Berner Fachhochschule
Haute école spécialisée bernoise
Bern University of Applied Sciences

Ultra-high-precision and high speed surface structuring by synchronizing a galvo scanner with an ultrashort pulsed laser system

SWISSPHOTONICS Workshop
»Photonics 4 Precision Manufacturing«
June 15th, 2016

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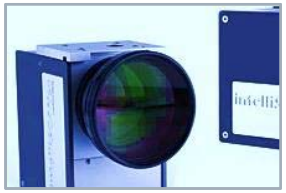
▸ Institute for Applied Laser, Photonics and Surface Technologies ALPS

SWISS PHOTONICS

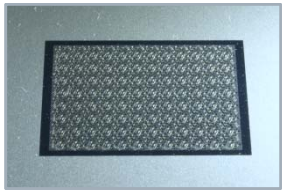
Outline

»Fast and Furious«

Introduction



Synchronized Scanner Setup



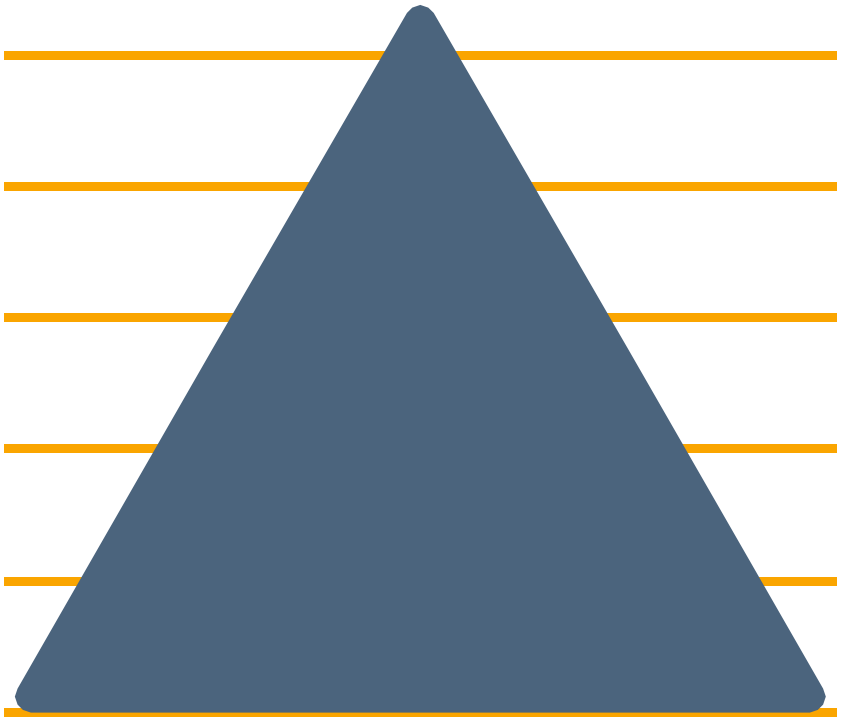
Applications

Summary and Outlook

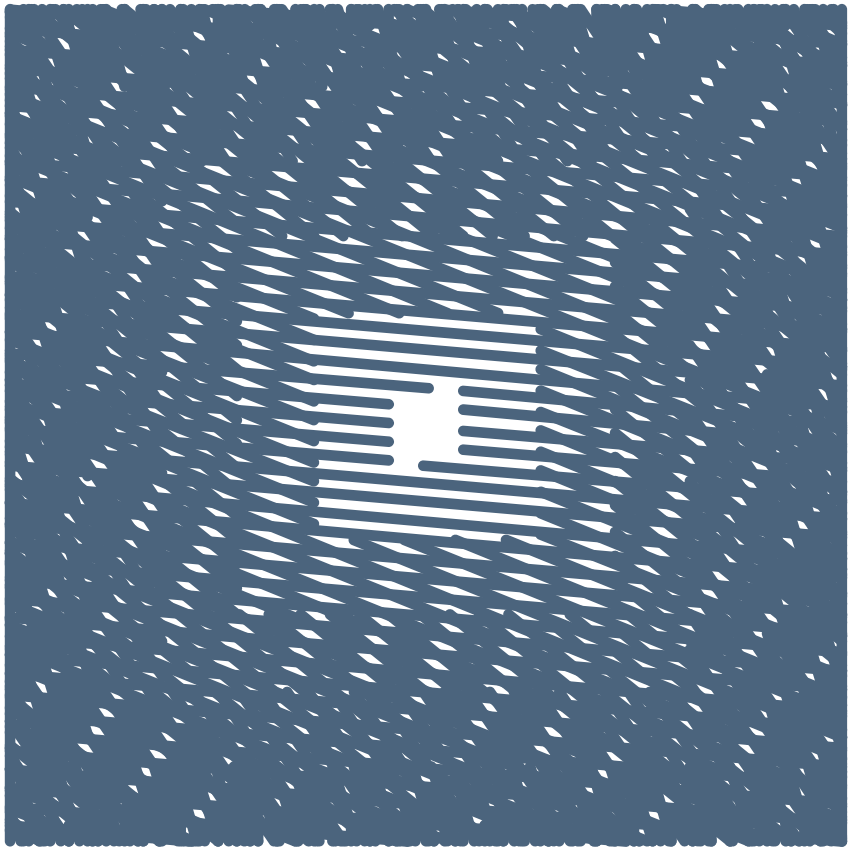
Introduction

Introduction

Conventional Processing

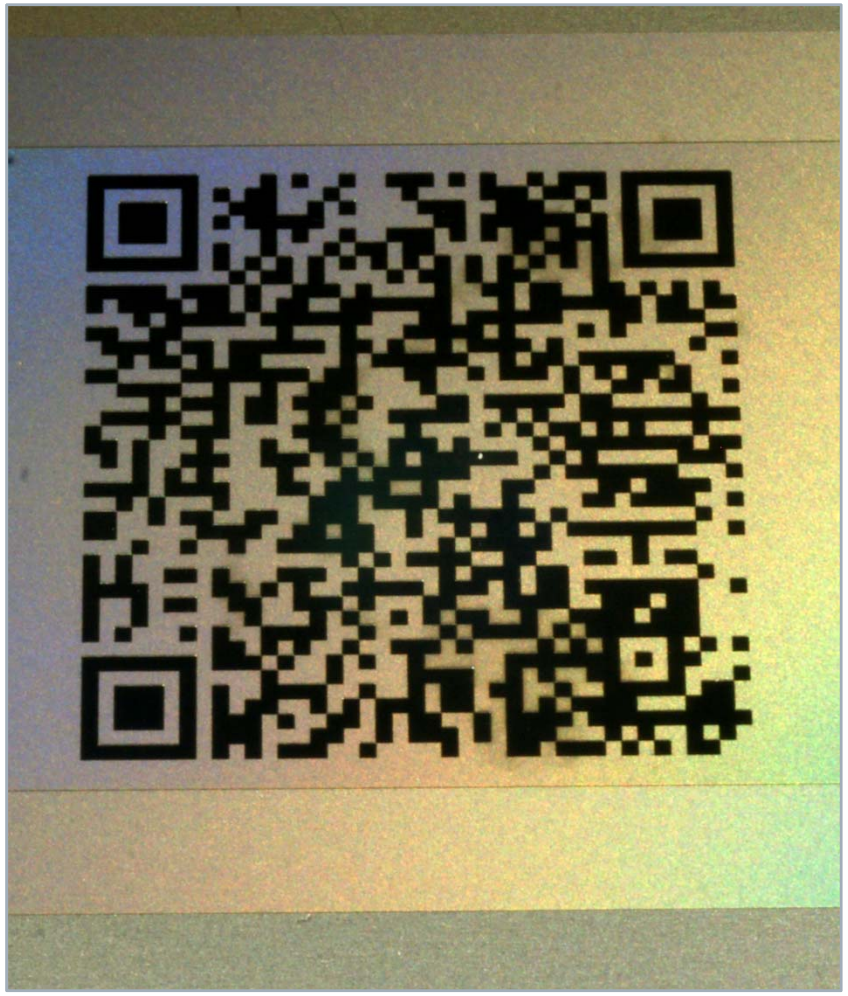


- 2.5D / 3D structure is sliced
- generation of layers
- typical layer thickness 0.1 µm



- Each layer is filled with hatch pattern

Introduction



Advantages

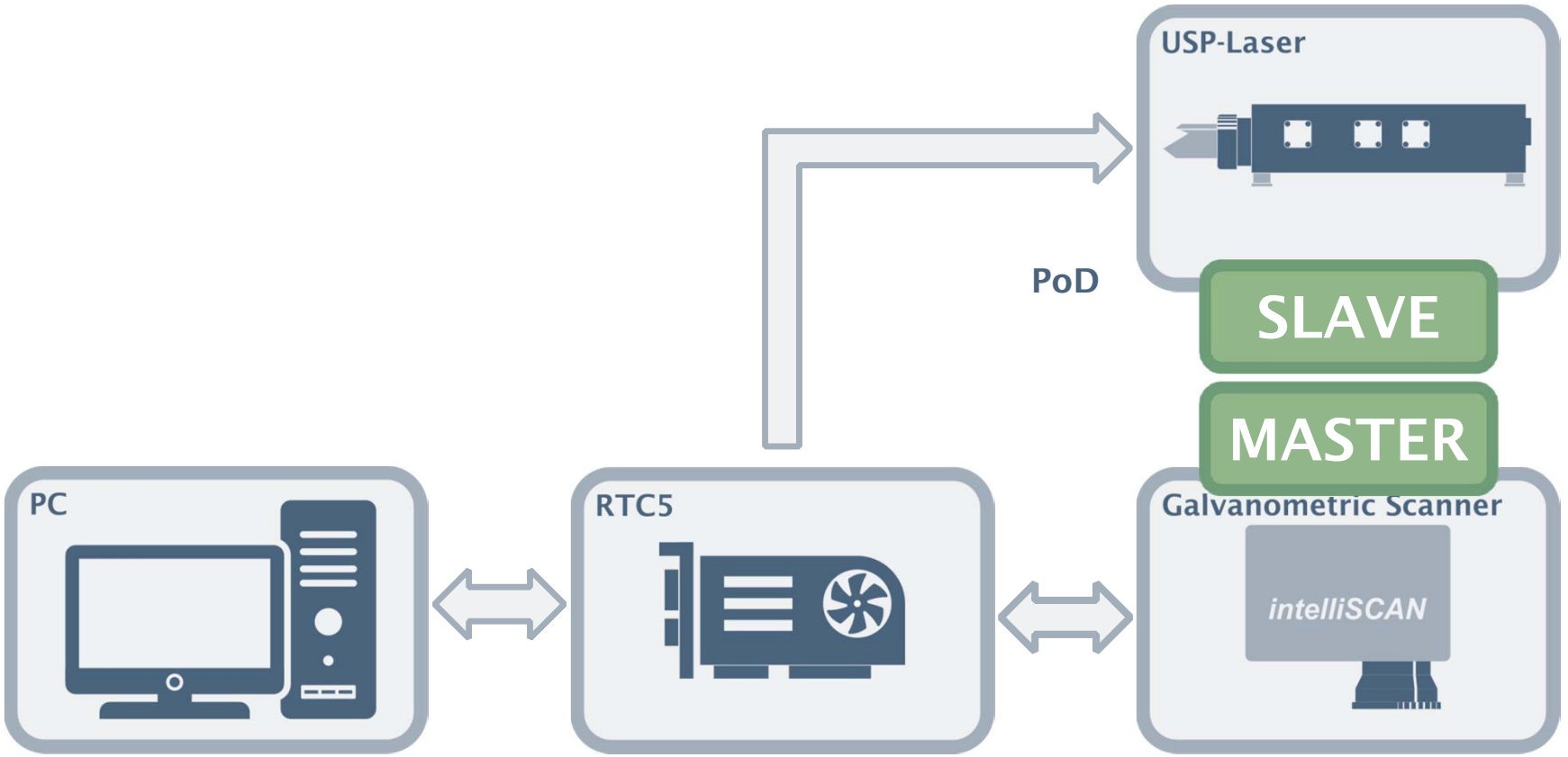
- flexible
- easy to use
- reliable
- industry proven
- mass-production compatible

Restrictions

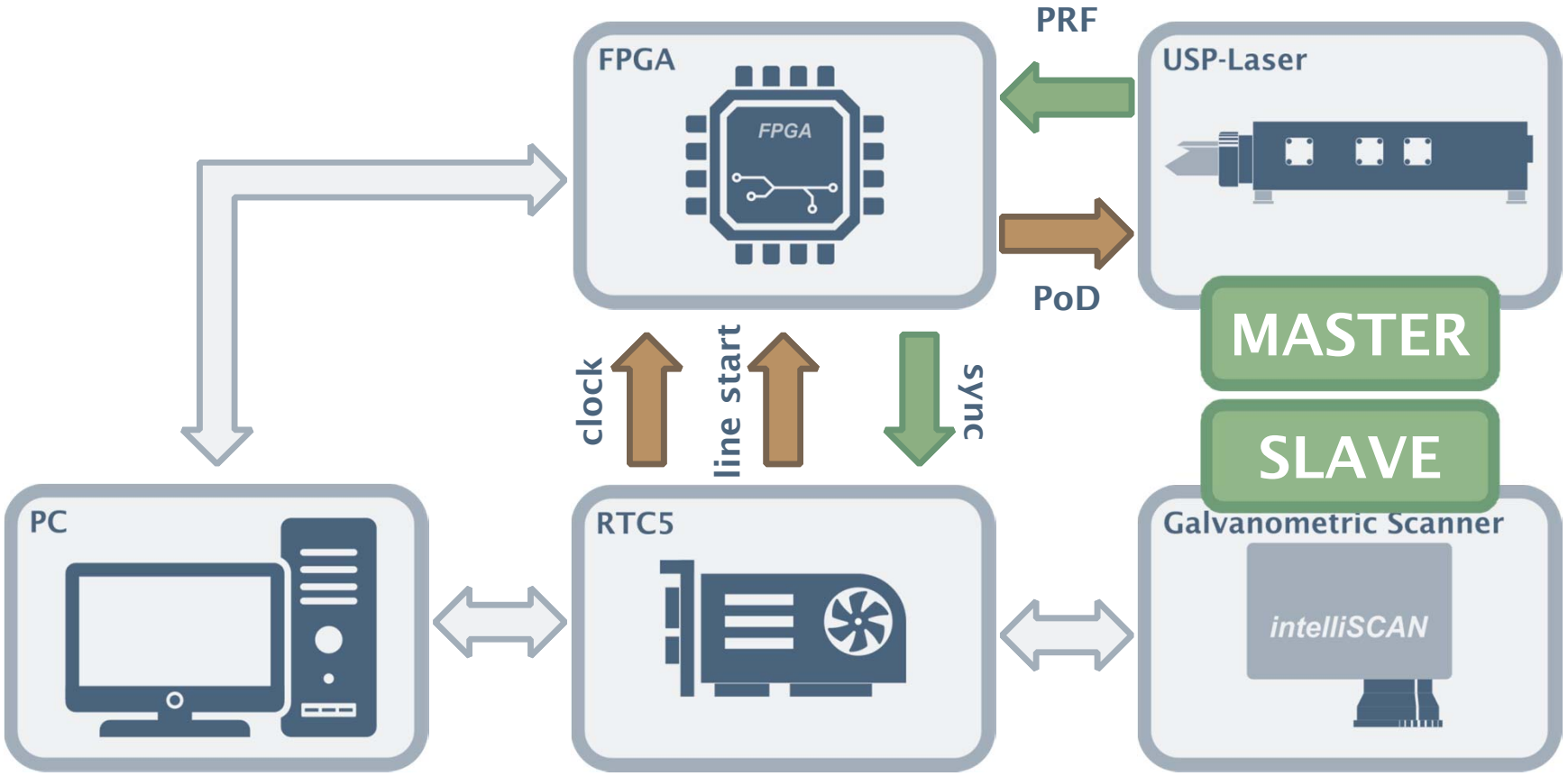
- short vectors
- acceleration / deceleration

Synchronized Scanner Setup

Standard laboratory setup



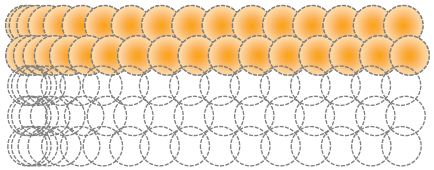
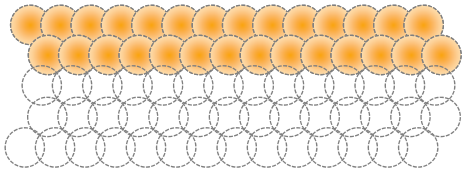
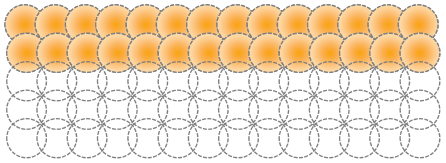
Synchronized scanner setup



Jaeggi B., Neuenschwander B. et al.:
"Ultra-high-precision surface structuring by synchronizing a galvo scanner with an ultra-short-pulsed laser system in MOPA arrangement"
Proceedings of SPIE 8243, (2012)

Synchronized scanner setup

Scanner Modes

normal operation	sky writing	synchronized
		
“acceleration” problem well defined border deep marking at borders	diffuse border no deep marking	well defined border no deep marking

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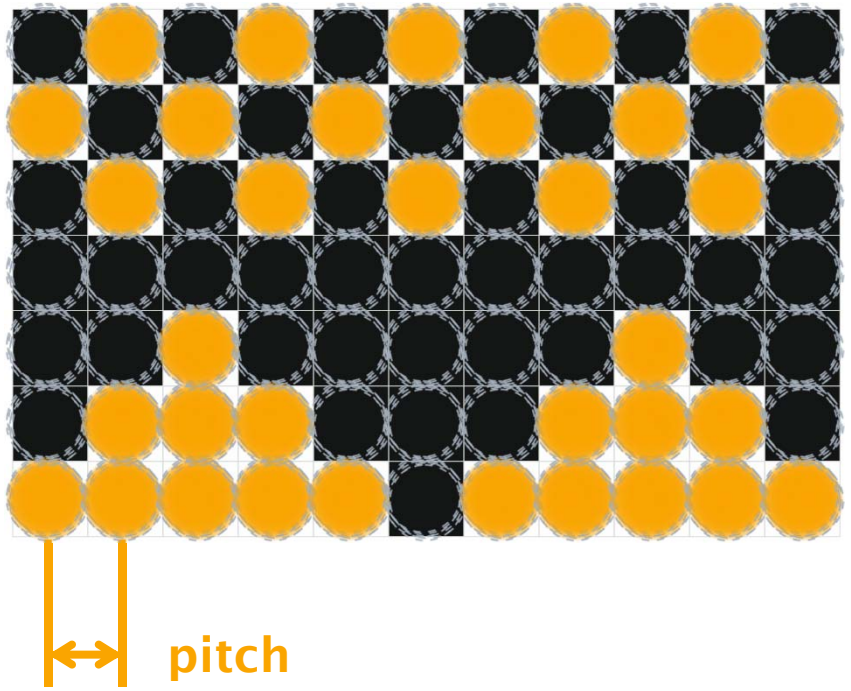
Synchronized scanner setup

SYNCHRO Instruction Manual

- create black & white bitmap
- define pitch
- specify number of repetitions

  or
- define config file
- distribute start points



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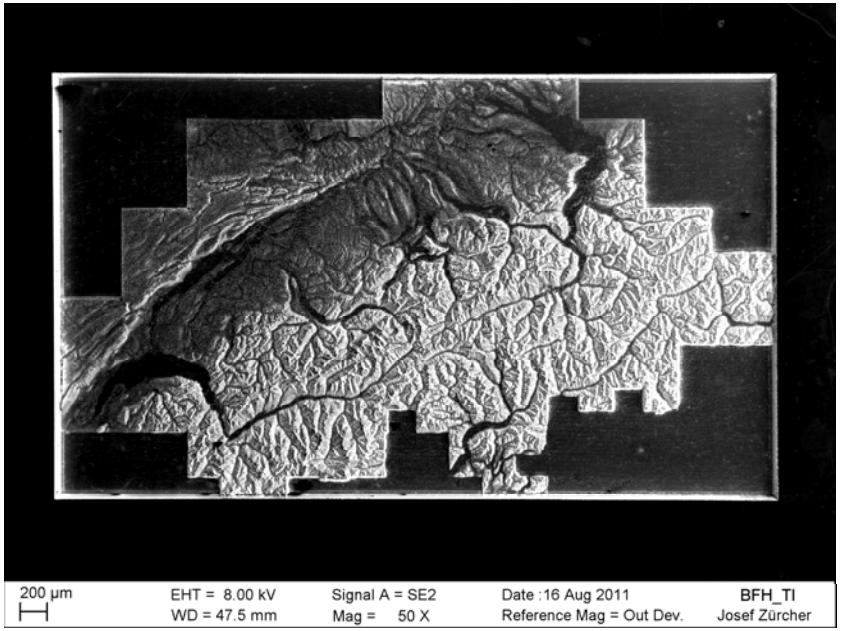
Applications

Applications

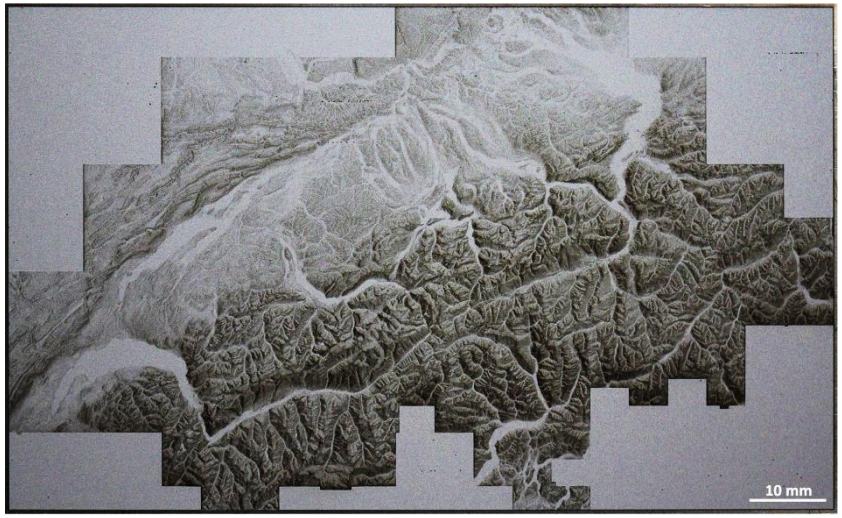
Repetition rate	f_{rep}	0.3	MHz
Average Power	P_{ave}	0.1	W
Pitch:		3.0	µm
Scan speed	v_{scan}	0.9	m/s
		447	layers



http://www.swisstopo.admin.ch/internet/swisstopo/de/home.html

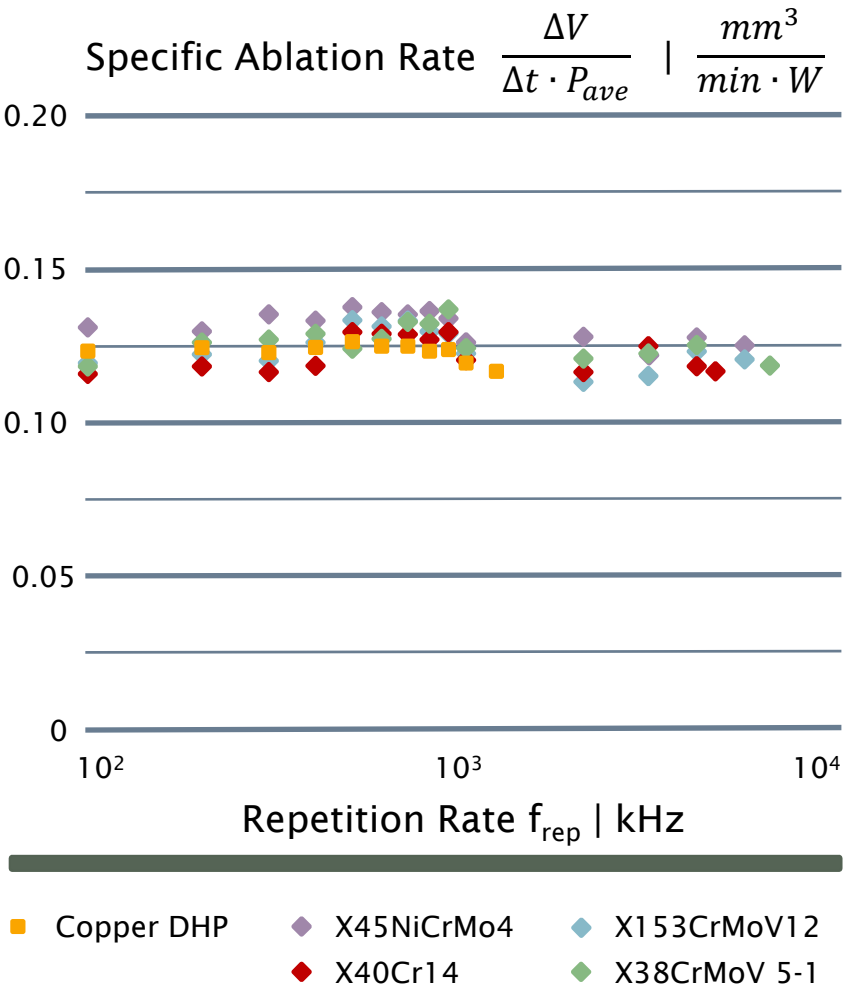
Jaeggi B., Neuenschwander B et al.
High precision and high throughput surface structuring by synchronizing mechanical axes with an ultra-short pulsed lasers system in MOPA arrangement
ICALEO paper M1207 (2012)

Applications

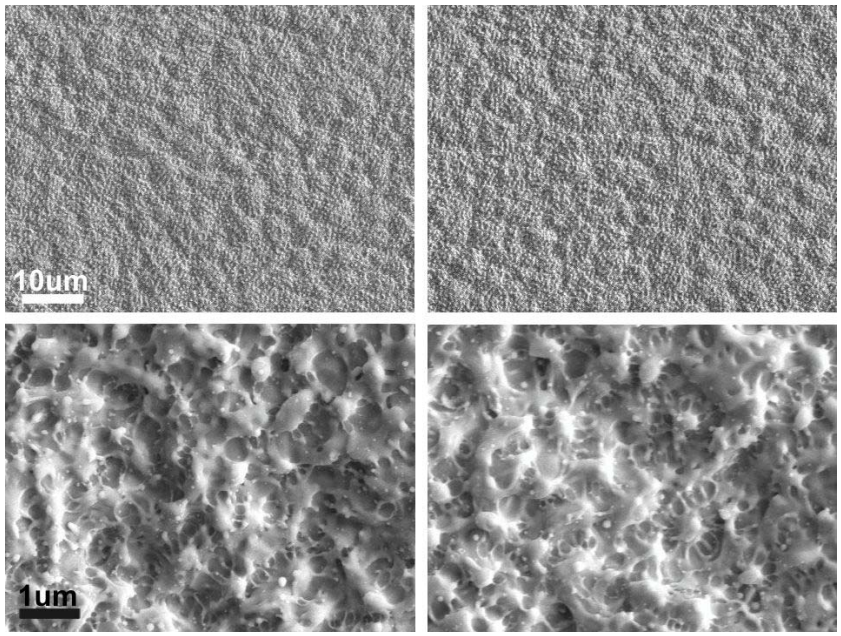


Repetition rate	f_{rep}	4.1	MHz
Average Power	P_{ave}	25.6	W
Pitch:		14.5	µm
Scan speed	v_{scan}	59.5	m/s
Polygon scanner		2233	layers

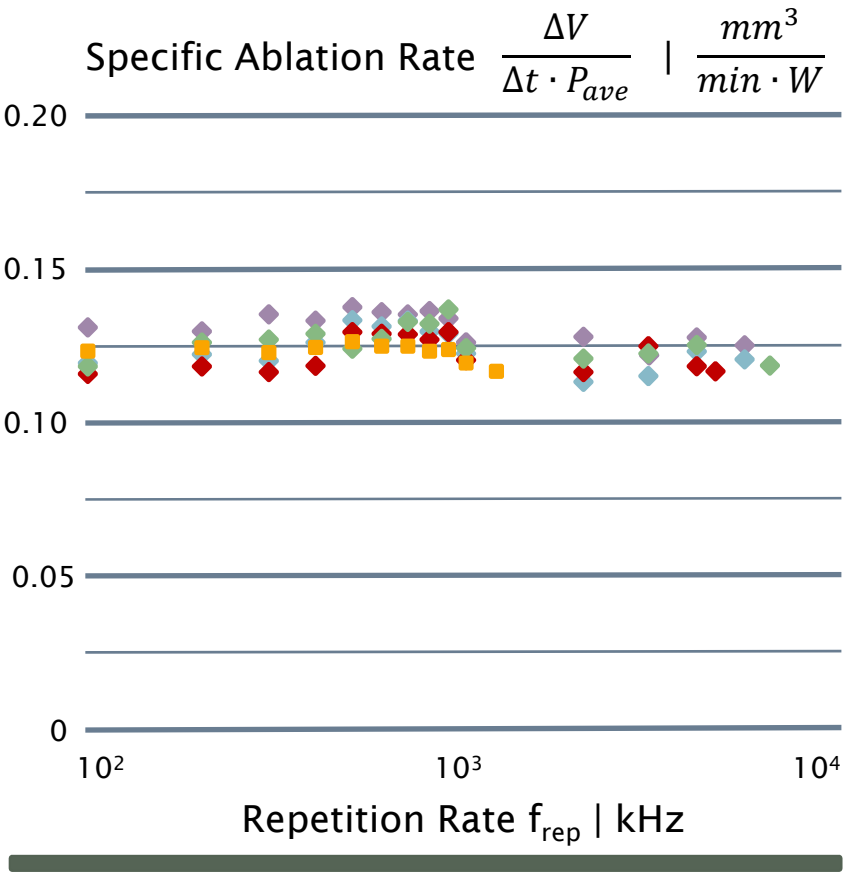
Neuenschwander B., Jaeggi B. et al.
Influence of Particle Shielding and Heat Accumulation Effects onto the Removal Rate for Laser Micromachining with Ultra-Short Pulses at High Repetition Rates
ICALEO paper M1104 (2014)



Applications



P_{ave}	12 W	42 W
f_{rep}	2.05 MHz	6.83 MHz



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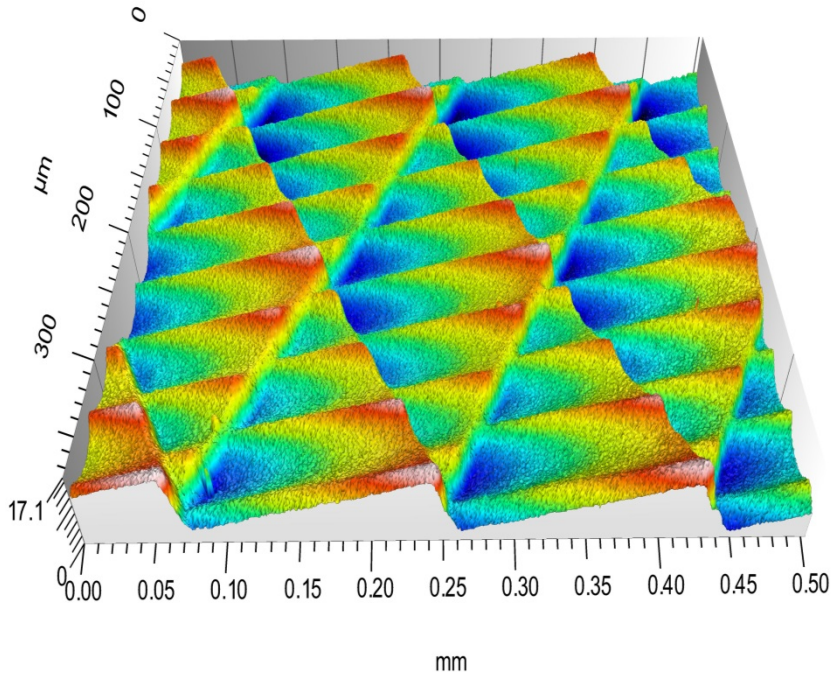
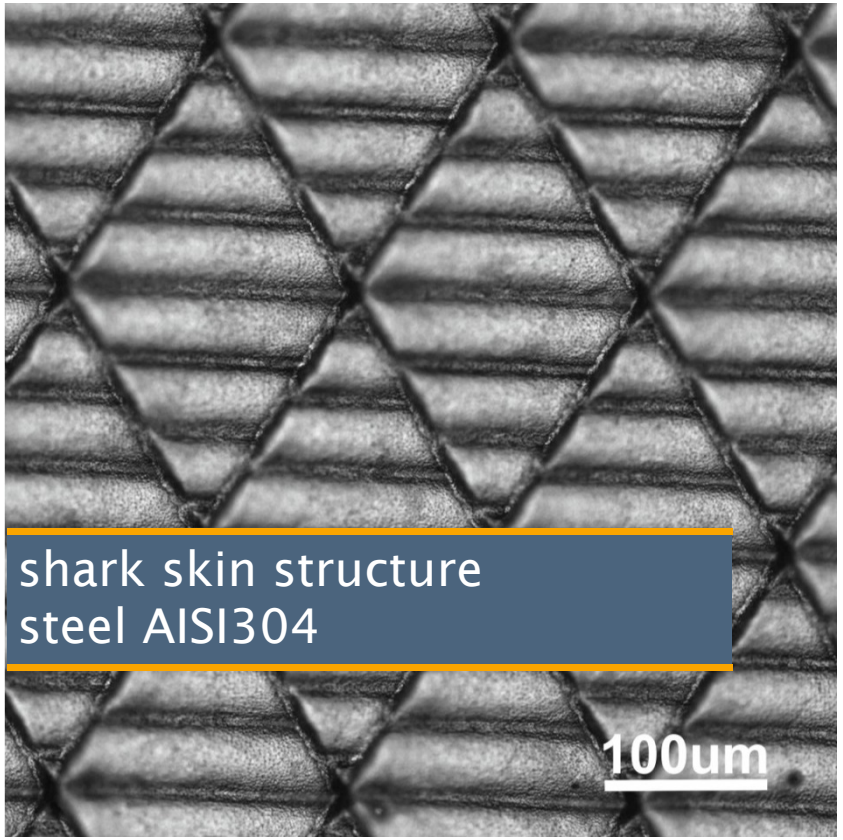
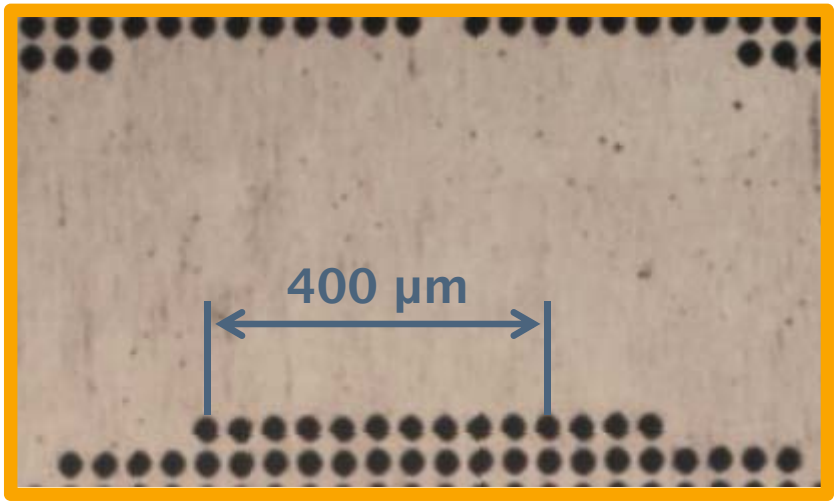


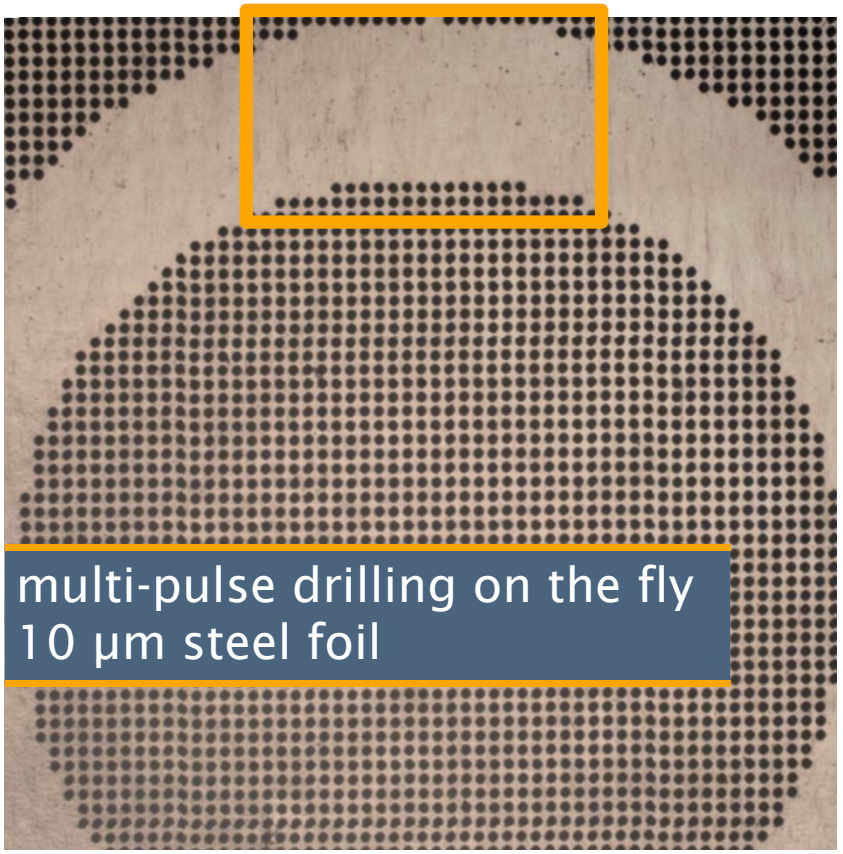


Jaeggi B.
Grundlagen zur Ablaufoptimierung beim Raster-Scannen mit synchronisiertem Galvo-Scanner
BFH, MSE Vertiefungsarbeit 1 (2015)

Applications

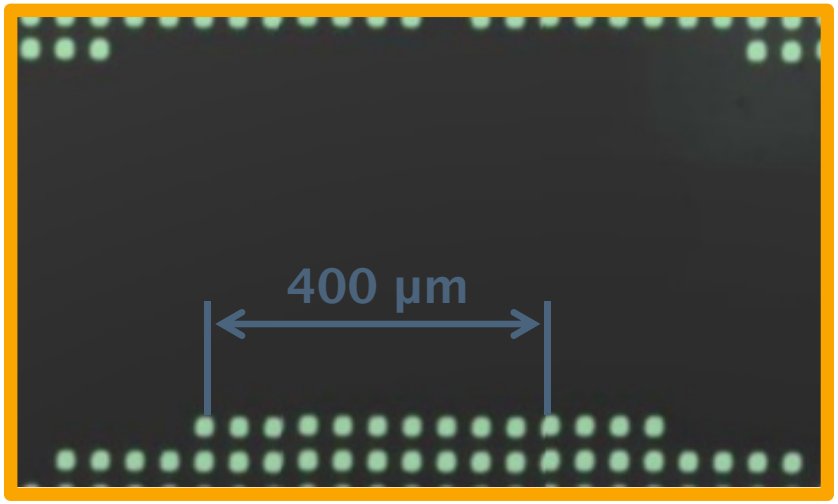


Repetition rate	f_{rep}	0.2	MHz
Average Power	P_{ave}	1.8	W
Pitch:		40.0	µm
Scan speed	v_{scan}	8.0	m/s
Picture size		250 x 250	pixels



Jaeggi B., Neuenschwander B. et al.
High Precision Surface Structuring with ultra-short Laser Pulses and Synchronized Mechanical Axes
LiM, Physics Procedia 41 (2013)

Applications



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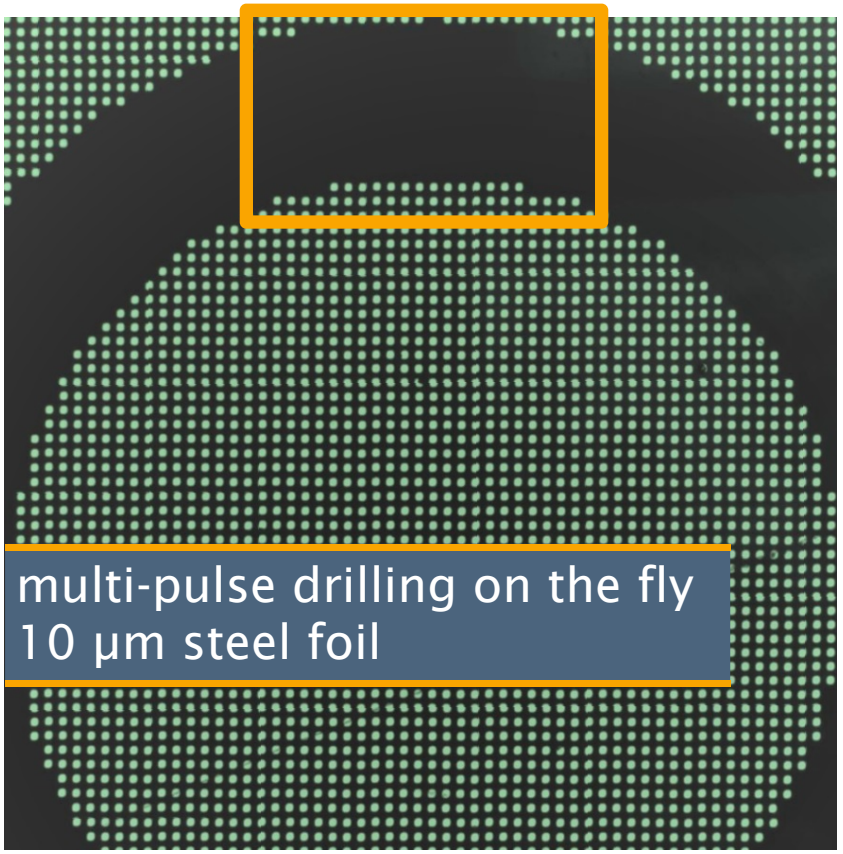

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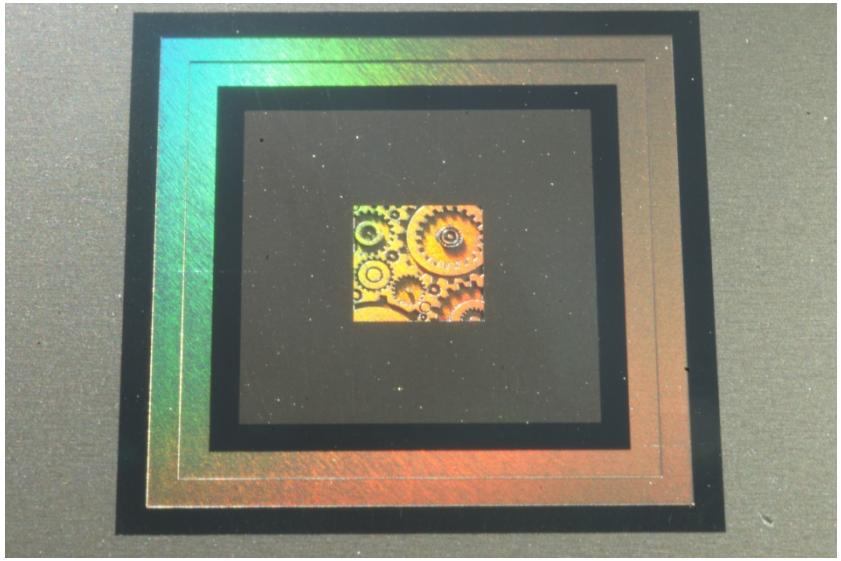
Applications

Microstructuring on stainless steel

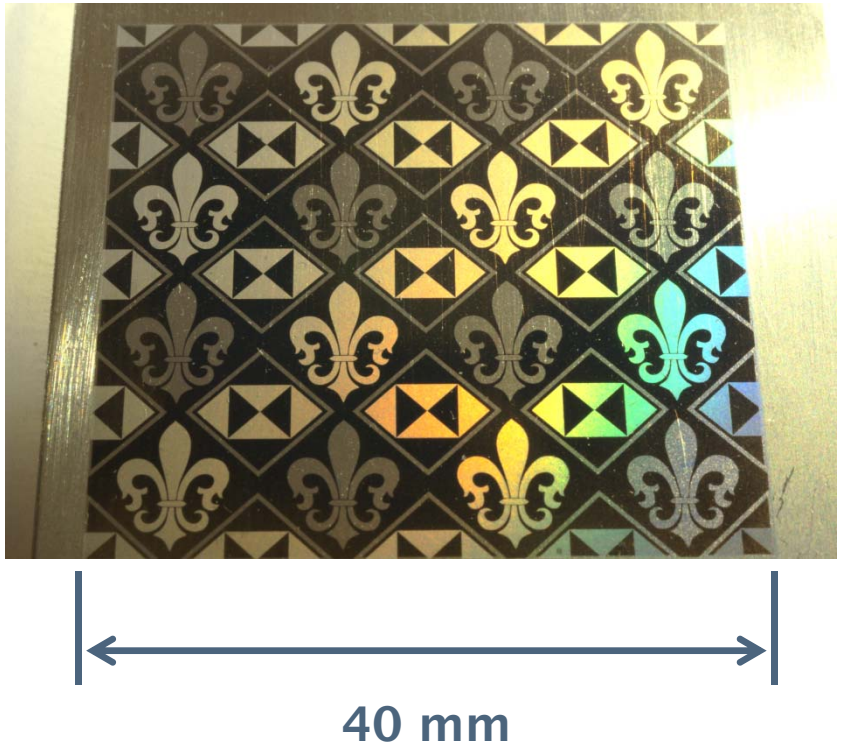


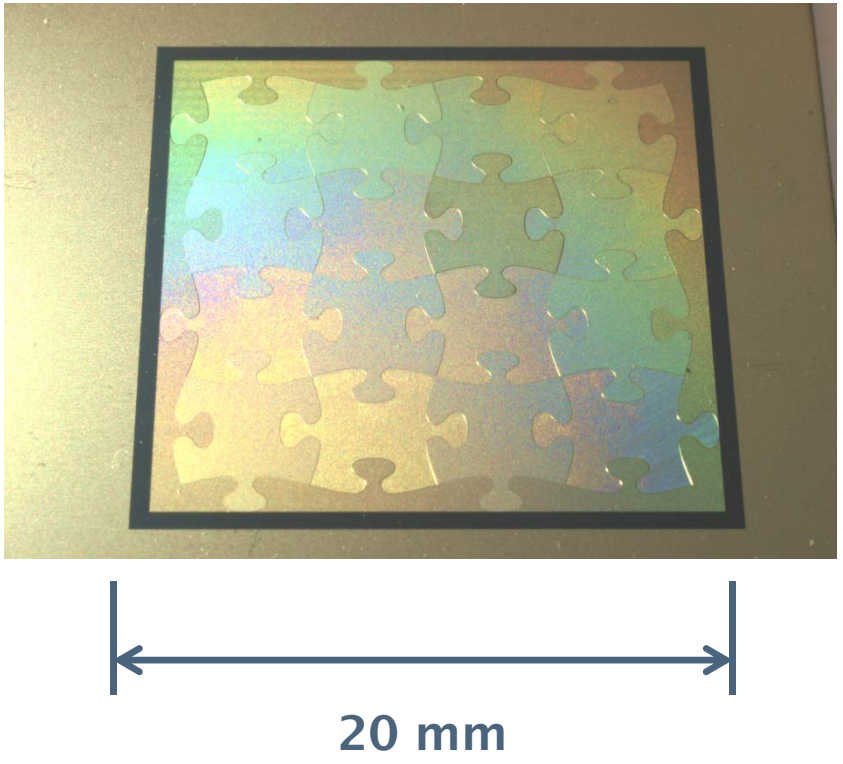
20 mm

20 mm

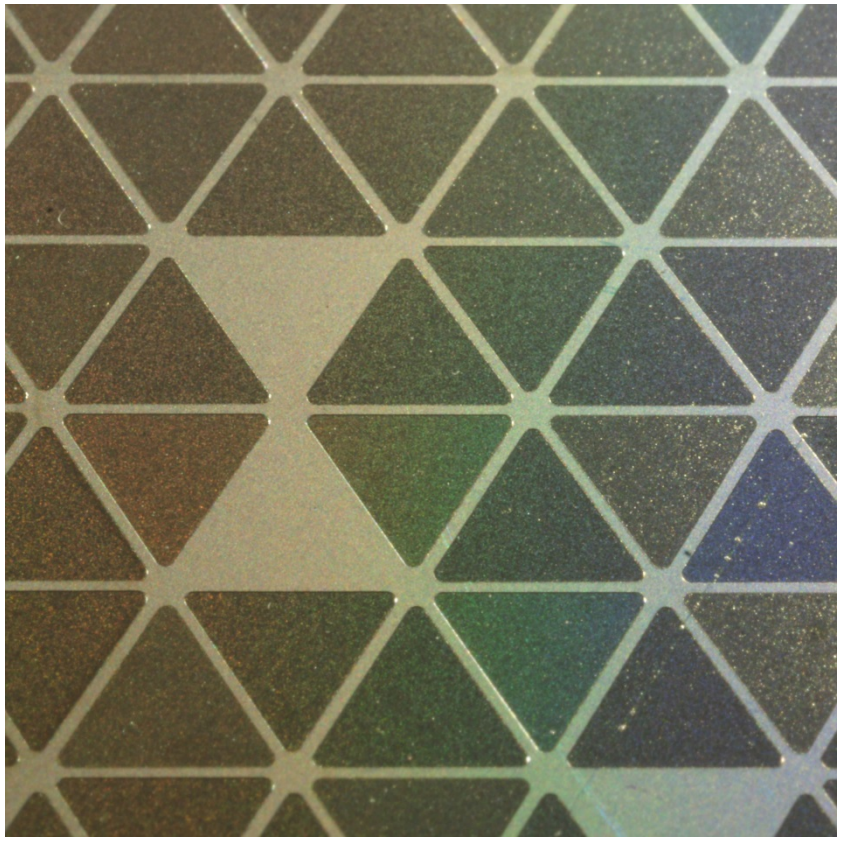
Applications

Microstructuring on stainless steel

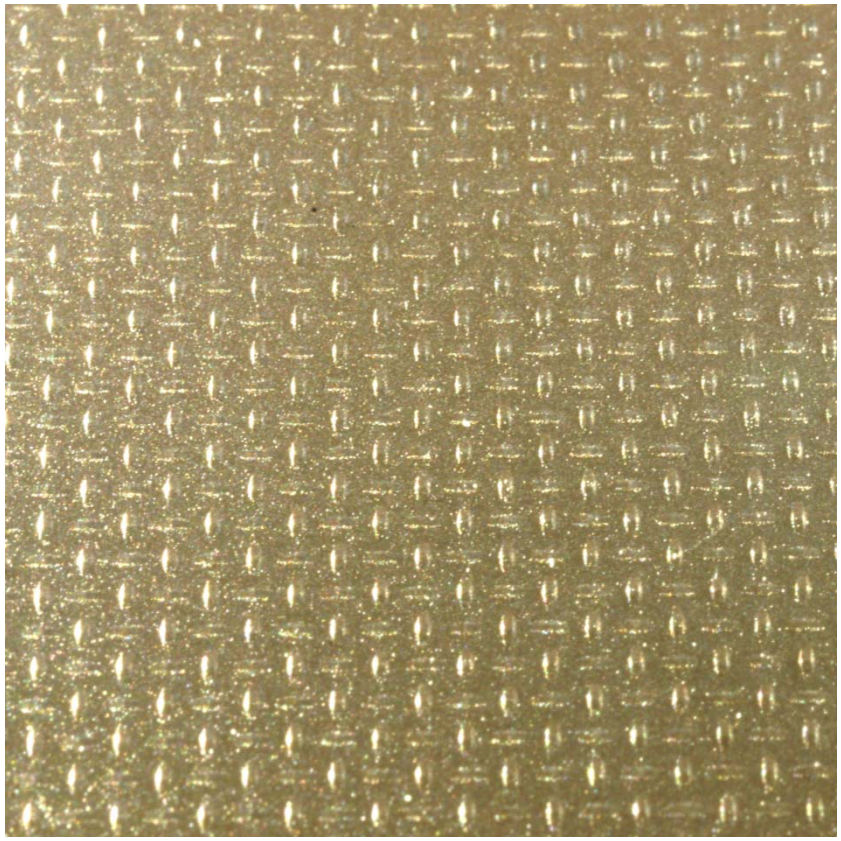


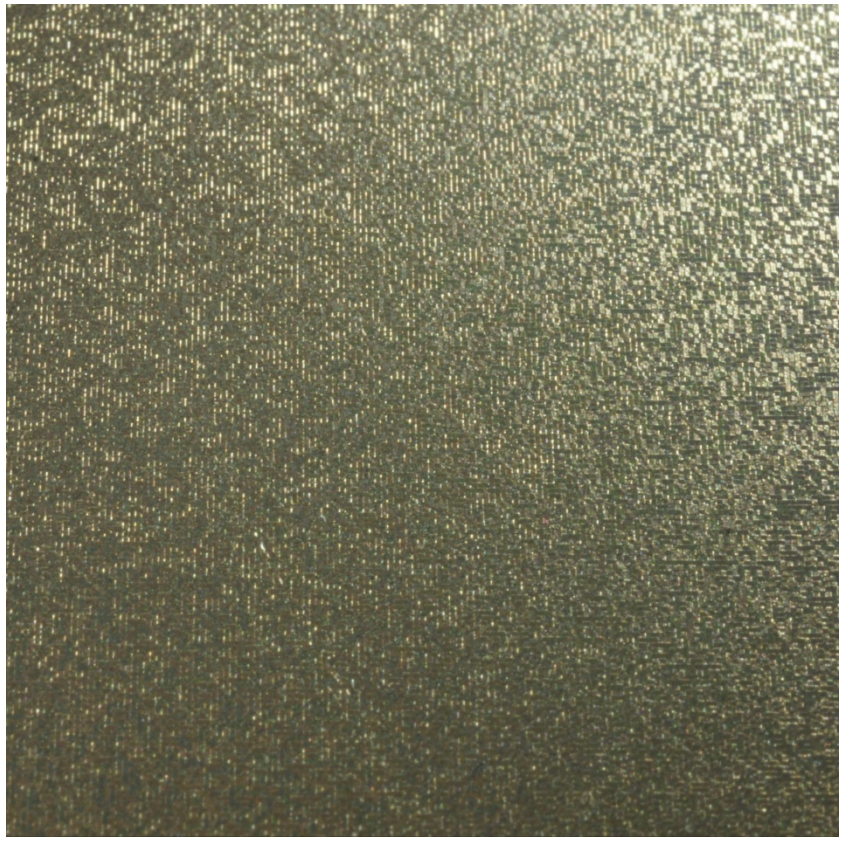


Applications

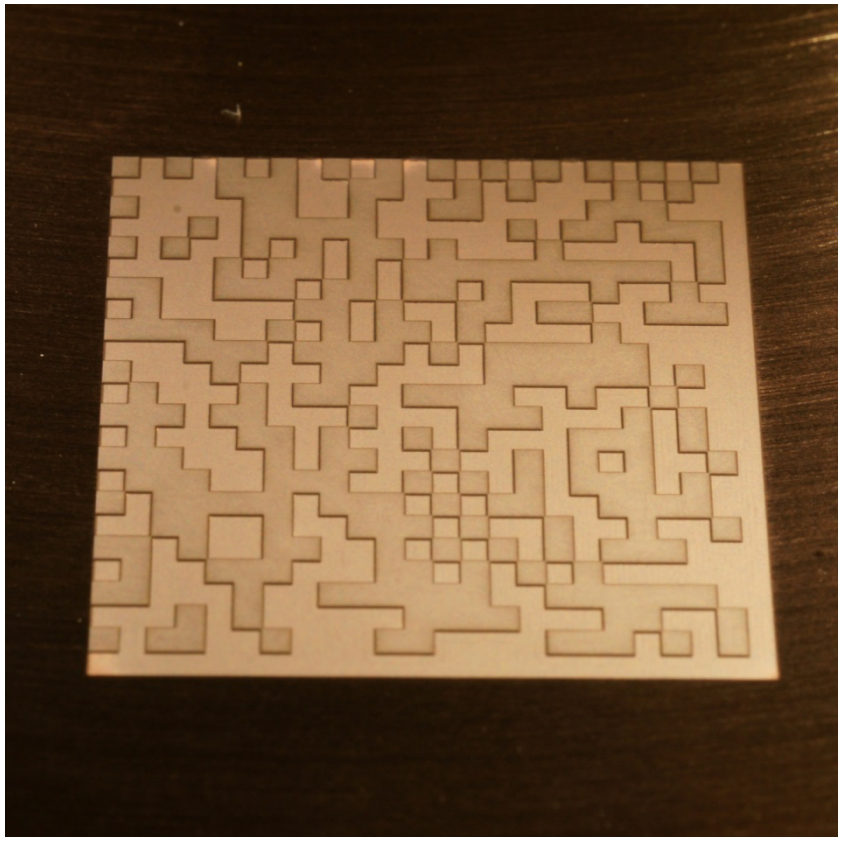


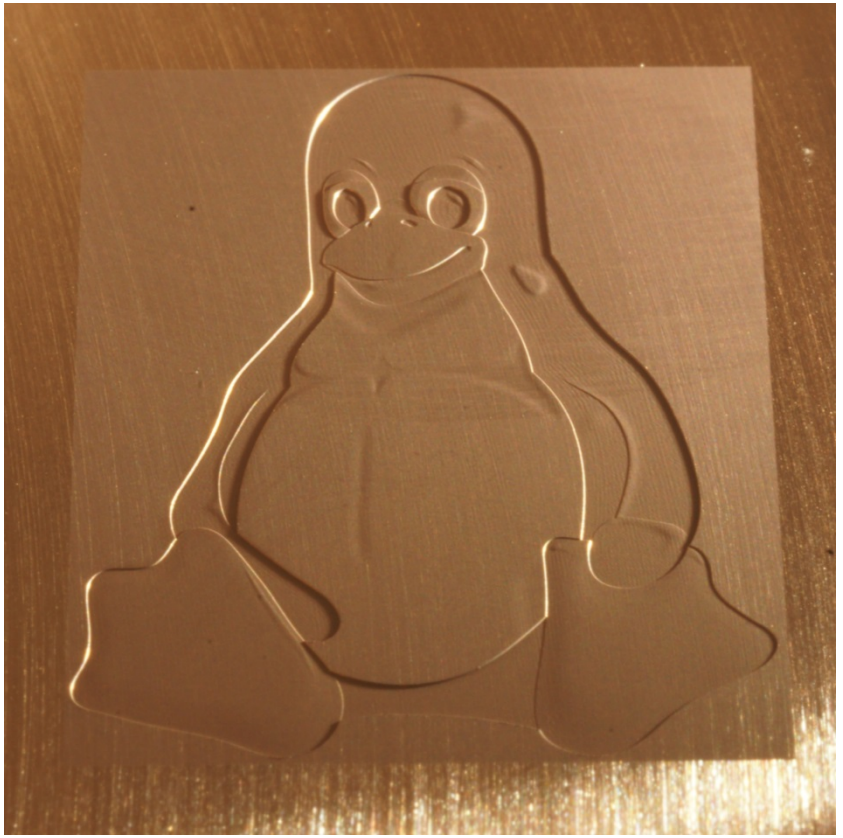
Applications





Applications





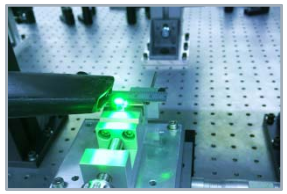
Microstructuring on copper

Summary and Outlook

Summary and Outlook

SYNCHRO

- fast
  - intelliSCAN$_{DE}$ > 10 m/s intelliSCAN$_{SE}$ > 25 m/s



- precise < 2 microns
  - limited by single pulse picking (PoD)

- enabling multi-level processing
  - microstructuring
  - matting
  - polishing

Acknowledgement

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Haute école spécialisée bernoise
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Do you have any questions?

We would be happy to help.

Meet us at booth E112