REPORT: Hafnium cutting and Mo grooving by Laser-MicroJet®

For Anonymous

by Synova SA, Mr. Stéphane Delahaye

1. TASK

The goal of this study is to demonstrate the feasibility of cutting small geometries on Hf samples and grooving a 3mm square on Mo in order to show the process capability.

2. SAMPLE DESCRIPTION

9 samples were available for the tests.

Supplied Material	Thickness	Quantity
Sample A and B: Hf Cutting	~0.07 mm	8
Sample C: Mo grooving	~0.4 mm	1

PICTURE 1: Macroscopic view of the Hf samples

Release of application report			
Project Leader		Industry BU Responsible	
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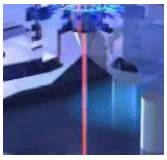
3. PROCESS: INSTRUMENT & TEST PARAMETERS

For this application, the LCS150, equipped with a frequency doubled, Q-switched, Nd:YAG laser (long pulse laser) and a short pulse laser, has been selected as the best machine configuration available in the lab.

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

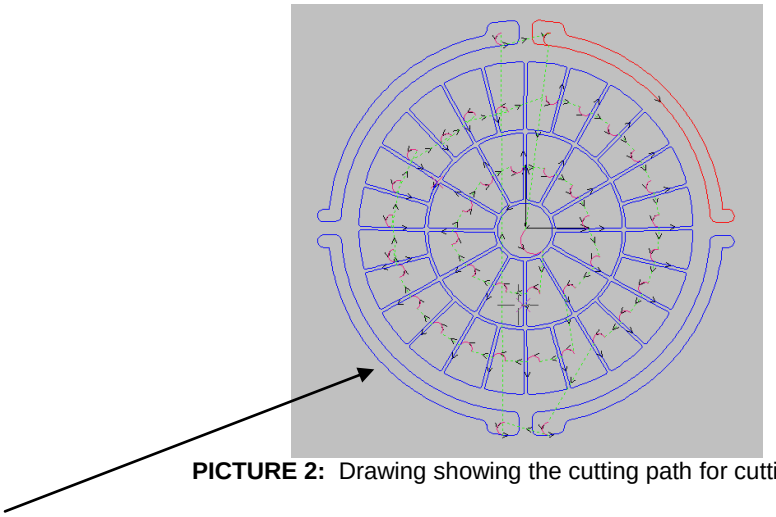
- Cutting of arbitrary shapes
- Parallel and smooth cut walls
- Low heat damage to the material
- Advantageous process rates

In the table below, the machine configuration is summarized:

	**SYSTEM**	Machine type	LCS150
	**MICROJET PARAMETERS**	Nozzle diameter	40 *µm*
		MicroJet diameter	~32 *µm*
		Water pressure	400 *bar*
		Assist gas	He (0.9 *L/min*)
	**LASER PARAMETERS**	Laser type	L51G
		Wavelength	532 *nm*

4. RESULTS

The following microscope pictures give an overview on the quality obtained with the Laser-MicroJet® technology.

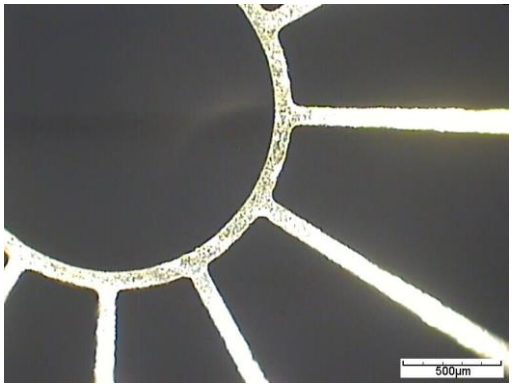


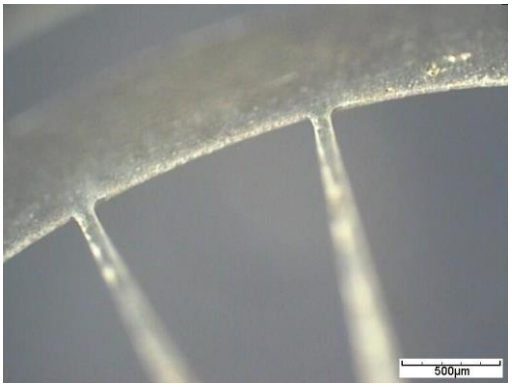
PICTURE 2: Drawing showing the cutting path for cutting of Hf

Please note that the customer requested to add the outer contour to the drawing provided in order to perform the tests.
Two laser sources (long and short pulse) were used to perform the tests and the table below summarizes the best cutting parameters:

LASER TYPE		Long pulse	Short Pulse	
LASER PARAMETERS	Frequency	20	*100*	*kHz*
	Pulse width	~140	*~16*	*ns*
	Power	6	*16*	*W*
	Power in jet	~4	*~8*	*W*
CUTTING PARAMETERS	Working distance	12	*12*	*mm*
	Motion speed	0.4	*0.3*	*mm/s*
	Pass numbers	1	*1*	
	Process time	~13	~18	*min*

- **Sample A: Hf cutting with a long pulse laser**

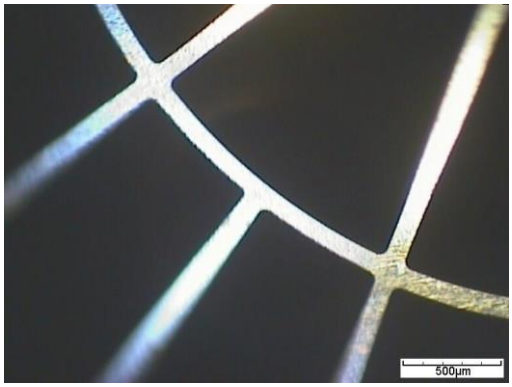




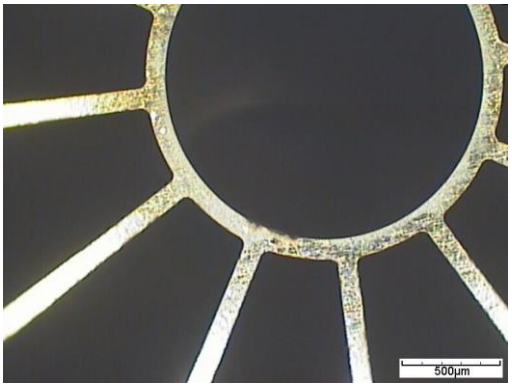
PICTURE 3: Microscope image of the frontside (dark field illumination)

PICTURE 4: Microscope image of the frontside (dark field illumination)

- **Sample B: Hf cutting with a short pulse laser**



PICTURE 5: Microscope image of the frontside (dark field illumination)

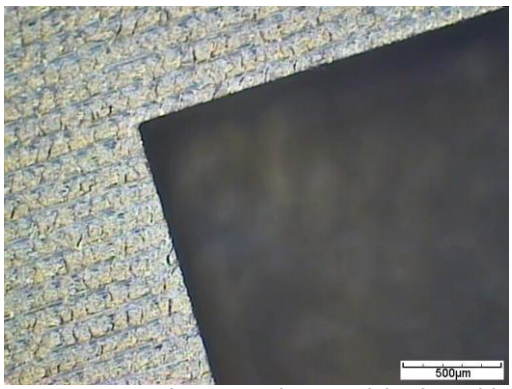


PICTURE 6: Microscope image of the frontside (dark field illumination)

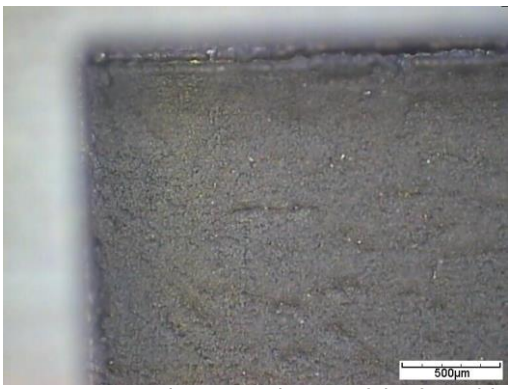
Note: A corner radius of 50 µm has been added to the original drawing to improve the contour accuracy.

Sample C: Grooving of Mo with a long pulse laser

LASER TYPE		Long pulse	
LASER PARAMETERS	Frequency	6	*kHz*
	Pulse width	160	*ns*
	Power	16	*W*
	Power in jet	~11	*W*
CUTTING PARAMETERS	Working distance	12	*mm*
	Motion speed	8	*mm/s*
	Pass numbers	6	
	Offset	20	*µm*
	Process time	~15	*min*



PICTURE 7: Microscope image of the frontside (Top view, dark field illumination)



PICTURE 8: Microscope image of the frontside backside (Bottom view, dark field illumination)

5. CONCLUSION

The cutting of Hf and Mo samples has been performed with a SYNOVA LCS150. 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 cutting Hf and Mo with high quality.

These tests show that:

- Cutting of Hf:

The cutting quality is very good especially with the short pulse laser. No burrs are visible on the frontside and the edges are sharp.
One bridge is visible on the sample processed with the short pulse laser. This can be easily solved by adjusting the cutting parameters.

- Grooving of Mo:

Grooving of ~400µm is feasible with a good overall quality. Further tests are required to optimize bottom quality.

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.