REPORT: Knitting parts cutting by Laser-MicroJet®

for Anonymous

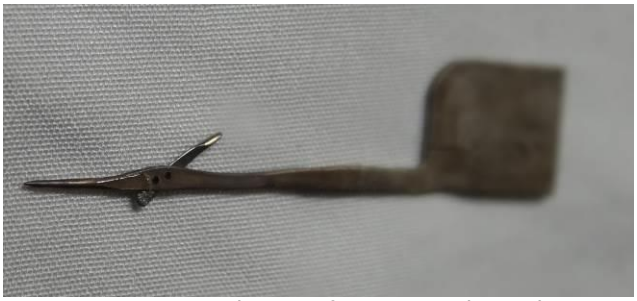
by Florent Bruckert, Synova SA

TASK

The Laser-MicroJet® technology has been tested for cutting knitting parts.
The aim is to prove that the Laser MicroJet® technology permits to cut 3 different parts altogether with expectations from the knitting-industry (picture 1, 2 and 3).

SAMPLE DESCRIPTION

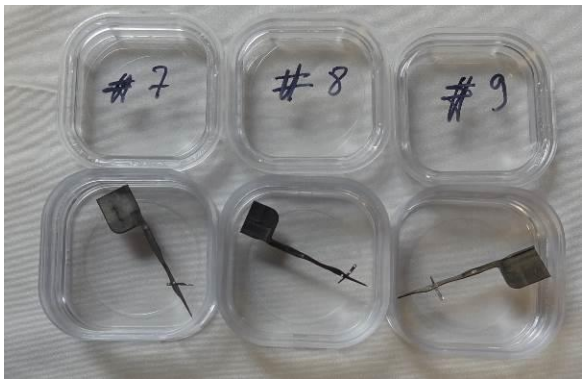
SUPPLIED MATERIAL	Material	C80 steel
	Thickness	0.68 mm
	Quantity	6



PICTURE 1: Pictures of a processed sample

Release of application report			
Project Leader		Industry BU Responsible	
Name:	Mr Florent Bruckert	Name:	Dr Carron Benjamin
Date:	22.07.2013	Date:	22.07.2013
Visum:	FBR	Visum:	BC

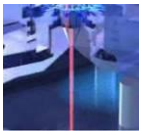
PICTURE 2: Picture of the samples processed with a 50W laser source



PICTURE 3: Picture of the samples processed with a 100W laser source

PROCESS: INSTRUMENT & TEST PARAMETERS

For this application, the LCS300, equipped with a frequency doubled, Q-switched, Nd:YAG laser, has been selected as the best machine configuration available in the lab. We have done the tests with two lasers: a 50W and a 100W laser sources.
In the table below, the optimised processing parameters used in the experiments are summarised:

	**SYSTEM**	Machine type	LCS300	
		Fixture	Clamped	
	**MICROJET® PARAMETER**	Nozzle diameter	50 // 60	*µm*
		Kerf width	60 // 70	*µm*
		Water pressure	250	*bar*
		Working distance	9	*mm*
		Assist gas	He	
	**LASER AND CUTTING PARAMETERS**	Laser type	L51G//L101G	
		Wavelength	532	*nm*
		Laser repetition rate	10//14 //20// 28	*kHz*
		Pulse width	150	*ns*

The aim was to cut a 440 µm diameter hole into 680 µm of steel (sample 1 to sample 4 and sample 7 to sample 9).
A rectangle slot (70 µm x 5000 µm) has been processed on sample 5 and 6.

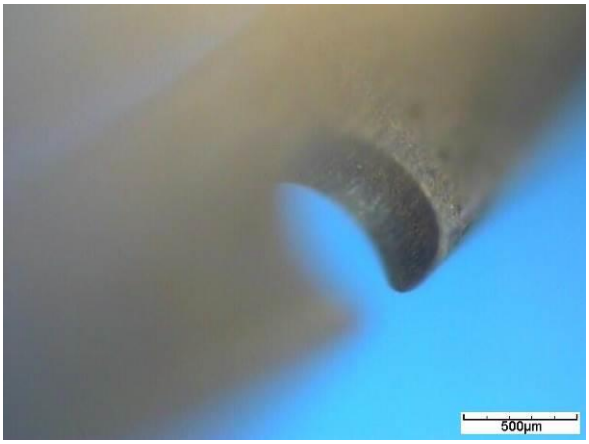
Sample	Image reference	Nozzle diameter [µm]	Power in the water jet [W]	Rep rate [kHz]	Cutting speed [mm/s]	Process time [s]
1	4-5	50	8.8	14	3	4
2	-					
3	6	60	8.8		3+1 (*)	5
4	7		18.9	28	7	4
5	8-9		22.6	10	10	<10
6	10-11		18.9	28	10	<10
7-8-9	**12-13**		**32.5**	**10**	**5**	**1.7(**)**
-	-		56	20	5	2.5
-	-				10	3.0

(*) A finishing pass has been added to optimize to roughness at the cutting edge.
(**) The best process time has been determined by video analysis and by repetition of 100 holes to estimate the exact process time per hole.

Note 1: The slot done on sample 5 measures 0.14 mm x 5 mm on the front and back side.
Note 2: The slot done on sample 6 measures 0.077 mm x 5 mm on the front and back side (0.066mm kerf width on the back side).

RESULTS

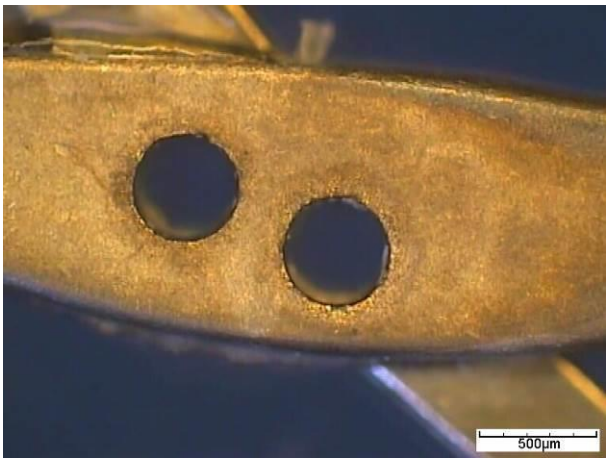
You can see below the pictures related to the previous tests.



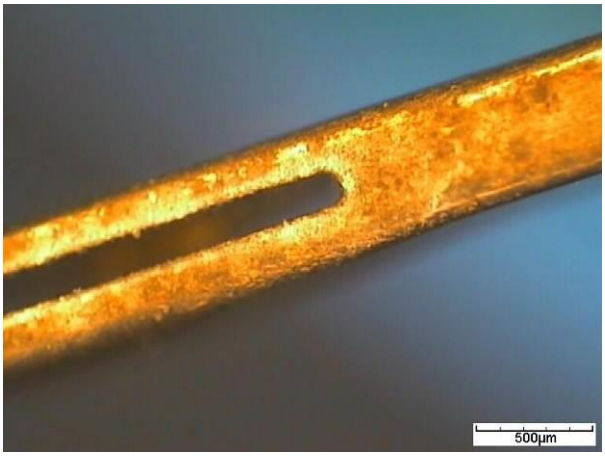
PICTURE 4: Microscope image of the sample 1 (edge view)

PICTURE 5: Microscope image of the sample 1 (front side view)

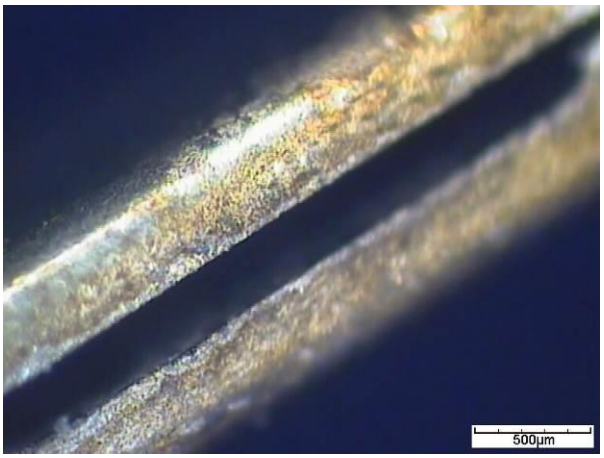
PICTURE 6: Microscope image of the sample 3 (back side view)



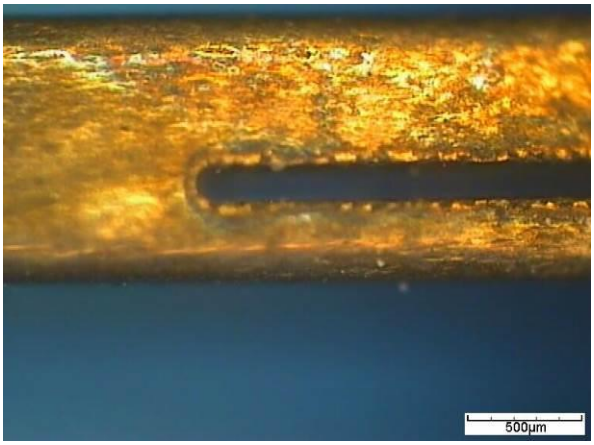
PICTURE 7: Microscope image of the sample 4 (front side view)



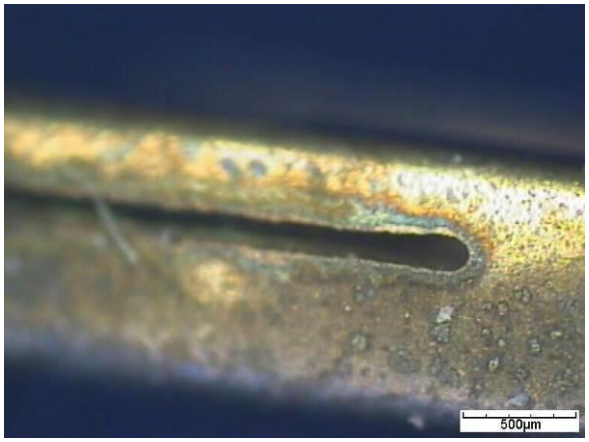
PICTURE 8: Microscope image of the sample 5 (front side view)



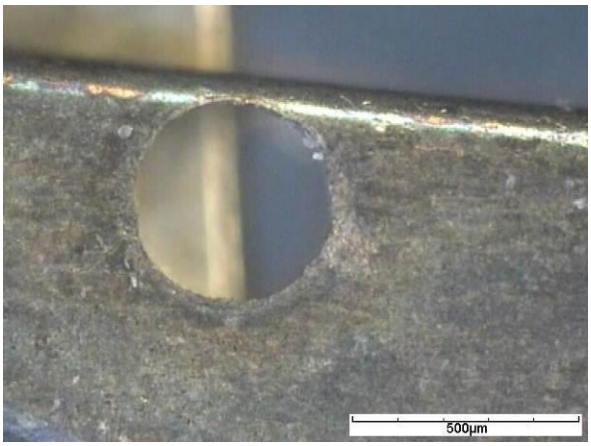
PICTURE 9: Microscope image of the sample 5 (back side view)



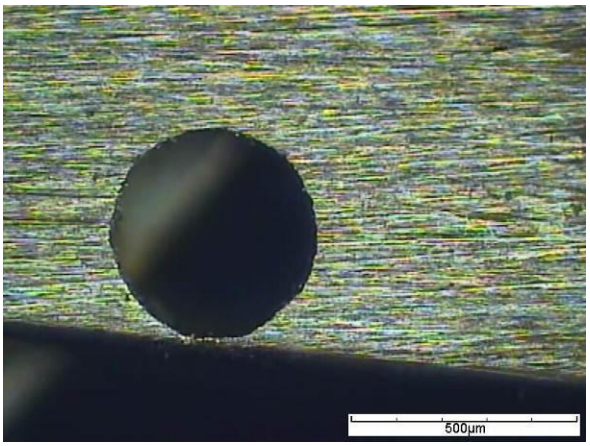
PICTURE 10: Microscope image of the sample 6 (front side view)



PICTURE 11: Microscope image of the sample 6 (back side view)



PICTURE 12: Microscope image of the sample 8 (back side view)



PICTURE 13: Microscope image of the sample 8 (front side view)

REQUIREMENTS ANALYSIS

	Priority	Anonymous expectations	Quantified expectations or improvements
• Chipping / cracks:	X	-	None
• Burrs free:	X	-	No Heat damage *
• Tolerances:	X	0.44 mm diameter	OK *
• Process time	X	< 2 s per hole	1.7 s per hole

*All quantifications were determined by optical analysis.

CONCLUSION

The cutting of knitting parts has been performed with a SYNOVA LCS 300. 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 for knitting parts with high quality.

These tests show that:

- It is possible to cut three different steel parts stuck altogether.
- It is possible to cut this hole with a minimum process time of 1.7 s.
- There is a good repeatability of the process for this material.
- The quality is good on the front/ back side and on the edge.
- The cutting walls are parallel by optical analysis.
- Using more power in the waterjet does not lead to a shorter process time.

We are open to further discuss your needs regarding:

- The edge roughness homogeneity.
- The position of the hole.
- The final diameters and kerf widths.

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.