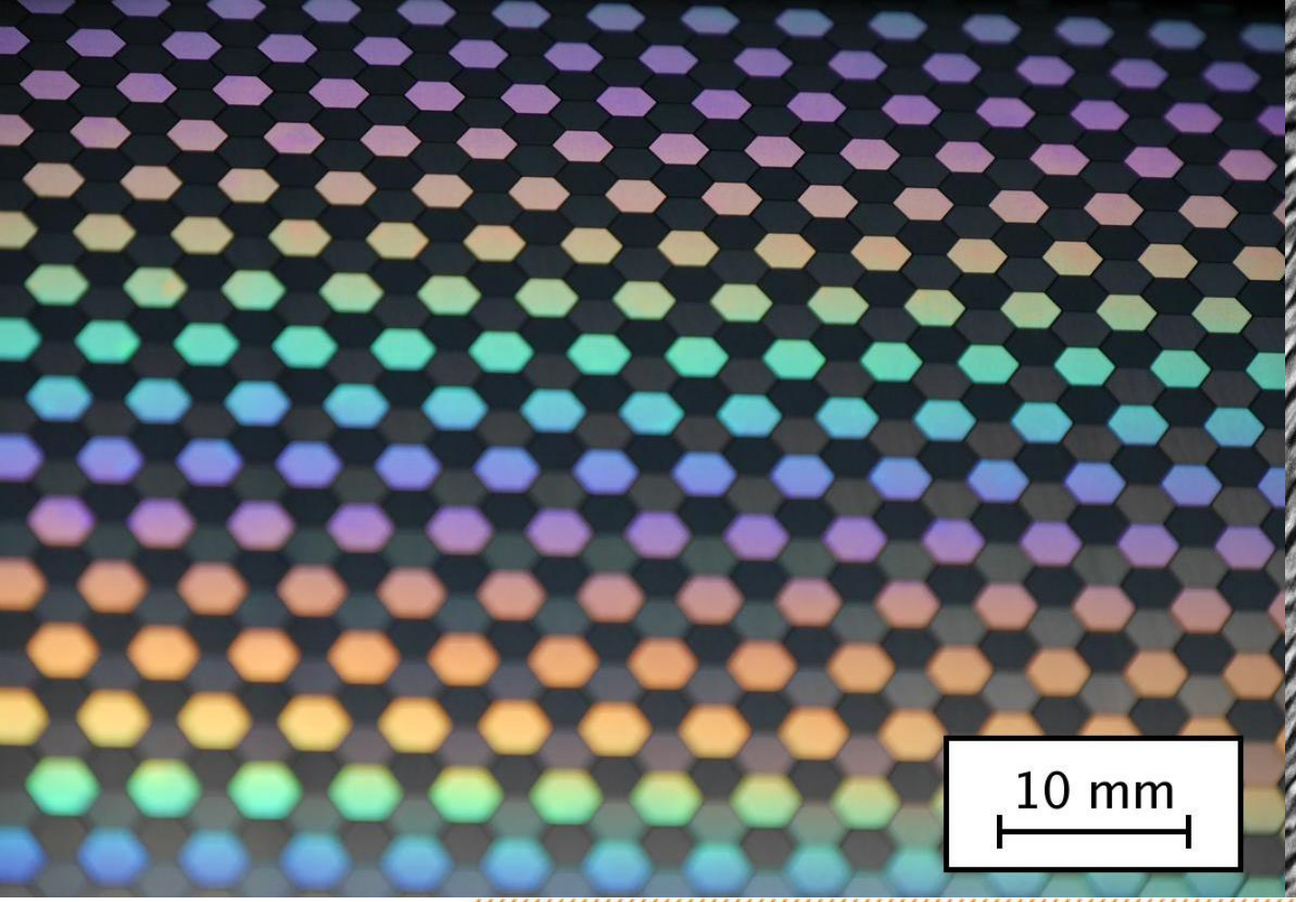

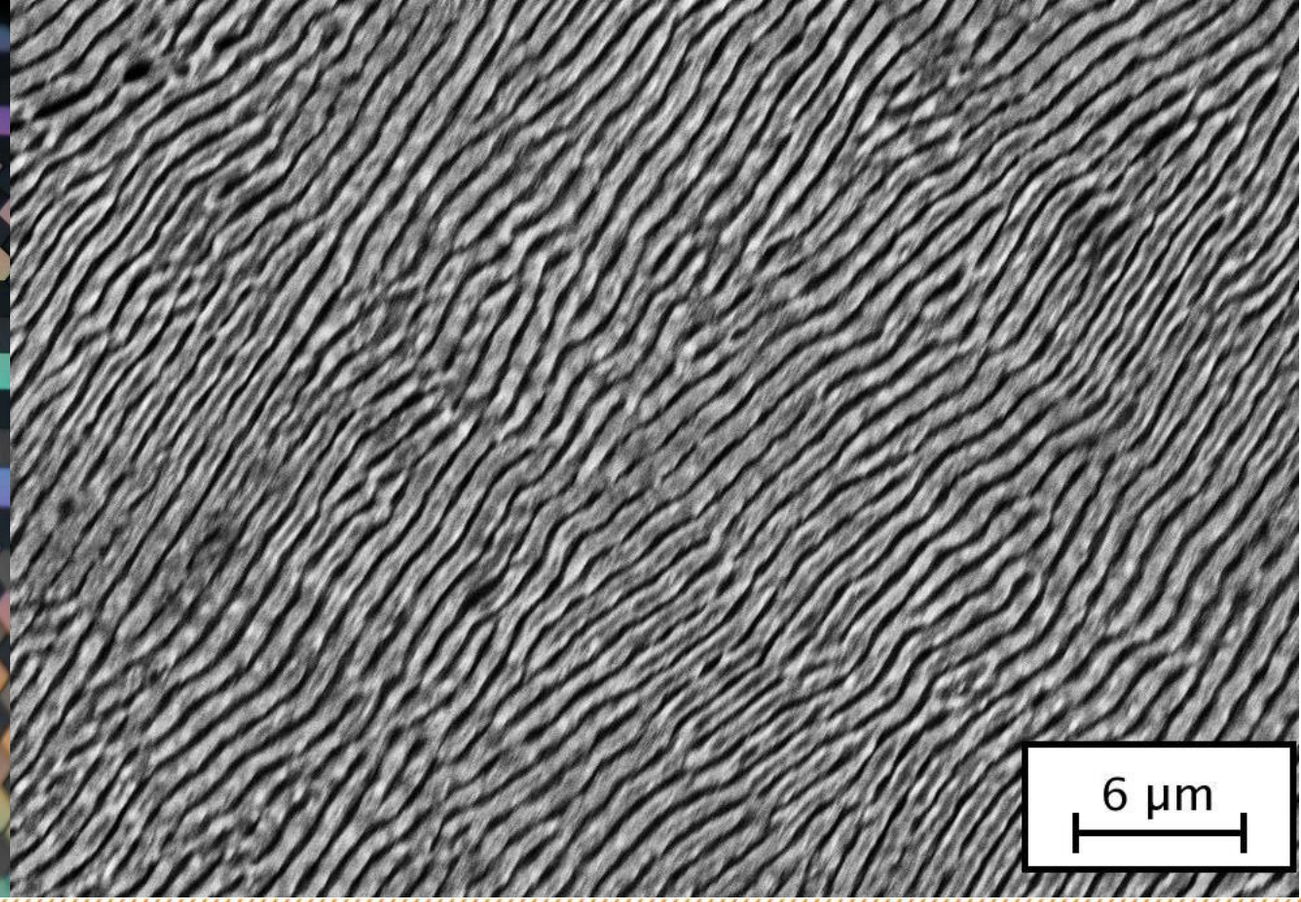

LARGE-AREA PICOSECOND LASER-INDUCED PERIODIC SURFACE STRUCTURE (LIPSS) ON CHROMIUM

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LANE 2016

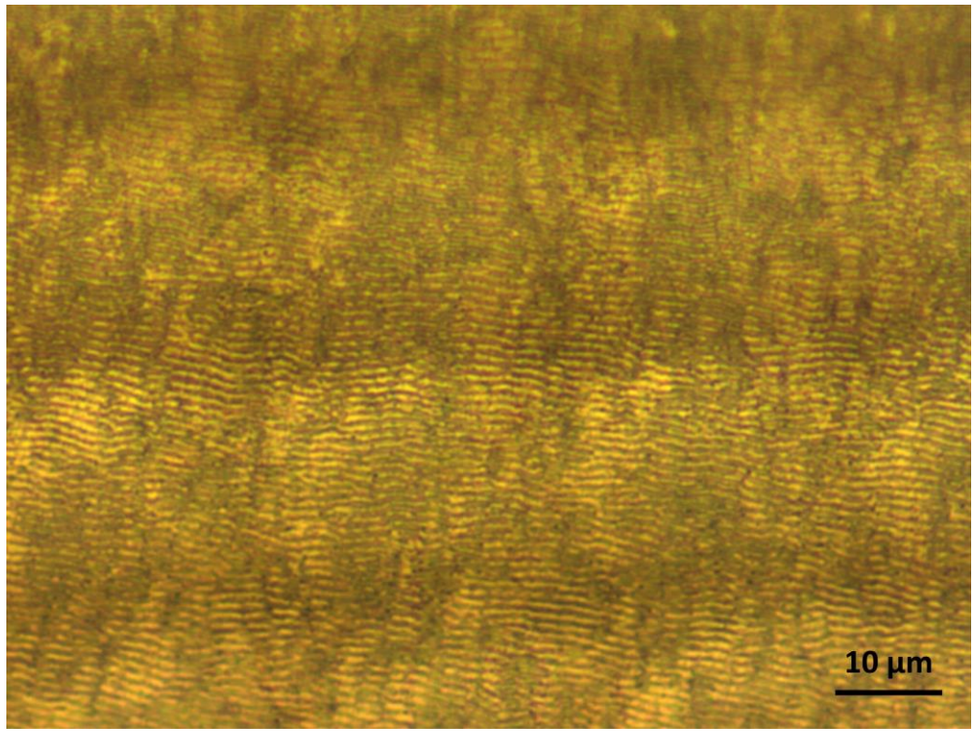
USP 3: Ultrashort pulse processes,

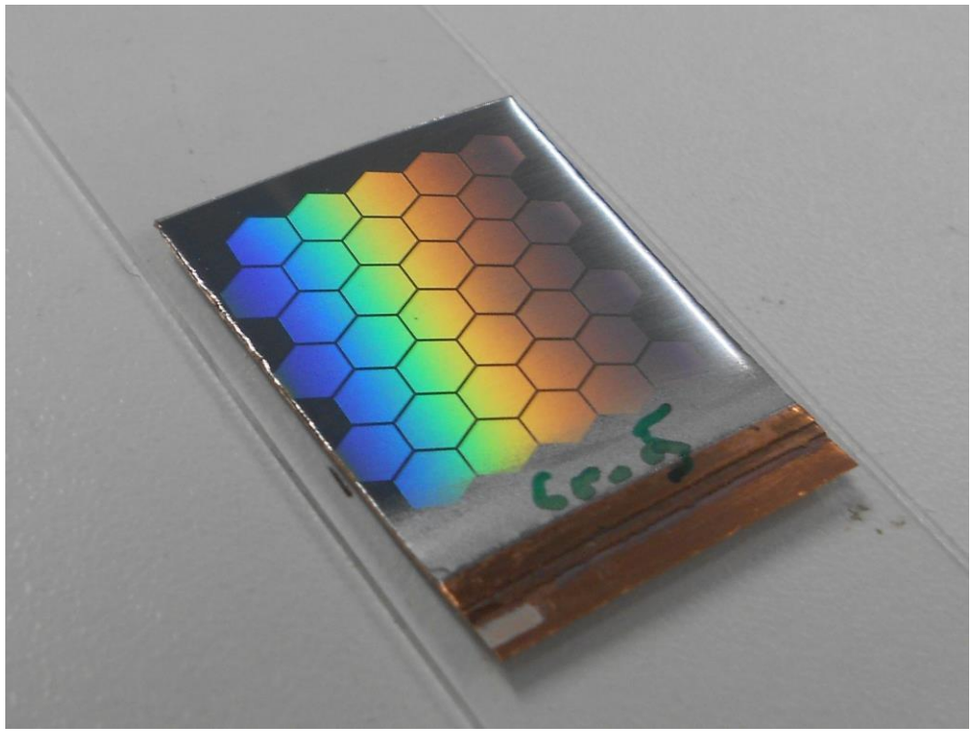
Leibniz Institute of Surface Modification

1. Introduction
2. LIPSS formation
3. Properties of LIPSS
4. Fast processing

1. Introduction

Goal: The fast production of laser-induced periodic surface structures (LIPSS) of Ni embossing rolls



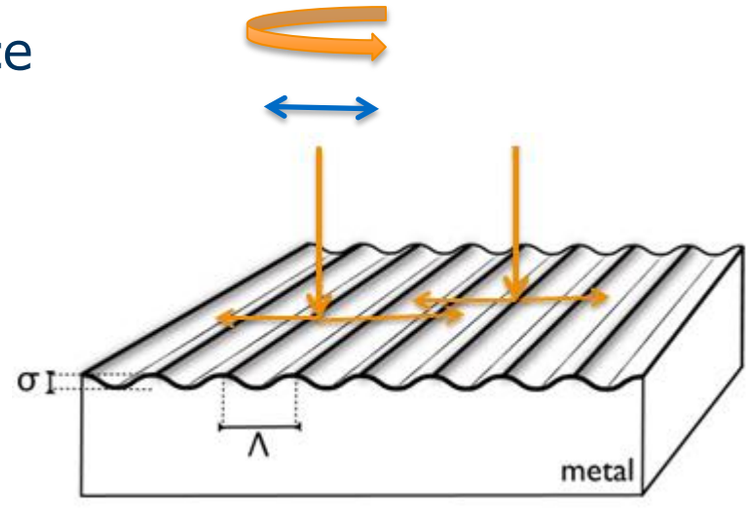


LIPSS structure of Ni

Model:

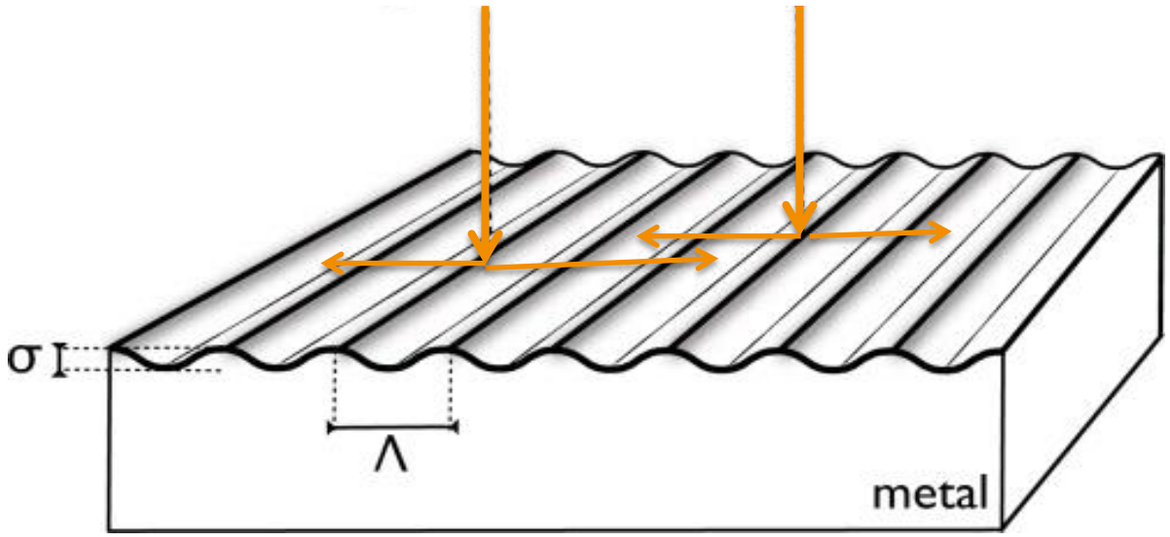
Interference of incident laser light with the surface electromagnetic wave (SEW)

$$\Lambda \approx \frac{\lambda}{1 \pm \sin\theta}$$



Ripples pattern depend on:
- used wavelength of the laser (λ)
- irradiation angle (θ)
- polarization (α)

- material
- fluence



INTERPLAY OF SCATTERING AND INTERFERENCE

light are scattered at rough surfaces

scattered waves in plane with the surface will interfere with the incidence light

➔ interference pattern

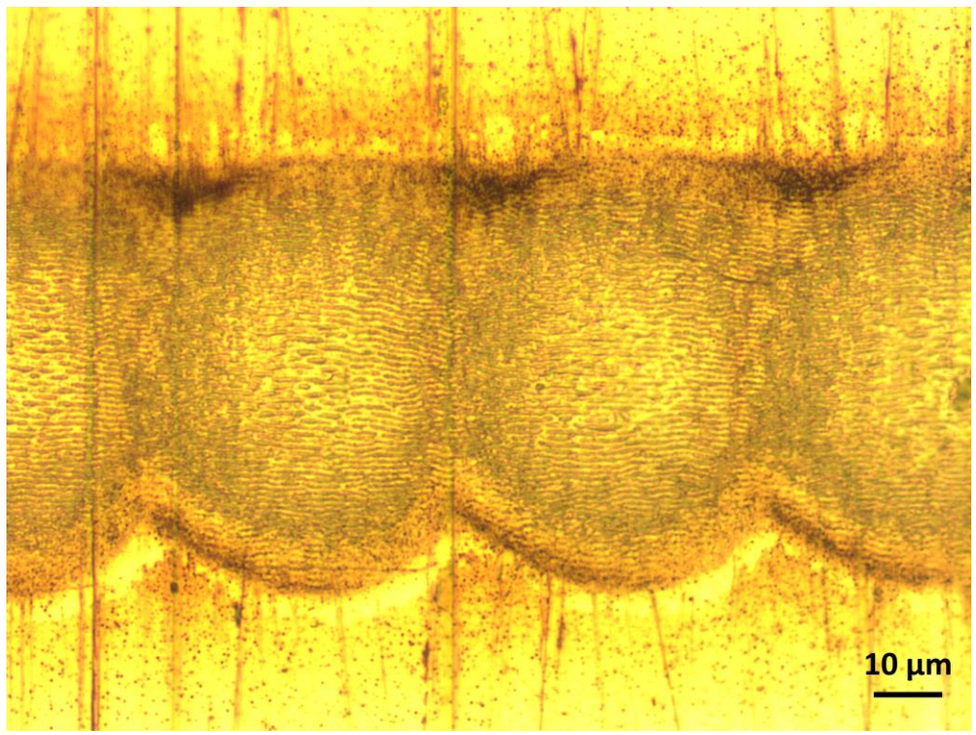
➔ local different ablation

➔ different surface roughness

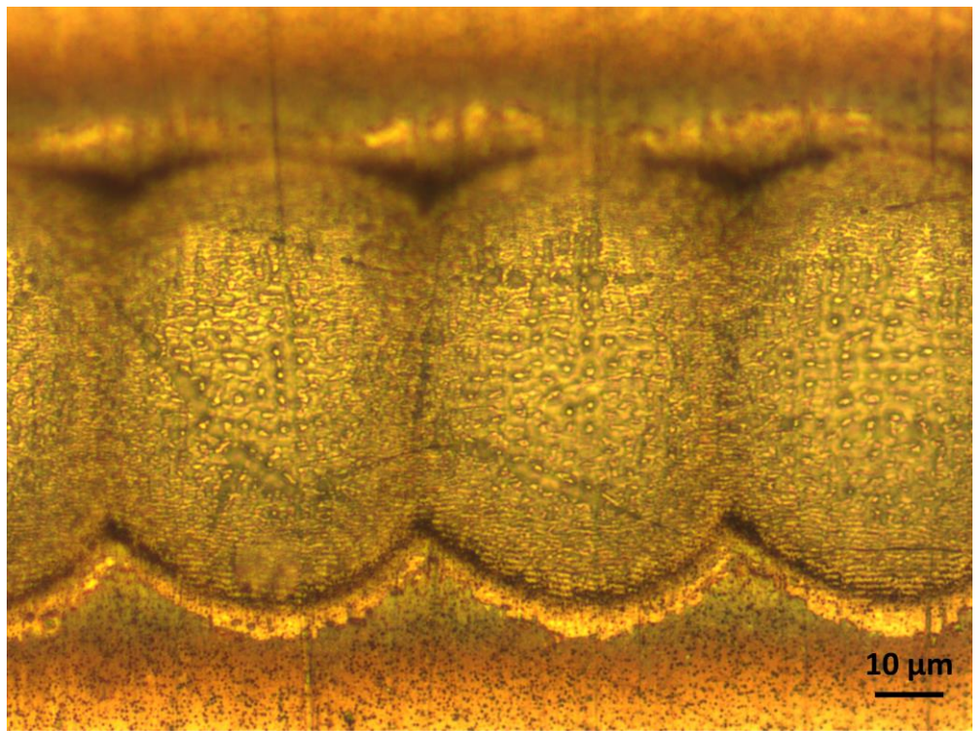
➔ feedback effect occurs

2. LIPSS formation

LIPSS in a single line



Power (30W), Pulse spacing 50µm, 20 pulses (left)



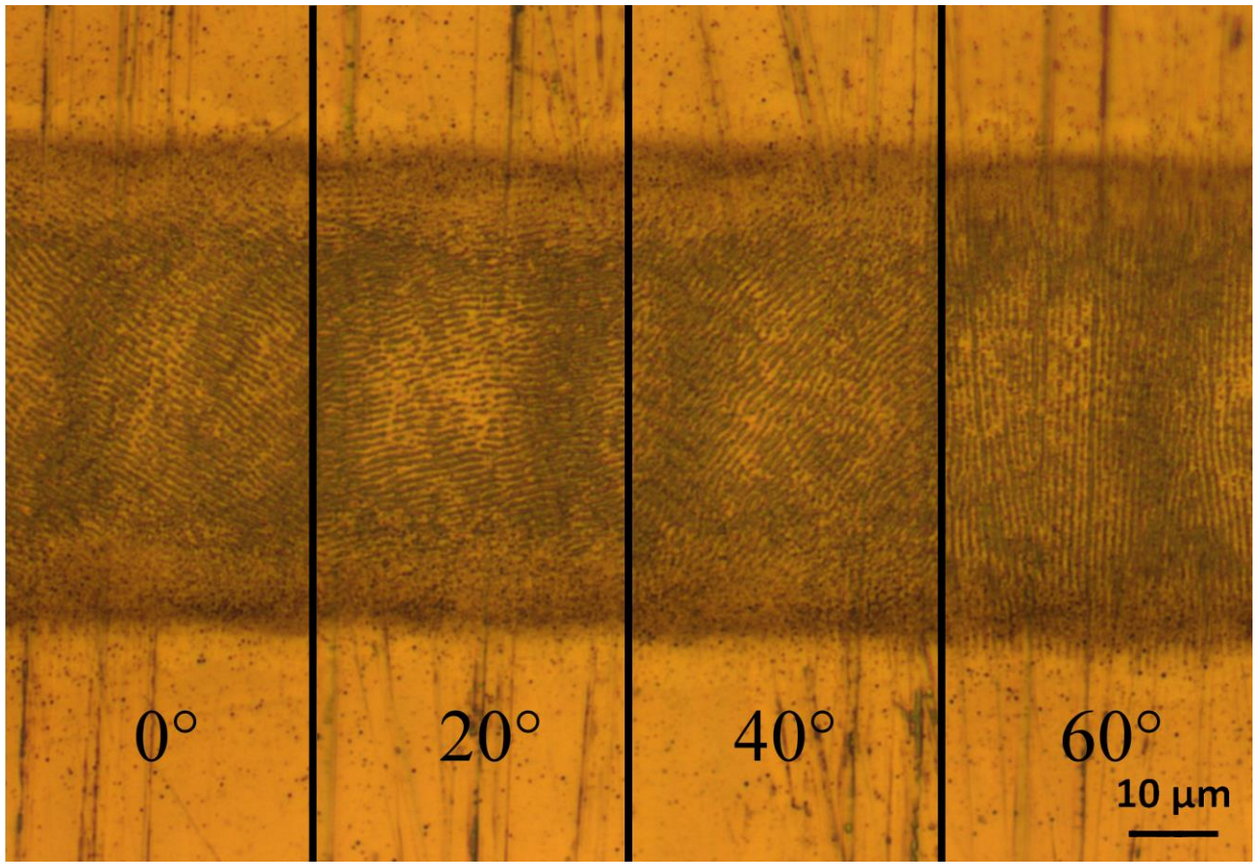
Power (30W), Pulse spacing 50µm, 80 pulses (right)

LIPSS formation in dependence form Laser power and number of applied laser pulses

Pulses \ Power [W]	30.1	27.1	24.1	21.1	18.1	15.1	12.1	9.1	6.1	3.1	2.5	1.9	1.3
10													
20													
30													
40													
50													
60													
70													
80													
90													
100													

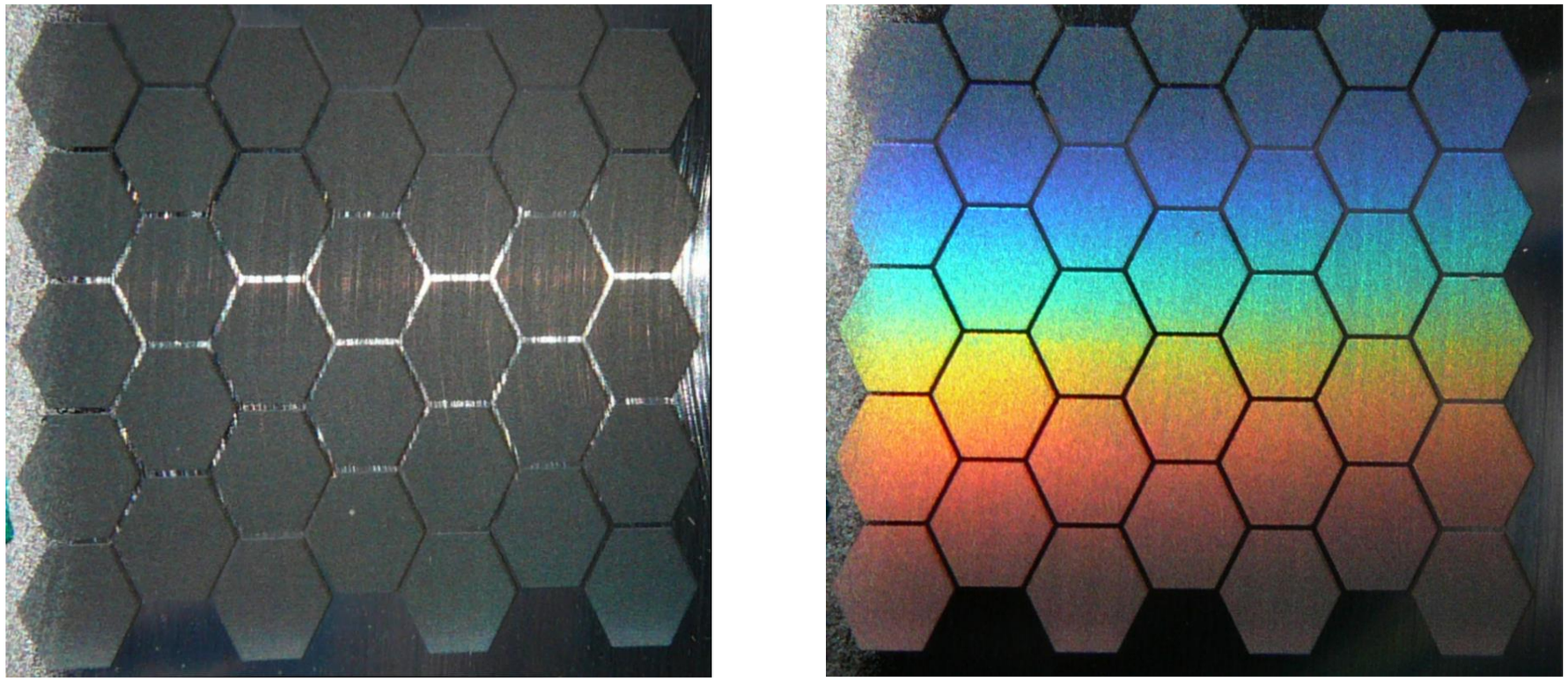
	no modification
	modification but no Rippels
	pulses separate - rippel continuously
	small overlap - rippel not continuously
	rippels with melting in beam center
	Rippels continuously
	Rippels with droplet formation

It is possible to rotate the orientation of the LIPSS using a half-wave plate which rotates the linear polarization of the laser radiation.



different wave orientations at different rotation angles of the half-wave plate

3. Properties of LIPSS

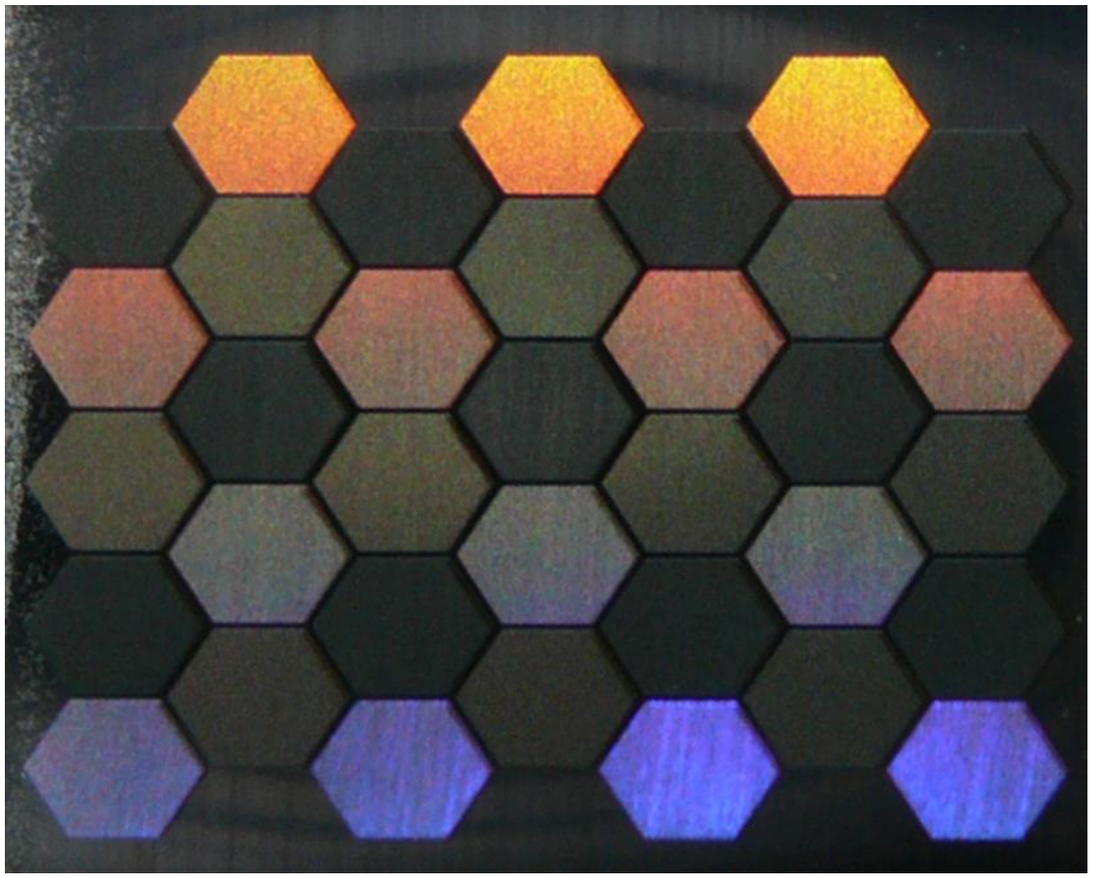


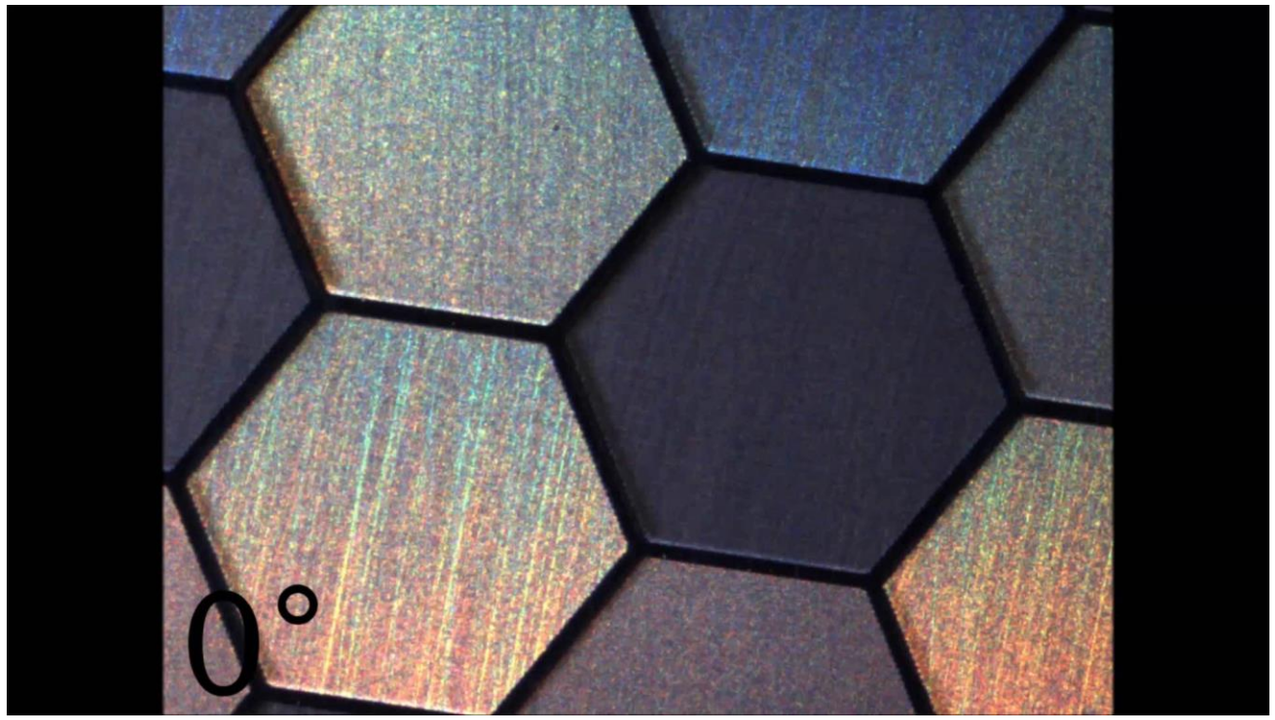
LIPSS under different illumination directions.

Produced with a laser fluence of 0.65 J/cm², a frequency of 984 kHz,

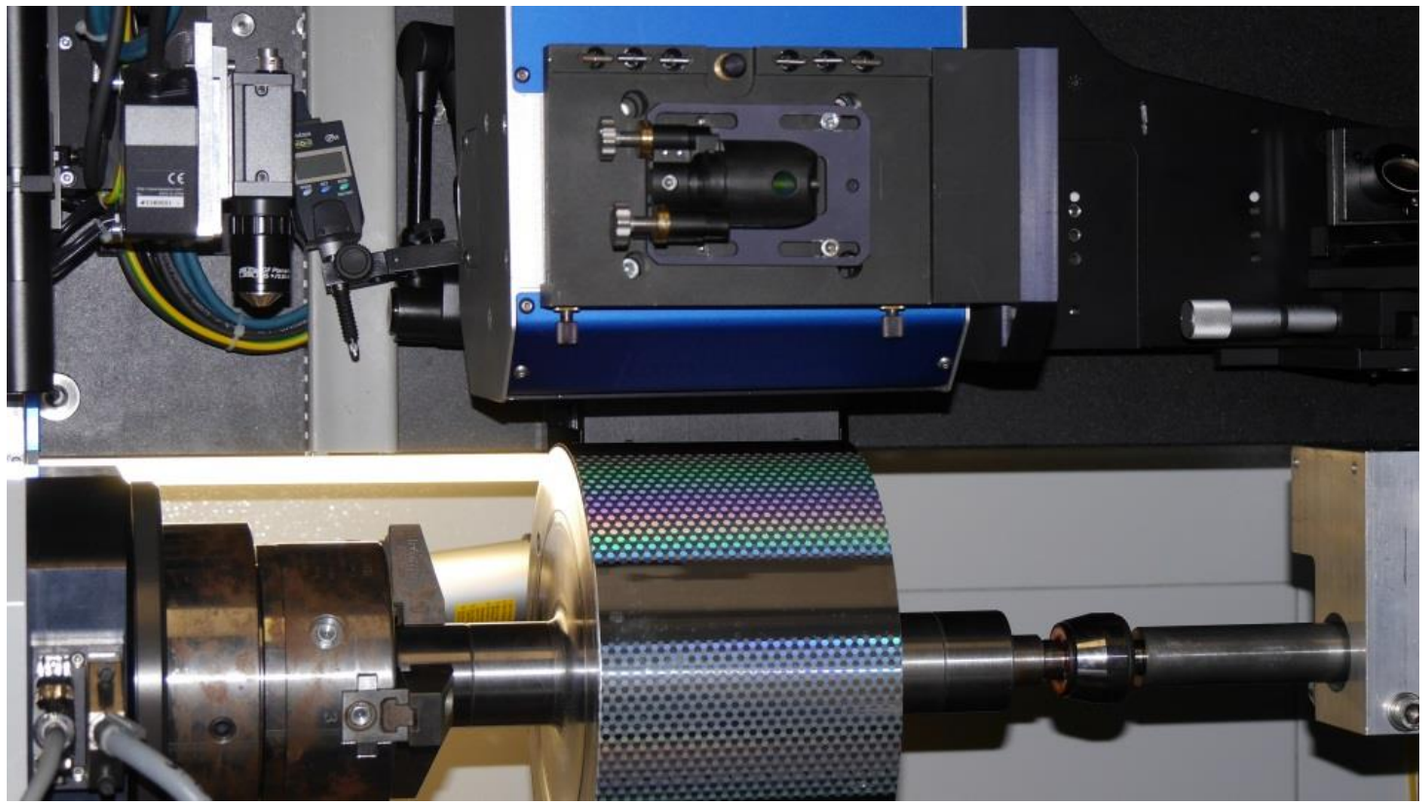
pulse space 28 µm (50%), line space 3 µm (95%)

LIPSS direction turned by 30 ° for each of the tree groups (I, II, III)





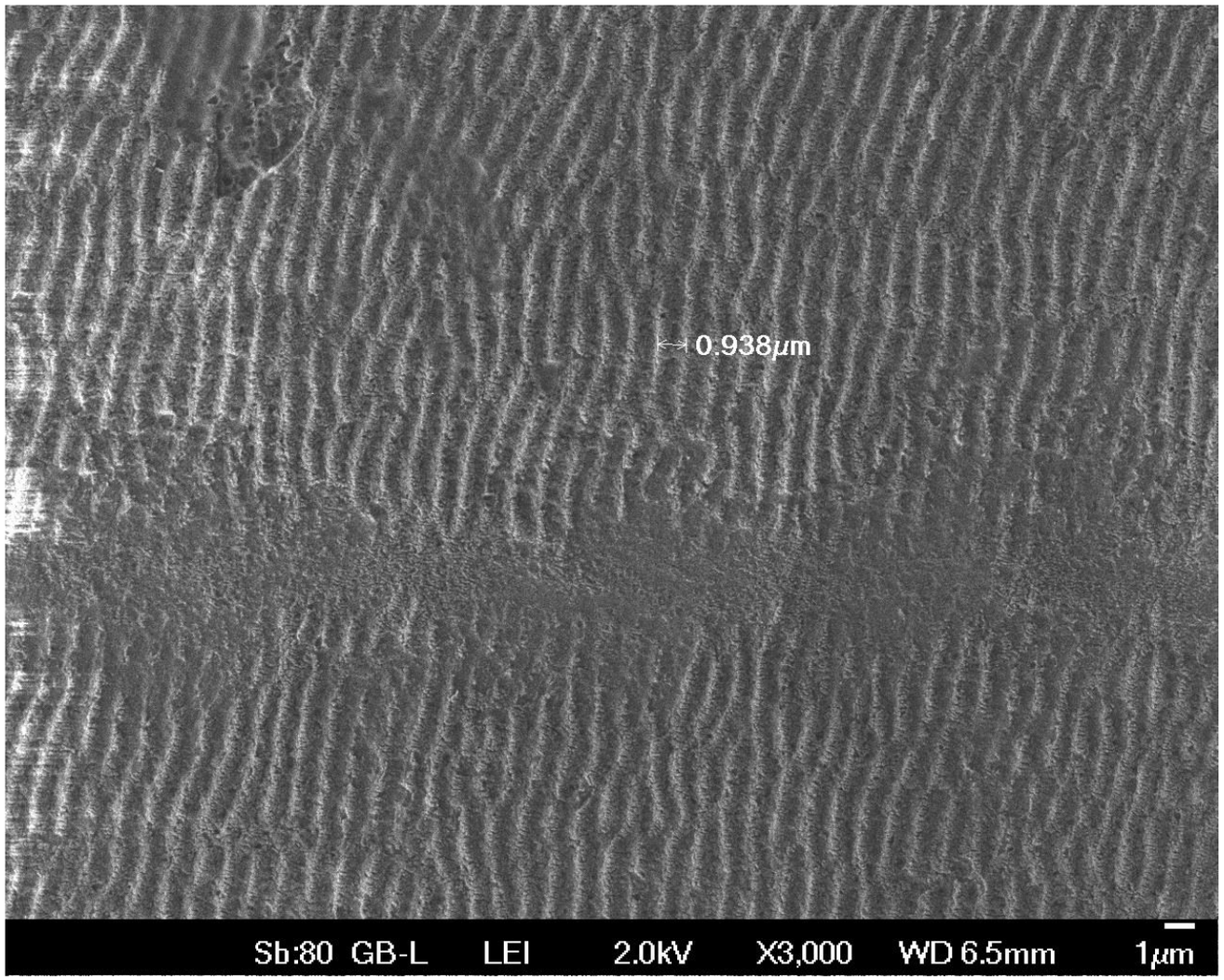
4. Fast processing



Rotation Axis and NextScan scan system

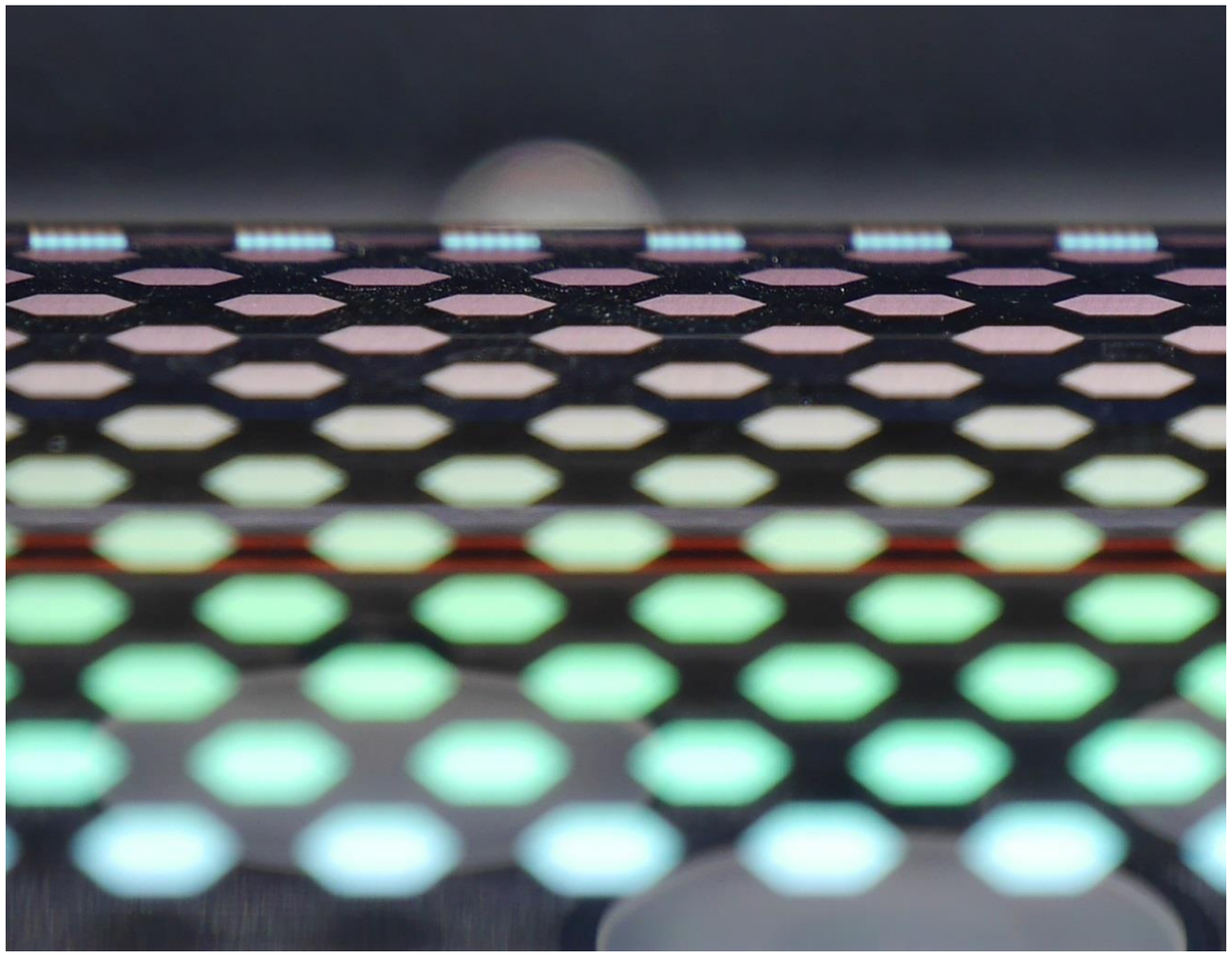
The fast processing of such structures is possible by high speed repetition rate lasers in combination with ultra fast scanner systems.

Example:
Atlantic 12 ps laser
@ 25W, 1 MHz in combination with Nextcscan LS170
@ 35 m/s



REM picture of copied LIPSS on polymer foil

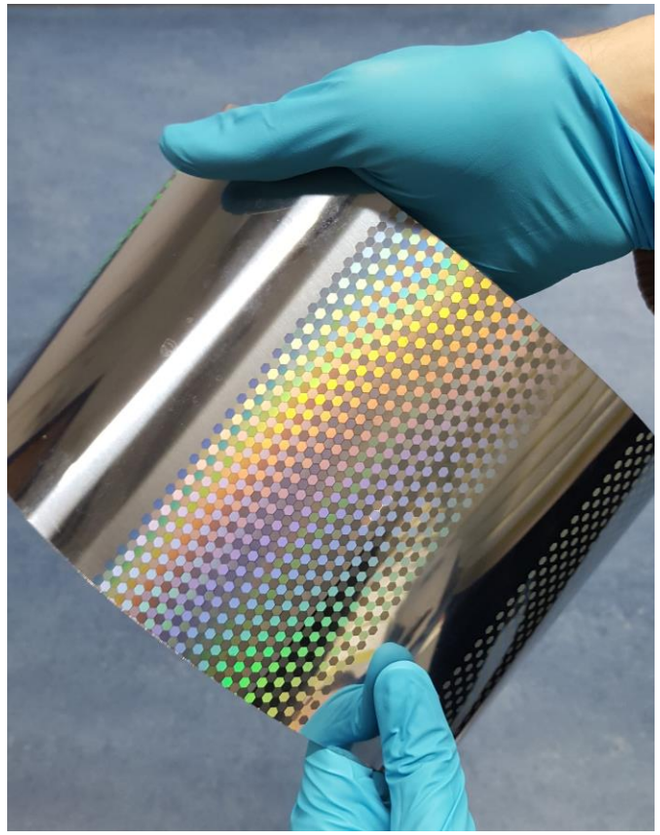
LIPSS are reproducible in polymer foils via roll to roll processing. This opens a wide spectrum of application possibilities in packaging in sense of functionality and design.



Picture of roll while laser structuring

We showed that due to the fast system a sleeve (D=220 mm w=170mm) can by structured in only 38 min per LIPSS orientation.

Thank you for your attention



http://appolo-fp7.eu/

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COOPERATION

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Thank you for your attention!