

UV-Nanoimprinting of Micro Optics on Foil

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**JOANNEUM RESEARCH
MATERIALS**

Institute for Sensors, Photonics and Manufacturing Technologies

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www.joanneum.at/materials

Roll-2-Roll UV-NIL Pilot Line

Nano goes Macro !

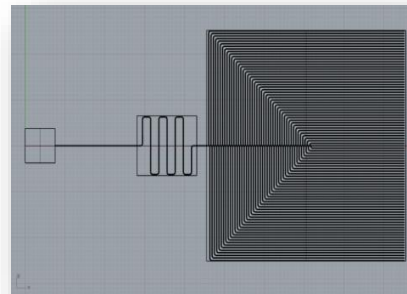
2

MATERIAL



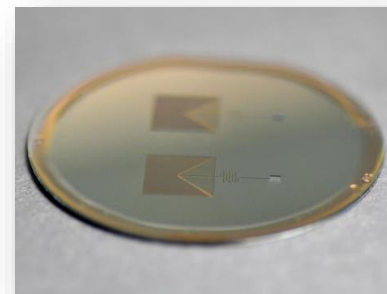
e.g. Poly-
Urethane-
Acrylates

SIMULATION & DESIGN



e.g. COMSOL,
Ray Tracing

MASTER



e.g. Maskless
Laser Lithography

STAMP / SHIM



Step & Repeat UV-NIL

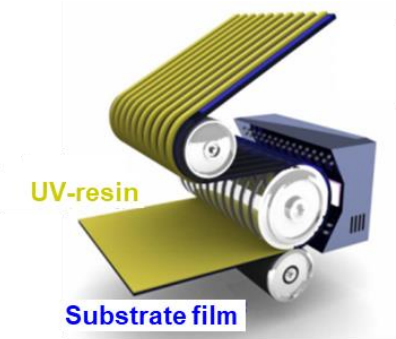
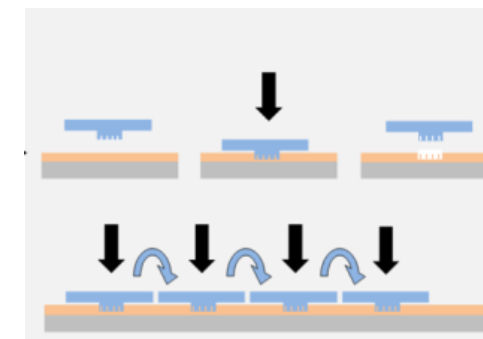
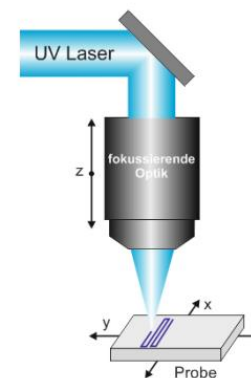
PRODUCTION



R2R-UV-NIL

MICRO-OPTICS IS...

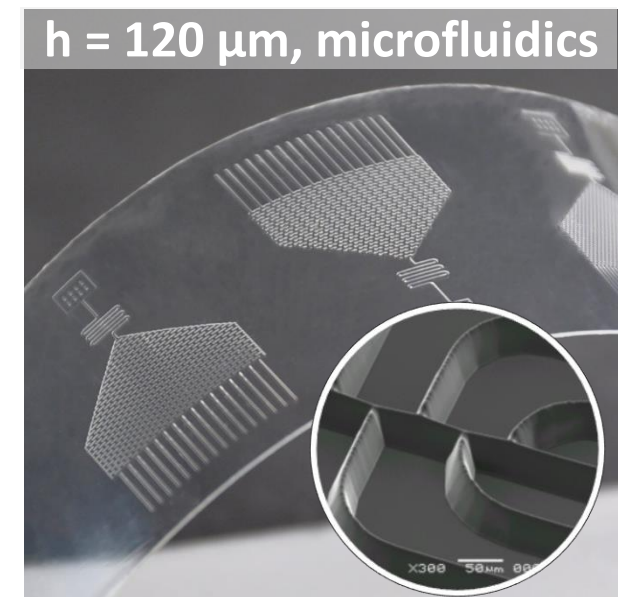
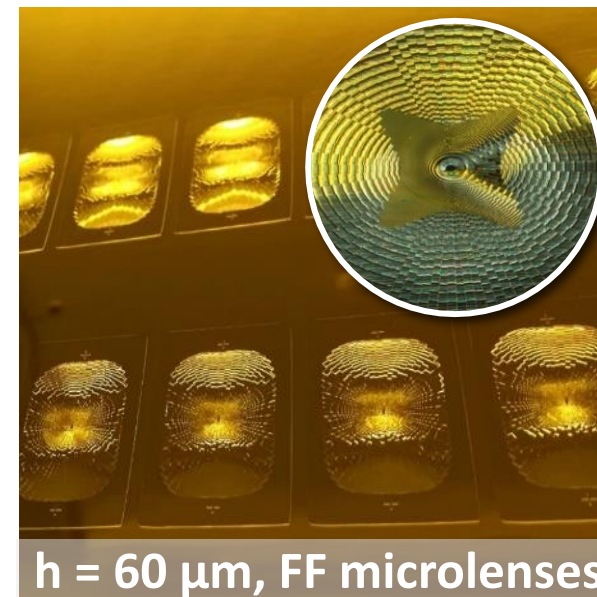
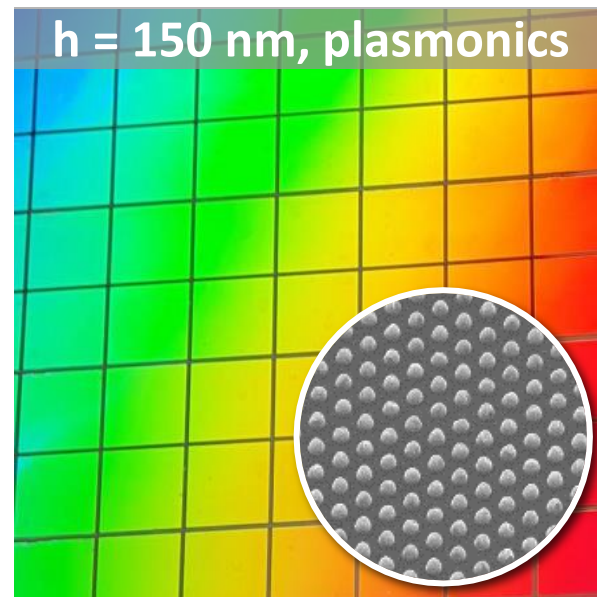
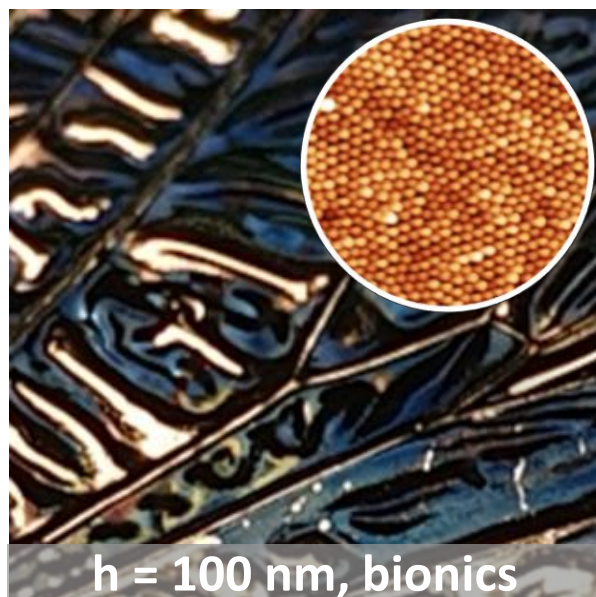
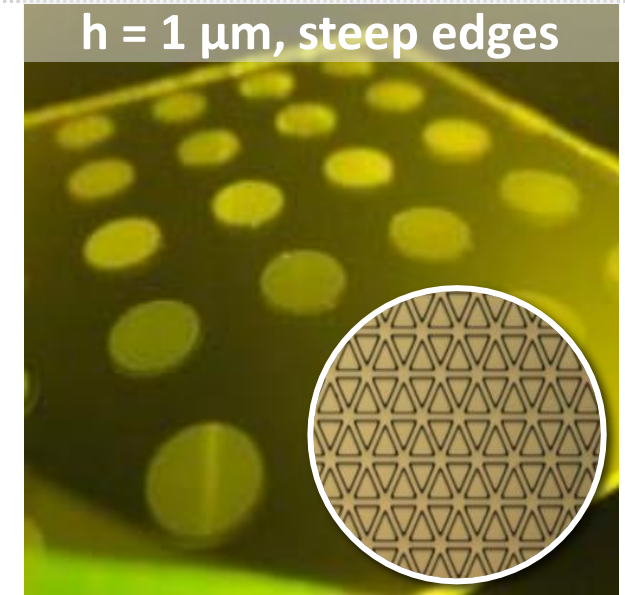
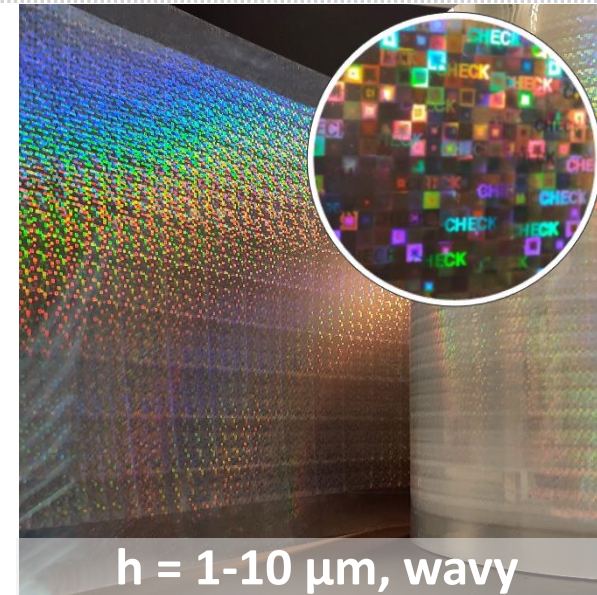
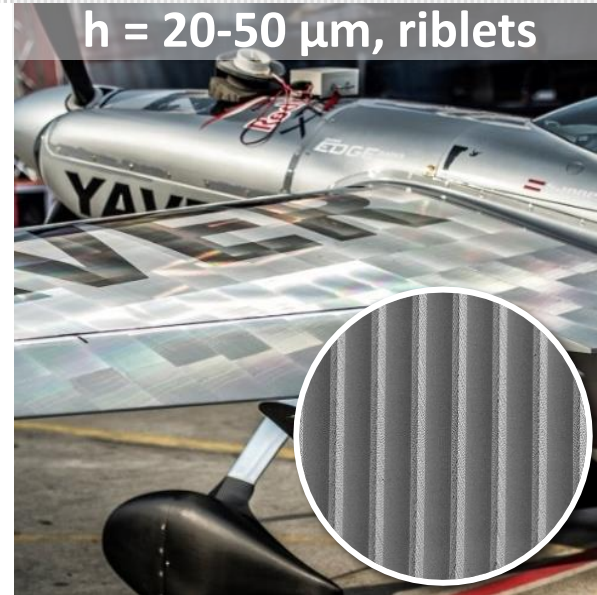
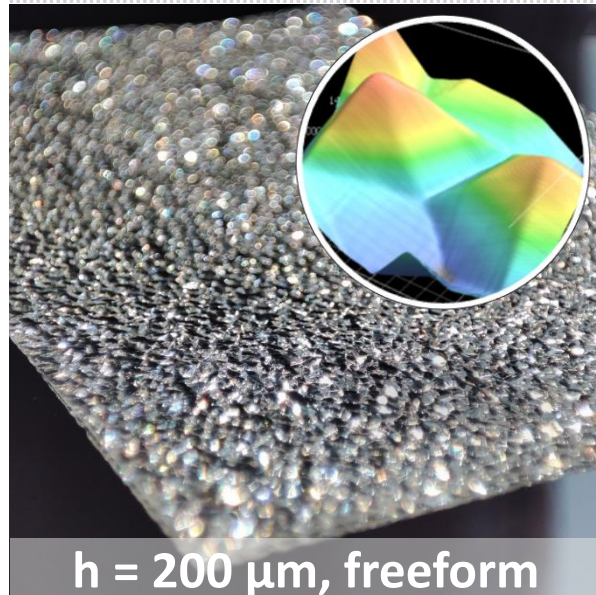
Phabulous



UPSCALING 

Imprinting is powerful

3





4

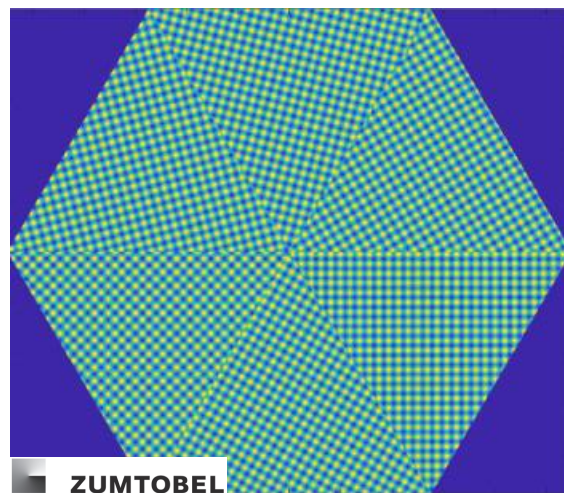
Use Case 1: Multi-Color Spot-Light

Application:

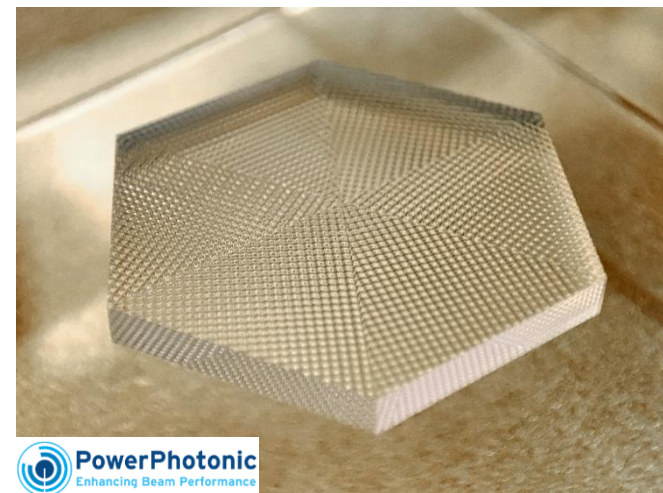
Freeform micro-optics to realize a homogeneous luminance and light distribution from a multi-color spot-light

Upscaling target: Seamless Step & Repeat Upscaling for Roll-to-Plate

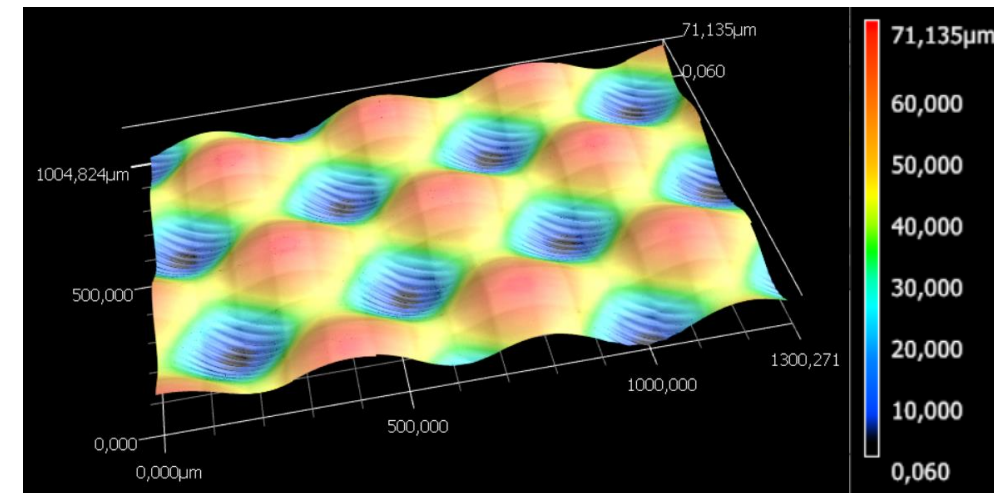
Seamless stitching of a hexagonal small-scale master to create a large-area continuously patterned tool – 200x200 mm²



Design of FFMO structure
h = 70 μm



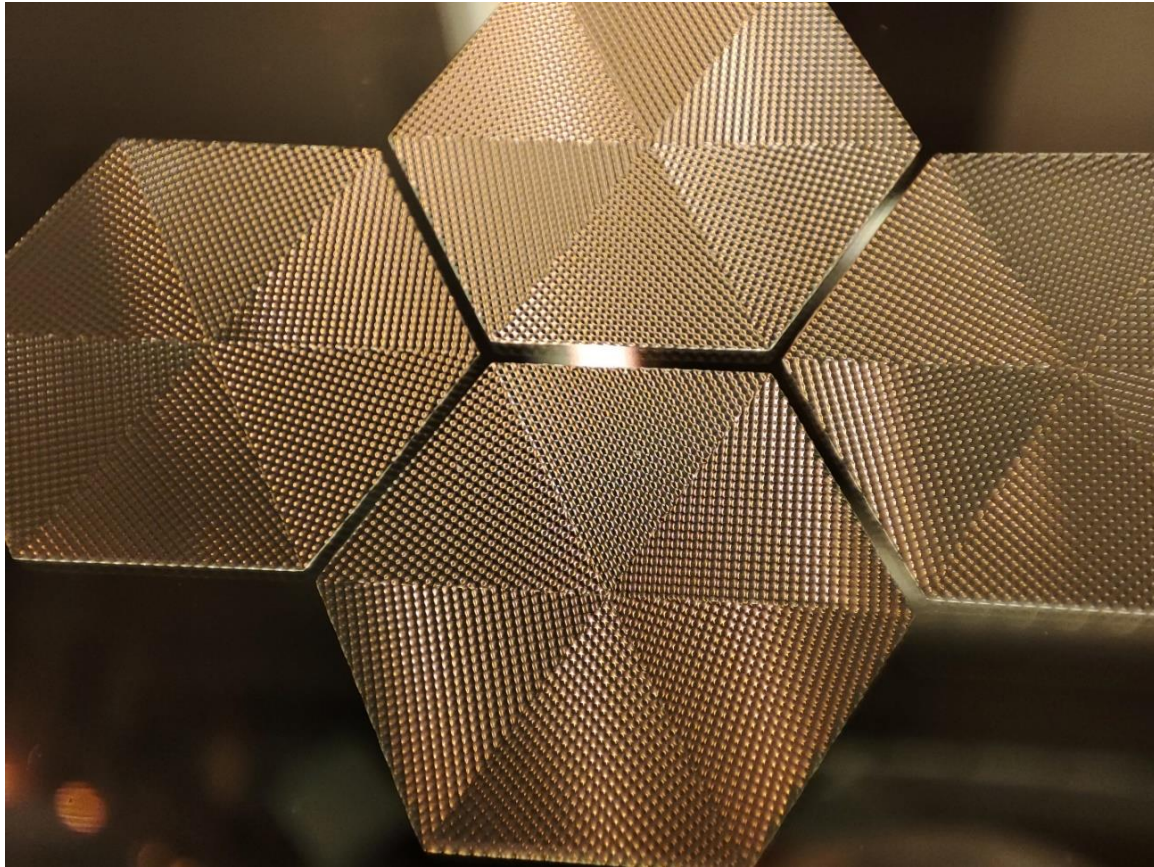
d ~ 20 mm quartz master
(laser ablation)



3D pattern

Seamless Step & Repeat Upscaling

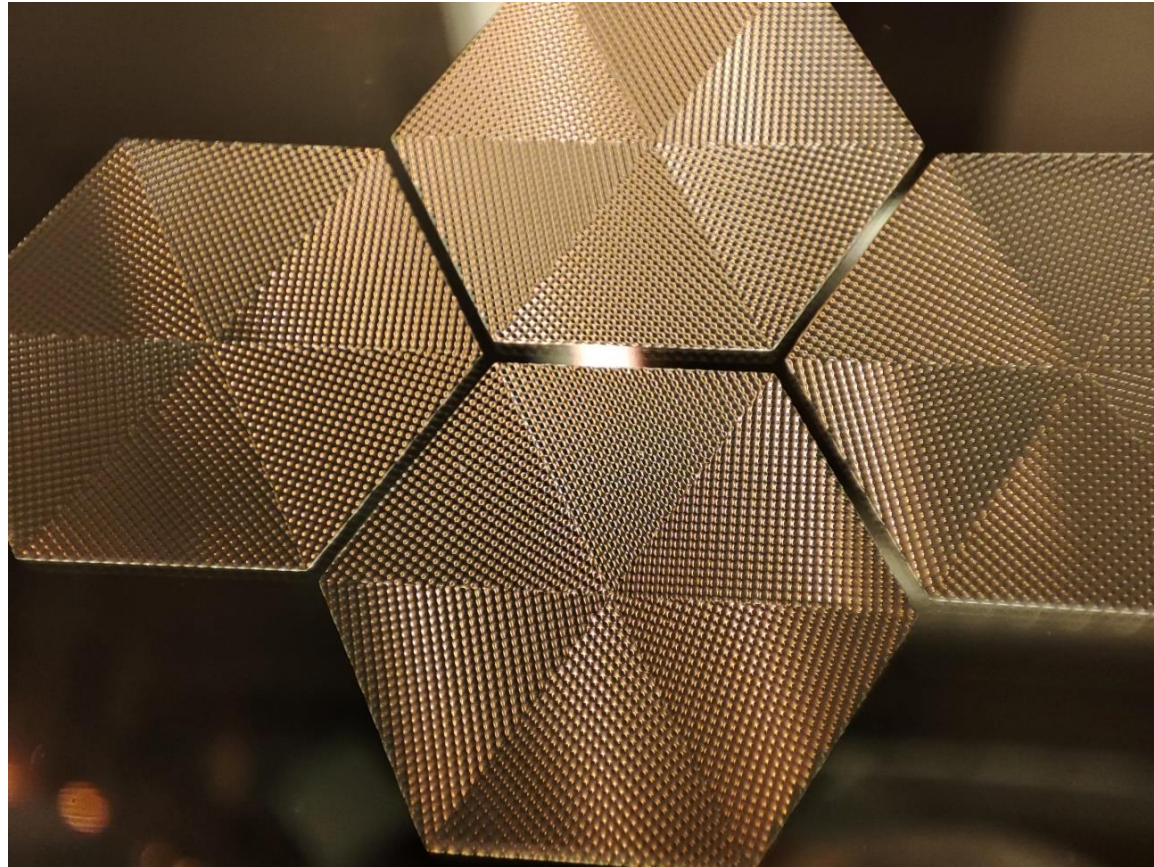
5



Step&Repeat UV imprints on PET foil
distance = 1 mm

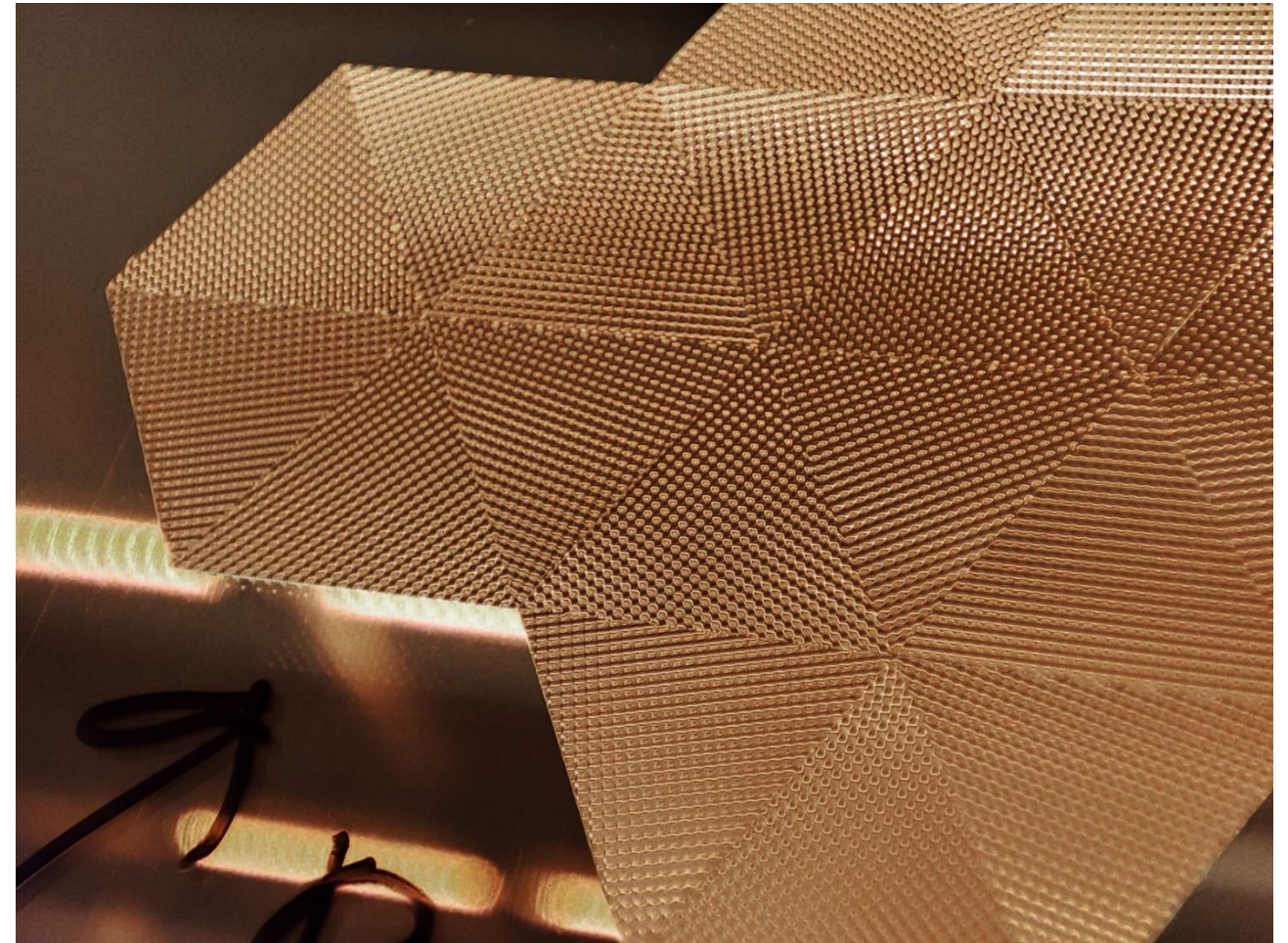
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Seamless Step & Repeat Upscaling



Step&Repeat UV imprints on PET foil
distance = 1 mm

Distance and
rotation optimization

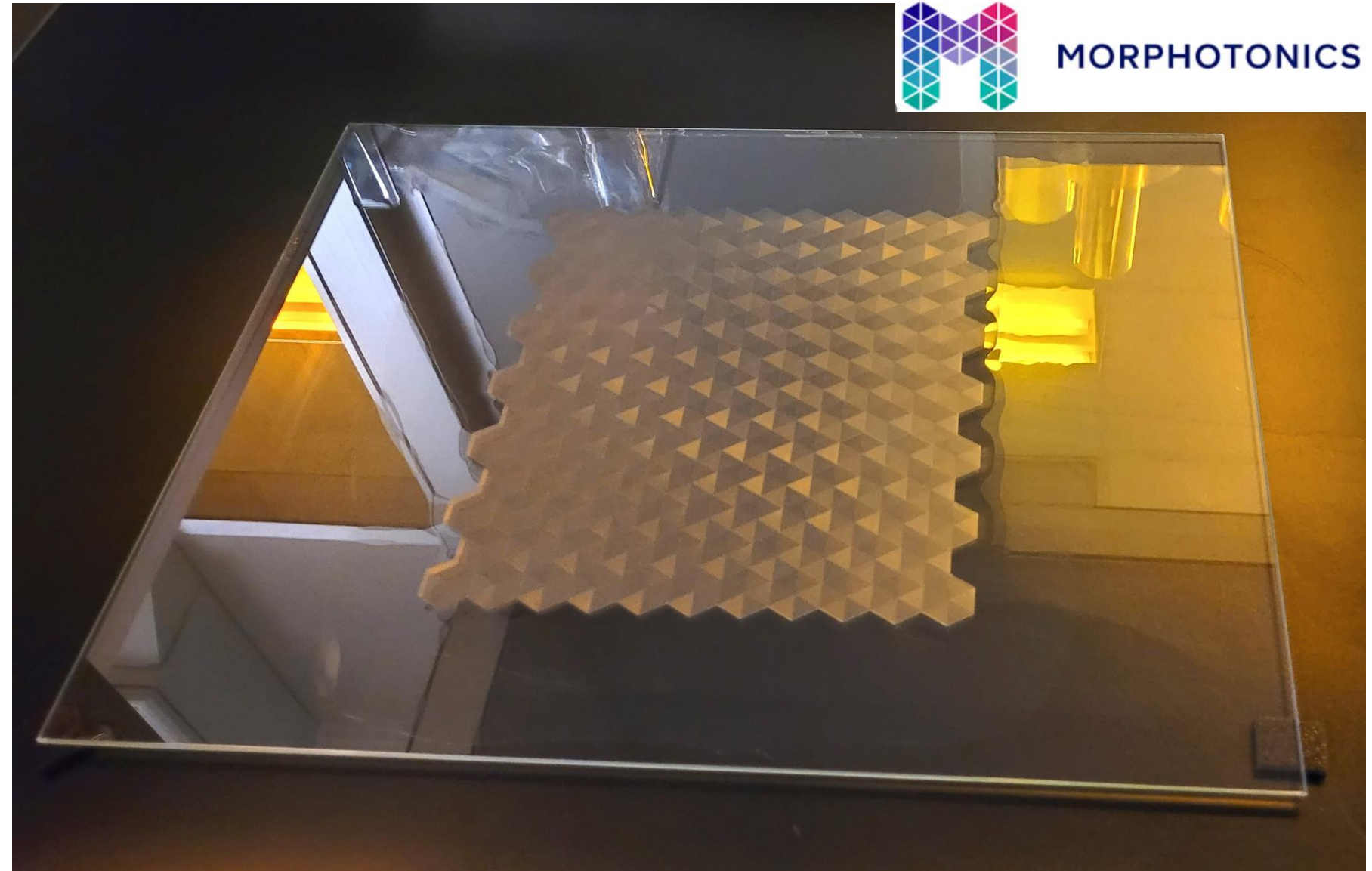
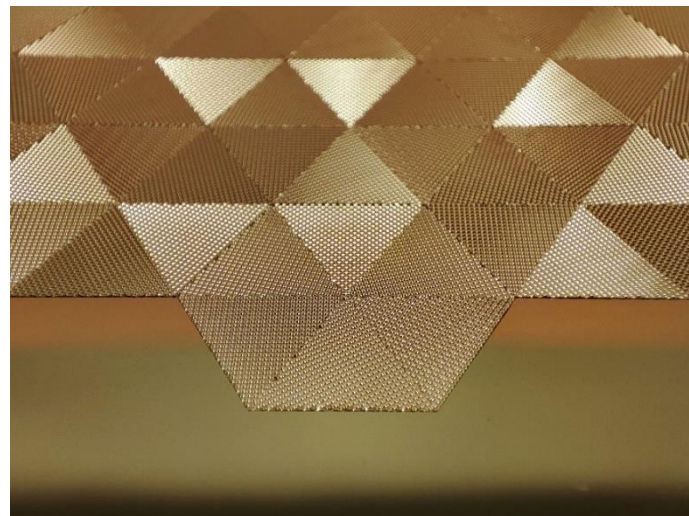
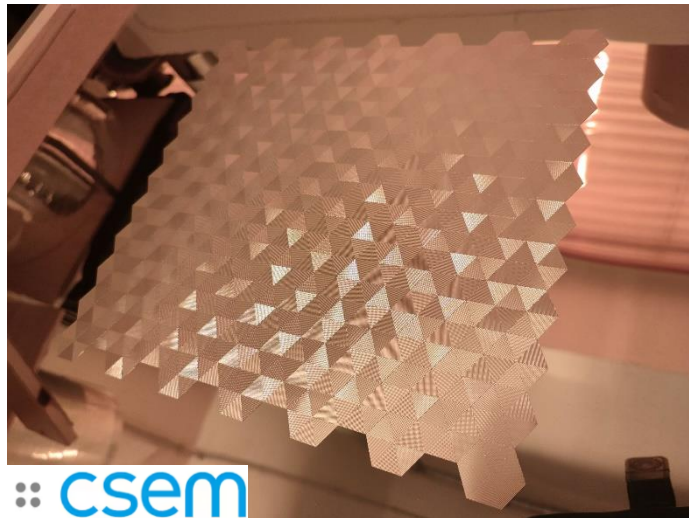




Roll-to-plate (R2P) replication

7

Converting the poly-shim to a durable Ni tool



Use Case 2: Decorative Films

Application:

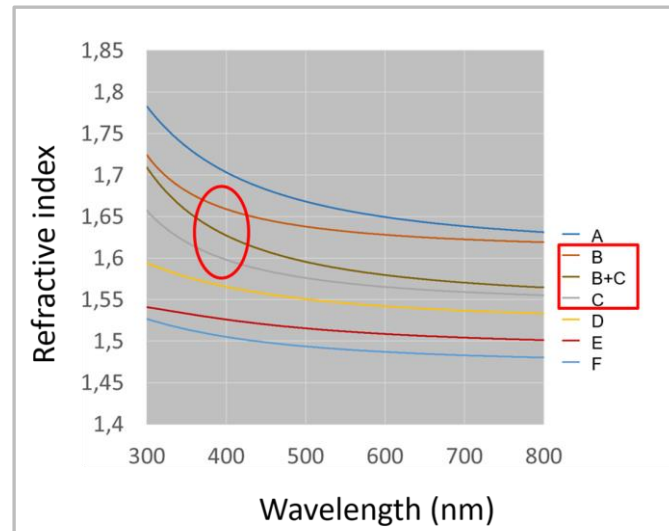
Freeform micro-facets to realize a sparkling effect for luxury goods

Upscaling target: Seamless Step & Repeat Upscaling for Roll-to-Roll production

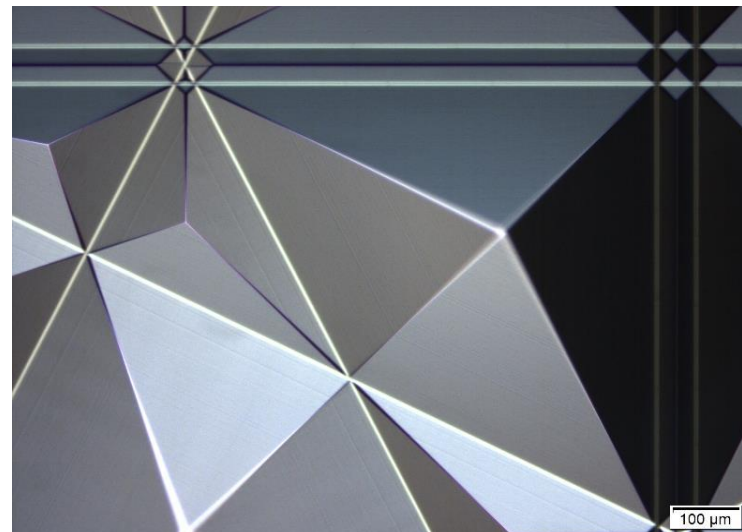
Seamless stitching of distributed facets with extremely high edge accuracy, low shrinking and low Abbe number



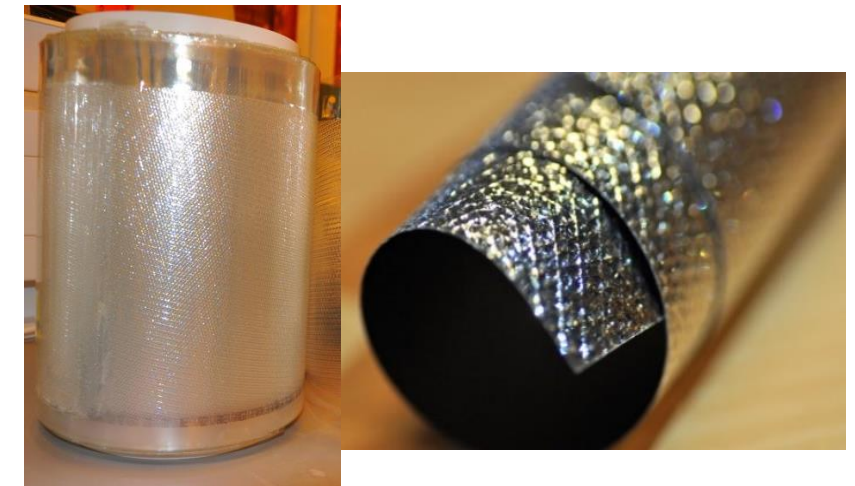
Resin with high dispersion



„Crystals“ with facet designs



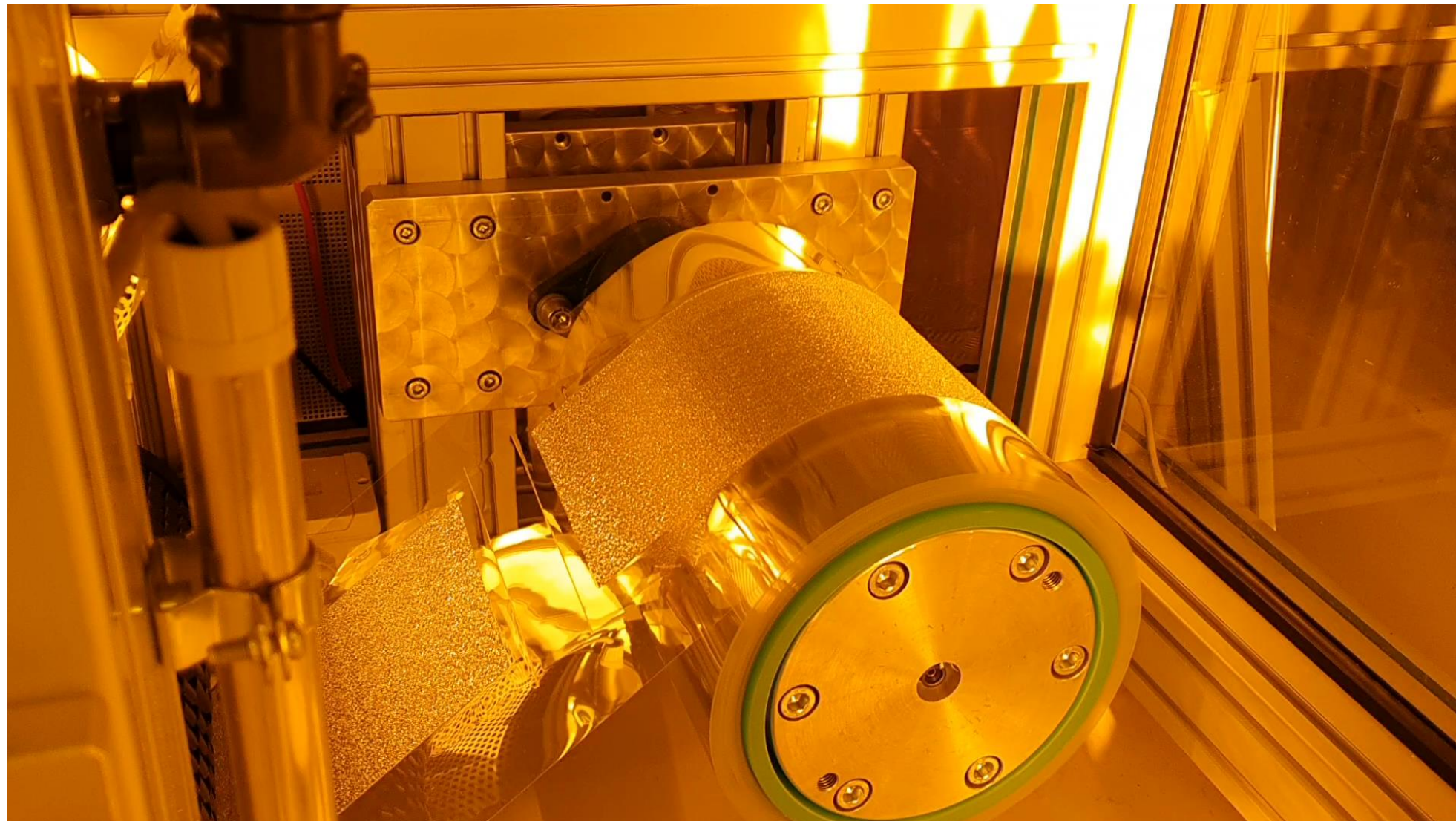
Double side imprinted „crystals“



Roll-to-roll (R2R) replication of facets with high accuracy of replication

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R2R UV imprint into high index, high dispersion resin




video

$v = 1 \text{ m/min}$

Roll-to-roll (R2R) replication: finished products



R2R UV imprint into **high dispersion resin**
+ R2R backside metallized  Fraunhofer
View: reflection

video



R2R UV imprint into **high dispersion resin**
View: transmission



Use Case 3: Interior Lighting for Trains

Application:

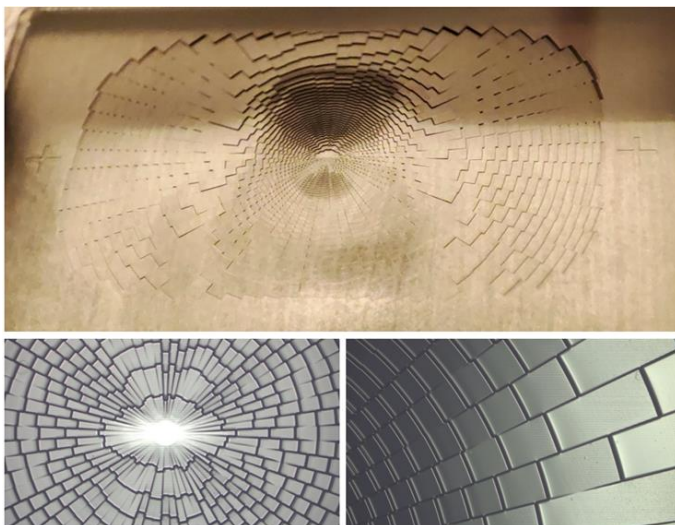
Freeform micro-lenses for a homogeneous large-area direct-lit luminaire as a linear lens array

Upscaling target: Grey Scale Lithography Mastering, Step & Repeat and Roll-to-Plate production

Freeform lenses with highest surface quality and shape fidelity



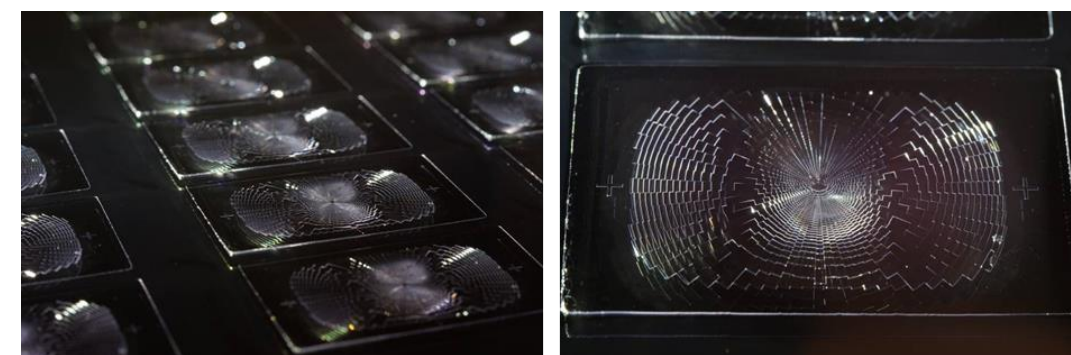
S&R working stamp



Polymer shim



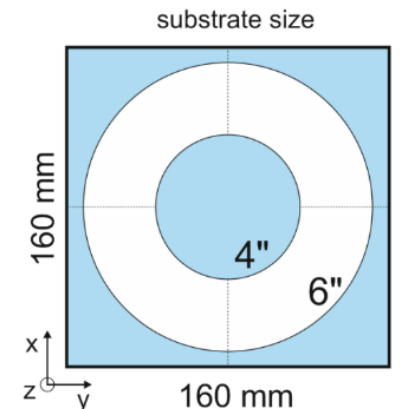
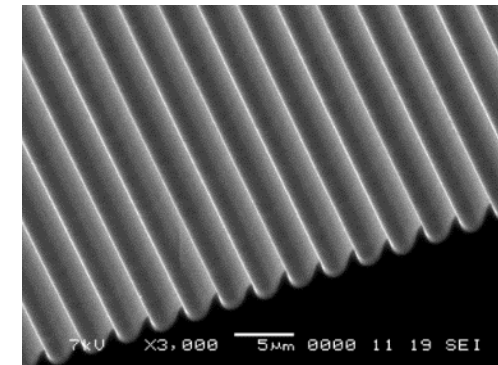
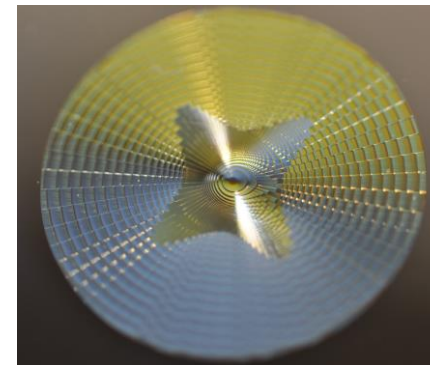
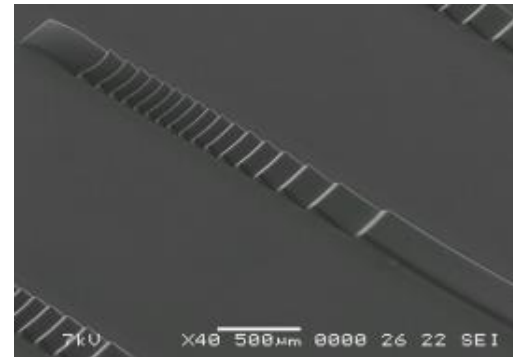
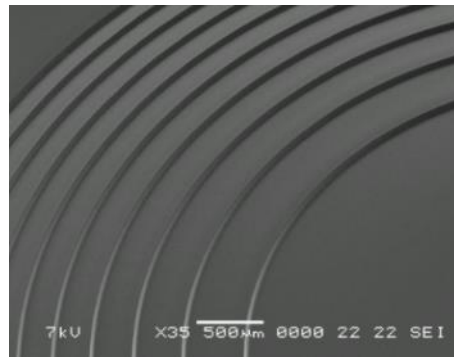
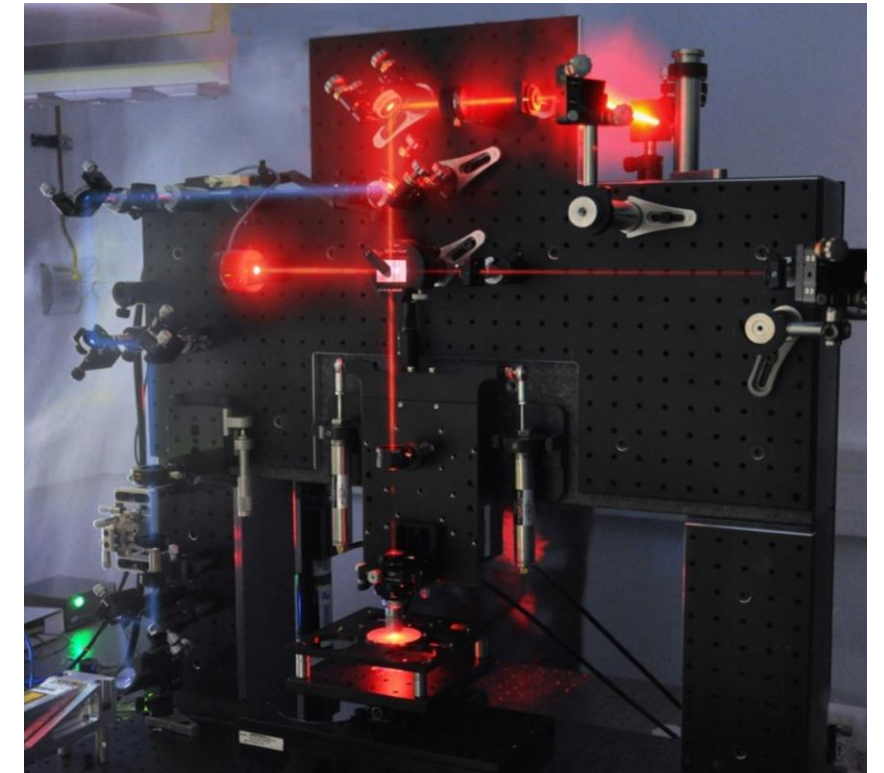
Roll-to-Plate lens arrays



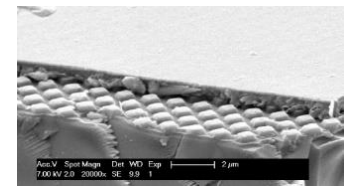
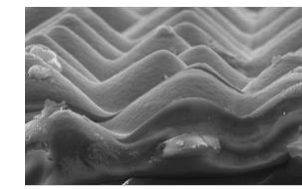
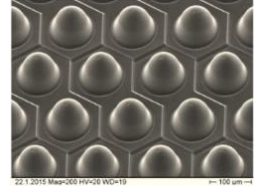
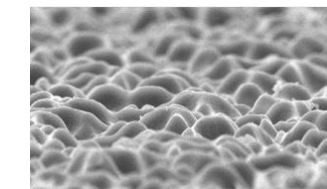
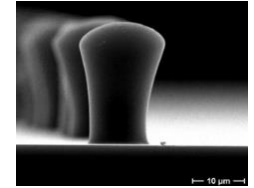
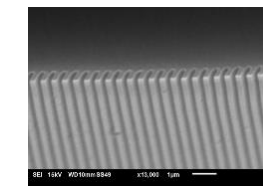
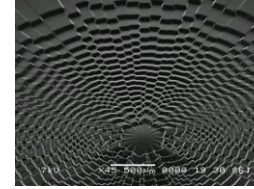
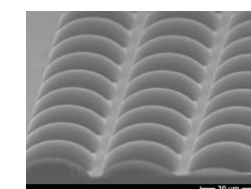
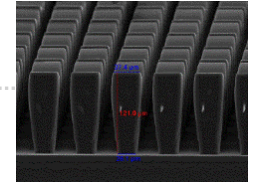
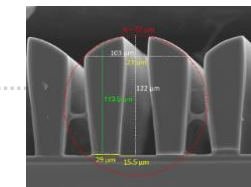
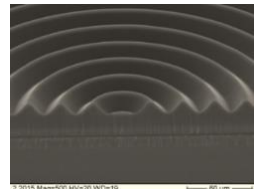
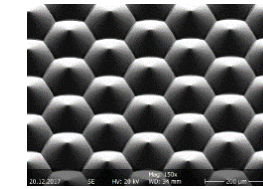
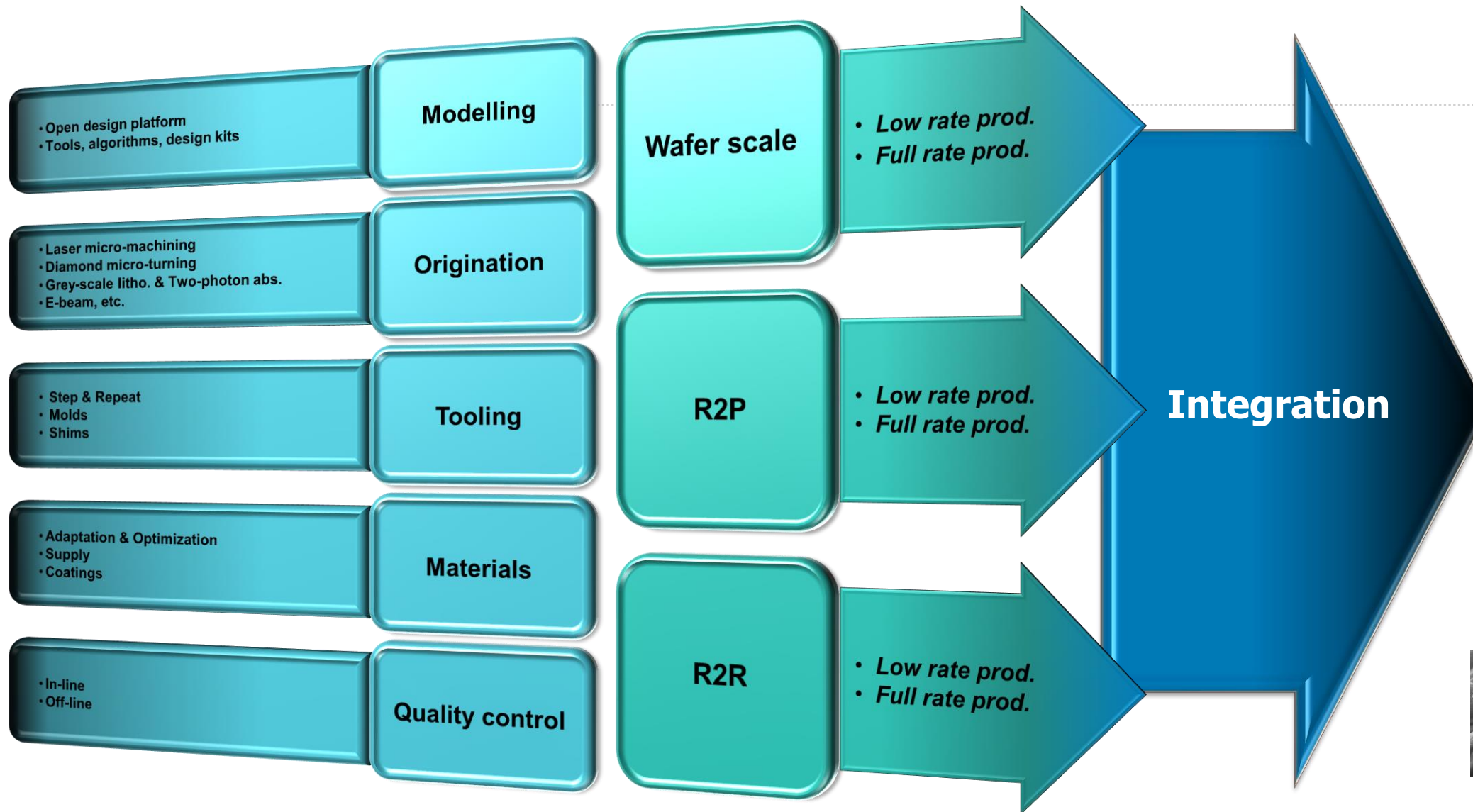
Mastering: Grey Scale Lithography

Main features

- ◆ Structuring on planar and curved substrates
- ◆ Min. feature size(XY): 200 nm
- ◆ Max. structure height(Z): 60 μm
- ◆ Aspect ratio: 4:1
- ◆ Structure type: 1D, 2D, 2.5D and free-form
- ◆ Writing speed (CD = 1 μm) 1 cm^2/h



Using UV Imprint technologies



To support European Industry

MICROOLED

SEISENBACHER

SWAROVSKI

FORVIA
HELLA

ZUMTOBEL



Thank you for your attention!

JOANNEUM RESEARCH
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