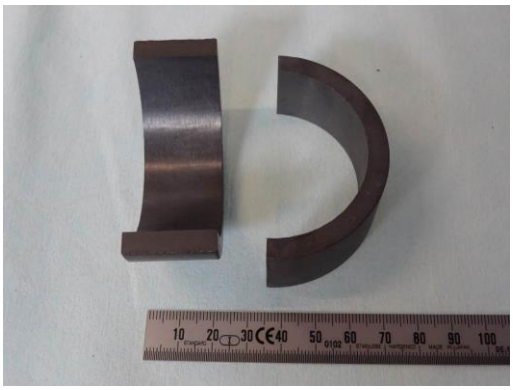


FIGURE 9: edge and lateral view of the sample cut without the B axis

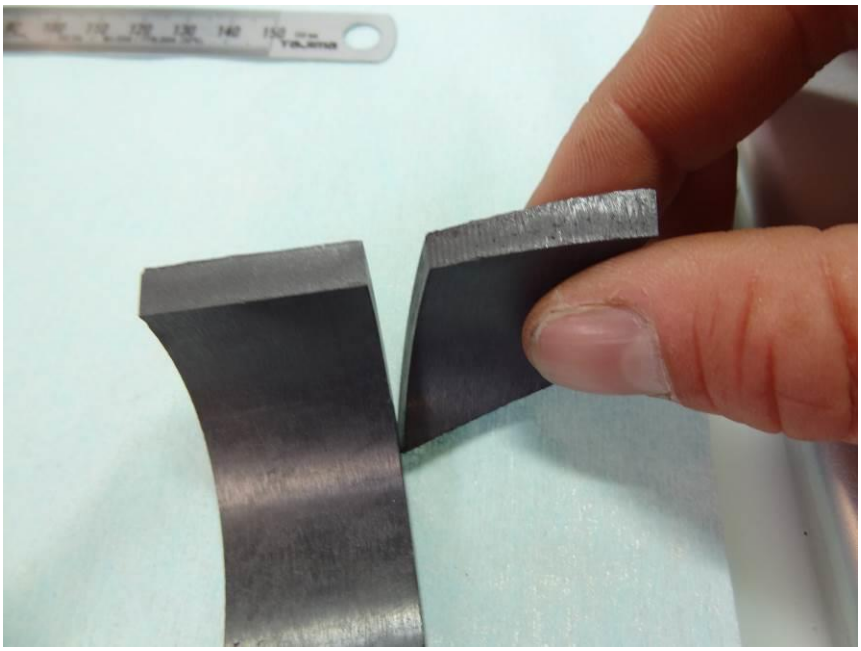


FIGURE 10: Edge view of the 2 samples: cut without the B axis (left) and with the B axis (right)

CONCLUSION

The magnet ring cutting was investigated on SYNOVA LCS 300.
This machine is 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 ferrite cutting with high quality.

The tests show that:

- It is possible to cut a 6 mm thick magnet ring in 6 different helicoidally parts thanks to a X-Y-B axes system.
- Some “unrepeatable” saturations have been observed. Some extra passes have been applied to cut through. Those saturations are neither correlated to the peak power nor the LaserMicrojet intrinsic parameters. A (working distance – speed – water pressure) DOE can significantly lead to stabilize the process.
- The current optimized process time lasts 4min40sec per line and so 26min40s on these samples. It fulfills your expectations thanks to our sales representative input.
- Some irregularity and a large Rz (ie Sz) have been identified. The origin is the nature of the rotary axis. The quality obtained thanks to a straight line can certainly be reached on your final product.

We are open to further discuss your needs regarding:

- The relative saturation.
- The cleaning.
- The final process time.
- The final edge quality thanks to another rotary axis.

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.