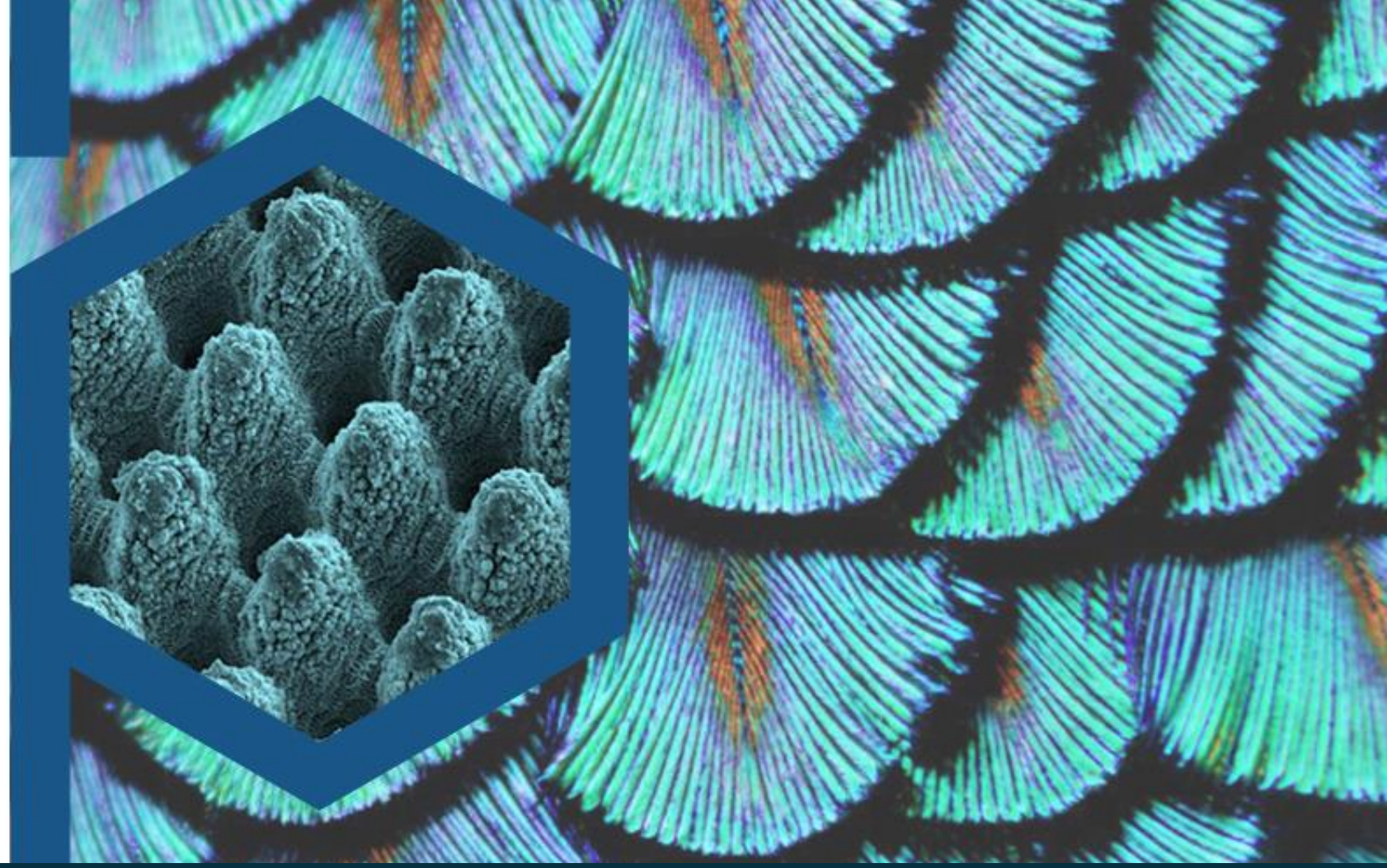

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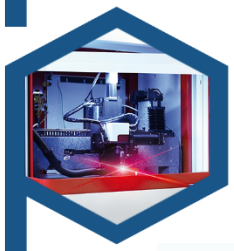
Nikolai Schröder[1], Sascha Teutoburg-Weiss[1], Germán Vergara[2], Andrés F. Lasagni[1,3]

[1] Technische Universität Dresden, Germany; [2] New Infrared Technologies, Spain; [3] Fraunhofer IWS, Germany

New Approach for Monitoring a DLIP Process – the LAMpAS project –

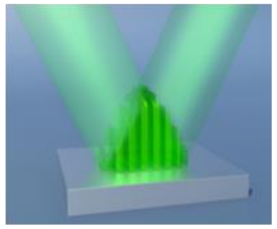


CAMP - Center for Advanced Micro-Photonics

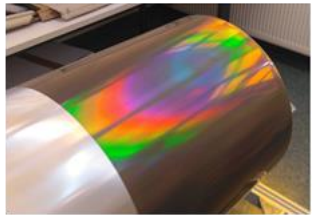
LAMPAS

Dresden, Saxony, Germany

From basic research to industrial applications








TECHNISCHE UNIVERSITÄT DRESDEN

CAMP
CENTER FOR ADVANCED MICRO–PHOTONICS

Fraunhofer IWS

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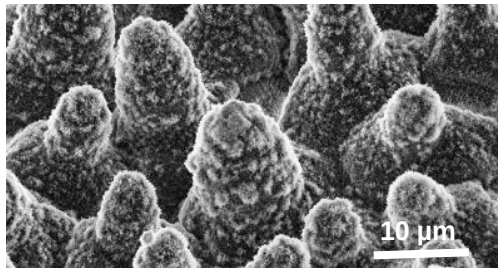
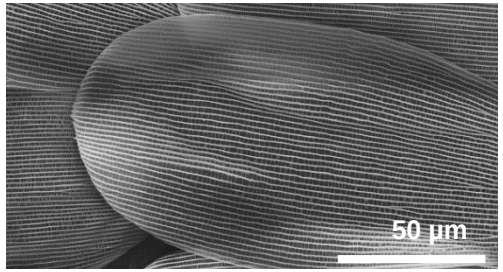
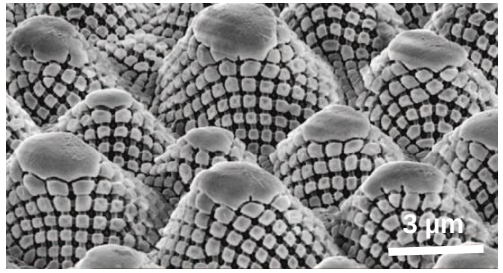
Nature is inspiring us!

	Nature	Surface	Application	
Plant leaf				Water repellent self-cleaning
	Ensikat et al., Beilstein, 2011			
Butterfly				Decorative finish
	Z. Schnepp, Butterfly wings, https://schneppgroup.wordpress.com			
Bug				Antibacterial
	Hensel et al., NPG Asia Materials, 5, e37, 2013			

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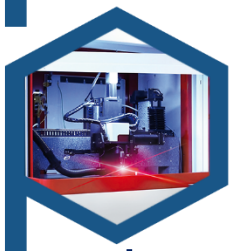
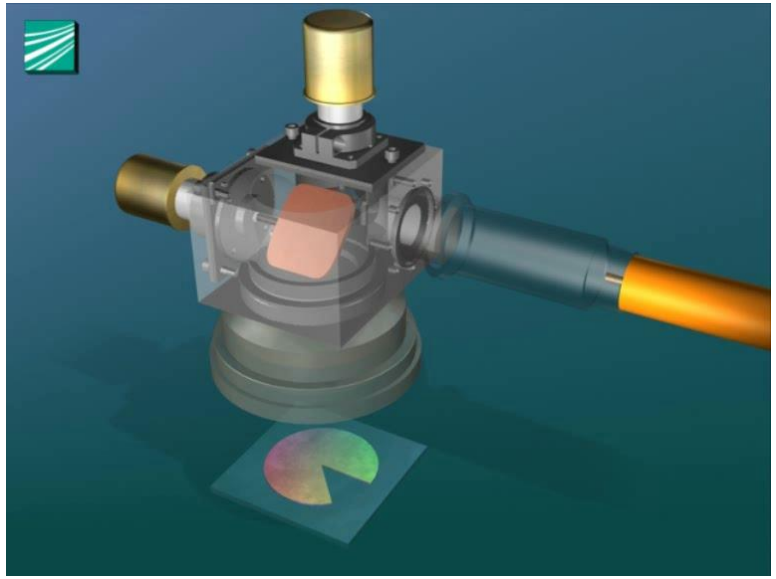


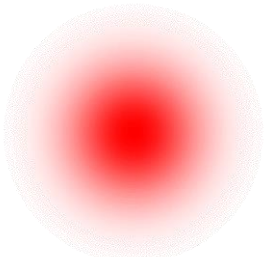
Technologies at CAMP

Direct Laser Writing (DLW)



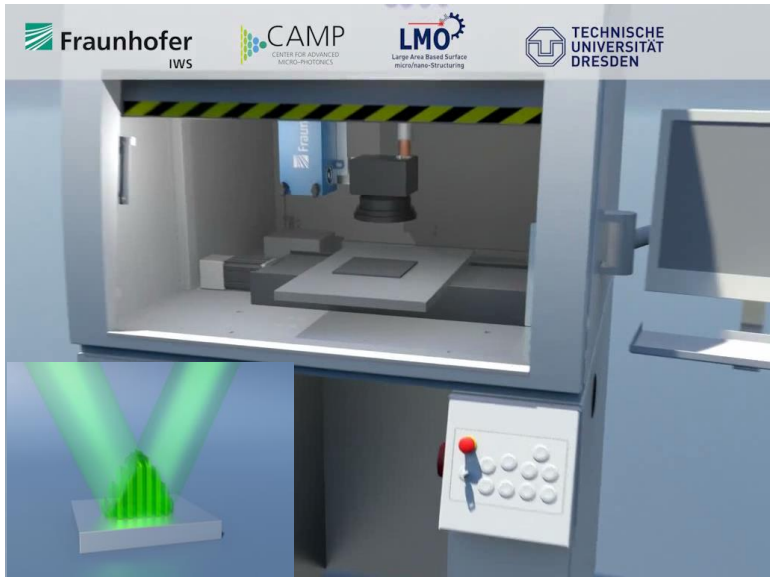
5 – 30 µm

Slower micro fabrication speed



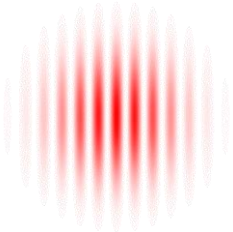
Energy distribution

Direct Laser Interference Patterning (DLIP)



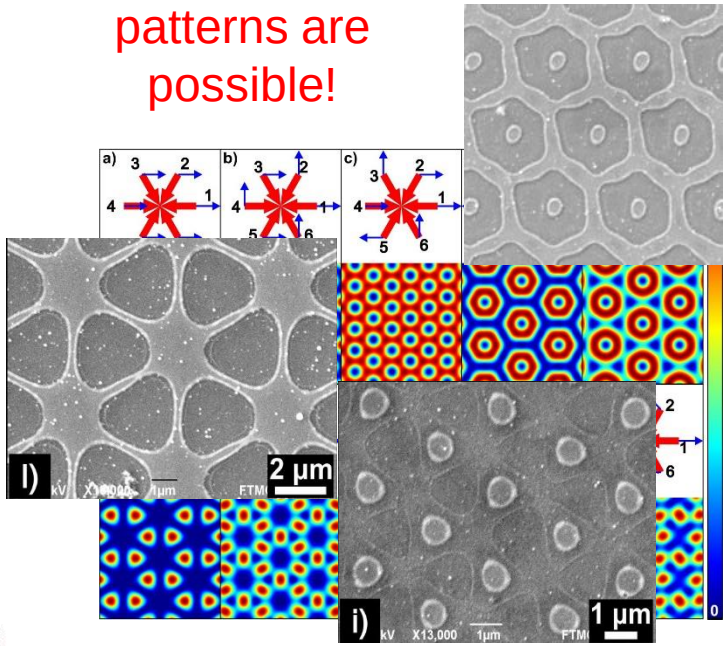
150 nm – 30 µm

Faster micro fabrication speed



Energy distribution

Thousands of patterns are possible!



S. Indrišiūnas, B. Voisiat, M. Gedvilas, G. Račiukaitis, Journal of Laser Applications, 29(1), 11501 (2017).
C. Zwahr, B. Voisiat, A. Welle, D. Günther, A.F. Lasagni, Adv. Eng. Mater., 20, 1800160 (2018)
B. Voisiat, C. Zwahr, A. Rank, S. Alamri, A.F. Lasagni, Appl. Surf. Sci., 471 1065–1071 (2019)

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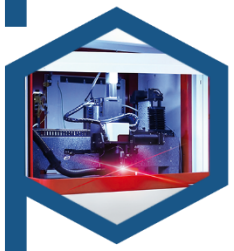
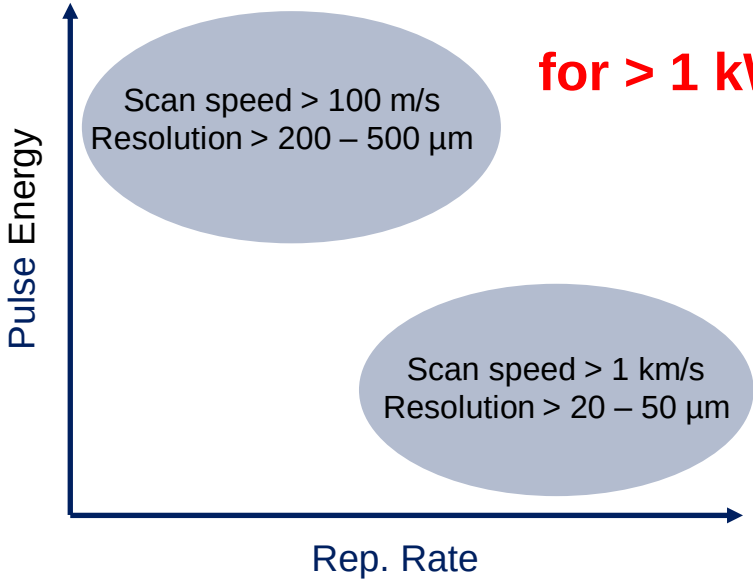
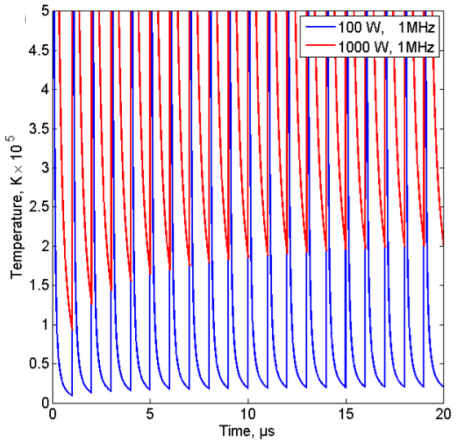


How to produce µ-nm/structures at high throughput?

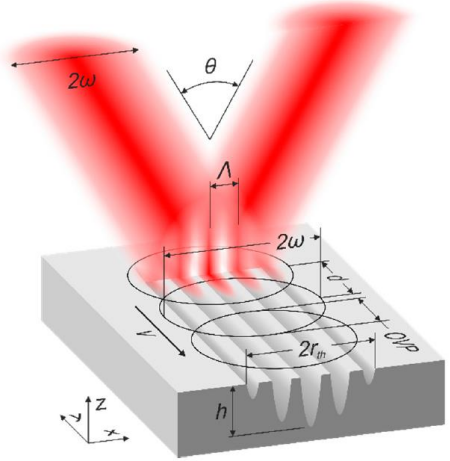
The high-power laser processing paradigm

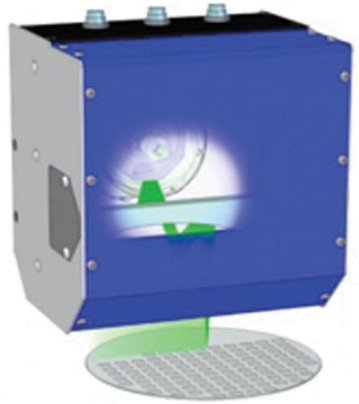


for > 1 kW



Heat accumulation!





- **Scenario 1**: low pulse energy (µJ) and high rep. rates (GHz – THz!)
  - Scanning speeds of several km/s required
  - Significant heat accumulation
- **Scenario 2**: high pulse energy (mJ) and moderate rep. rates (few GHz)
  - Large spot sizes
  - Low feature size resolution
- **Scenario 3**: high pulse energy (mJ), moderate rep. rates and utilization of interference patterns!
  - Scanning speeds of some 100 m/s required
  - Lower heat accumulation
  - Higher resolution due to interference pattern!

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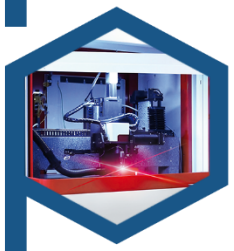
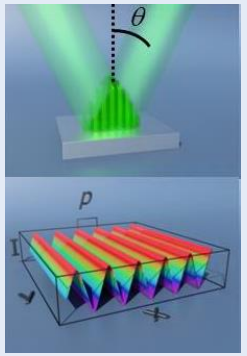
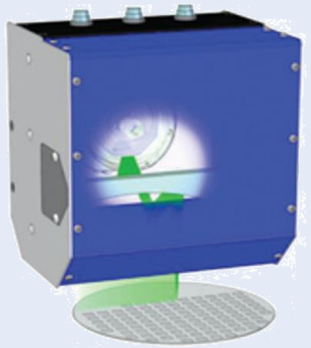
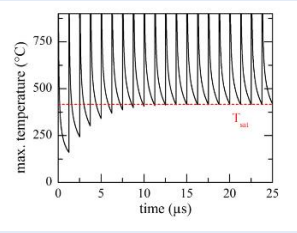


The idea of LAMpAS

“**Multi-beam high-speed processing**” with interference patterns on large spots delivered to the material surface by polygon scanners!

High resolution multi-beam processing	High-speed beam deflection	Ultra-short pulse laser ablation	In-line monitoring	System design and integration	Demonstration, validation and simulation
					
Interference Patterning	Polygon scanner	High-power USP laser	Process control	Process development	Product development

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Project partners

Laser development

TRUMPF

Beam delivery

next scan technology

TECHNISCHE UNIVERSITÄT DRESDEN

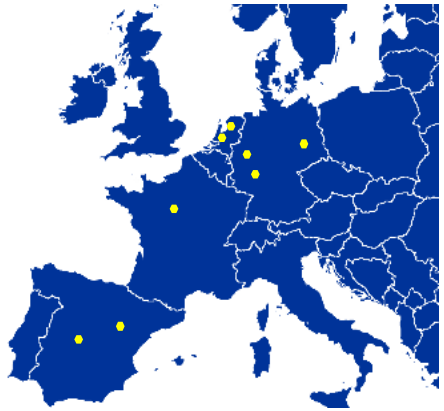
Process monitoring

NIT New Infrared Technologies

TECHNISCHE UNIVERSITÄT DRESDEN

Process simulation

BOSCH



System integration

lasea PRECISION LASER SOLUTIONS

Demonstration and validation

BOSCH

B/S/H/

Dissimination

EPIC European Photonics Industry Consortium

Coordination

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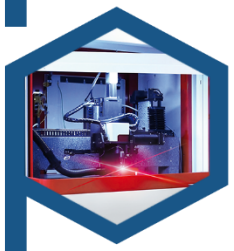


Unique in-line monitoring system

Combination of…

In-line monitoring of two process effects

- Accumulated heat
- Topography quality assessment of patterned structure

High-speed infrared camera

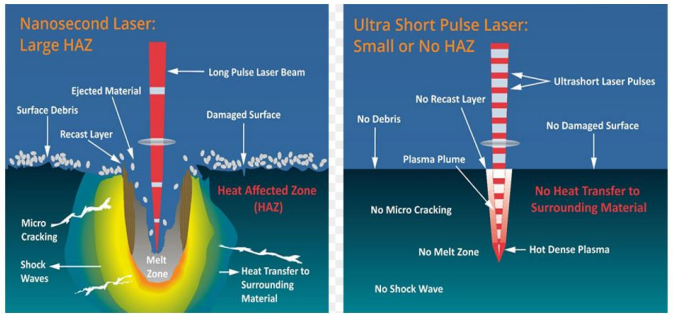
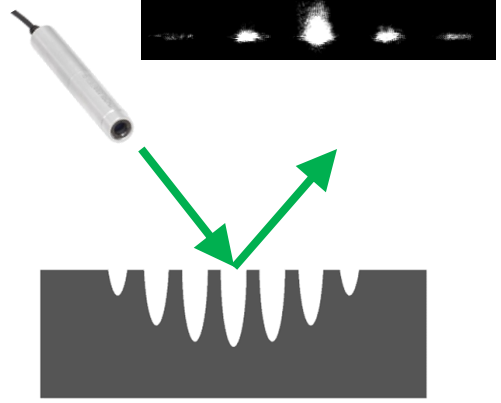


Image reference: "Ytterbium picosecond pulsed fiber laser" by IPG photonics

Fast-Fourier-Transform (FFT) system



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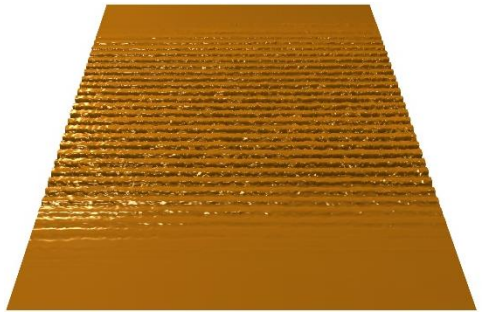
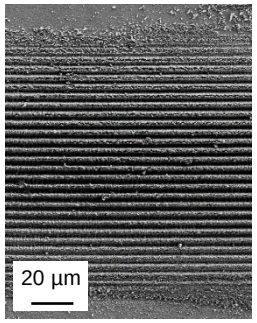
Unique in-line monitoring system

Stainless steel (AISI 304)

Good surface condition

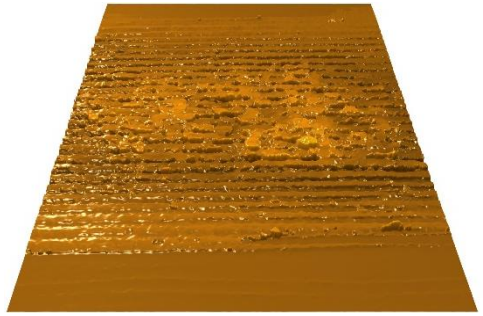


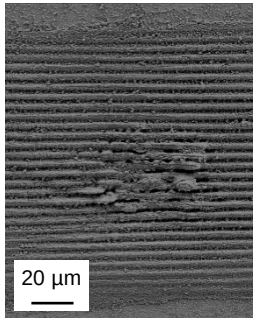


F = 0.24 J/cm²

…with no significant resolidified material

Bad surface condition

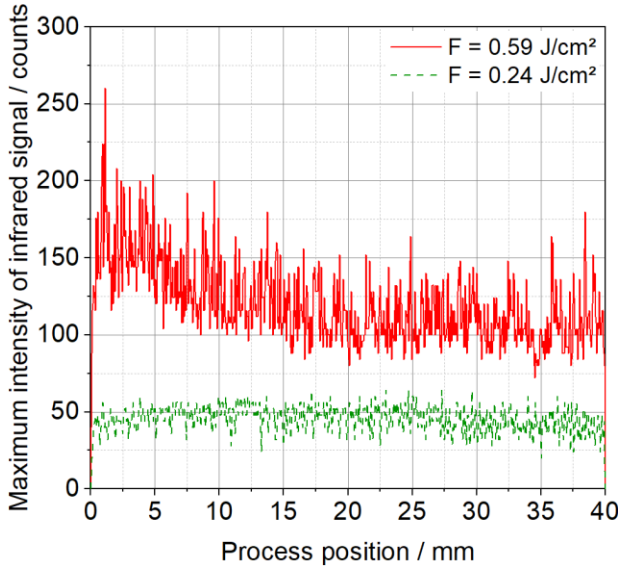




F = 0.59 J/cm²

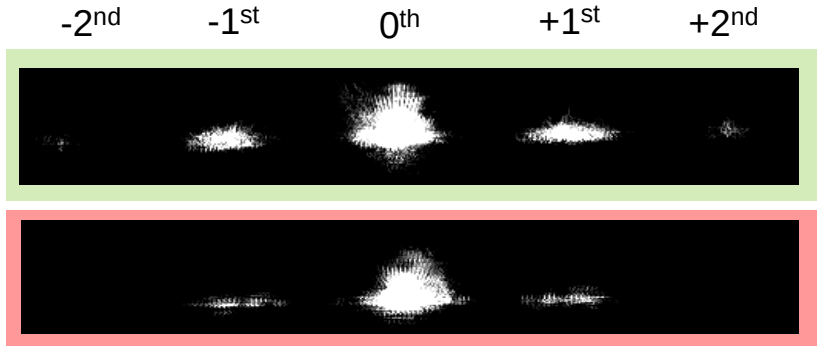
…significant amount of resolidified/redeposited material

Infrared camera



FFT system

Diffraction order m:



Powerful tool to differ

Good surface condition

&

Bad surface condition

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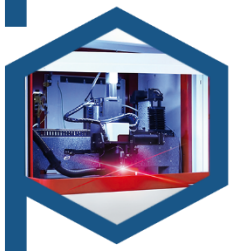
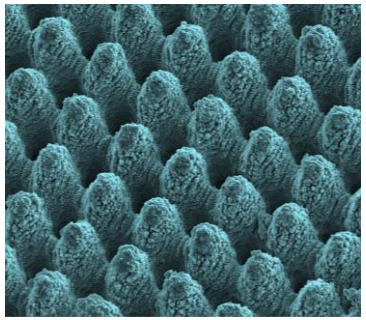
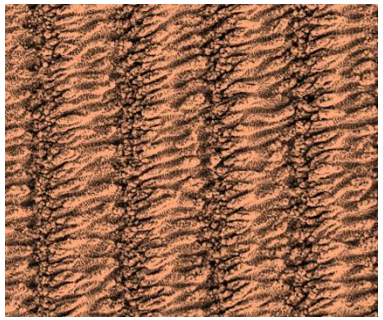


Objectives and benefits of LAMpAS

- High power UKP lasers development (1.5 kW)
- High throughputs up to 1 – 5 m²/min
- Resolution (feature sizes from 200 nm – 200 µm)
- Minimal workpiece heating with process monitoring
- Multiple-scaled structures (hierarchical patterns)
- Advanced surface functions on large areas



- Development of a new generation of products with novel functionalities, including ant-fingerprint surfaces, decorative holographic motives, easy-to-clean and anti-bacteria properties
- Performance improvement of products over 20%
- Accelerated product development
- Strengthened global position of European manufacturing industry



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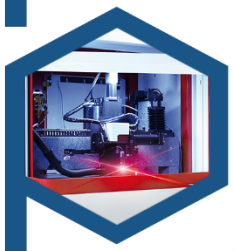
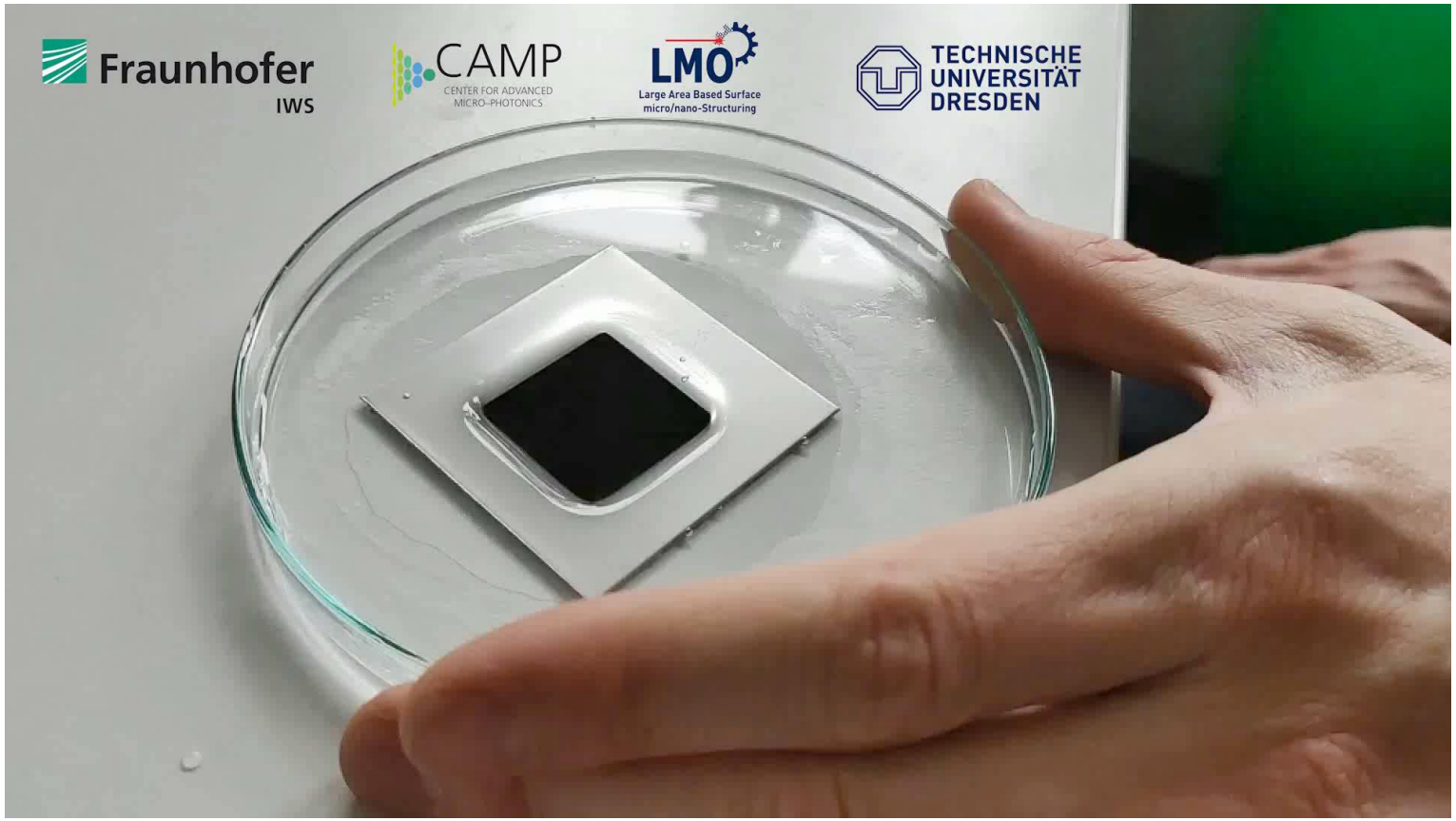


Applications

Superhydrophobic properties: water repellence



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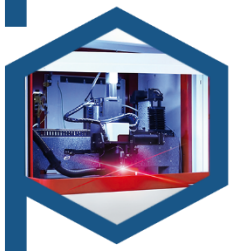

Applications

Colorful individual finishing

Target image:

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LAMPAS

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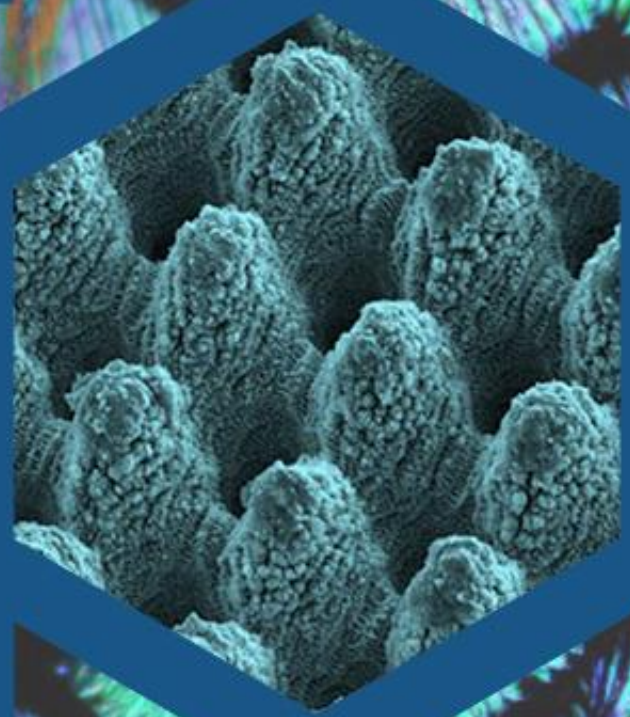

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lampas-eu-project

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Questions?

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