REPORT: Functional watch parts cutting by laser MicroJet®

for Anonymous

by Rémi Laure, Florent Bruckert, Synova SA

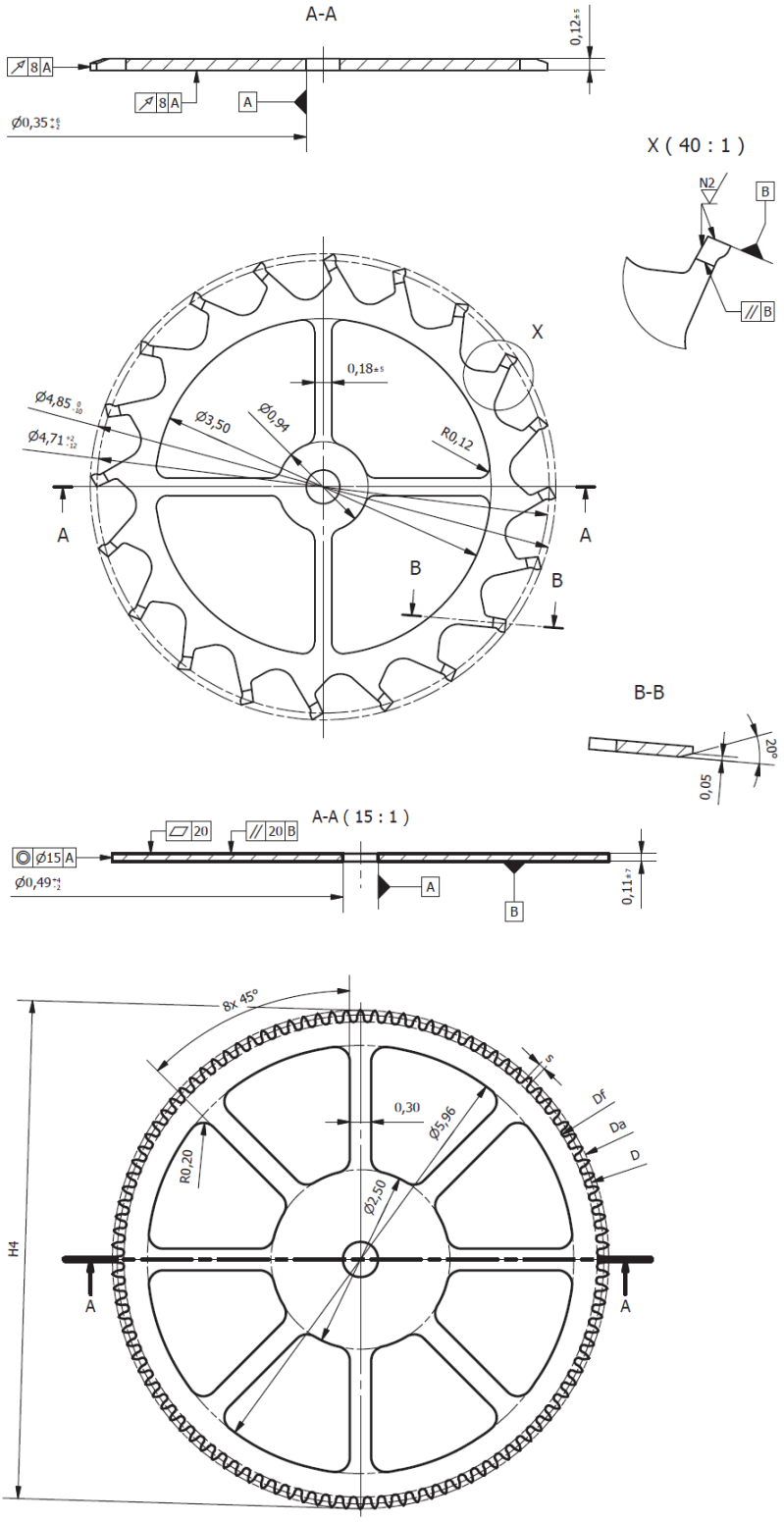
OBJECTIVE

The Laser-MicroJet® technology has been tested for cutting 110 µm CuBe2 substrates. The aim was to cut both second wheels and escape wheel to check the quality of cutting and tolerances.

SAMPLES DESCRIPTION

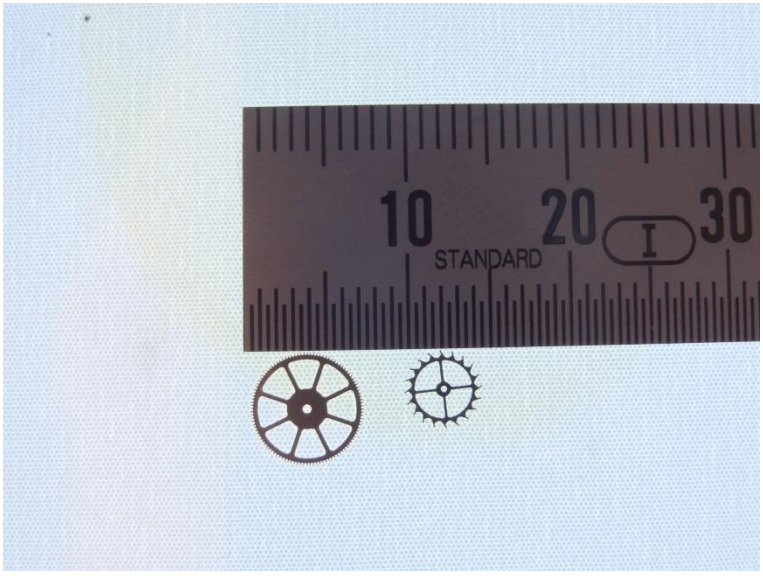
SAMPLE	Material	CuBe2	
	Thickness	0.110	mm
	Quantity	7	pieces

Release of application report			
Project Leader		Responsible Application Group	
Name:	Florent Bruckert	Name:	Benjamin Carron
Date:	18.09.2015	Date:	18.09.2015
Visum:	FBR	Visum:	BC



Nombre de dents	Z	108
Module	m	0.063
Diamètre de tête	Da	6.9364
Diamètre primitif	D	6.8040
Diamètre de pied	Df	6.6151+10/-10
Epaisseur de dents	s	0.085 +4/-6
Distance sur dents	H3/H4	6.9335 +4/-12

PICTURE 1: Drawing and measurements for the escape wheel up and the second wheel down



PICTURE 2: Macroscopic view of the two different wheels, second wheel to the left and an escape wheel to the right

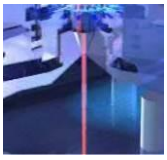
PICTURE 3: General view of production

The escape wheel 1 has already been given during the visit and does not appear in this report.

PROCESS: INSTRUMENT & TEST PARAMETERS

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:

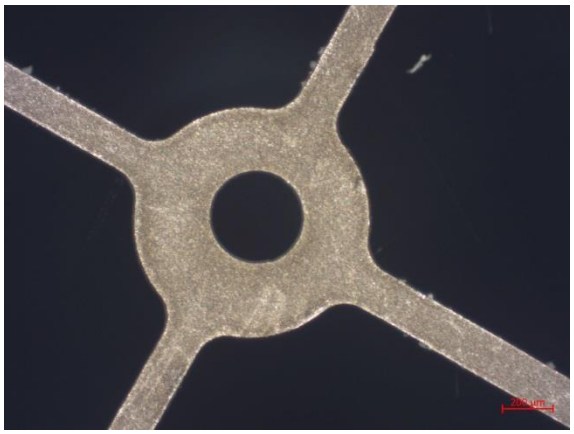
	**SYSTÈME**	Machine	LCS300
		Fixing type	Clamped
	**PARAMÈTRES DU MICROJET®**	Nozzle diameter	30 *µm*
		Width of jet	24 *µm*
		Protect gas	He
		Rate of flow	1.1 *L/min*
		Waterjet pressure	600 *bar*
		Working Distance	8 *mm*
	**PARAMÈTRES LASER**	Laser type	VG21G
		Wavelength	532 *nm*
		Taux de répétition laser	100 *kHz*
		Durée d'impulsion	13 *ns*
		Puissance dans le jet	4.3 *W*

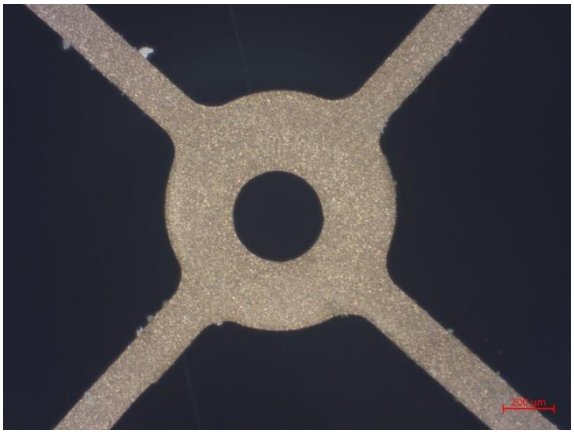
To carry out this test we use a single-pass strategy which consist to cut the piece only once on the same contour. Furthermore, a finishing pass was performed on some parts to improve the quality of the edge after cutting. The finishing pass corresponds to a pass with a small offset, in our case 15 µm into the material, to remove imperfection of the cutting edge.

Reference (all speed in mm/s)	Hole speed	Hole speed FP	Arm speed	Arm speed FP	External speed non functional	External speed functional	Time of process
Escape #1 and 2	0.3	0.1	0.3	0.1	0.3	0.1	8min 20s
Escape #3 and 4	0.3	0.1	0.3	NA	0.3	0.1	4min 40s
Escape #5 and 6	0.3	NA	0.3	NA	0.3	0.3	3min 42s
Second	0.3	0.1	0.3	0.1	NA	0.1	20min 16s

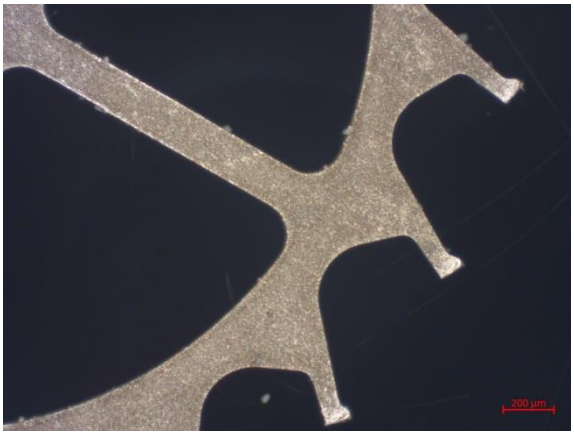
RESULTS

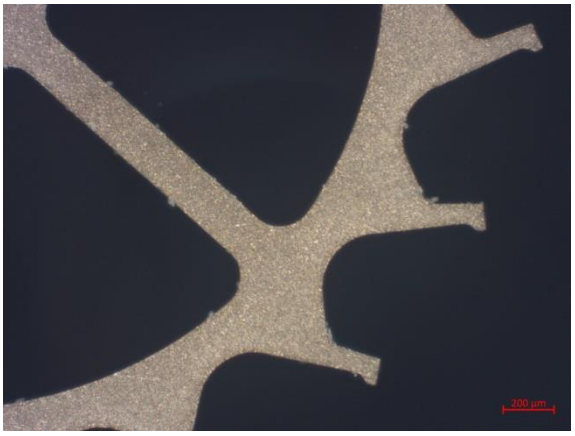
The following pictures show an overview of the cutting quality available with the LaserMicroJet®:



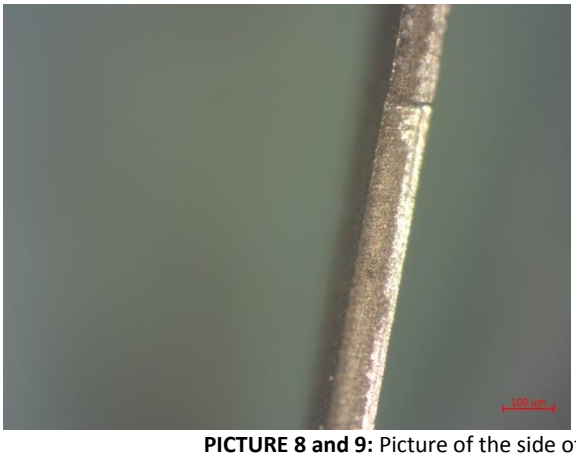


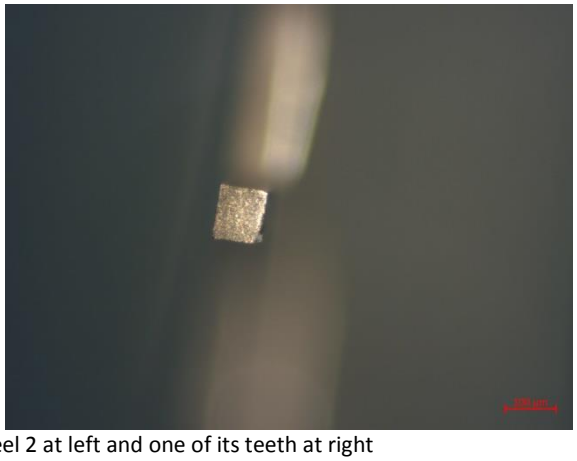
PICTURE 4 and 5: Picture of the center hole for escape wheel 2, frontside at left and backside at right



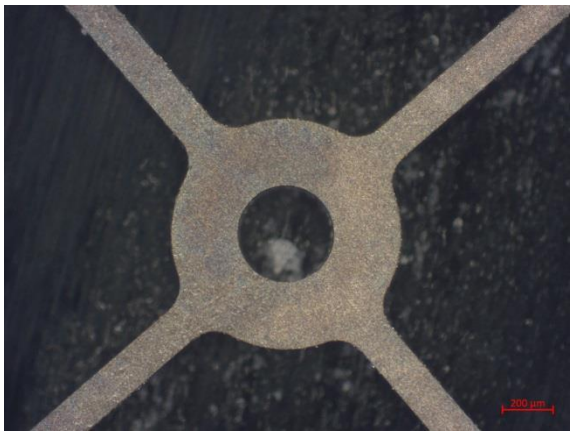
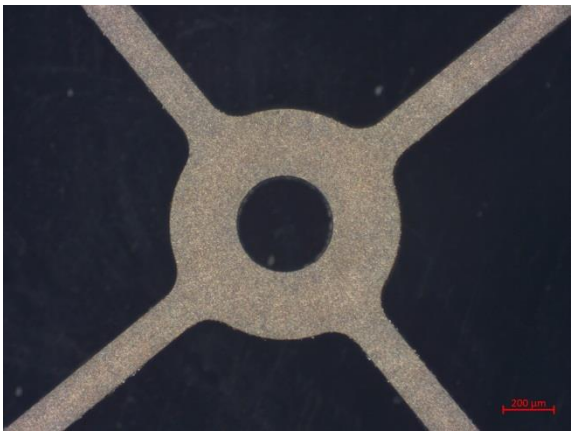


PICTURE 6 and 7: Picture of the teeth for escape wheel 2, frontside at left and backside at right

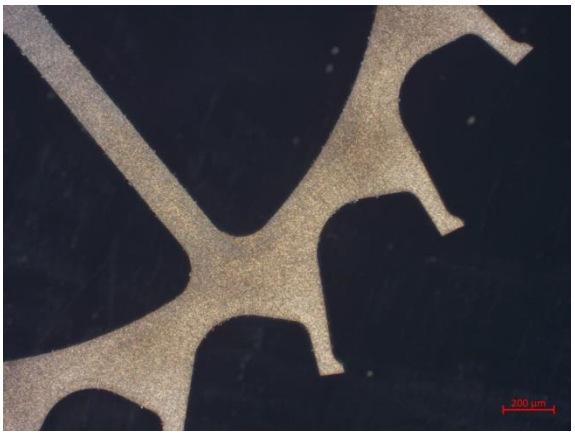




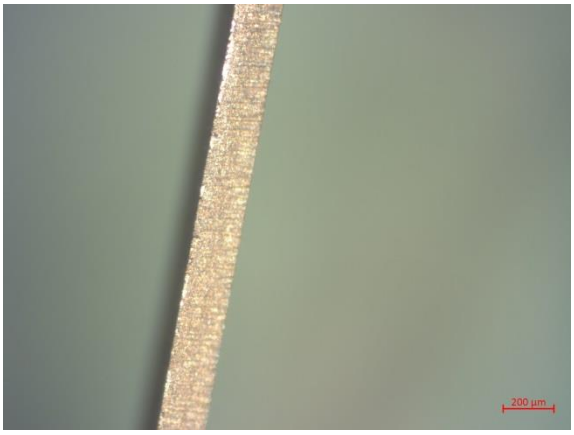
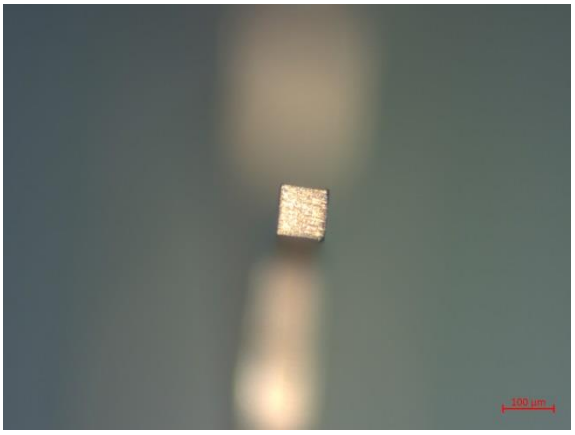
PICTURE 8 and 9: Picture of the side of escape wheel 2 at left and one of its teeth at right

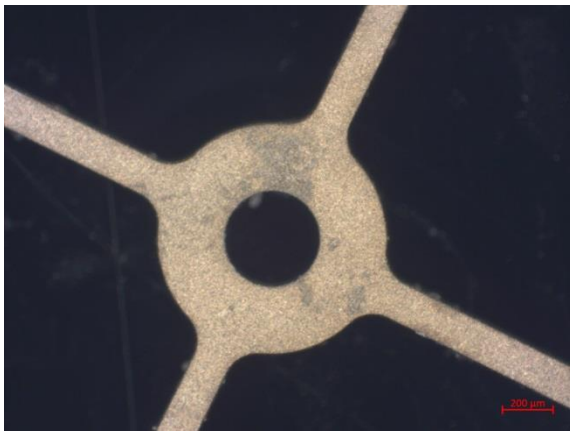
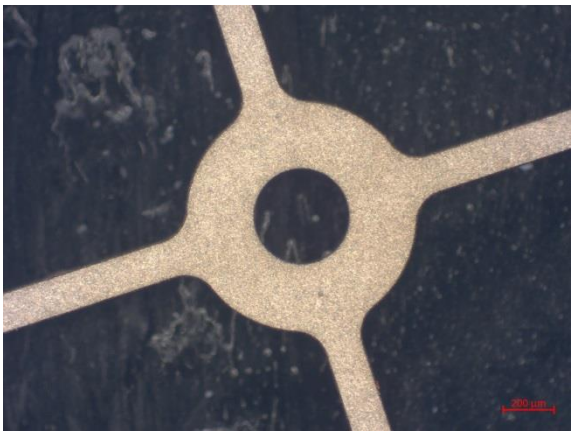
PICTURE 10 and 11: Picture of the center hole for escape wheel 4, frontside at left and backside at right

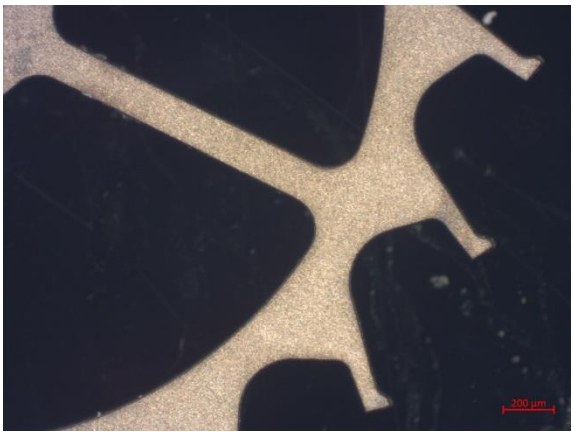
PICTURE 12 and 13: Picture of the teeth for escape wheel 4, frontside at left and backside at right

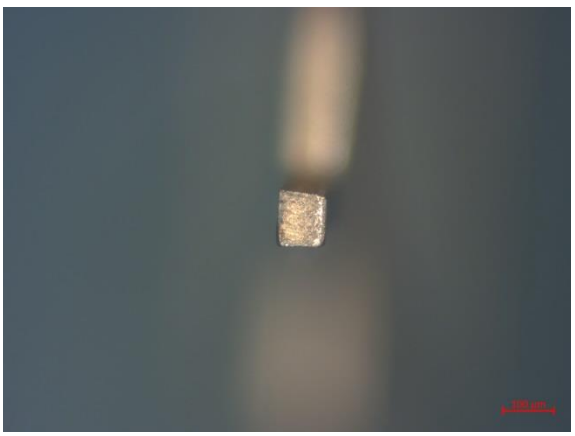
PICTURE 14 and 15: Picture of the side of escape wheel 4 at left and one of its teeth at right

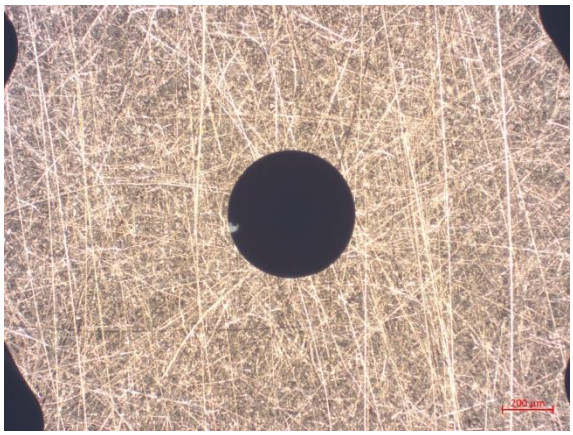
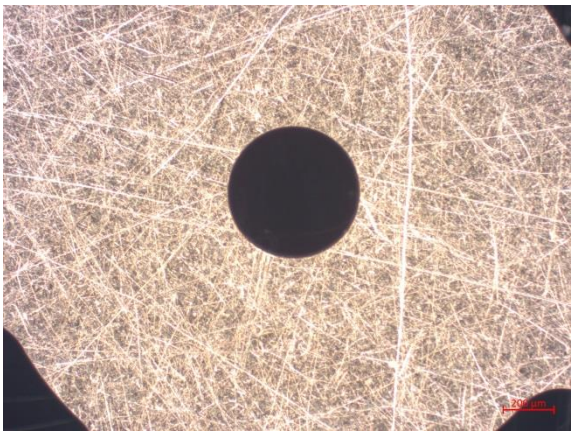
PICTURE 16 and 17: Picture of the center hole for escape wheel 6, frontside at left and backside at right



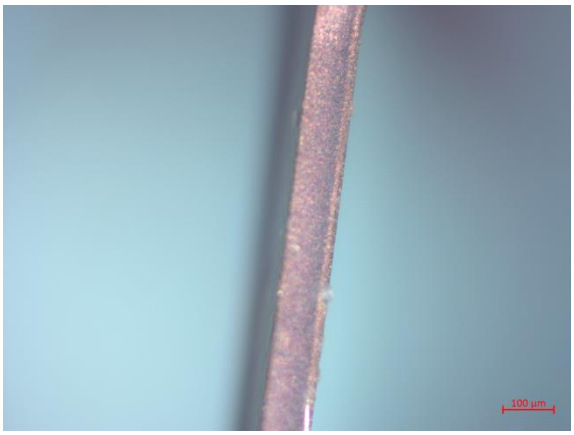
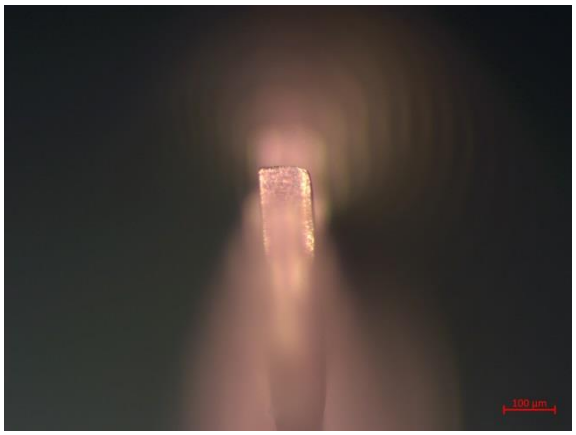

PICTURE 18 and 19: Picture of the teeth for escape wheel 6, frontside at left and backside at right

PICTURE 20 and 21: Picture of the side of escape wheel 6 at left and one of its teeth at right

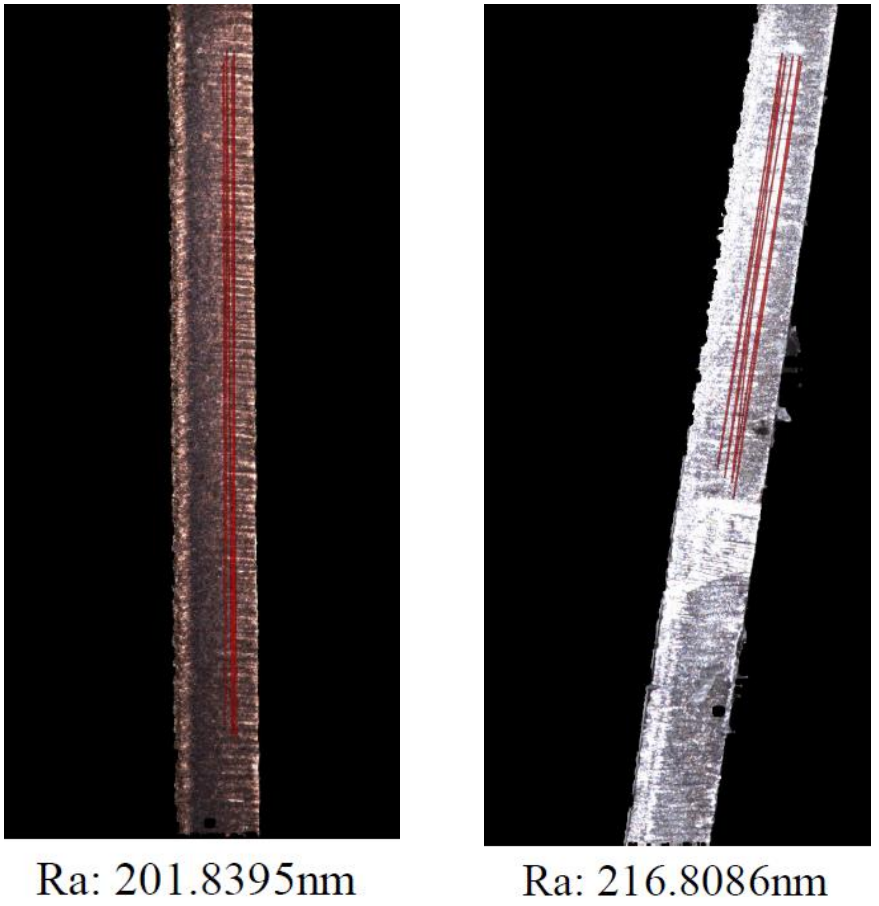



PICTURE 22 and 23: Picture of the center hole for second wheel, frontside at left and backside at right

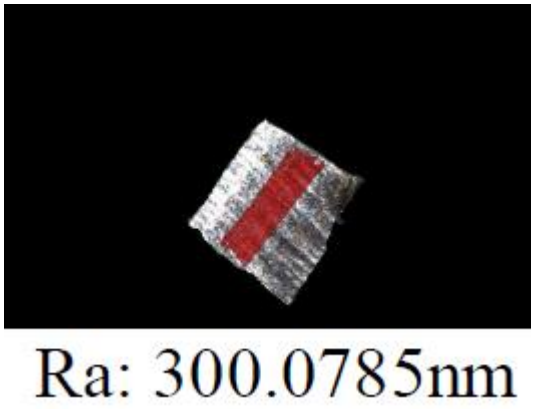



PICTURE 24 and 25: Picture of the side of second wheel at left and one of its teeth at right

Measurents of roughness were performed with a 3D microscope Alicona. The next pictures show the results of this tests:



PICTURE 28 and 29: Roughness measurement for an arm of the second wheel at left and escape wheel at right



PICTURE 30: Roughness measurement for a tooth of the escape wheel

CONCLUSION

The functional watch parts 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 thin metals cutting with high quality.

The tests show that:

- The cutting time concerning the escape wheel varies from 3min42s to 8min20s according to the quality.
- The cutting time concerning the second wheel is 20min16s.
- The cutting time can be improved according to the quality expectations.
- The cut induced roughness (Ra) are 0.220 µm for escape wheels on arm, 0.3 µm for the escape wheel on tooth and 0.200 µm for the second wheel.
- The processes are stable and repeatable.

We are open to further discuss your needs regarding:

- The cutting strategy to optimize the time of process.
- The parameters to optimize the quality of the two wheels.

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.