

# MICRO-OPTICS IN AUTOMOTIVE LIGHTING APPLICATIONS

Advances and Challenges

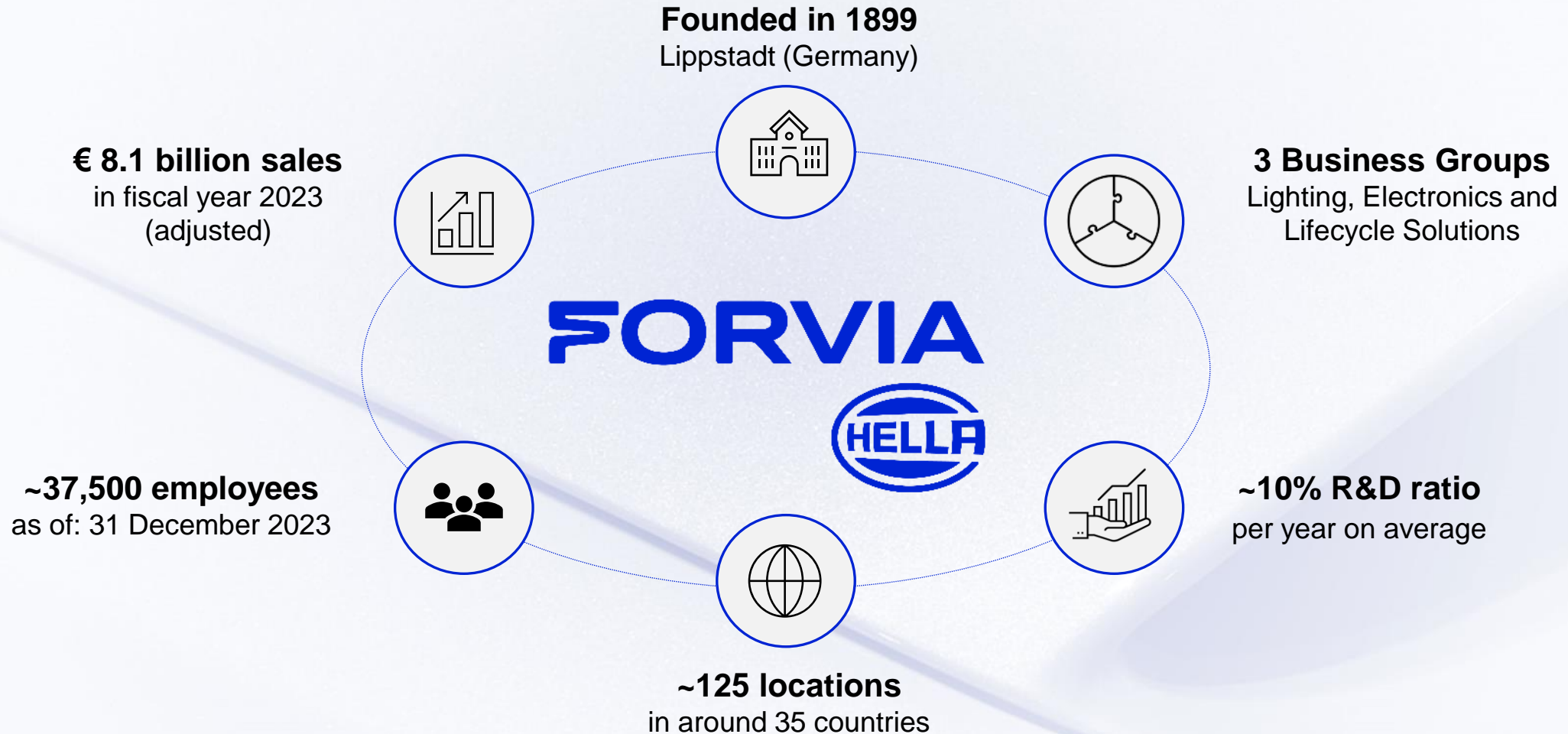
September 18, 2024

**FORVIA**



# FORVIA HELLA HAS BEEN SHAPING MOBILITY FOR 125 YEARS

## FORVIA HELLA: an overview



# A COMPREHENSIVE PORTFOLIO

Six international business groups with differentiating product lines



## Seating

- > Seat structures
- > Complete seats



## Interiors

- > Instrument Panels
- > Door Panels
- > Center Consoles
- > Sustainable Materials
- > Surface activation



## Clean Mobility

- > Ultra low emissions solutions for passenger and light commercial vehicles
- > Zero emission hydrogen solutions for mobility, energy storage and distribution



## Electronics

- > Sensors & Actuators
- > Automated Driving
- > Lighting/Body Electronics
- > Energy Management
- > Cockpit Electronics
- > Cockpit Experiences



## Lighting

- > Headlamps
- > Rear Lamps
- > Interior Lighting
- > Car Body Lighting



## Lifecycle Solutions

- > Independent Aftermarket
- > Workshop Solutions
- > Special Original Equipment

FORVIA Faurecia

FORVIA HELLA

FORVIA Faurecia & FORVIA HELLA

# MICRO-OPTICS IN AUTOMOTIVE LIGHTING APPLICATIONS

Impact

## NEEDS ON AUTOMOTIVE LIGHTING SYSTEMS

BRAND & CARLINE DIFFERENTIATION

PERFORMANCE & EFFICIENCY

EMOTIONS & WOW EFFECTS

HOMOGENEITY

CUSTOMER EXPERIENCE

MINIATURISATION

CUSTOMIZED GRAPHICS

LOW WEIGHT

LOW COST

SYSTAINABILITY

## ADVANTAGES OF MICRO & NANO OPTICS

INCREASED EFFICIENCY IN LIGHT SHAPING

LOW WEIGHT AND MATERIAL CONSUMPTION

DESIGN FLEXIBILITY

AVOIDANCE OF SCATTERING MATERIALS (E.G. DF23)

AFFORDABILITY

MINIATURIZATION

HIGH PRECISION OPTICS

SPECIAL LIGHTING EFFECTS

SCALABLE PRODUCTION

THIN OPTICS

# MICRO-OPTICS IN AUTOMOTIVE LIGHTING APPLICATIONS

## Impact - Developments at HELLA



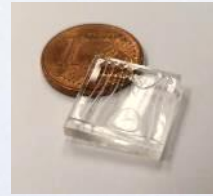
MLAs for Headlamps



CLAs for Headlamps



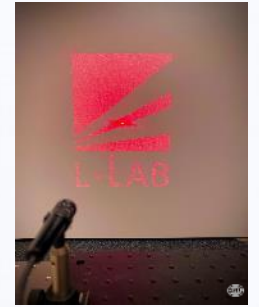
μCLAs for Headlamps



FFMOs for Headlamps



FlatLight for Signal Lighting



Projections with Meta-Optics

2018

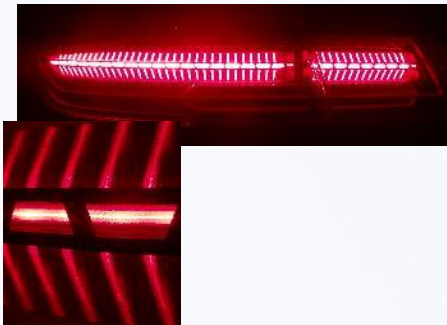
2020

2022

2024

Today

3D-effects with diffractive diffusor optics



Micro-Optics Diffusor



3D-effects with volume holograms 2.0



FlatLight | μMX



Digital FlatLight



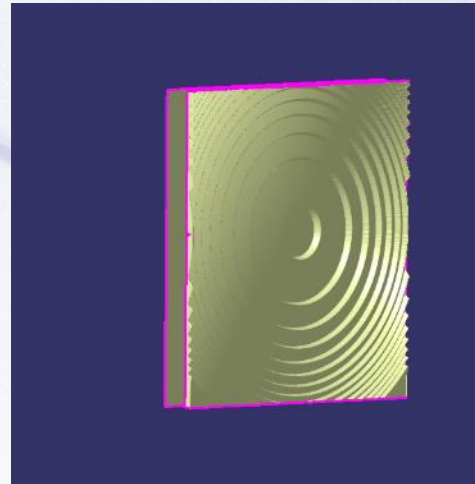
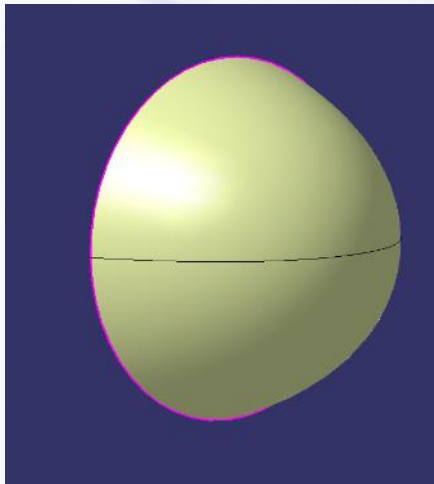
# MICRO-OPTICS IN AUTOMOTIVE LIGHTING APPLICATIONS

## Challenges

### Why don't we have a widespread use of Micro-optics in automotive applications?

➤ Selection of appropriate use cases

1:1 replacement of a lens is often required but not possible\*



Example:

- Aspheric primary optics
- Diameter: 13 mm
- Back focal length: 2 mm
- Polycarbonate

Replaced by:

- Fresnel lens
- Structure height 250µm
- Back focal length: 2 mm
- Polycarbonate

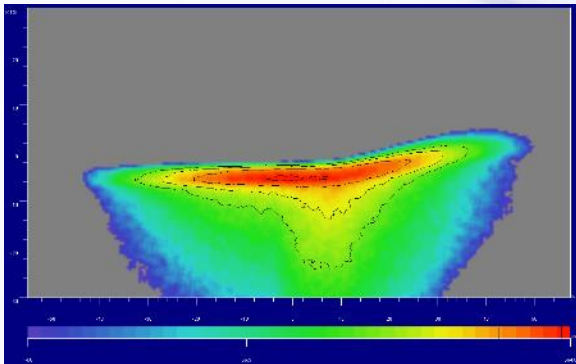
# MICRO-OPTICS IN AUTOMOTIVE LIGHTING APPLICATIONS

## Challenges

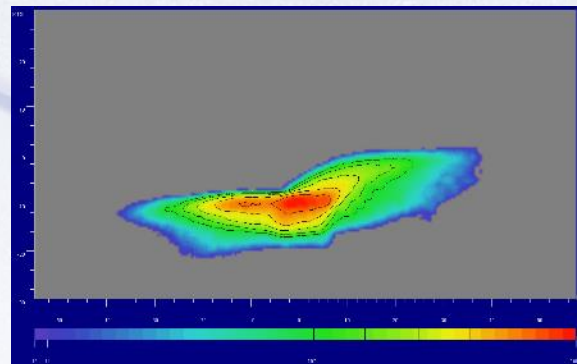
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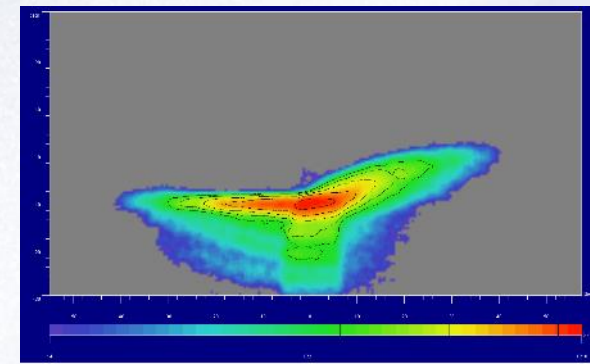
Light distribution with macro-optics



Light distribution with micro-optics



Light distribution with micro-optics and modified setup

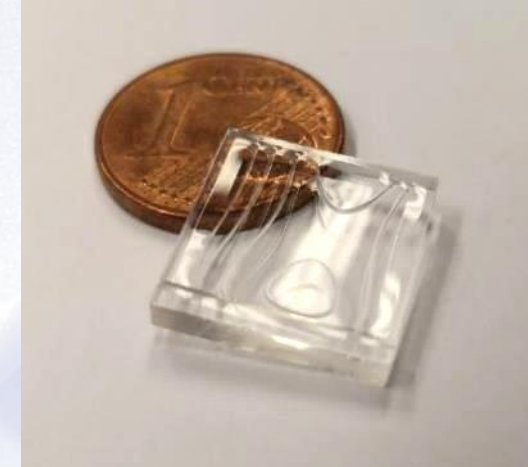
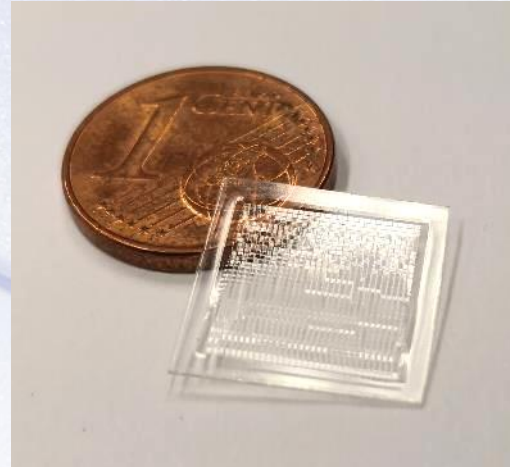
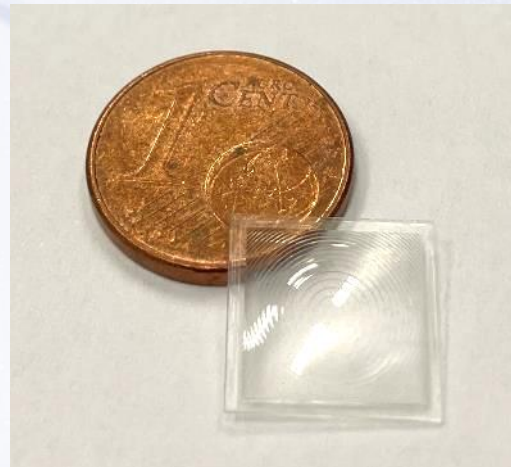


# MICRO-OPTICS IN AUTOMOTIVE LIGHTING APPLICATIONS

## Challenges

### Why don't we have a widespread use of Micro-optics in automotive applications?

- Selection of appropriate use cases
- Required structure sizes vs. manufacturing limits  
Slope angles are a limiting factor especially for Fresnel-like / facet structures in the mid and upper  $\mu\text{m}$ -range



Phabulous

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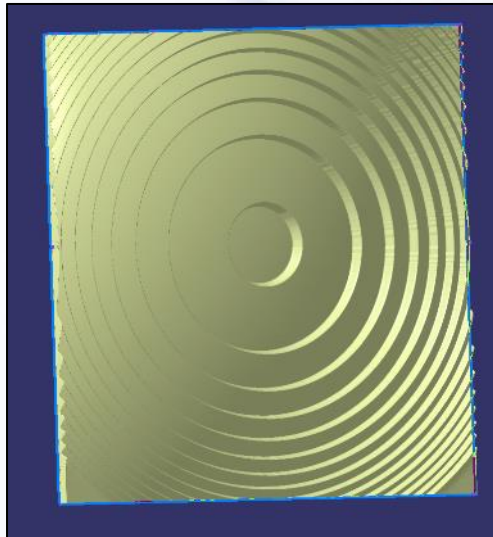


# MICRO-OPTICS IN AUTOMOTIVE LIGHTING APPLICATIONS

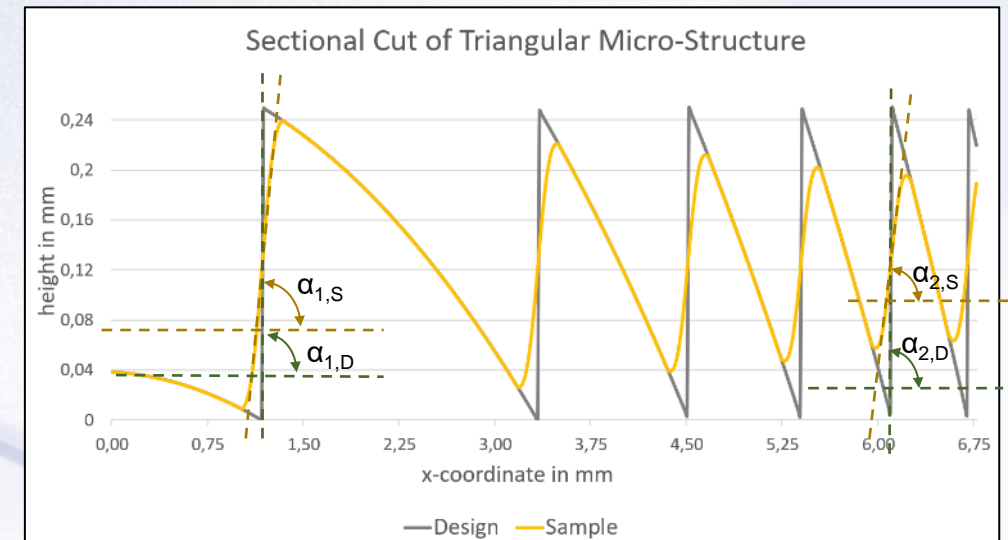
## Challenges

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- > Required structure sizes vs. manufacturing limits  
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Slope angles - Design -	Slope angles - Sample -
$\alpha_{1,D} = 87.8^\circ$	$\alpha_{1,S} = 47.7^\circ$
$\alpha_{2,D} = 87.6^\circ$	$\alpha_{2,S} = 42.1^\circ$



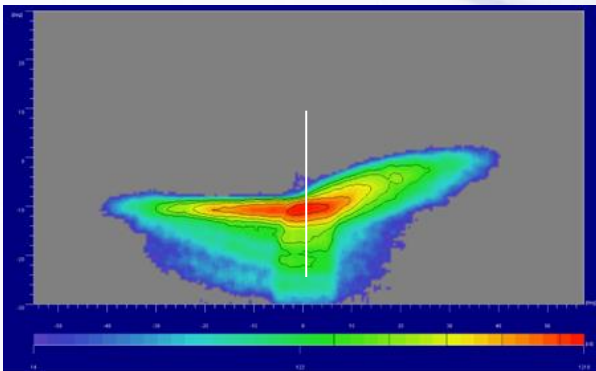
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## Challenges

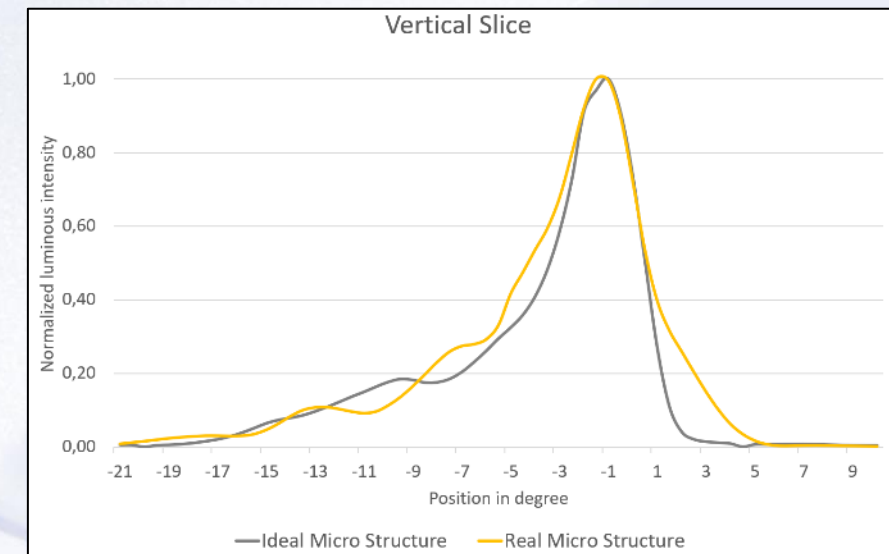
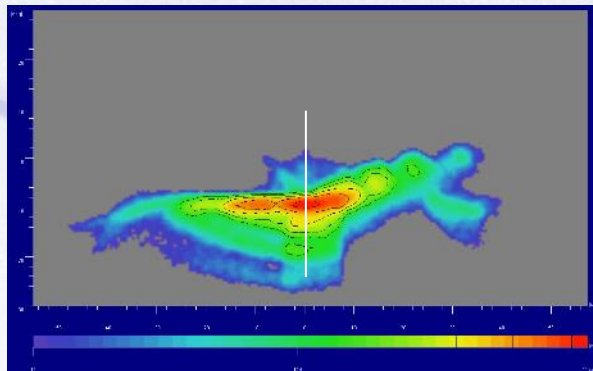
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Light distribution - ideal micro-optics



Light distribution - real micro-optics

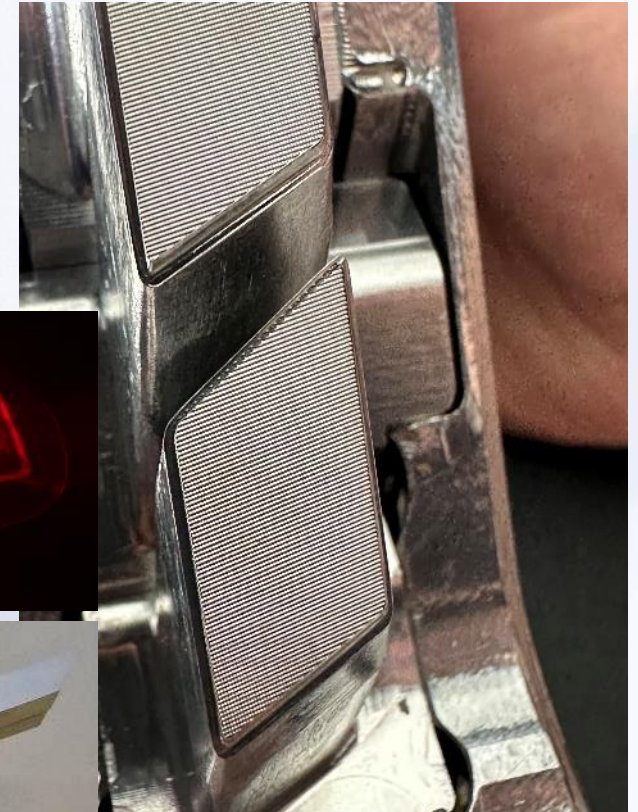


# MICRO-OPTICS IN AUTOMOTIVE LIGHTING APPLICATIONS

## Challenges

### Why don't we have a widespread use of Micro-optics in automotive applications?

- Selection of appropriate use cases
- Required structure sizes vs. manufacturing limits
- Integration
  - From mastering to complex plastic parts, e.g., curved optics for rear lamps
  - Integrating foils
  - Structuring existing optic parts

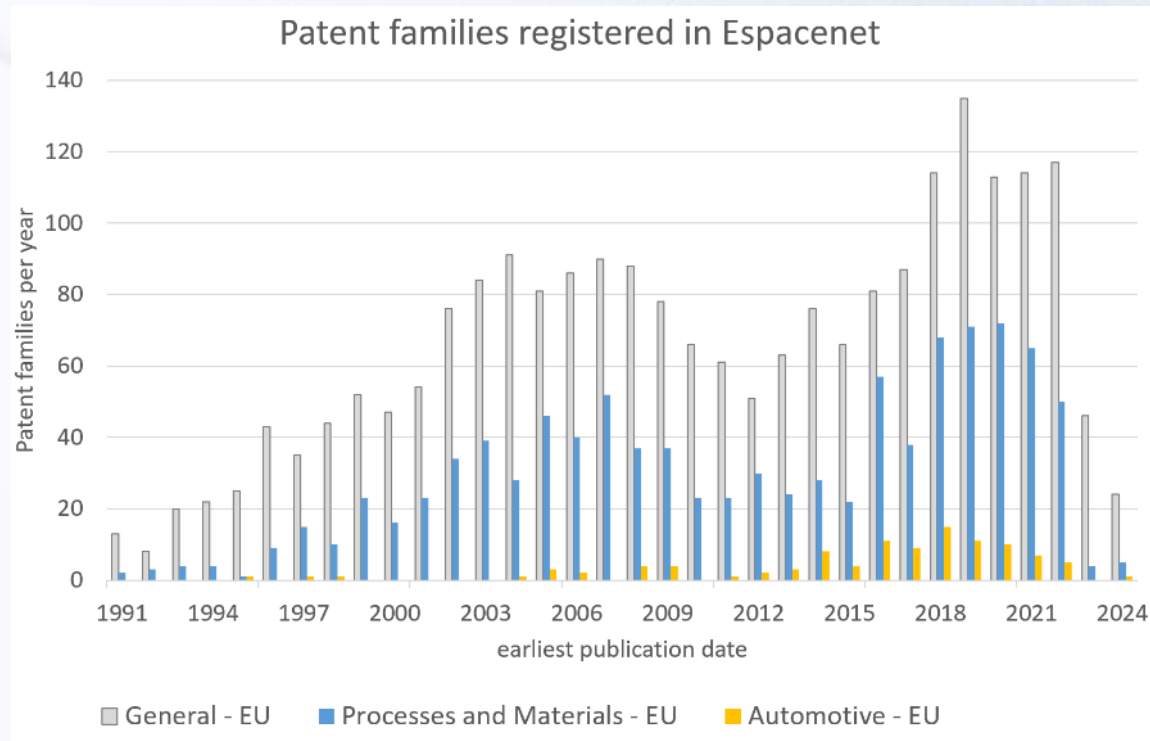


# MICRO-OPTICS IN AUTOMOTIVE LIGHTING APPLICATIONS

## Summary and Outlook

### How can we push micro-optics for a widespread use in automotive applications?

- Number of patent families registered in the Espacenet database\*



\* Micro-optics or diffractive optics mentioned in title, summary or claims

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