REPORT: Cutting of PZT by Laser-MicroJet®

For Anonymous

by Synova SA, Mr Sylvain Hirth

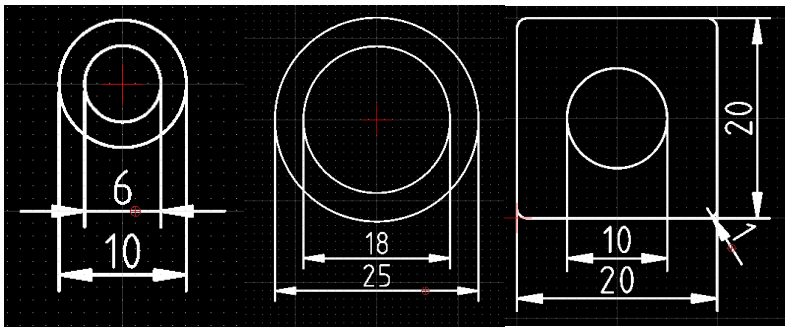
1. TASK

This application aimed at cutting PZT plates using the Laser-MicroJet® technology.

2. TASK DESCRIPTION

SUPPLIED MATERIAL	Sample	PZT, PZT with a 5µm thick silver coating
	Dimensions	ca 90 x 90 mm^2
	Thickness	4.8 mm

For this application, three different geometries had to be cut twice in each PZT plate (with and without silver coating)

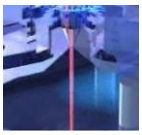


PICTURE 1: geometries to be cut

3. PROCESS: INSTRUMENT & TEST PARAMETERS

For this application, the LCS150, equipped with a frequency doubled, Q-switched, Nd:YAG laser, has been selected as the best machine configuration available in the lab. In the table below, the optimised processing parameters used in the experiments are summarised:

Release of application report			
Project Leaders		Industry BU Responsible	
Name:	Mr Sylvain Hirth	Name:	Dr Carron Benjamin
Date:	01.07.2014	Date:	01.07.2014
Visum:	SHI	Visum:	BC

	**SYSTEM**	Machine type	LCS150	
		Fixture	Clamped	
	**MICROJET® PARAMETER**	Nozzle diameter	50	*µm*
		Water pressure	300	*bar*
		Working distance	15	*mm*
		Assist gas	He	
	**LASER PARAMETERS**	Laser type	L51G	
		Wavelength	532	*nm*

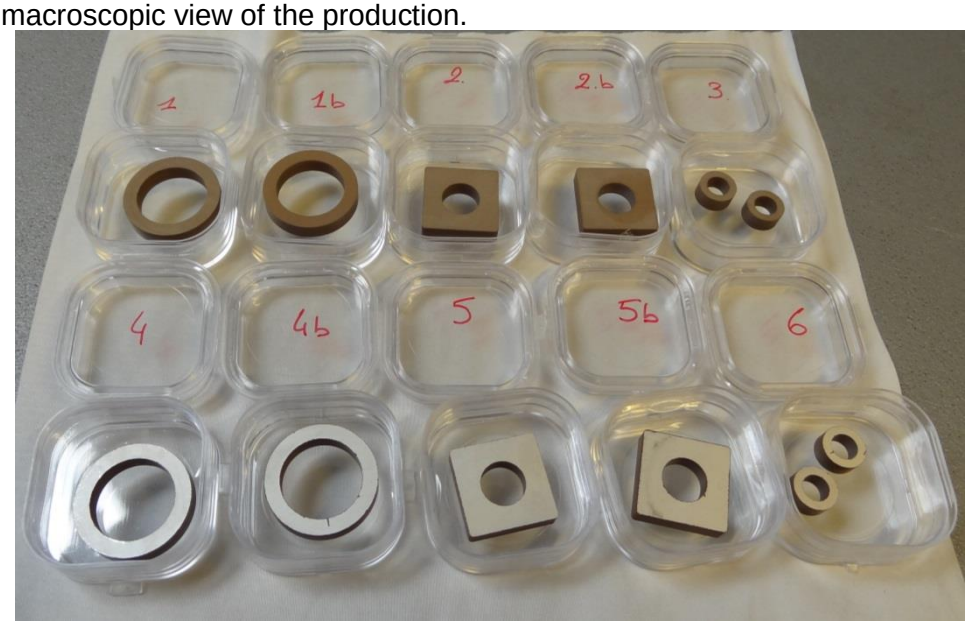
The following laser parameters have been used during this application

Frequency [kHz]	Power (internal) [W]	Power (water jet) [W]	Pulse duration [ns]
25	40.5	15.7	150

TABLE 1: Sets of cutting parameter used

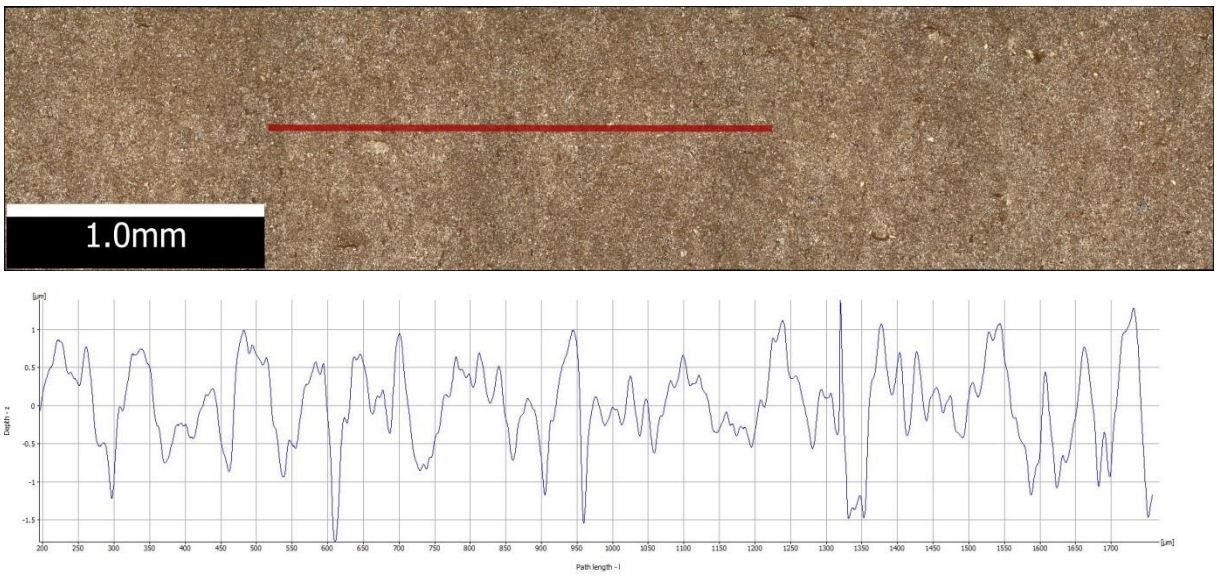
4. RESULTS

Every geometry was cut twice in each sample (with and without silver coating). Picture 2 shows a macroscopic view of the production.



PICTURE 2: macroscopic view of the production

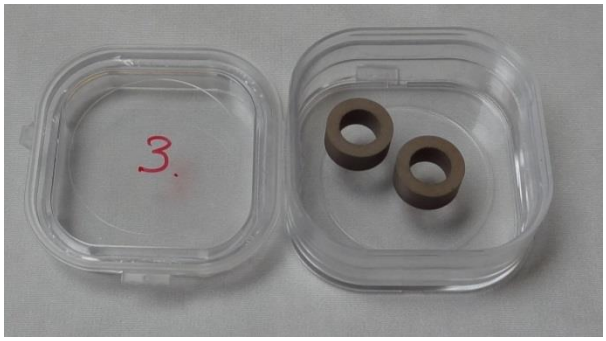
Since the main objective of this application was a low roughness, many parameters have been tested. The ones cited in Table 1 offered the best results:



PICTURE 3: roughness measurement on the edge of sample 2b

Values of Ra = 0.45 µm and Rz = 3 µm have been measured. These values are averaged over 20 profiles taken over a 10µm wide line. The measurement length was 1.8 mm and the cut-off value 250 µm. This measurement is in accordance to the ISO 4287 norm. However, these values are not consistent through the entire surface due to the formation of localized deeper holes on the cut edge. The absence of any formation pattern seems to suggest that these holes are not directly created by the Laser-MicroJet® but rather appear due to inhomogeneities in the material itself.

The following pictures show a macroscopic view of each geometry.

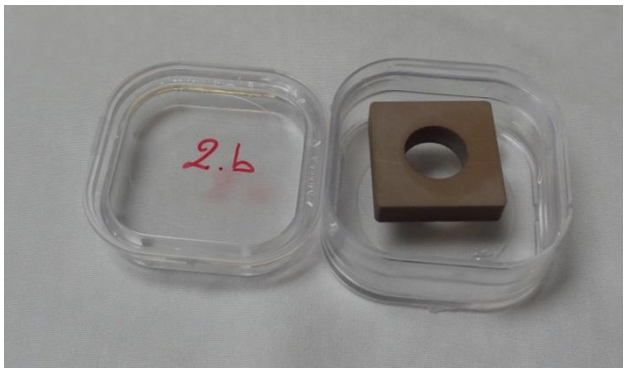


PICTURE 4: Sample 3 (macroscopic view)

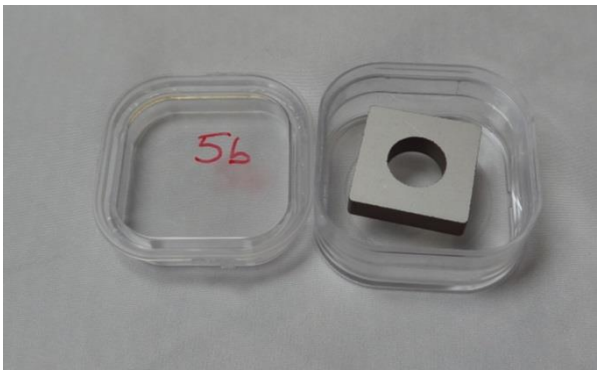
PICTURE 5: Sample 6 (macroscopic view)

PICTURE 6: Sample 1b (macroscopic view)

PICTURE 7: Sample 4b (macroscopic view)

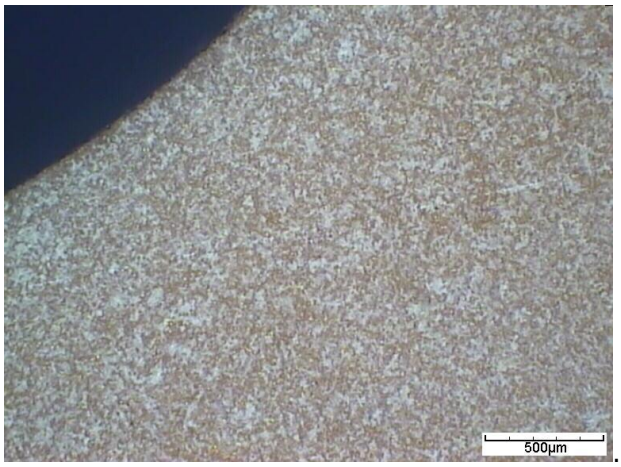


PICTURE 8: Sample 2b (macroscopic view)

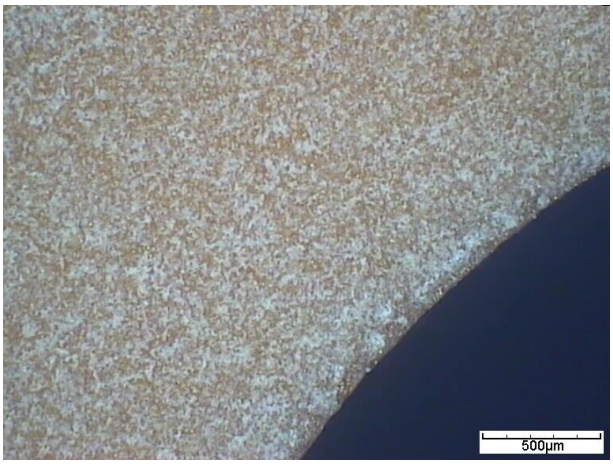


PICTURE 9: Sample 5b (macroscopic view)

The following pictures show a macroscopic view of two samples

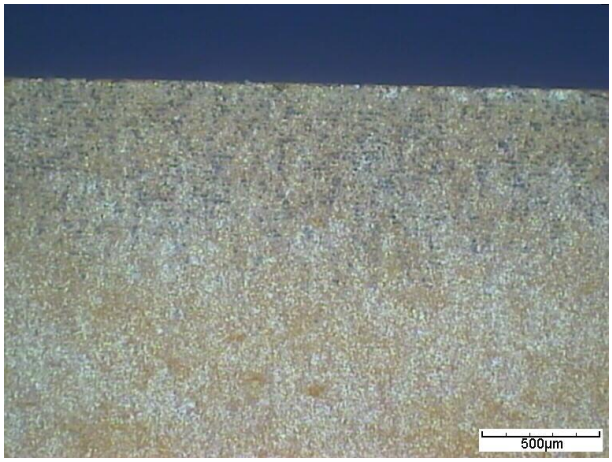


PICTURE 10: Sample 2 (front side[1] view)

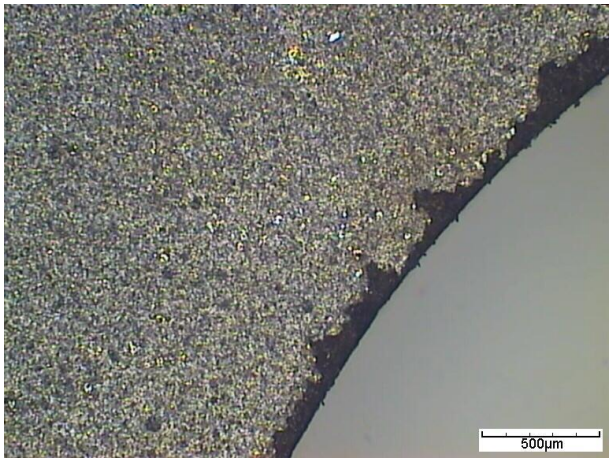


PICTURE 11: Sample 2 (back side view)

[1] The front side indicates the side onto which the laser shines directly during the cutting process.



PICTURE 12: Sample 2 (edge view)



PICTURE 13: Sample 5b (front side view)

The silver coating is delaminated on the side of the cut. It is supposed that the water pressure inserts water between the PZT and the silver coating once the cutting starts. The water pressure has been lowered and another cutting strategy has been tested (shorter pulse width and more power during the first two passes to clearly cut the silver and then change back to the previous parameters to cut the PZT) but the effect remained. It seems that even during the cleaning of the pieces in the ultra-sound bath, the coating starts to wear off. This led us to the conclusion of very small adhesive forces between the coating and the PZT.

The samples were cut with the following process time (for one part):

Sample	Process time	Picture
1, 1b, 4, 4b	8 min 37s	6, 7
2, 2b, 5, 5b	7 min 51s	8, 9
3, 6	3 min 15 s	4, 5

TABLE 2: Process times

5. CONCLUSION

The cutting of PZT has been performed with a 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 a high quality cutting process.

This application shows that:

- The process does not cause any heat damage
- The process is burr-free
- The roughness is low (Ra = 0.45 µm)
- The process does not create any mechanical constraints in the parts

We are open to further discuss your needs regarding:

- The surface roughness
- The cutting speed
- The tolerances

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.