

**microrelleus**

# **ENHANCING AUTOMOTIVE LIGHTING DESIGN AND FUNCTIONALITIES THROUGH TOOL MICROSTRUCTURING**

**PHABULOUS Webinar on Micro-Optics in Automotive, Oct 2025**

# Who we are

## Services provider:

- Laser microstructuring
- Surface texturing
- Industrial engraving

## Since 1983:

Pantograph → Die-Sinking  
EDM → CNC milling →  
Nano Laser → Femto Laser

Facilities in **Barcelona**

## Laser texturing advanced solutions:

- 2013: first laser texturing in Spain
- 2016: **pioneers femtosecond laser 5 axis**
- 2022: **femto 5 axis for big and heavy tools**
- 2025: **Microrelleus Lighting Laboratory**

**WHO**

**WHEN**

**WHERE**

**STATE-OF-THE-ART**

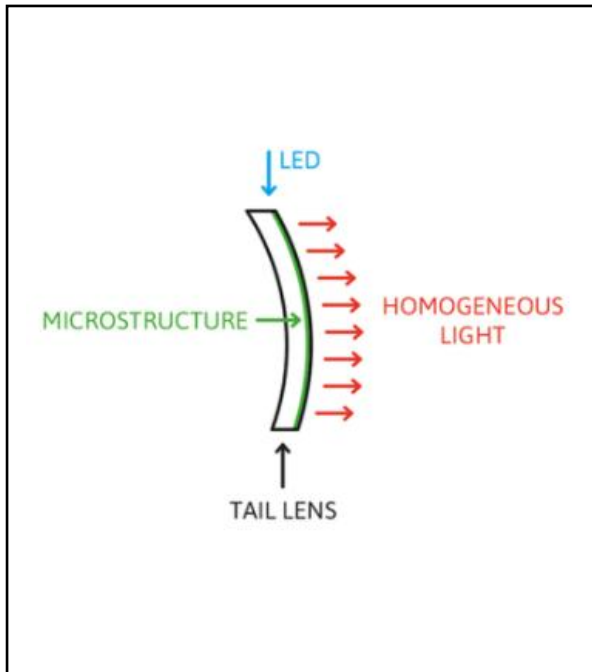


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# Manufacturing process - introduction

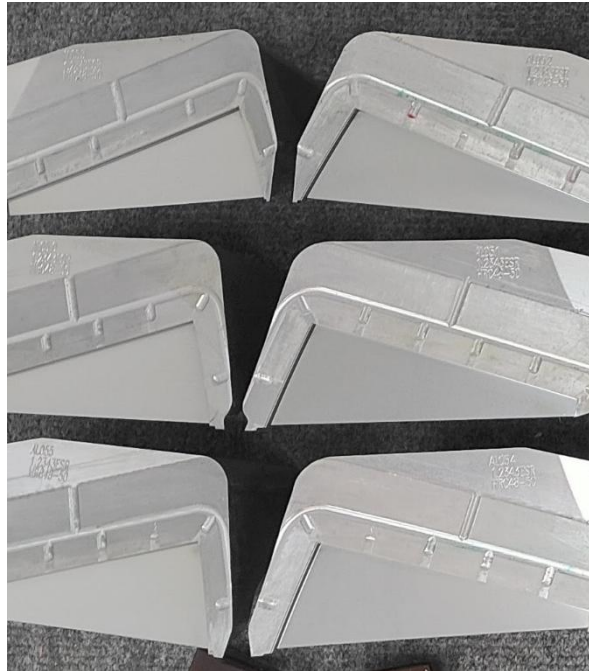
## 1) Micro-optics design concept

Microstructure design or Microscatt reference. Our optical engineering team can support you.



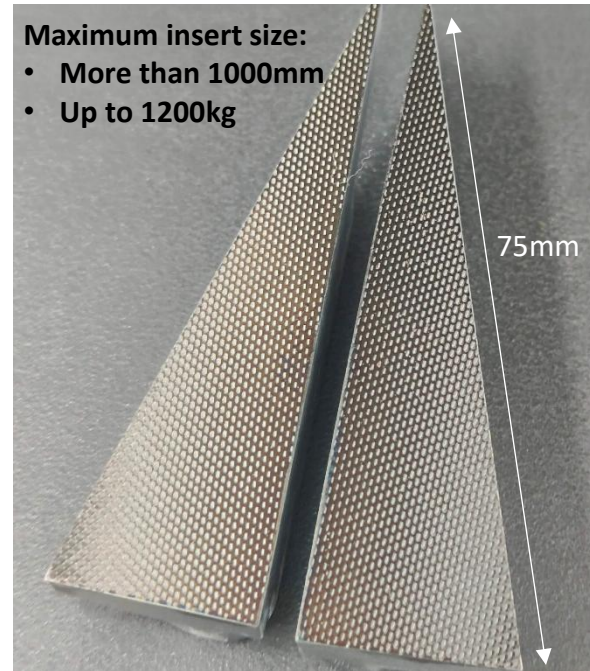
## 2) Mold / tool manufacturing

Mold-maker manufactures the mold. We engrave inserts already produced or manufactured by us.



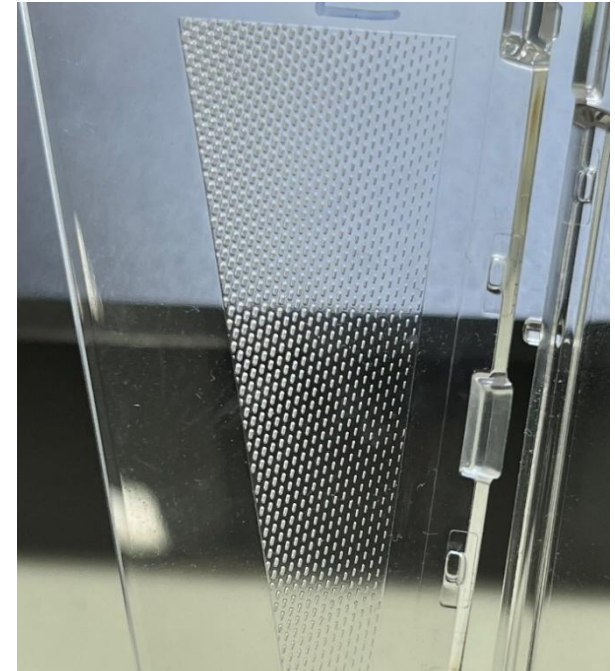
## 3) Injection mold engraving

We engrave or/and texturize the steel mold using precise femtolaser or nanolaser depending on the needs



## 4) Plastic part injected

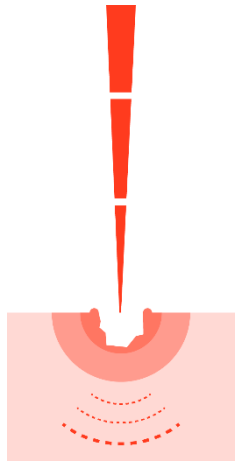
Scalability: All injected parts in the mold will be functional



# Femtosecond laser – what is it?

**Nanosecond laser:** short pulse duration laser

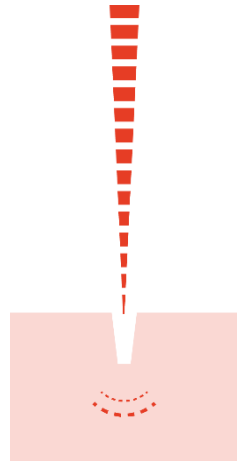
**Femtosecond laser:** ultra-short pulse duration laser



**Nanosecond laser ( $10^{-9}$ sec)**

Heat affected zone

Burr



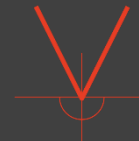
**Femtosecond laser ( $10^{-15}$ sec)**

“Cold” ablation

Absolutely burr-free

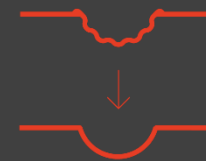
**Smaller engraving details  
New possibilities in lighting**

## Engraving characteristics of the femtosecond laser:

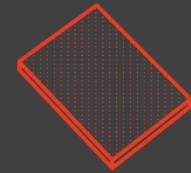


$R < 0,007 \text{ mm}$

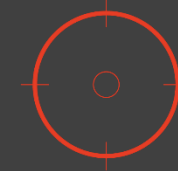
Clean engraving  
with Sharp edges



Absolutely  
Burr-free



High-quality  
surface finishing



Excellent  
tolerances



Engraving over  
any material

# Femtosecond laser – How do we use it in lighting?



**Free-form** microstructures and micro-optics  
in production tools or prototypes

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**Smaller details** and **better tolerances**  
than using conventional technologies

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**New** design and functional **possibilities**



**Microscatt®**: Micro-textures to control light  
diffusion from engraving production tools

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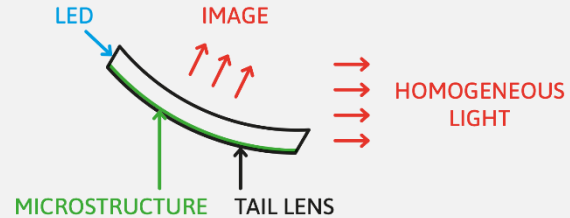
Imitation of **VDI** textures in PMMA **prototypes**:  
better imitation in prototypes than even

# Tool microstructuring – Odelo

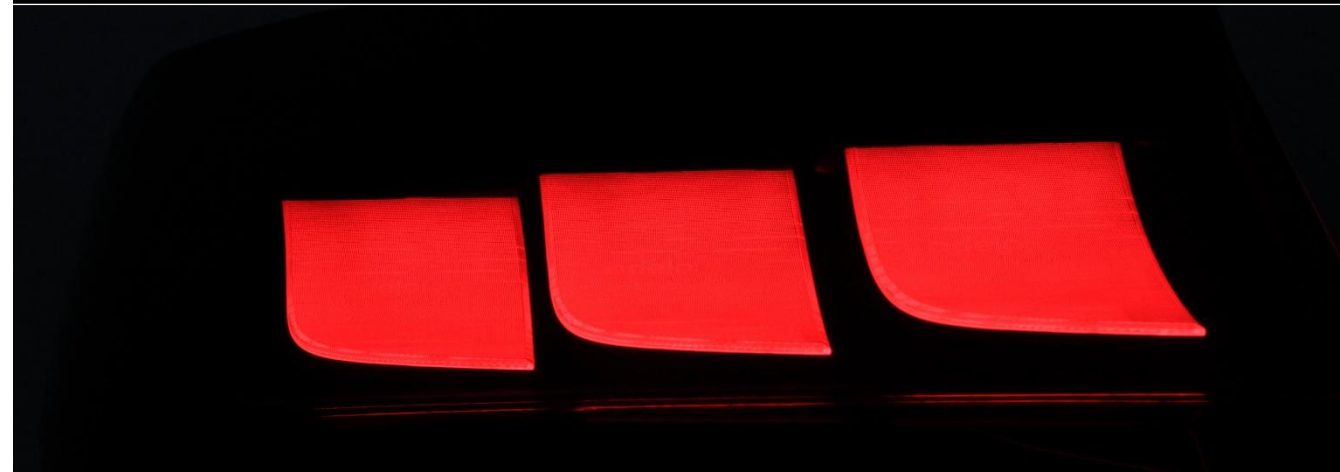
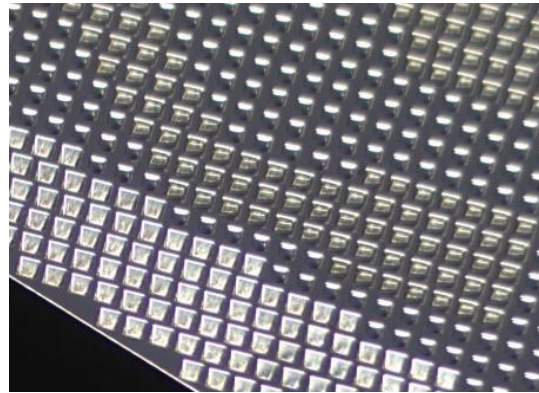
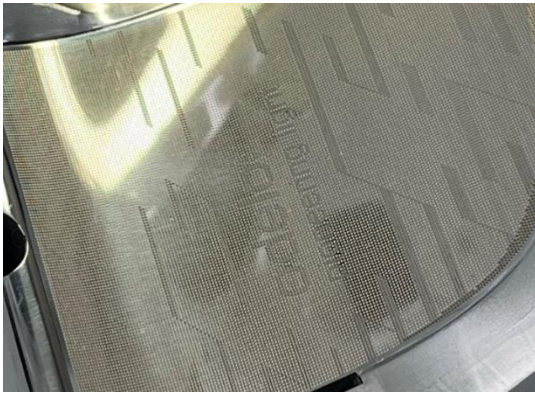
Homogeneous surface  
lightguide from behind

+

Free-form image  
from above



Engraving of thousands of microprisms in the production tool insert



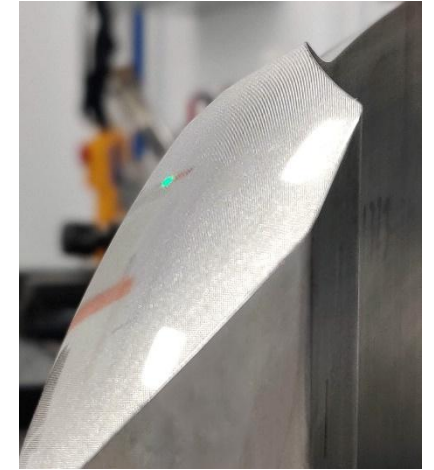
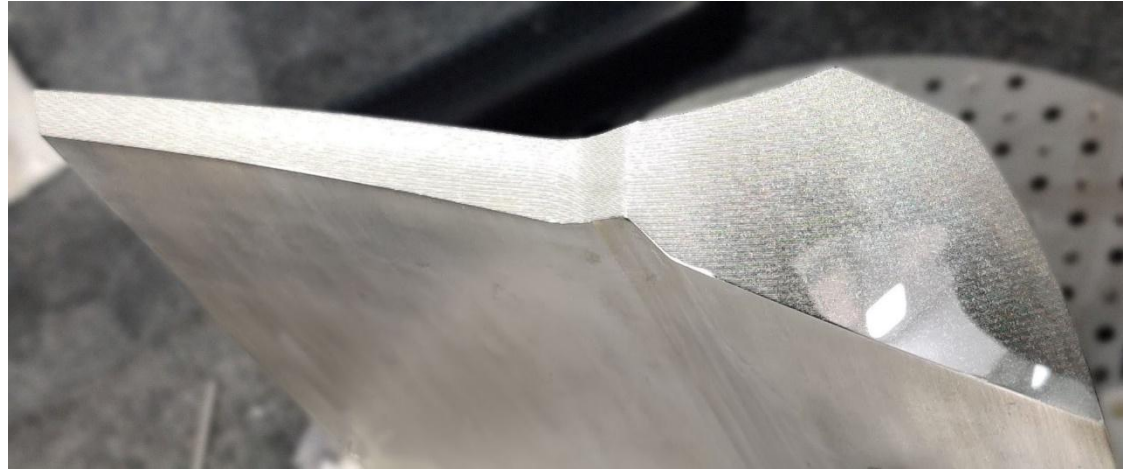
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# Tool microstructuring – OP mobility: Illuvision

## PRODUCTION TOOL INSERTS

Use of state-of-the-art femtosecond laser technology to engrave thousands of tiny micro-optics in the production tool:

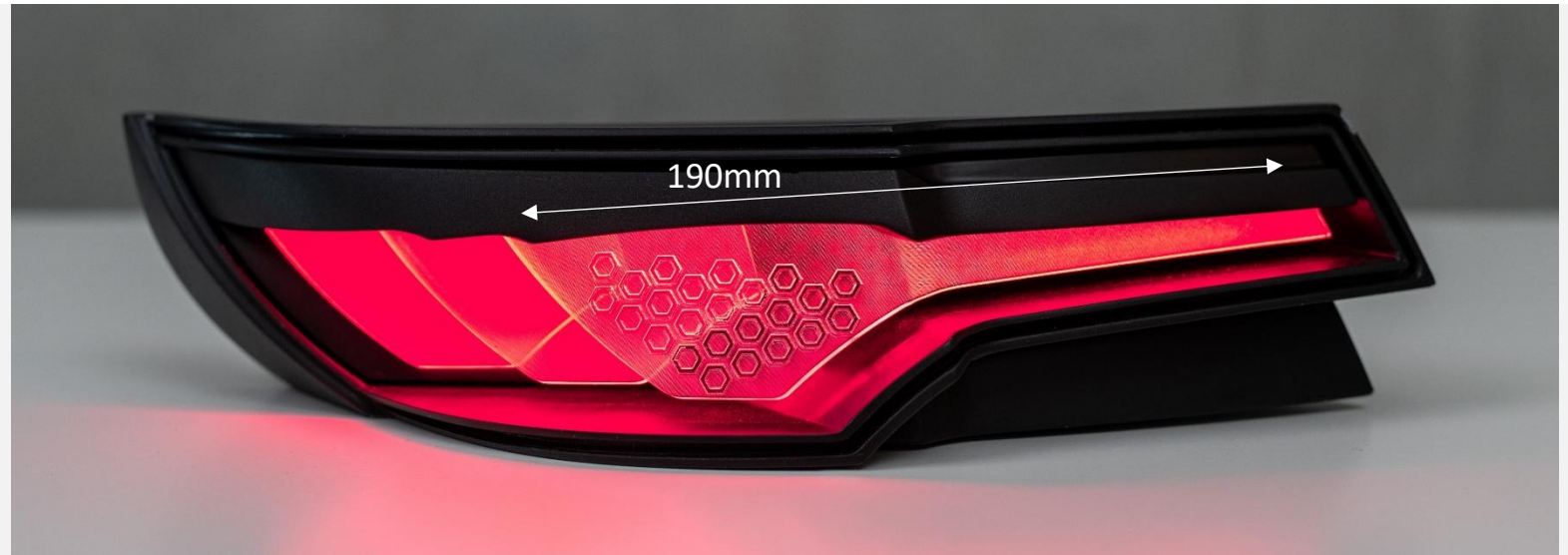
- Free-form optics
- High quality finishing
- Homogeneity
- 3D surface



## FINAL PRODUCT

Illuvision: new concept of tail lenses

- Ultra homogeneous appearance
- Super-thin frameless design
- Simple concept
- Fully three-dimensional shapes
- Semi-transparent appearance



# Tool microstructuring – some examples in the market



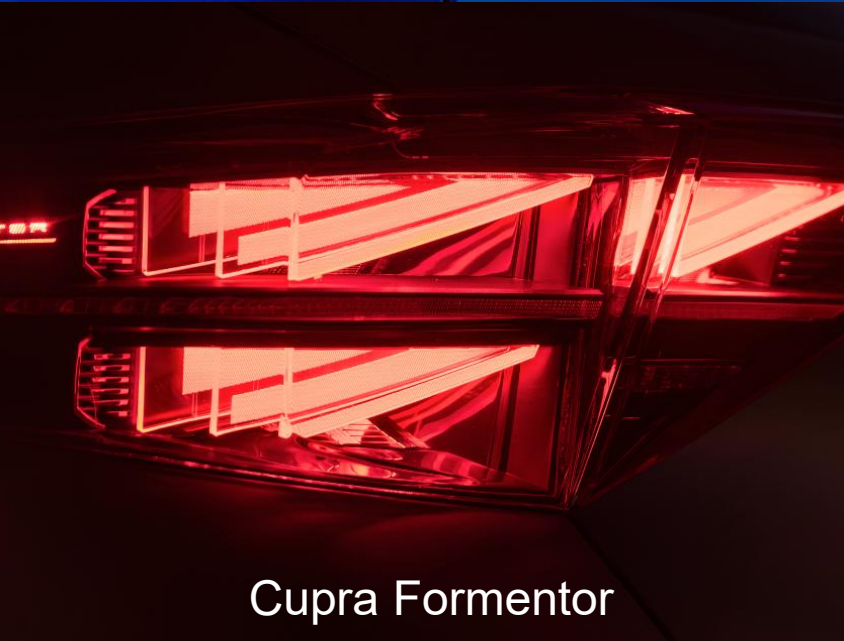
Renault Rafale



DS N. 8



Range Rover Sport



Cupra Formentor



Lancia Ypsilon

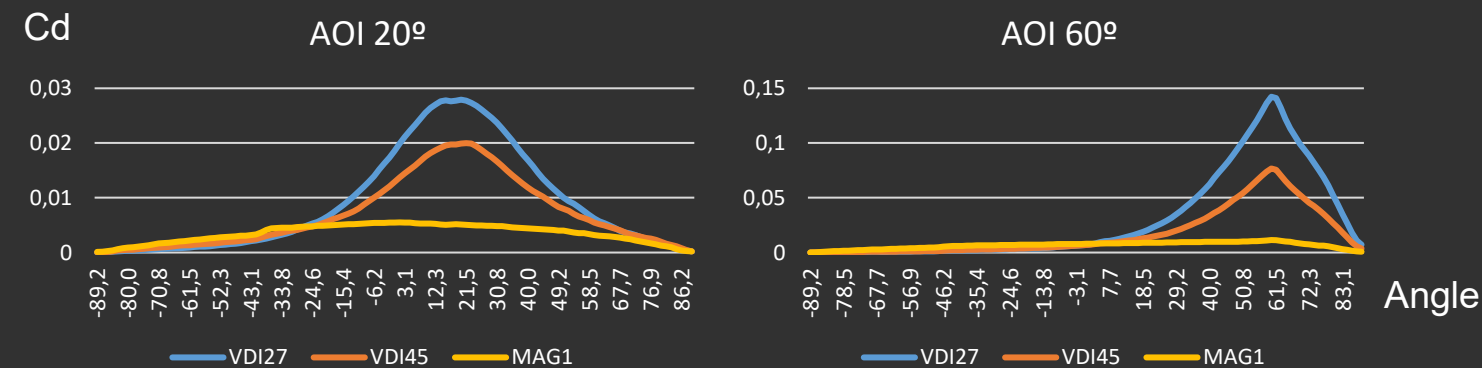


Fiat Topolino

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# Tool microstructuring – Anti-glare (MAG1 texture)

- Ultra-low reflection on plastic part (PC, PMMA, ABS, etc.) by texturing the tool
- Applications: bezels, housings, etc,
- Characterization available for simulation in Lucidshape, Lighttools and Speos.
- Reduce unwished reflections close to 0%. Comparison with VDI:

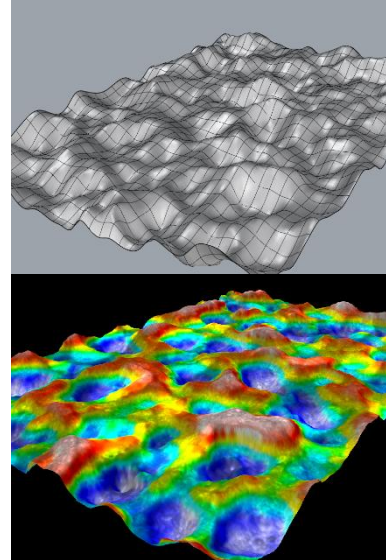
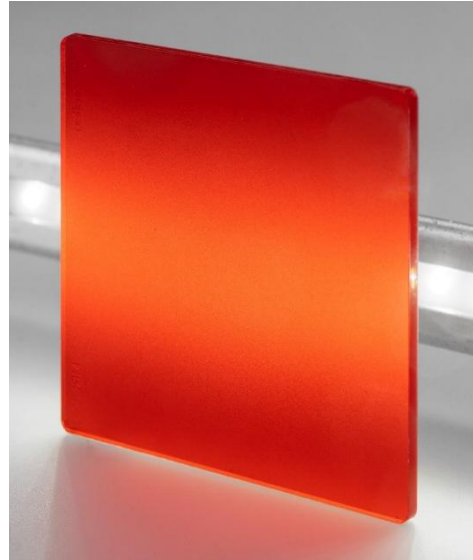


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# Microscatt® Technology – What is it about?

**MICRO**texturing & **MICRO**structuring for light **SCATT**ering control from tool



Tool engraving using  
**femtosecond laser for  
diffusion purposes**

**MOULD ENGRAVING  
WITH FEMTOLASER**

- Homogeneous
- Repeatable
- Small demolding angles

**ENGRAVING  
CHARACTERISTICS**

- High-quality diffusion
- Great luminance
- Circular & Elliptical

**DIFFUSION  
CHARACTERISTICS**

Burr-free process. Burr is  
having no influence in the  
light diffusion

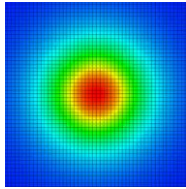
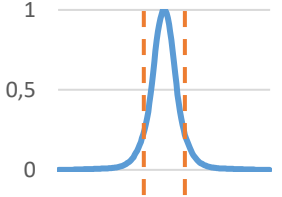
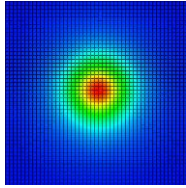
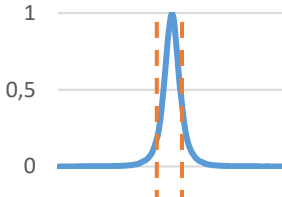
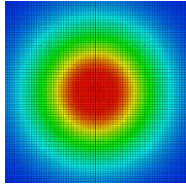
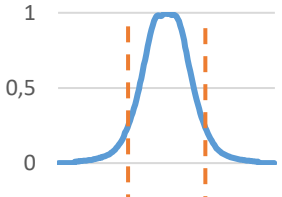
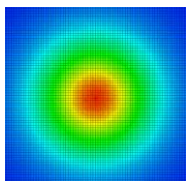
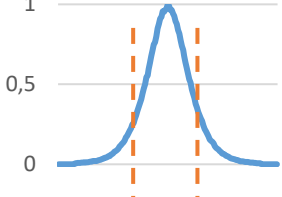
**CONTROLLED:  
BURR-FREE**

The randomness of the  
texture is controlled by an  
algorithm

**CONTROLLED:  
ALGORITHM**

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# Microscatt® – vs scattering surfaces in the market

|                                                                                                           | Reference           | Photo (d=20mm)                                                                       | Isocandela                                                                            | Horizontal section                                                                    | HWHM       |
|-----------------------------------------------------------------------------------------------------------|---------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|------------|
| <b>Comparison<br/>MSC30 vs VDI24<br/>(similar Depth)</b>                                                  | Microscatt<br>MSC30 |    |    |    | HWHM 8,6°  |
|                                                                                                           | VDI24               |    |    |    | HWHM 5,2°  |
| <b>Comparison<br/>MSC40 injected in<br/>transparent material<br/>vs DF23 (2mm)<br/>diffusive material</b> | Microscatt<br>MSC40 |   |   |   | HWHM 17,7° |
|                                                                                                           | DF23                |  |  |  | HWHM 14,3° |

# Microscatt® – Applications

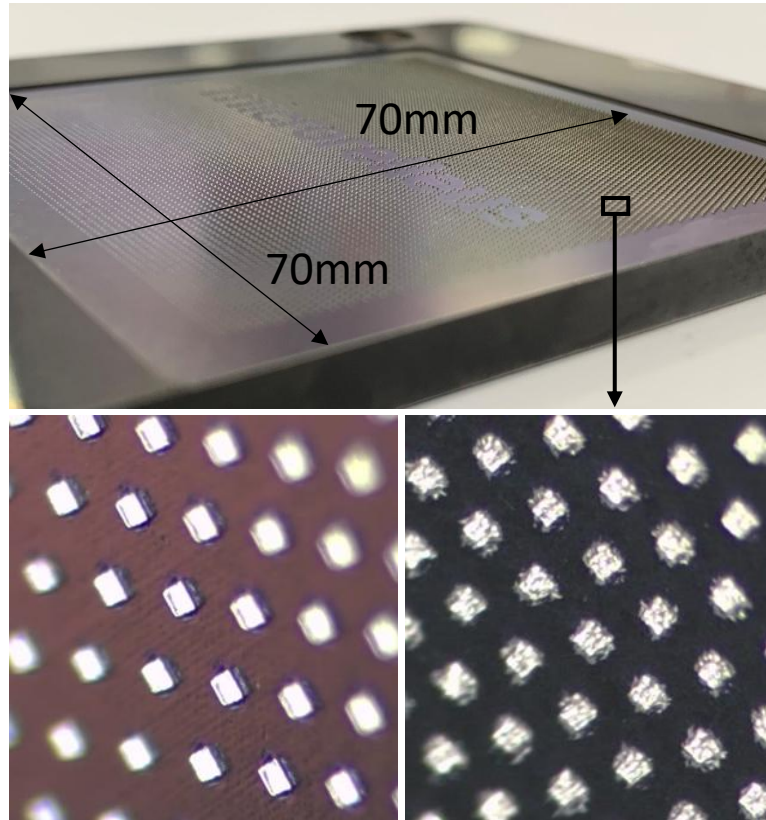
- **3D shape diffusive areas**

Controlled diffusion on the desired 3D or flat areas by injecting transparent material



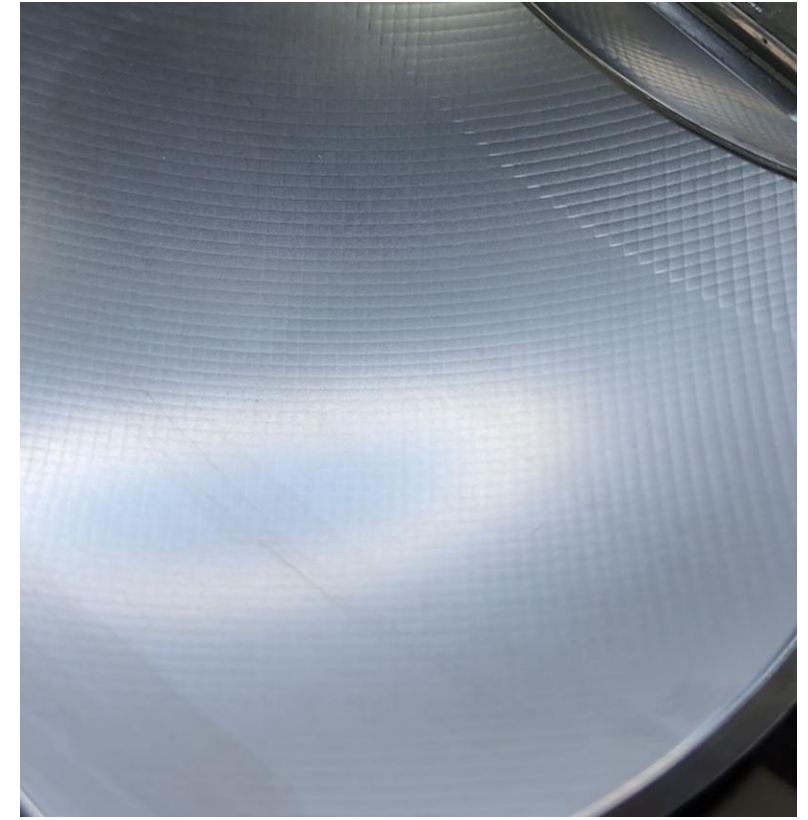
- **Over microstructures**

Increased homogeneity by engraving just over the microstructures, not the background



- **On reflectors**

Increasing the diffusion of the metallized surfaces by engraving the mold.



# Microscatt® Technology – How it Works?

1

## Simulation and decision

Use BRDF/BTDF files in *Speos*, *LightTools*, or *LucidShape* to simulate Microscatt® references and select the best match for you

ASK US FOR OUR OPTICAL  
ENGINEERING SUPPORT!

2

## Mould engraving

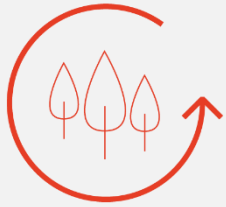
Microrelleus engraves the selected texture directly on the production mold using femtosecond laser

3

## Plastic injection

The mould is ready for series production — no additional process steps required

# Microscatt® Technology - Benefits



## ENVIRONMENTAL

**Material reduction:** diffusion is independent from material thickness

**Easy to recycle** by using monocomponent material without particles

**Easy to recycle** by avoiding added films



## DESIGN

**High-quality** surface finishing with nearly invisible pattern

Possibility of controlled diffusion on **ultra thick** pieces

Possibility of engraving 3D curved tools  
100% digital process: **free-form design area**



## COST-EFFECTIVE

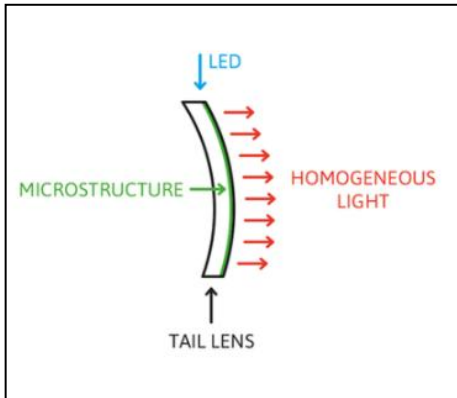
**Energy reduction:** possibility of less LED

**Reduction** of injected **material** and weight

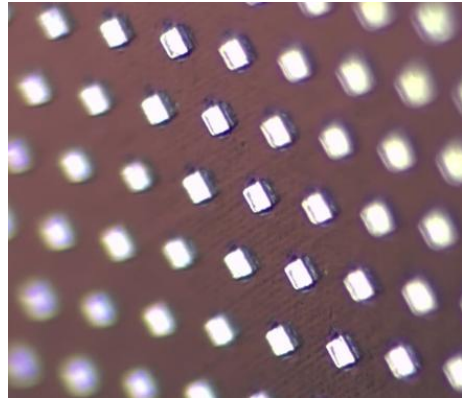
No need of expensive diffusers or films

**Processes simplification:**  
tool engraving + injection

# Case Study – Cupra Formentor&León 2024



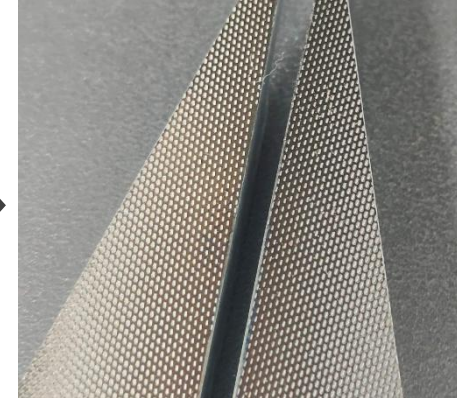
Customer request:  
New concept of tail lense



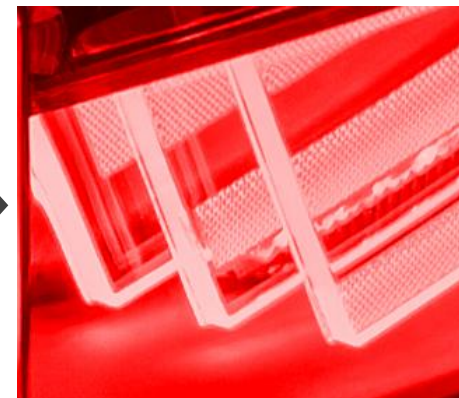
Micro-prisms concept for  
light distribution



PMMA prototype engraving:  
engraving on any material



Production tool insert  
microstructuring & texturing

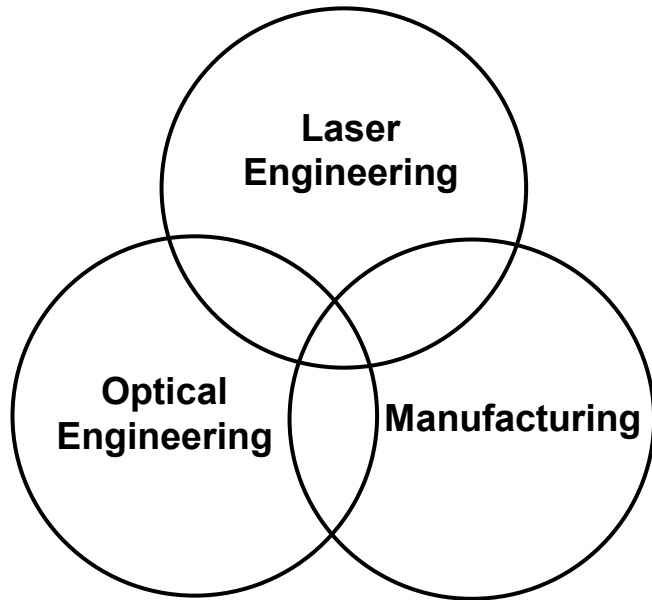


Microscatt® technology on  
production tool inserts



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# Microrelleus Lighting Capabilities



## Development

- Optical design
- Optical simulation (Lighttools)

## Production

- Optical tooling manufacturing
- Texturing and microstructuring

## Consultancy

- Optical analysis & feedback
- Microscatt application

## microrelleus COMPETENCES

## Mockup

- Prototypes manufacturing
- Lightmatch service

## Measurement

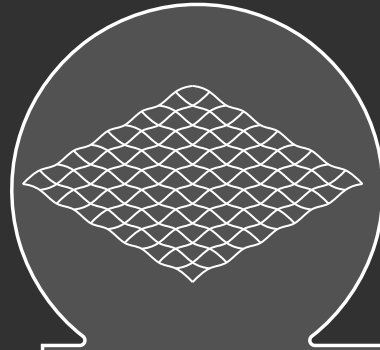
- Luminance analysis
- Validation & correlation

# Microrelleus Lighting Capabilities

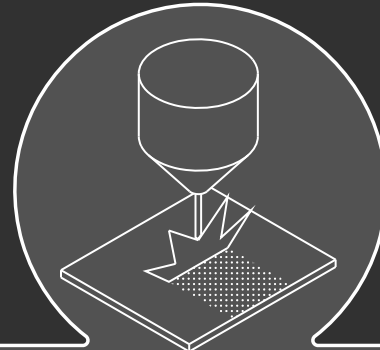
Development of **any Texture / Pattern / Design**

We shape light with custom-made solutions to **reproduce existing designs or create new textures** tailored to your product vision.

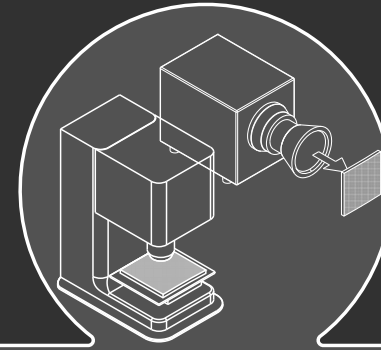
1. Surface design or confocal microscope analysis



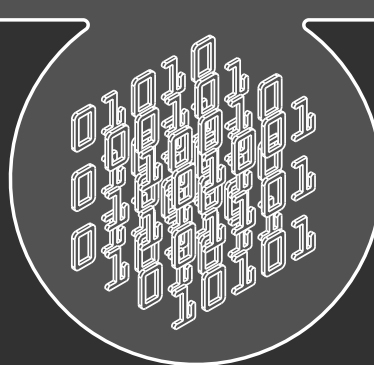
3. Texture engraving



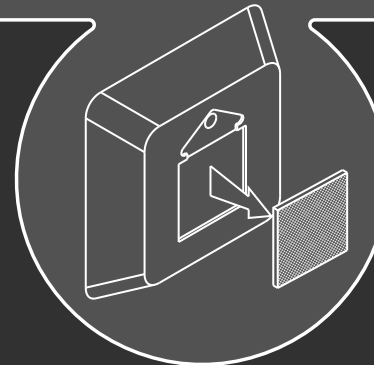
5. Morphological & optical analysis



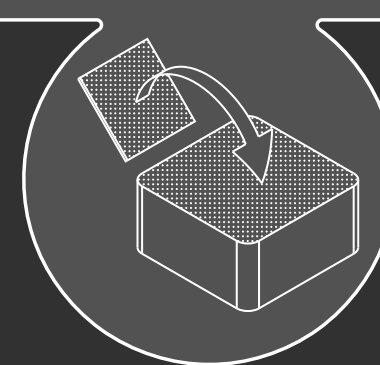
2. Algorithmic texture development



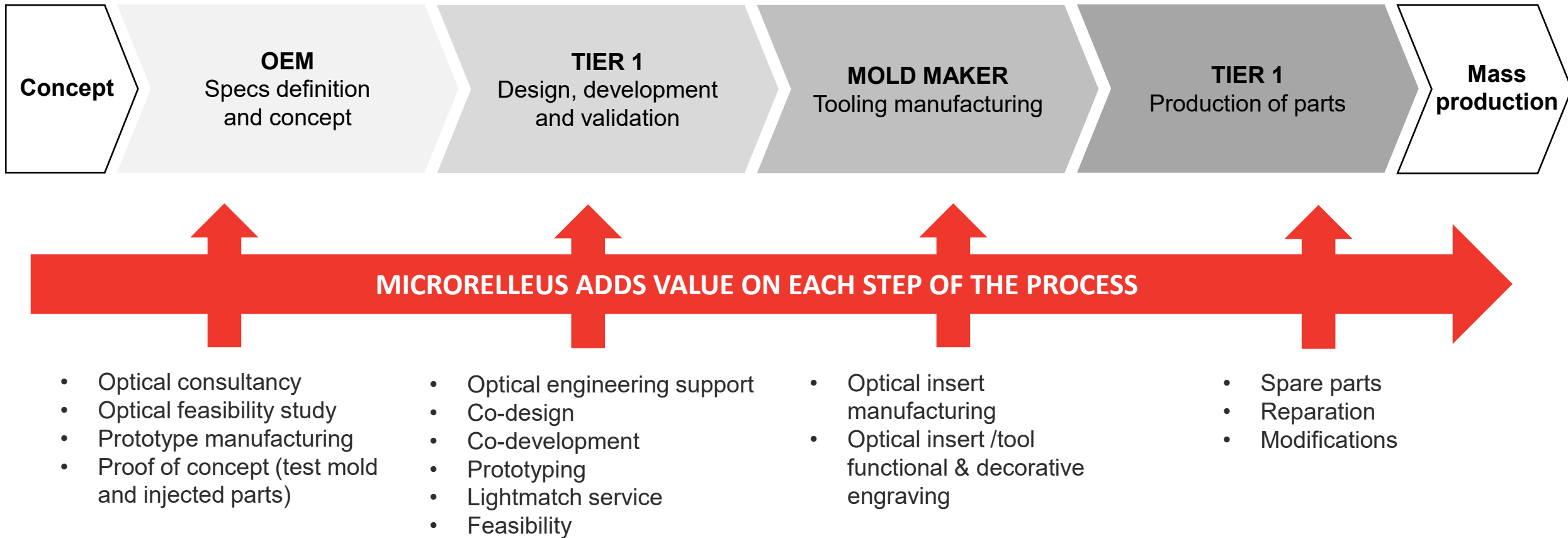
4. Mold injection



6. Implementation: Tool engraving



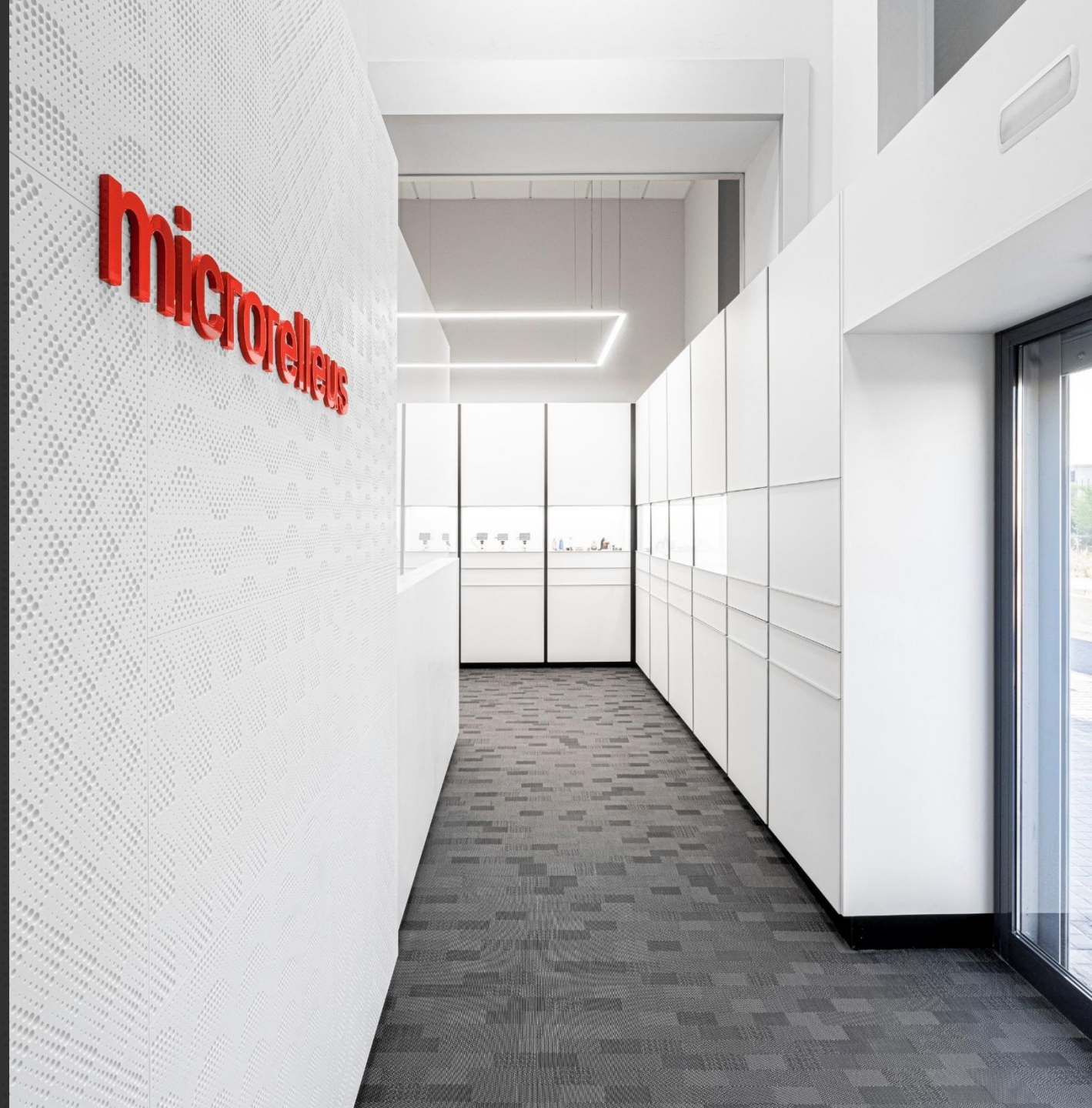
# Microrelleus Lighting Capabilities – A partner across the optical surface value chain



# Microrelleus Services

- **Ultra-precise** laser microstructuring & surface texturing
- Nano and femtosecond laser engraving on **production tool & prototype**
- **Optical insert manufacturing**
- **Microrelleus Lighting laboratory** (optical engineering + simulation + prototype + injection + photometry)
- Our **customers**: OEM's, Tier 1, Tier 2, mold-makers, plastic injectors, etc.

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## FROM TECHNICAL ENGRAVING TO FUNCTIONAL SOLUTIONS WITH MEASURABLE VALUE

Laser microstructuring / Surface texturing / Industrial engraving

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