

MICRO-OPTICS IS...

Phabulous

Enabling **solutions** through design and
manufacturing of **free-form** micro-optics

Introduction to PHABULOuS

- PHABULO μ S is a European funded project / pilot line within the Horizon H2020 Program for the manufacturing of free-form micro-optics
- PHABULOuS Pilot Line Association is the legal entity created within this project to serve as entry point and continue the offering of services after the project.

MICRO-OPTICS IS...

Phabulo μ s

Funded by:



Our Goals

- **Unify** European research and technology organisations and industrial partners into a **Pilot Line for the design and manufacturing** of free-form micro-optics solutions.
- **Promote** advanced micro-optics technologies and solutions and **offer a single-entry point** (one-stop shop) in order to facilitate access to the complete production chain.
- **Represent** the interests of the **micro-optics community**



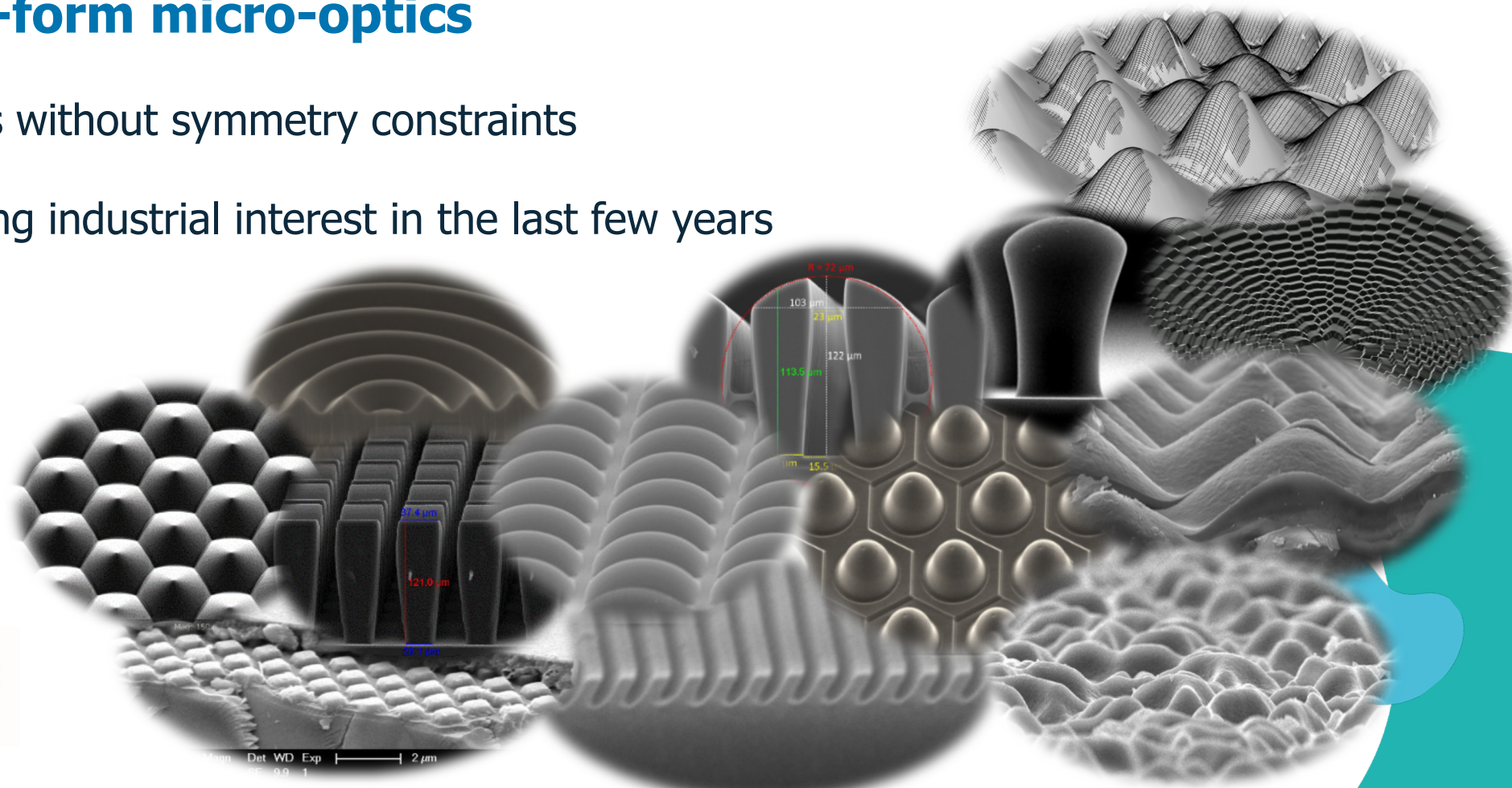
Pilot Line for design and manufacturing



Pilot Line for design and manufacturing

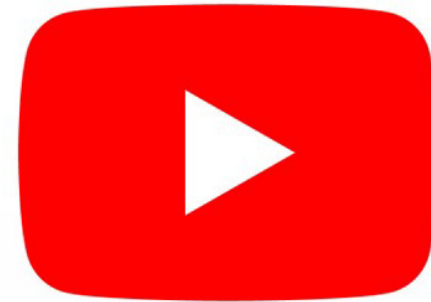
Focused on free-form micro-optics

- Optical components without symmetry constraints
- Gaining an increasing industrial interest in the last few years



Phabulous

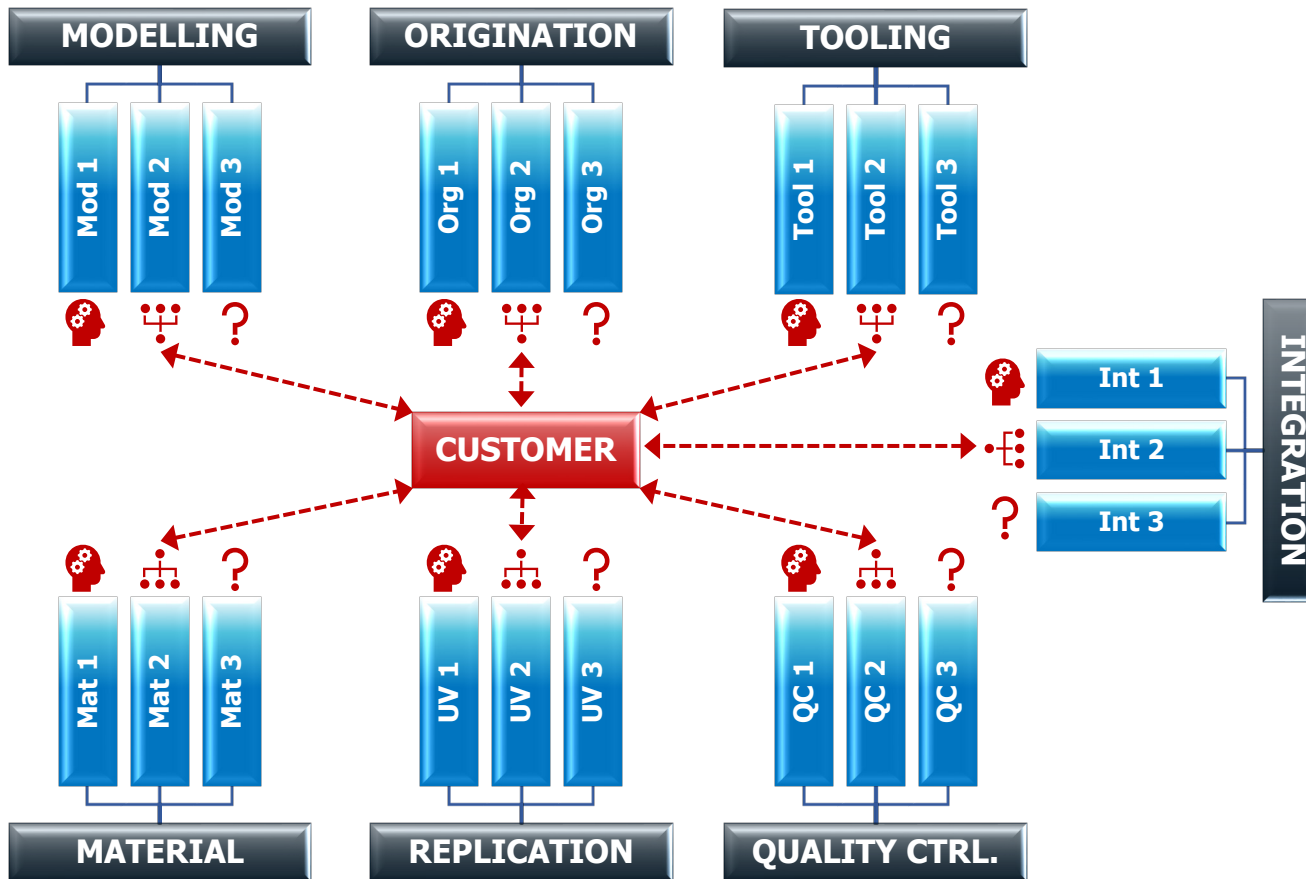
THE EUROPEAN PILOT LINE
AND ONE-STOP-SHOP FOR
THE MANUFACTURING OF
FREE-FORM MICRO-OPTICS



[Click to visit YouTube and watch our introduction video](#)

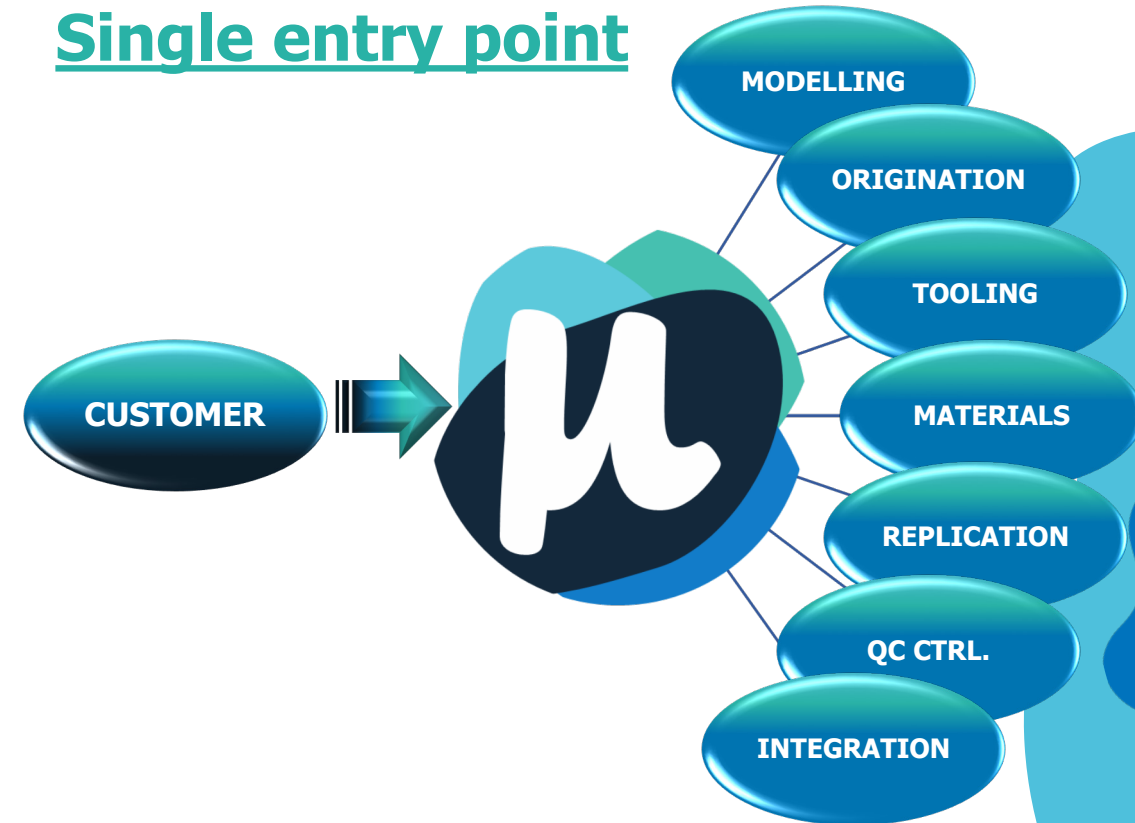
Pilot Line for design and manufacturing

Without PHABULOU S



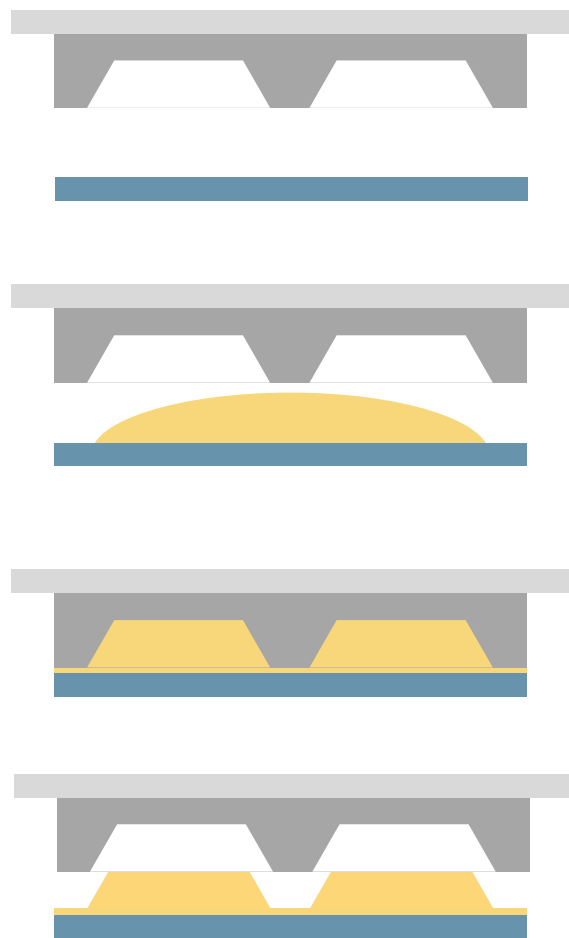
With PHABULOU S

Single entry point



UV Imprint Manufacturing

Waferscale



Stamp



Prepared substrate



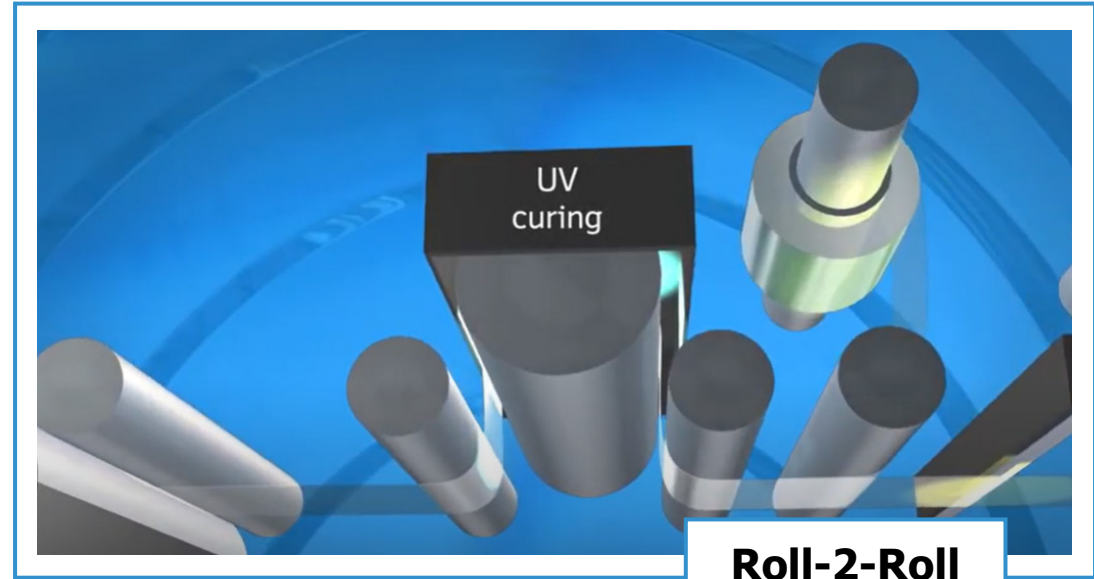
Dispensing of imprint resist
Alignment



Imprint and curing

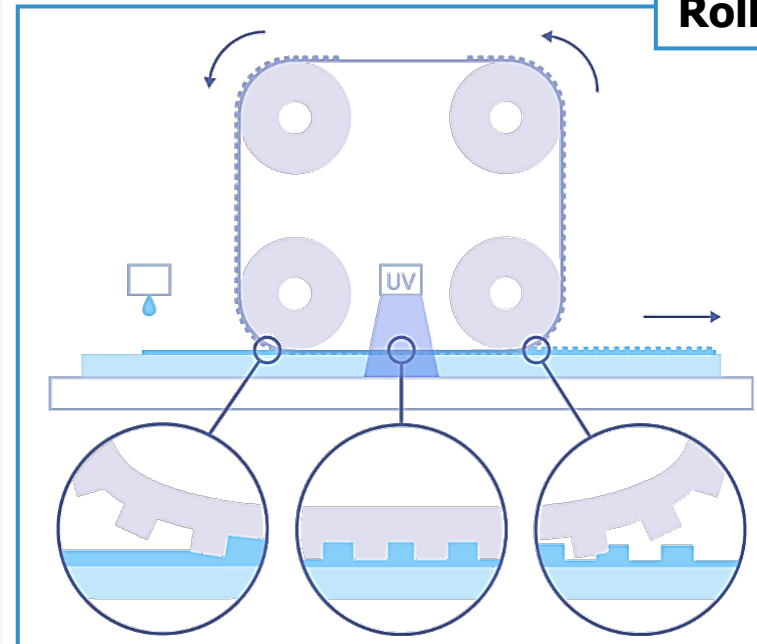


Release and posttreatment



Roll-2-Roll

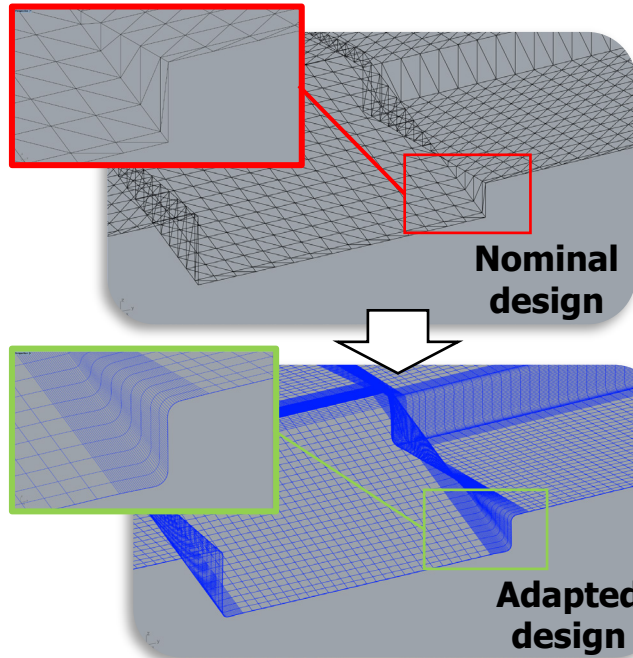
Roll-2-Plate



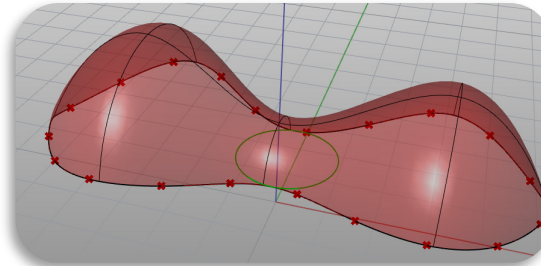
REPLICATION

Design Tools for Manufacturing

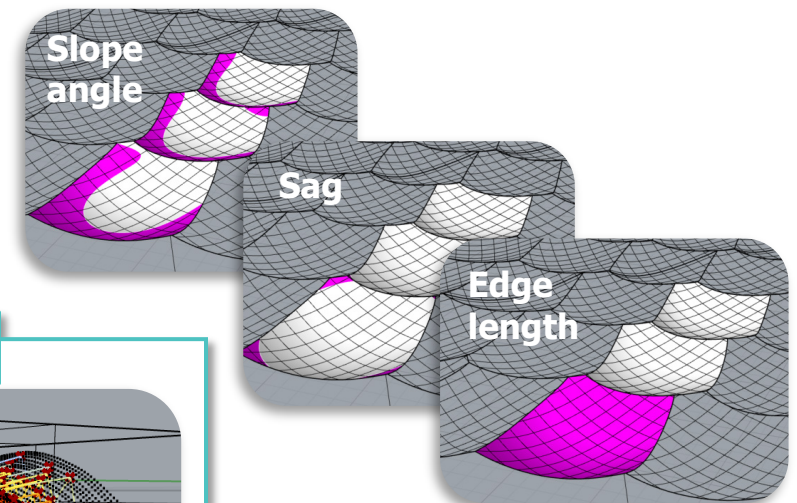
Edge smoothing



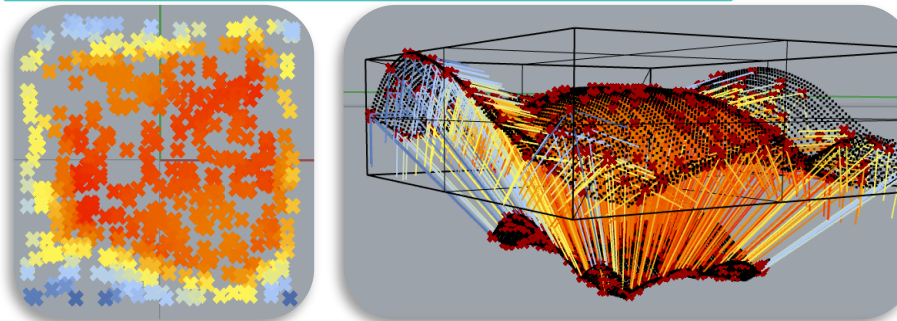
Minimal feature size



Visualization of constraints



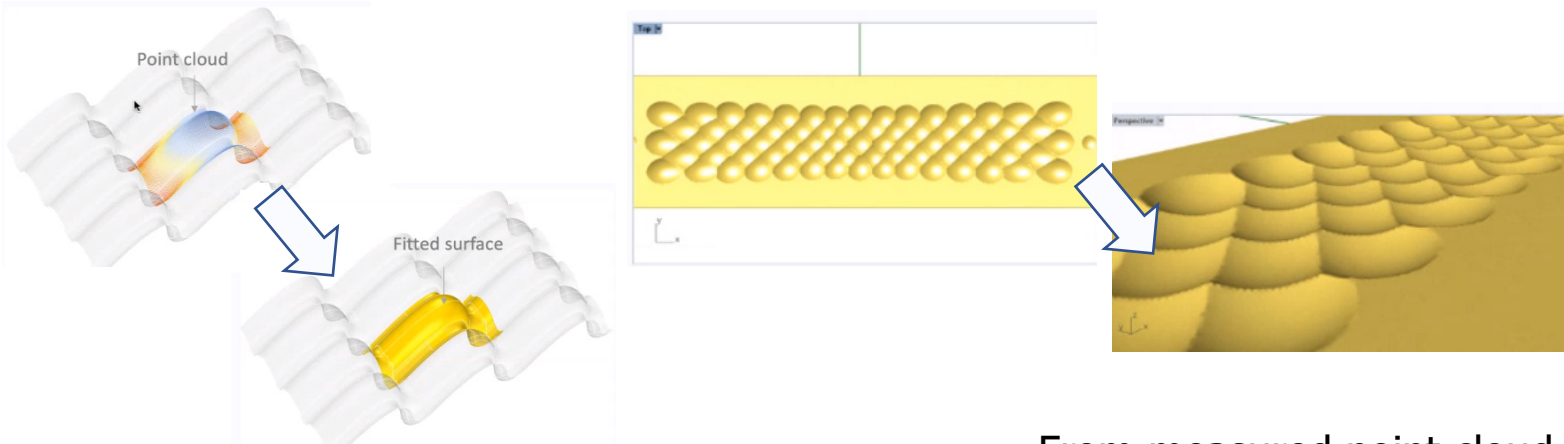
Visualization of shrinkage



**DESIGN &
MODELLING**

Design Tools for Manufacturing

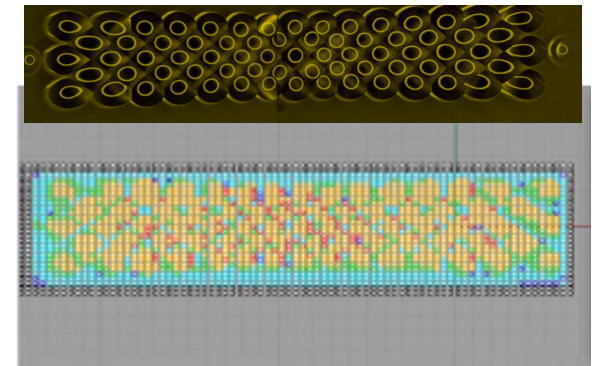
Point cloud into ray traceable solid



From design CAD to ray traceable solid

From measured point cloud to ray traceable solid

CAD comparison tool

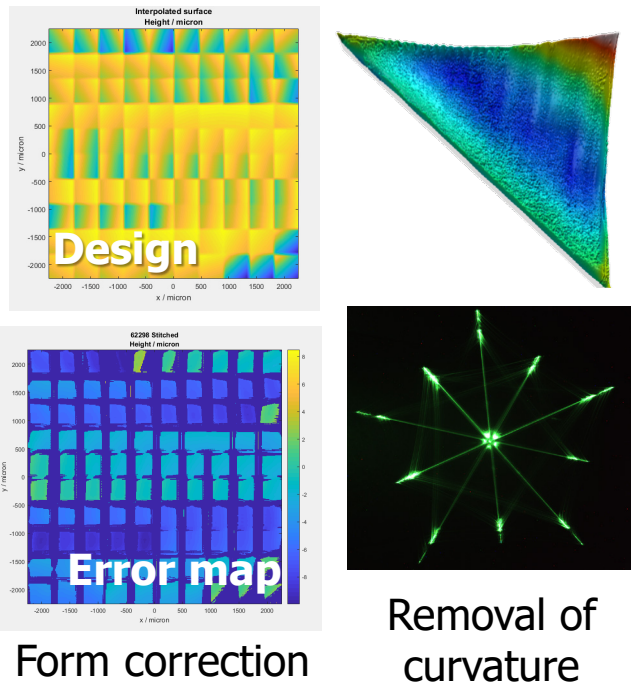


- Comparison of actual master/imprint to design
- Accelerated evaluation

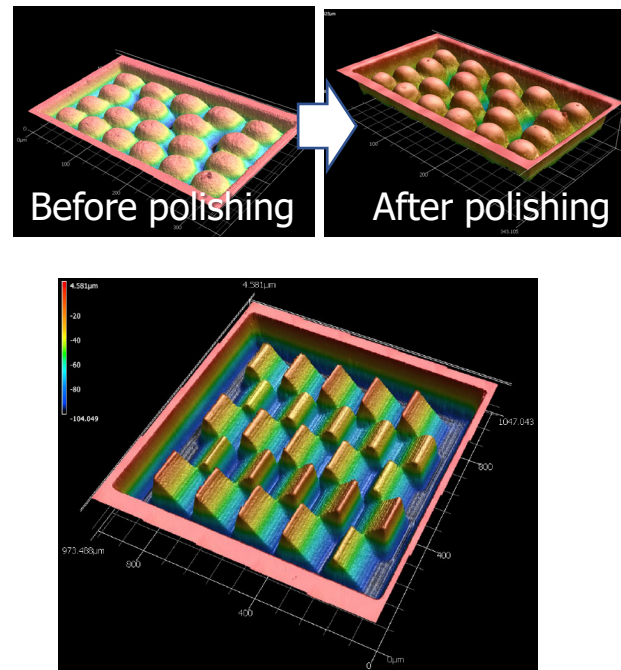
**DESIGN &
MODELLING**

Origination Technologies

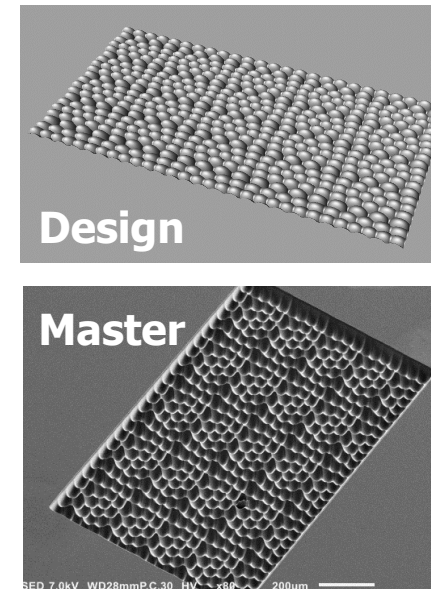
Laser micro machining



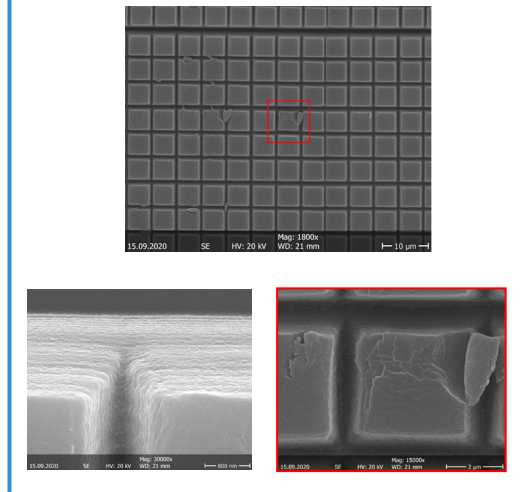
Laser ablation



Grayscale laser lithography



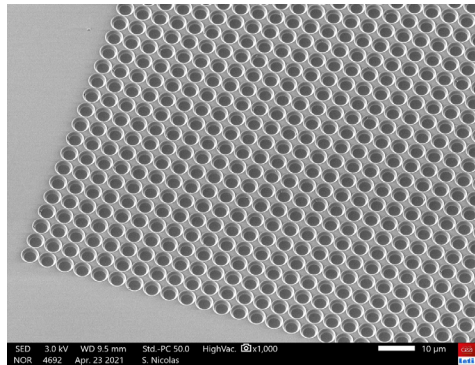
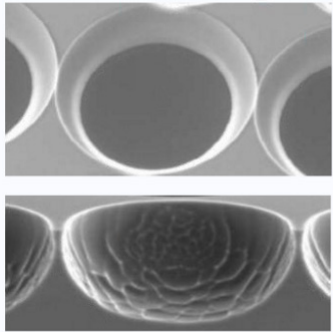
Two Photon Absorption



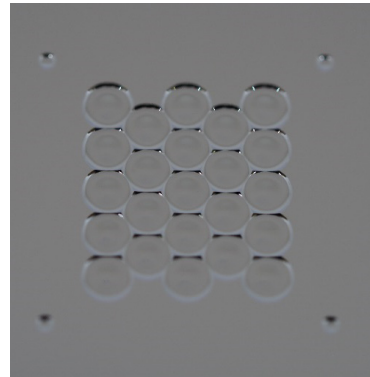
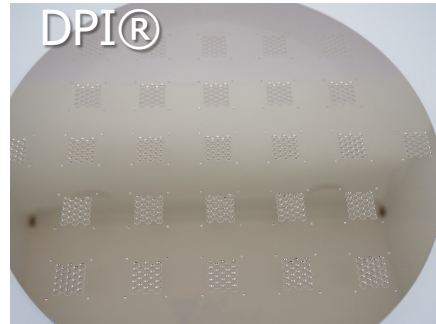
ORIGINATION

Origination Technologies

Silicon etching



Diamond turning

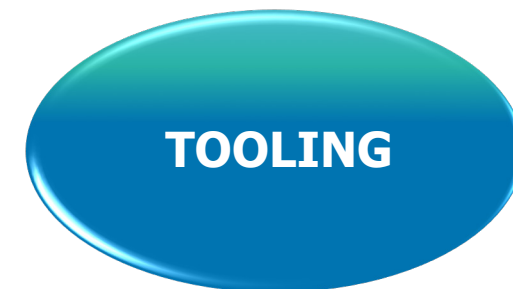
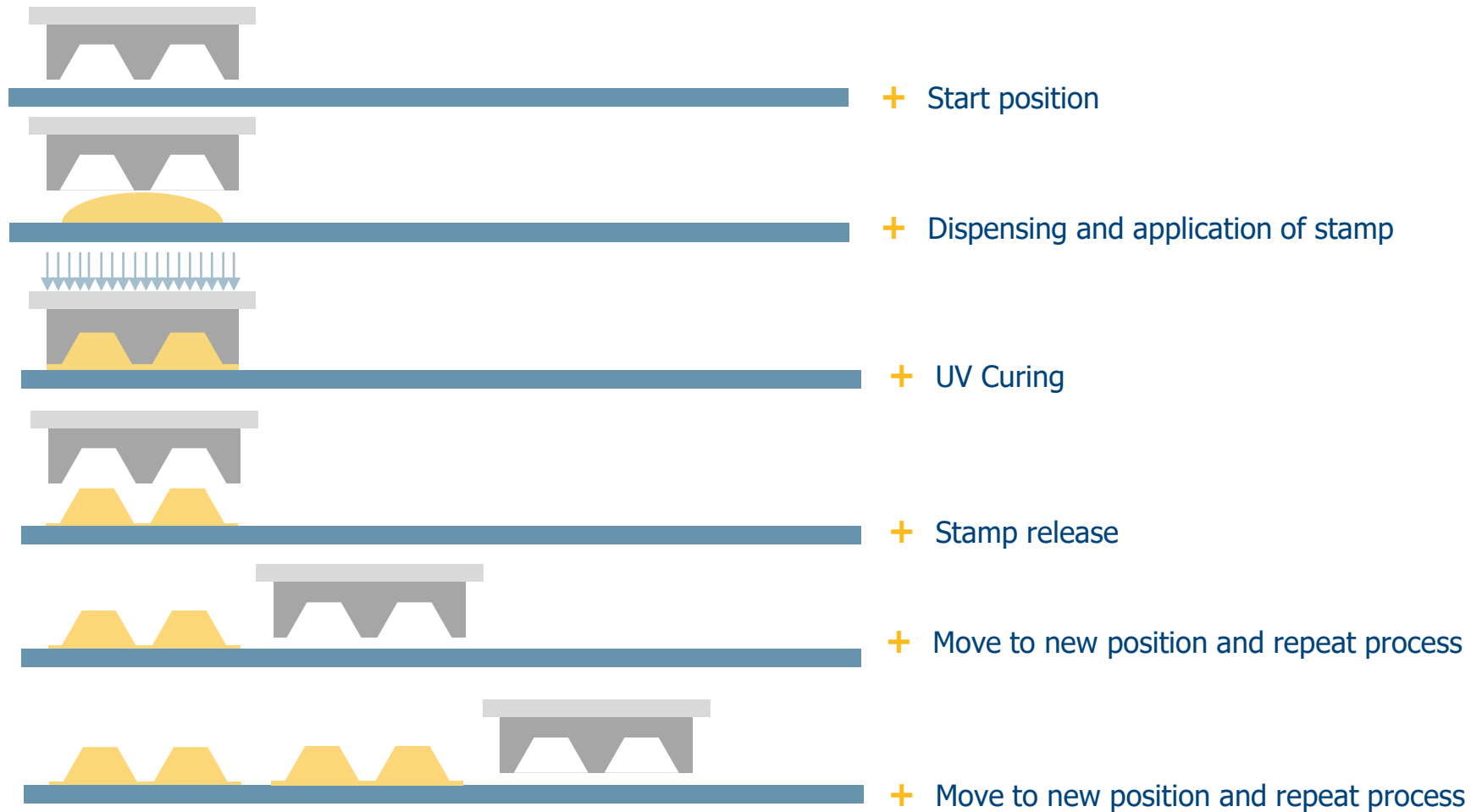


Diamond ruling

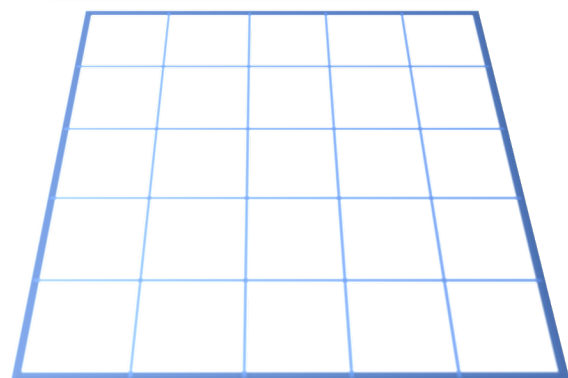


ORIGINATION

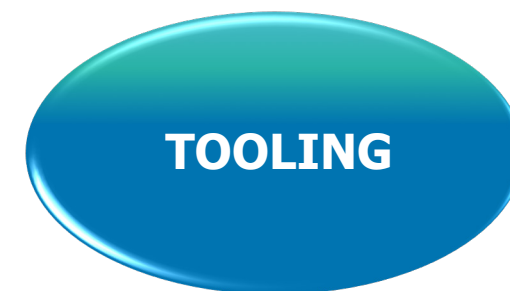
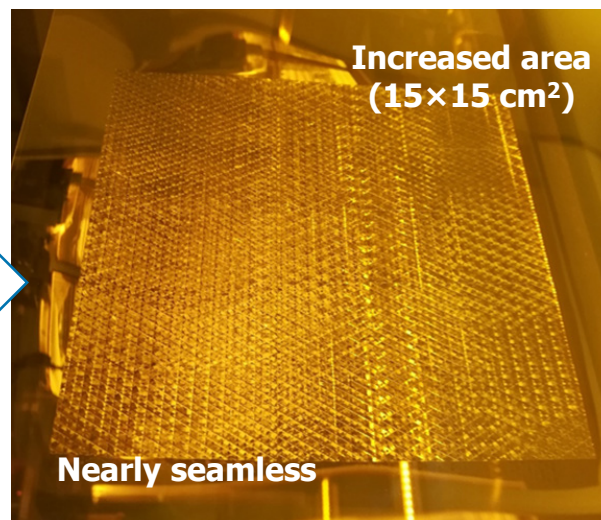
Step & Repeat Upscaling



Step & Repeat Upscaling

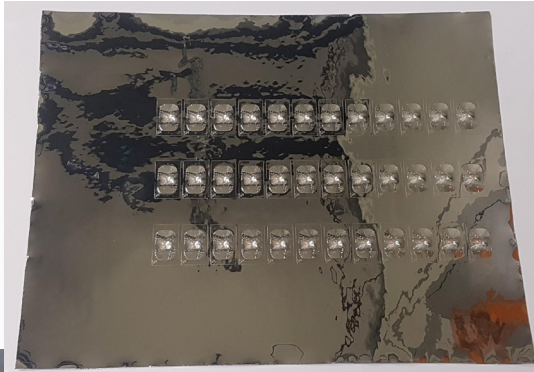


5x5 fields = 15x15 cm²

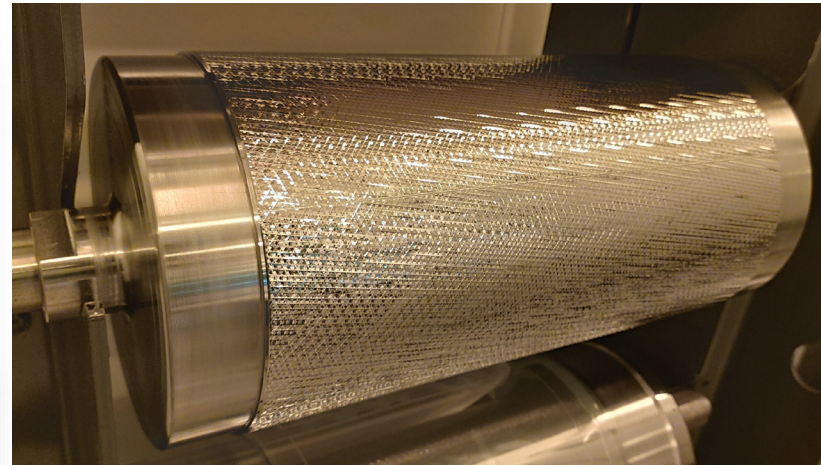


Stamp/tool fabrication

Large area Ni shims



Large area R2R tool



Metallized polymer shims



TOOLING

Material Portfolio

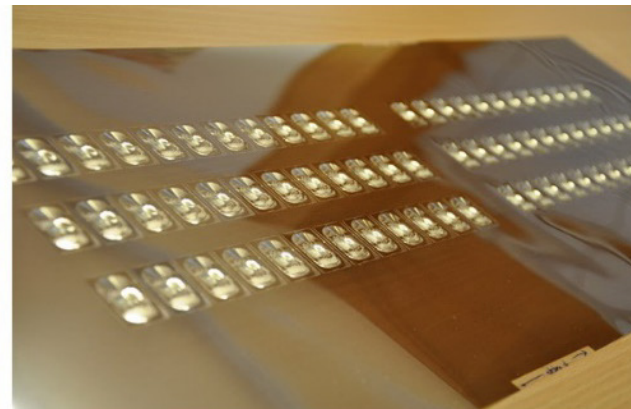
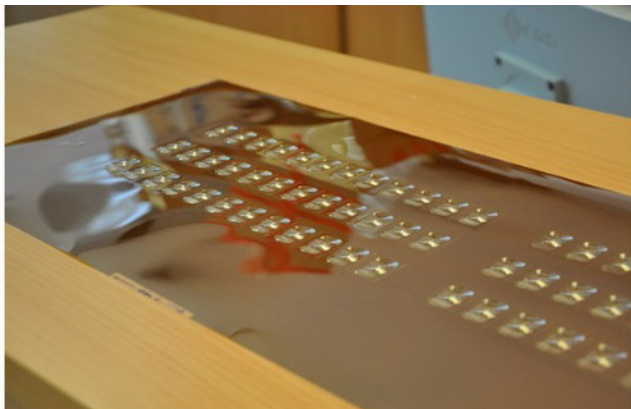
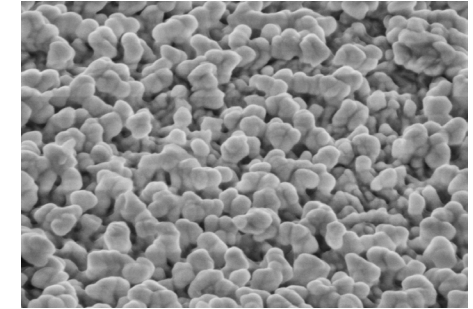
Property	Wafer-scale	R2P	R2R	
Refractive index	1.5 - 1.6	1.45 - 1.85	1.40 – 1.70	1.43-1.58 (uncured resin)
Transparency	>90%	>99%	Negligible (Fresnel-losses) in the Vis range	~90 %
Max. height	500 µm	500 µm	100 µm	90 µm
Shrinkage (%)	1-5%	2 to 8% vertical shrinkage	3-8%	3-5 %
Stability	Automotive qualified	>3000 h DH (85°C/85%RH)	UV stability up to n=1.6	85 °C (tested)
Characterization	Optical and mechanical, surface shape, aesthetics and functional test	Confocal microscopy ellipsometry	-	Reliability tested for consumer electronics
Other relevant prop. (adhesion, mechanical, etc.)		Adhesion to polymers, glass, metal	tuneable	Substrate film material: PC, PMMA, PET, and TPU



Optical Coatings

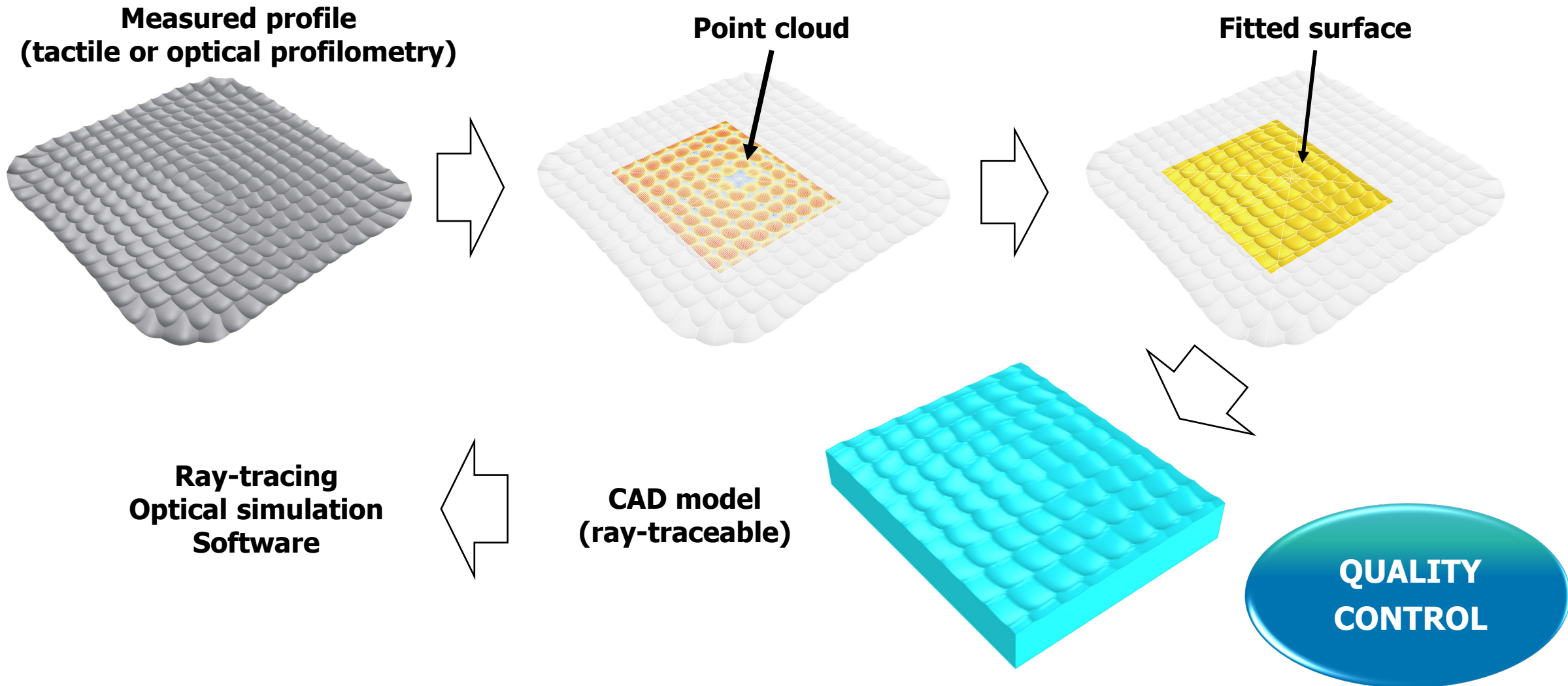
Magnetron sputtering of anti-reflective (AR) coatings

- for the imprinted micro-optical systems
- Optical filters (low-, high- and band-pass)
- Highly-reflective layers
- Anti-adhesive metallization of replication stamps with UV-reflective properties for enhancement of UV-curing procedure of resins



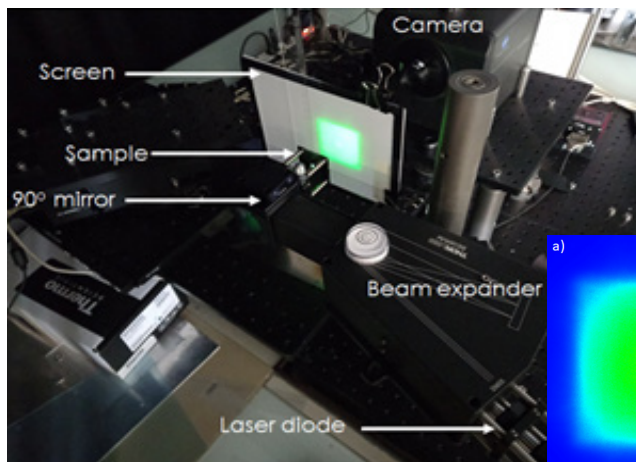
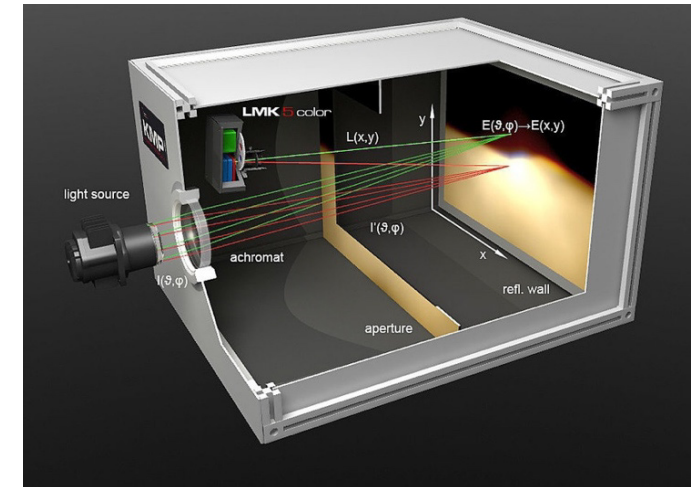
COATINGS

Performance evaluation

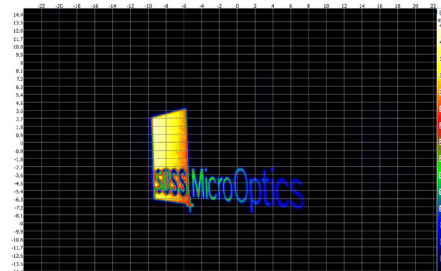
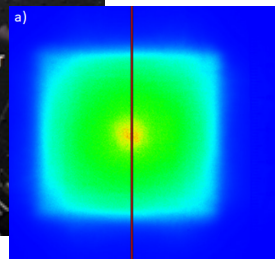


Functional testing

- Functional testing equipment for small-area prototypes and large-area products
- Calibrated light level measurement
- Angular range: horizontal (-24° , $+24^\circ$), vertical (-15° , $+15^\circ$)
- Luminance intensity distribution measurement range: up to 500'000 cd
- Evaluation of contrast & absolute light level at specific points in the field
- Testing according to automotive regulations



**Illuminance map (far field)
BTDF (@ normal inc. calculated)**



Pilot Line for design and manufacturing

FORVIA



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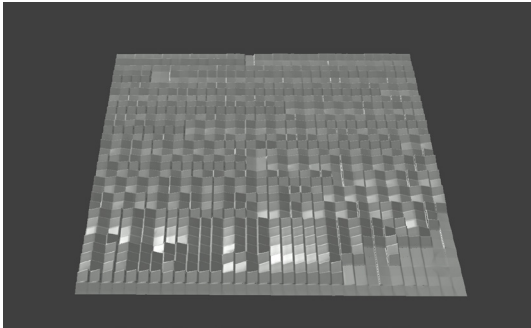
Advanced FMLAs for next generation headlights

Enable headlights with optimized light distribution and low installation space and weight.



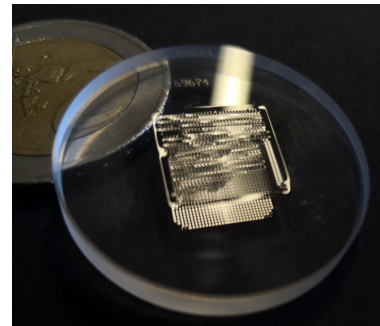
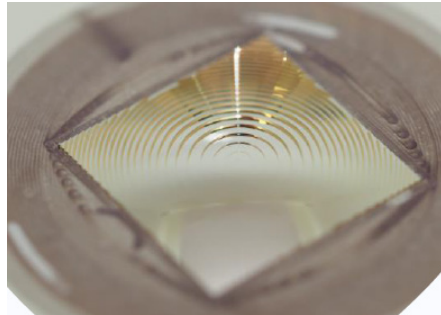
DESIGN

Micro-facets that are oriented and arranged in a specific way to generate the light distribution and reduce the stray light.



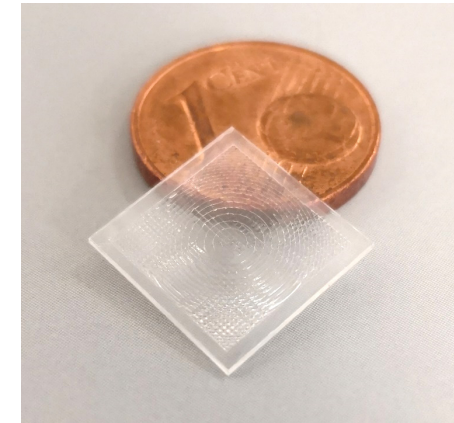
ORIGNATION

One side a micro-Fresnel lens by ultra-precision machining. Other side a facet array by laser micro-machining.



REPLICATION

Replicate the master structures but also to accurately combine the two functional surfaces.



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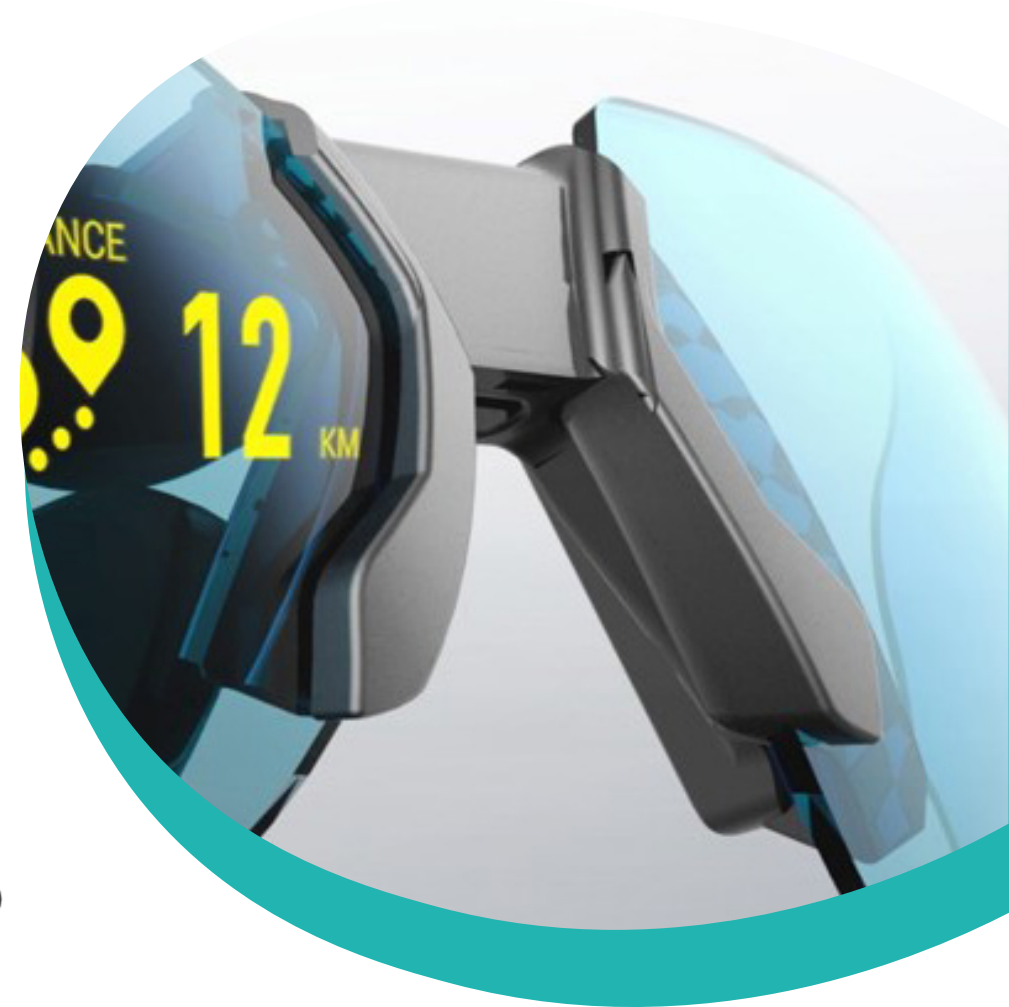
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MICROOLED

Micro Displays for Augmented Reality solutions

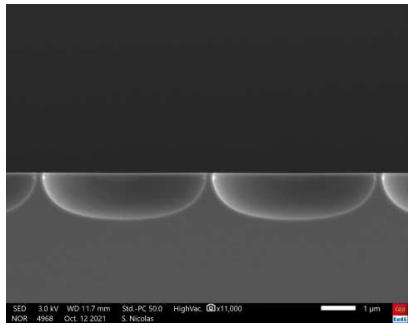
Control the angular shape of light output
and to enhance brightness.

ActiveLook®



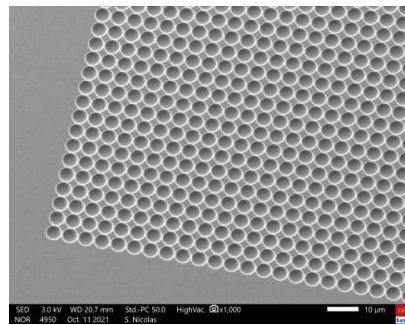
DESIGN

The design is characterized by a small pitch together with a high aspect ratio.



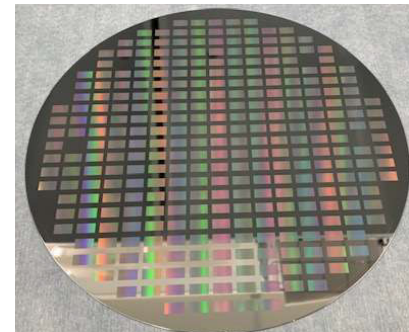
ORINATION

Silicon etch technologies as well as by laser grayscale lithography.



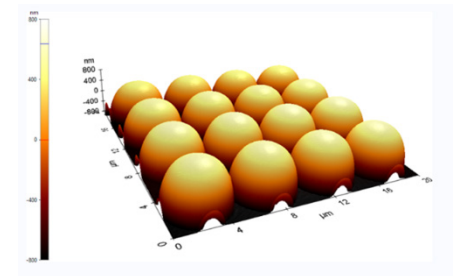
REPLICATION

On a 200mm glass wafer using a suitable polymer material.



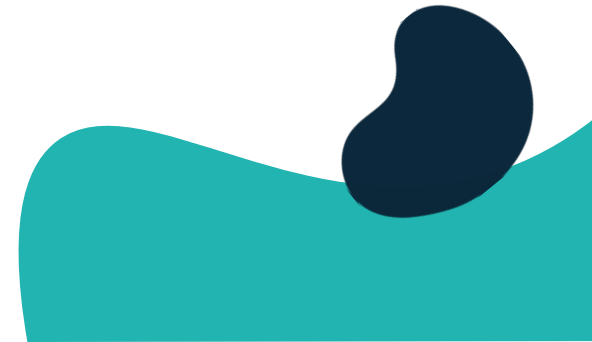
INTEGRATION

Assembly to the micro-display chips.



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Transportation Interior Lighting

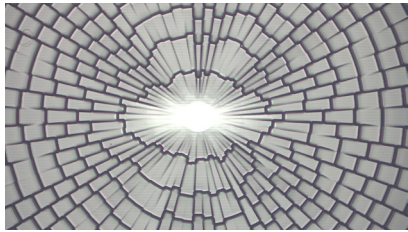
Develop ultrathin luminaires or luminaires with a significantly reduced number of LEDs and with a customized illumination pattern.



© Neomind / BEG / DB

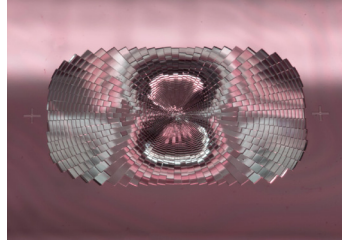
DESIGN

A free-form structure realizing a very homogeneous irradiance on the diffuser plane.



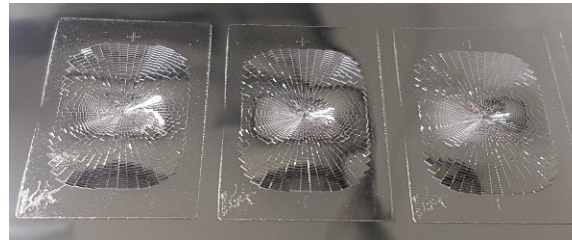
ORINATION

Laser-based mastering technology produced with a high accuracy.



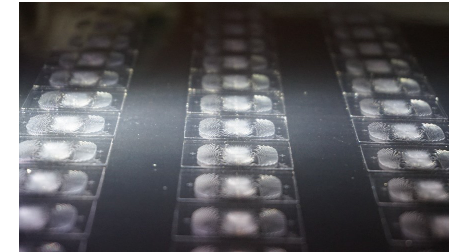
TOOLING

Upscaled into a so-called multi-lens-array. Then the galvanized multi-lens-array to create the final tool for replication.



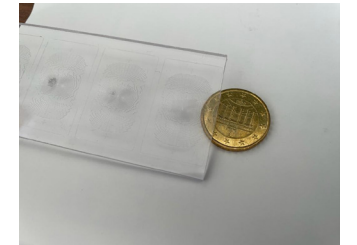
REPLICATION

Replicas using UV-imprint R2P (roll-to-plate) technology.



INTEGRATION

Integration into the luminaires.



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SWAROVSKI

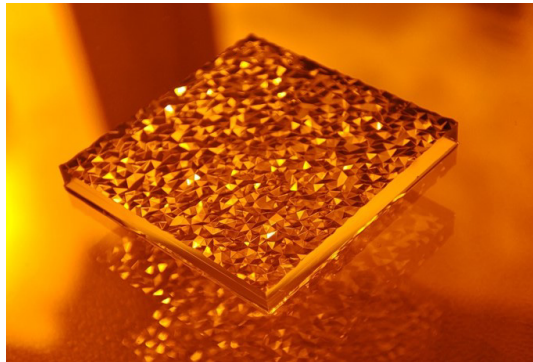
Brilliance in Luxury

Seamless manufacturing of
micro-structured foils with
gemstone appearance.



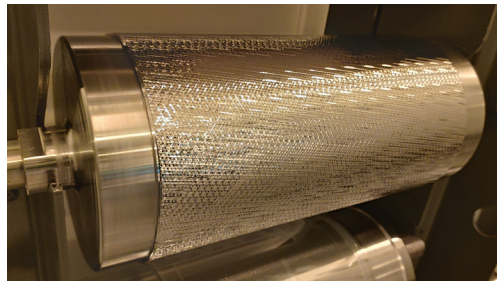
DESIGN

Free-form micro-optics structure based on the faceted-structure of cut crystals.



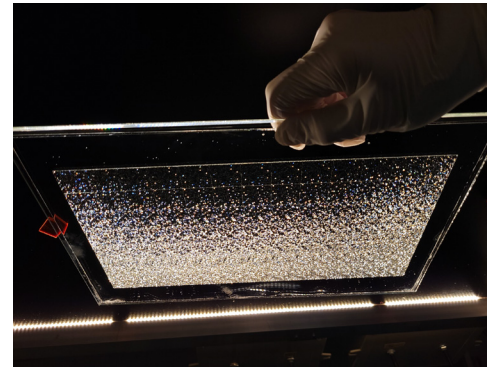
ORIGINATION

Laser ablation and ultra-precision diamond ruling were tested for different structures.



REPLICATION

Roll-2-roll replication and roll-2-plate on a glass substrate were tested.



COATINGS

Roll-2-roll application of silver mirror on the back of the structure.



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Novel lighting solutions

Luminaires with asymmetric
uniform light distribution.

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Phabulops



DESIGN

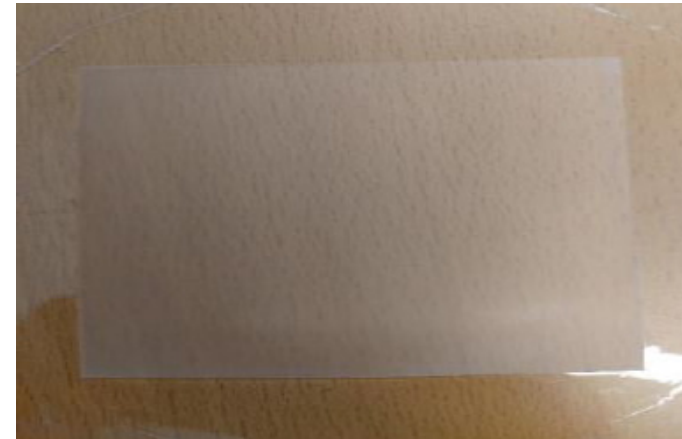
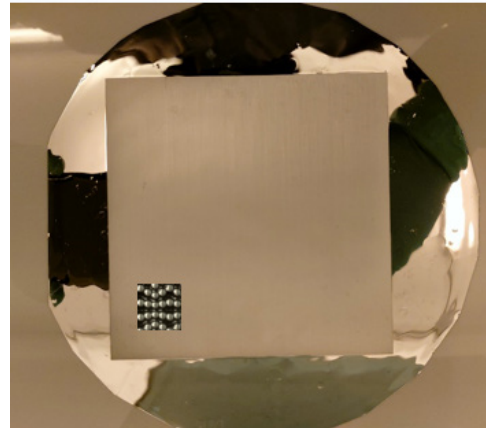
Design to achieve a high asymmetric distribution and enable a very homogeneous distribution.

ORIGINATION

Different technologies have been benchmarked making sample coupon of the design in different scales.

REPLICATION

Replica on plate and imprints in Roll-2-Roll (R2R) technology.



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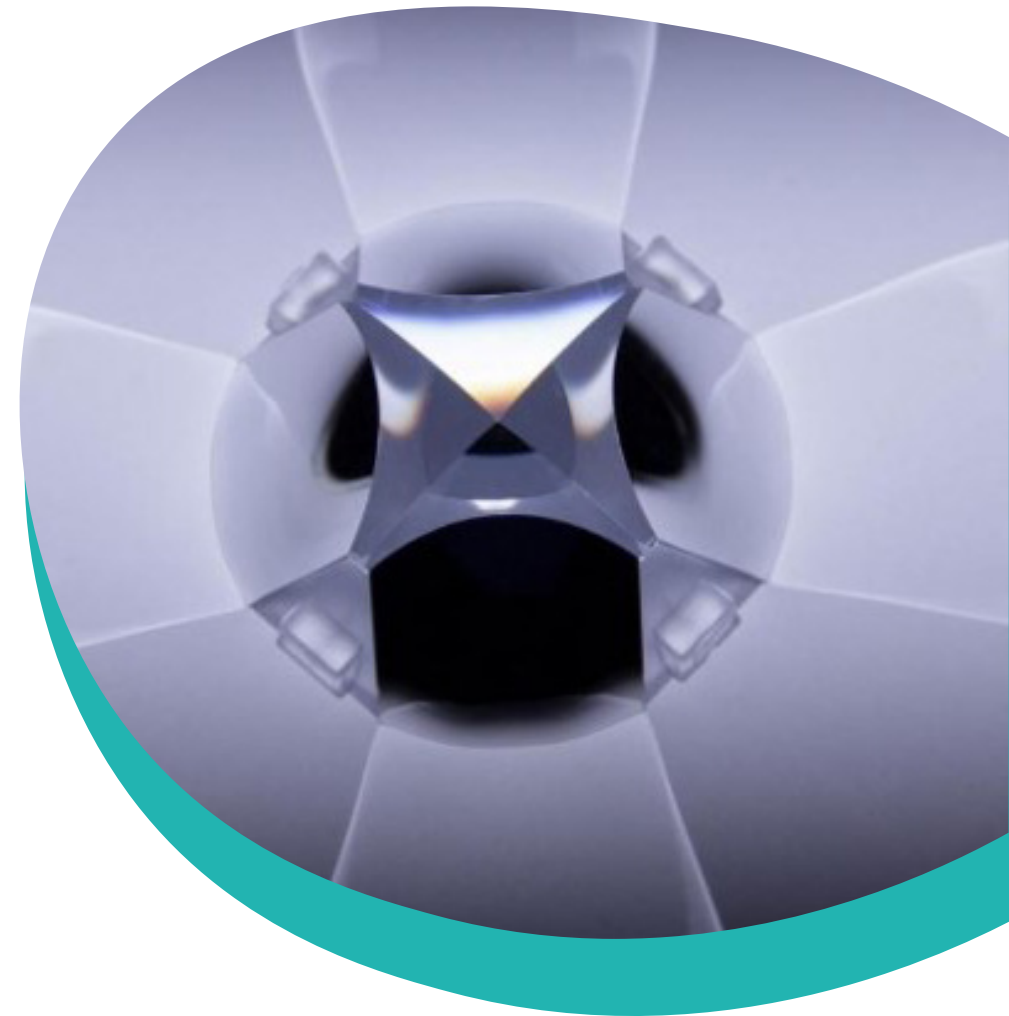
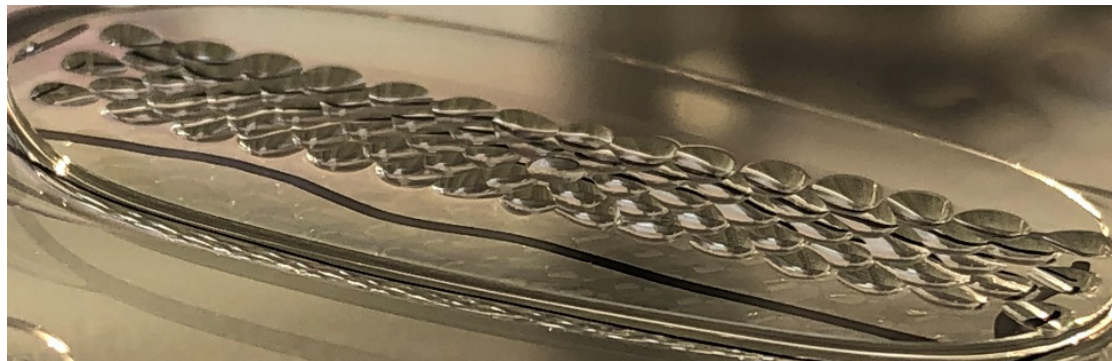




Optical system for VR headsets

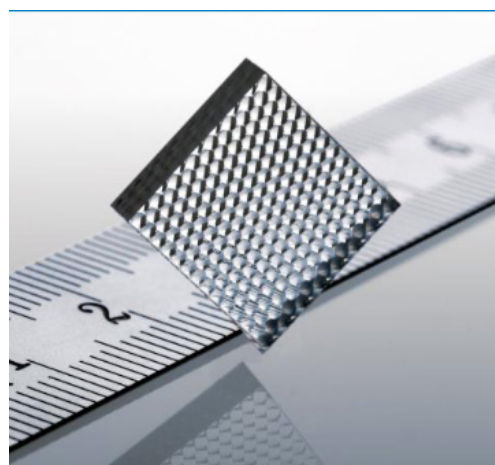
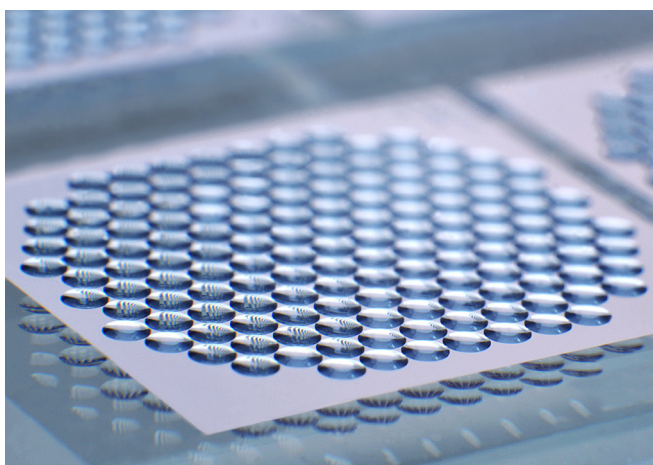
VR/AR headsets with improved performance and reduced volume.

Thin free-form optical lenses with better image resolution and field of view.



Automotive Lighting

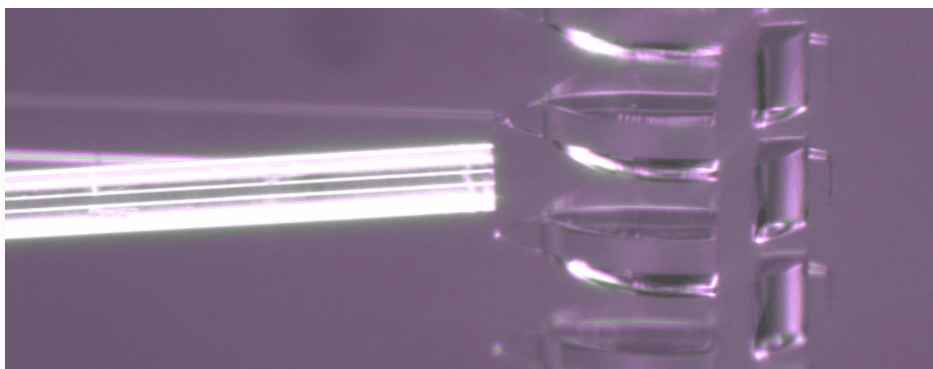
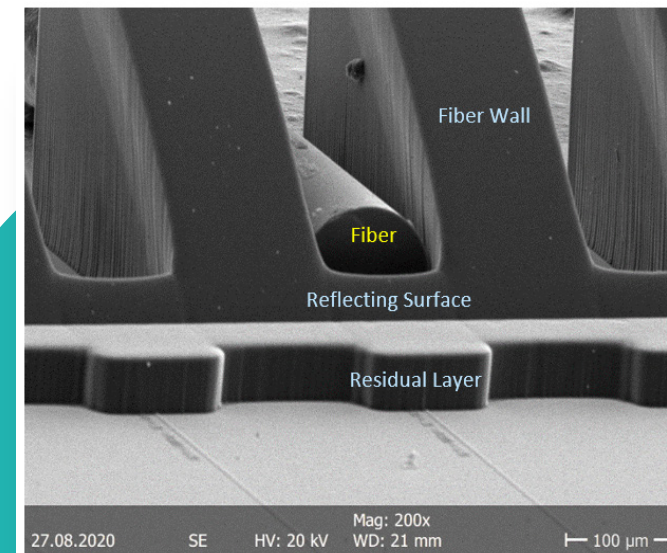
UV-imprinted micro lens arrays (MLAs)
for light carpets.



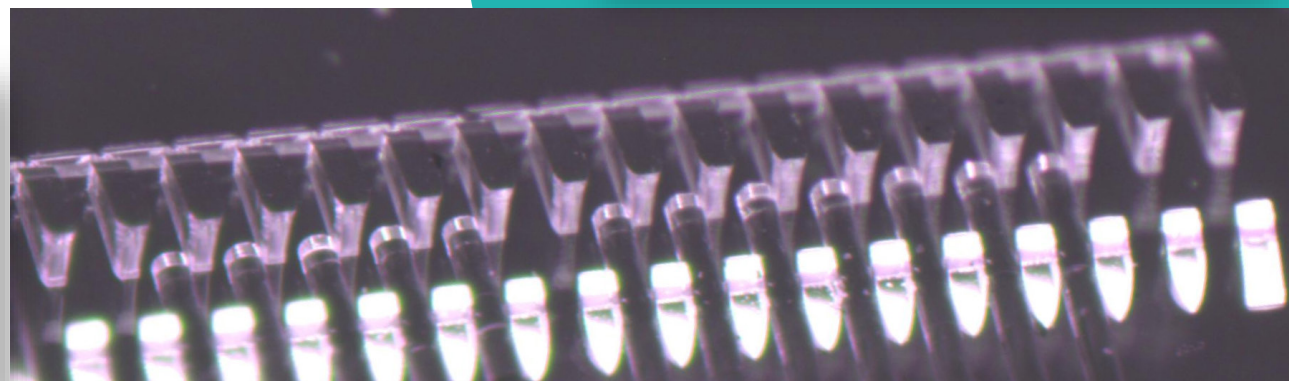
Optical Communication

UV-Replication of in-plane micro-optical interconnects on SiN waveguides.

Plug & Play assembly of fibers with self-alignment structures.



Fiber self alignment



partly inserted fiber array

Our offer

- Easy access to a full value chain
- Manufacturing services from prototyping to piloting and large volume production
- **Now with funding up to 90% through the open call**

www.phabulous.eu/open-call/



Phabulous

Pilot-line providing highly advanced & robust manufacturing technology for optical free-form micro-structures

PROJECT ▾

PILOT LINE

OPEN CALL

MARKETPLACE

NEWS & EVENTS ▾

DOWNLOADS

CONTACT US



What?

When?

Who?

Why?

Process?

How?

Package

Helpdesk

Complaints



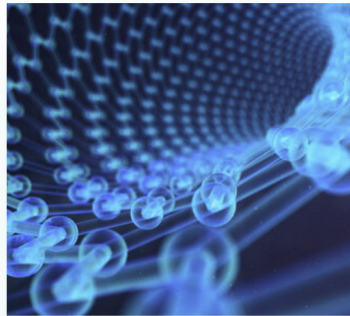
PHABULOUS Open Call
Funding opportunities
to implement free-form
micro-optical components



www.phabulous.eu/open-call/

Offer a single-entry point

Promote advanced micro-optics technologies and solutions and offer a single-entry point (one-stop shop) in order to facilitate access to the complete production chain.



Technical Marketplace

(catalogue of products, prototypes and technical services)



Organisation registry

(catalogue of ecosystem organisations)



Community



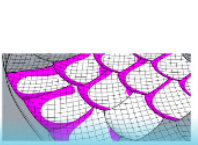


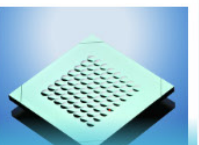

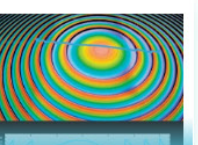

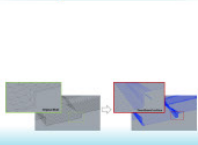




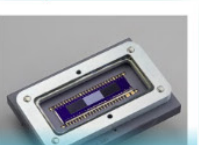







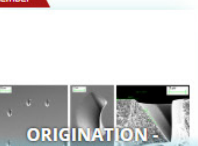


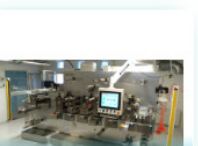





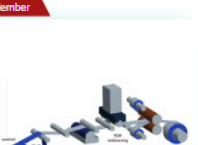

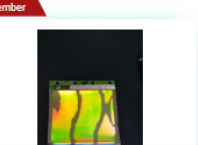
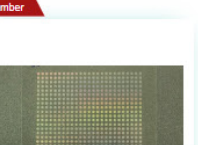
(Shared information for benefit of PHABULOUS ecosystem)

Organisation Registry

 3D AG	 AMIRES S.R.O.	 AXETRIS AG	 BLÖSCH AG	 CEA	 CORNING LASER TECHNOLOGIES GMBH	 CSEM SA	 DELO INDUSTRIAL ADHESIVES
 EPIC EUROPEAN PHOTONICS PHOTONICS INDUSTRY CONSORTIUM	 FEMTOPRINT	 FOLEX AG	 FRAUNHOFER FEP	 HELLA GMBH & CO. KGAA	 IMAGINE OPTIC SA	 JOANNEUM RESEARCH FORSCHUNGSGESellschaft MBH	 JOYA TEAM
 LASEA	 MATHYM	 MICRORELLEUS, S.L.	 MORPHOTONICS B.V.	 NANOCOMP OY LTD	 NANOSCRIBE GMBH & CO. KG	 PHABULOUS PILOT LINE ASSOCIATION	 PHOTONICS PRECISION ENGINEERING GMBH
 POWERPHOTONIC LTD	 STANDEX INTERNATIONAL	 STENSBORG A/S	 SUSS MICROOPTICS	 TEMICON GMBH	 VTT TECHNICAL RESEARCH CENTRE OF FINLAND LTD	 WIELANDTS UPMT	 YALOSYS AG

Technical Marketplace

Listed items: 35 Sort by: AZ - Offering Title Items/page: all Show as: Grid

<p>Member</p>  <p>ADVANCED LASER ABLATION</p>	 <p>ASPHERICAL MICROLENS AND MLA ON SILICON AND GLASS WAFER</p>	<p>Member</p>  <p>DESIGN & DESIGN FOR MANUFACTURING</p>	<p>Member</p>  <p>DIFFRACTIVE OPTICS (DOES)</p>	 <p>ELECTROFORMING NICKEL SHIMS MOLDS FOR REPLICATION</p>	<p>Member</p>  <p>ETCHED MICROLENSSES</p>	 <p>FEMTOSECOND LASER MICROSTRUCTURING SERVICES IN 5 AXIS</p>	<p>Member</p>  <p>FRESNEL LENS FILMS</p>	<p>User</p>  <p>HEADLAMPS WITH MICRO-OPTICS</p>
<p>Member</p>  <p>CHARACTERIZATION & QUALITY CONTROL</p>	 <p>LASER DICING OF GLASS BASED WAFER LEVEL MANUFACTURED PRODUCTS</p>	<p>Member</p>  <p>LENS ARRAYS & LENS ARRAY MASTERS</p>	<p>Member</p>  <p>MASK-LESS LASER LITHOGRAPHY</p>	 <p>MICRO- AND NANO LASER STRUCTURING</p>	<p>Member</p>  <p>MICRO-LENSES & MICRO-LENS ARRAYS</p>	<p>Member</p>  <p>MICROIMPRINT ON WAFER LEVEL</p>	<p>Member</p>  <p>MICROLENS ARRAY FILMS</p>	<p>Member</p>  <p>NANOIMPRINT (REPLICATION OF NANO/MICRON TEXTURES)</p>
<p>Member</p>  <p>NANOIMPRINT AT WAFER-SCALE</p>	 <p>NIL DESKTOP TOOLING</p>	 <p>OPTICAL GRADE POLYMERS ON WAFER-LEVEL</p>	<p>Member</p>  <p>ORIGINATION</p>	<p>Member</p>  <p>ORIGINATION - GRAYSACLE DIRECT WRITE LASER LITHOGRAPHY</p>	<p>Member</p>  <p>ORIGINATION - MICROLENS ARRAY</p>	 <p>R2R ASSEMBLY PILOT LINE</p>	 <p>R2R PILOT CONVERTING LINE</p>	 <p>R2R UV-IMPRINT MANUFACTURING</p>
<p>Member</p>  <p>RAPID-PROTOTYPING OF COMPLEX 3D PLASTIC OPTICAL COMPONENTS</p>	<p>Member</p>  <p>100 µm REPLICATION AT WAFER-SCALE</p>	<p>Member</p>  <p>REPLICATION BY R2P</p>	<p>Member</p>  <p>ROLL-TO-ROLL</p>	<p>Member</p>  <p>ROLL-TO-ROLL UV IMPRINT REPLICATION</p>	<p>Member</p>  <p>STEP AND REPEAT</p>	<p>Member</p>  <p>TOOLING (ELECTRO-FORMING)</p>	<p>Member</p>  <p>TOOLING (STEP & REPEAT)</p>	

Community



EVENTS



FUNDING OPPORTUNITIES



JOB OFFERINGS



NEWS



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SKILLS & TRAININGS



VIDEOS

News

THE LIGHT TUNNEL GENERATOR BY POWERPHOTONIC

Executive summary

Launch of a game-changing new class of optical Beam Shaper that improves high power laser cutting & welding: The Light Tunnel Generator

News

ENHANCED LIGHTFORGE RAPID PROTOTYPING SERVICE

Executive summary

PowerPhotonic has enhanced its rapid prototyping service known as LightForge.

Funding opportunities

FUNDING OPPORTUNITY TO IMPLEMENT FREE-FORM MICRO-OPTICAL COMPONENTS

Executive summary

PHABULOuS launched its open call to support companies with the implementation and integration of free-form micro-optical components.

Publications

ORINATION OF FREE-FORM MICRO-OPTICAL ELEMENTS USING ONE- AND TWO-PHOTON GRAYSCALE LASER LITHOGRAPHY

Executive summary

Publication about the development of an origination process for planar free-form micro-optical elements from a given optical design.

News

PHABULOUS LAUNCHES ITS OPEN CALL

Executive summary

PHABULOuS launches its open call to support the implementation and integration of free-form micro-optics and the scale up to pilot production.

Skills & Trainings

PHABULOUS TECHNOLOGY HANDBOOK

Executive summary

Here you can download the PHABULOuS technology handbook giving you an overview of the technological capabilities for the PHABULOuS Pilot Line.

News

POWERPHOTONIC INC APPOINTS MARK MCELHINNEY TO SPEAR HEAD THE FOUNDING OF US MANUFACTURING.

Executive summary

PowerPhotonic has appointed Mark McElhinney as CEO of PowerPhotonic Inc. Mark's initial focus will be quickly establishing US engineering & manufact

Job offerings

PRODUCT DEVELOPMENT ENGINEER

Executive summary

Optical design, design for manufacture and product optimization for best performance in customer application

Job offerings

SCIENTIST - LASER LITHOGRAPHY FOR INTEGRATED PHOTONICS AND MICRO-OPTICAL STRUCTURES

Executive summary

JOANNEUM RESEARCH Forschungsgesellschaft mbH is seeking a Scientist - Laser lithography for integrated photonics and micro-optical structures

Videos

VIDEO INTRODUCTION TO PHABULOUS

Executive summary

Official video introducing the capabilities of free-form micro-optics and the services of PHABULOuS.

Videos

VIDEO ON CUTTING-EDGE R2R TECHNOLOGY

Executive summary

Nanocomp is a global forerunner in micro- and nanophotonics design and manufacturing showcased in this newly released video about our capabilities.

Our offer

- Integration into the value chain for micro-optics
- Organization registry → Marketplace → Community
- **Lead generation**

ecosystem.phabulous.eu



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PHABULOuS Pilot Line



PHABULOuS EU



PHOTONICS PUBLIC PRIVATE PARTNERSHIP

Thank you



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MICRO-OPTICS IS...

Phabulous

Thank you