Diffractive Optics
Key Technology or just Hype?

Dr. Daniela Karthaus, EPIC Meeting on Diffractive Optics, 28.04.2022

HELLA – company profile

FACTS & FIGURES

- Founded in 1899 and today one of the leading suppliers for automotive industry and aftermarket
- Part of the Forvia group since 2022
- More than 125 locations in around 35 countries
- Around 36,000 employees worldwide, thereof almost 8,000 in Research & Development
- Attractive business portfolio with the three segments Lighting, Electronic and Lifecycle solutions

DIVISION LIGHTING - PRODUCTS

Headlamps and modules

Rear lamps

Car body lighting

Interior lighting

Lighting electronics

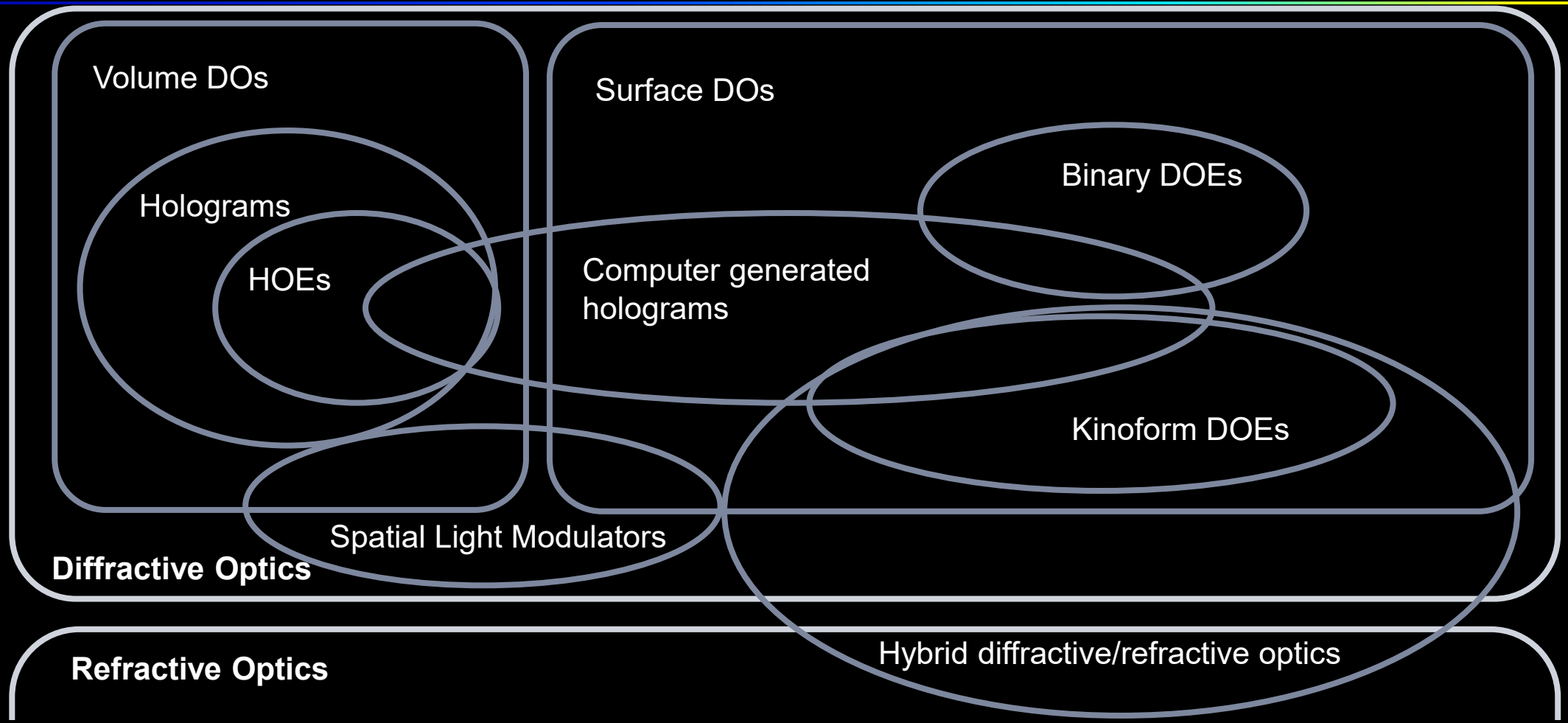
Radomes

„In 10 years no one will
use **refractive** optics anymore!“

Max, diffractive optics enthusiast, 2019

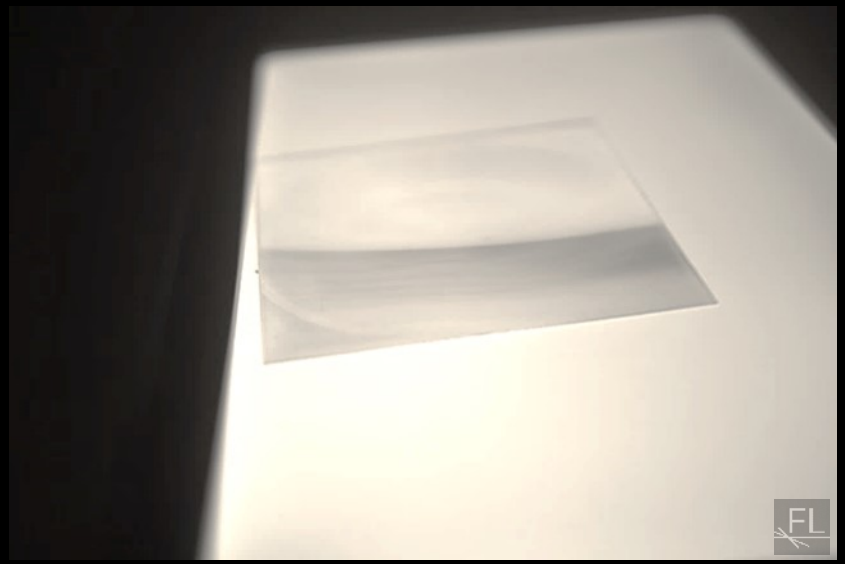
Diffractive Optics
Key Technology or just Hype?

Diffractive optics – an overview



Motivation to use diffractive optics

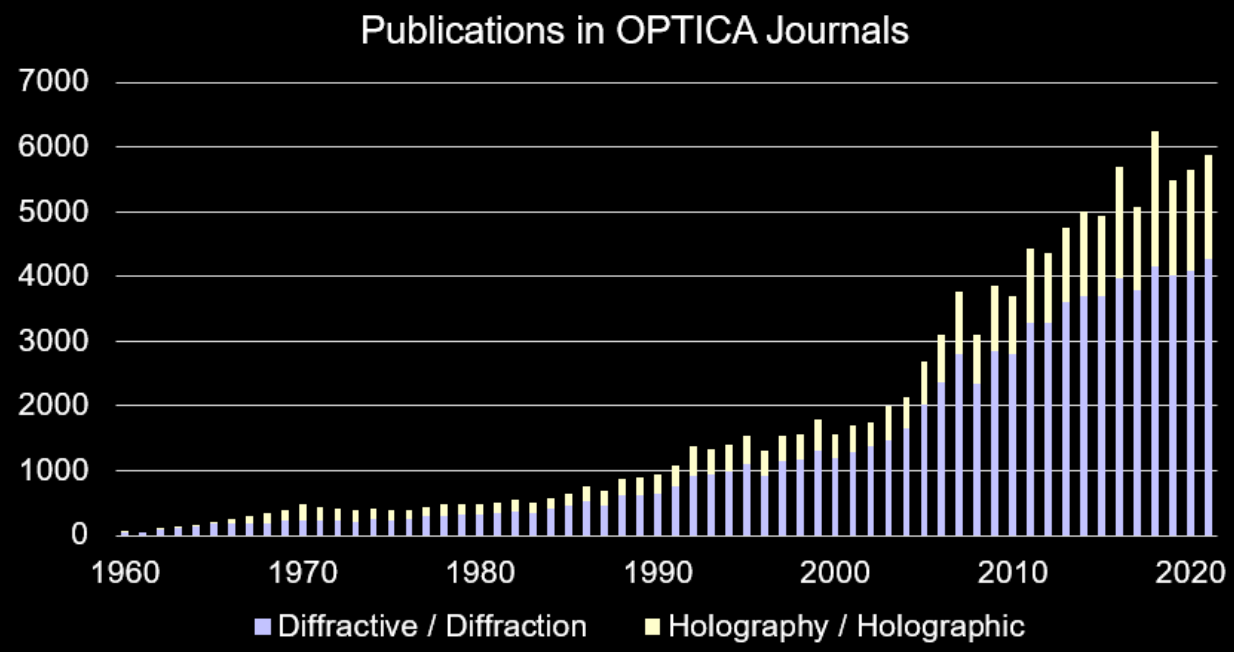
- Miniaturization of lightsources
- Reduction of thickness, weight and material consumption
- Adding new optical functions to different applications
- Invisibility of optical structure
- Increasing efficiency



Development trends and innovative applications

Research on diffractive optics

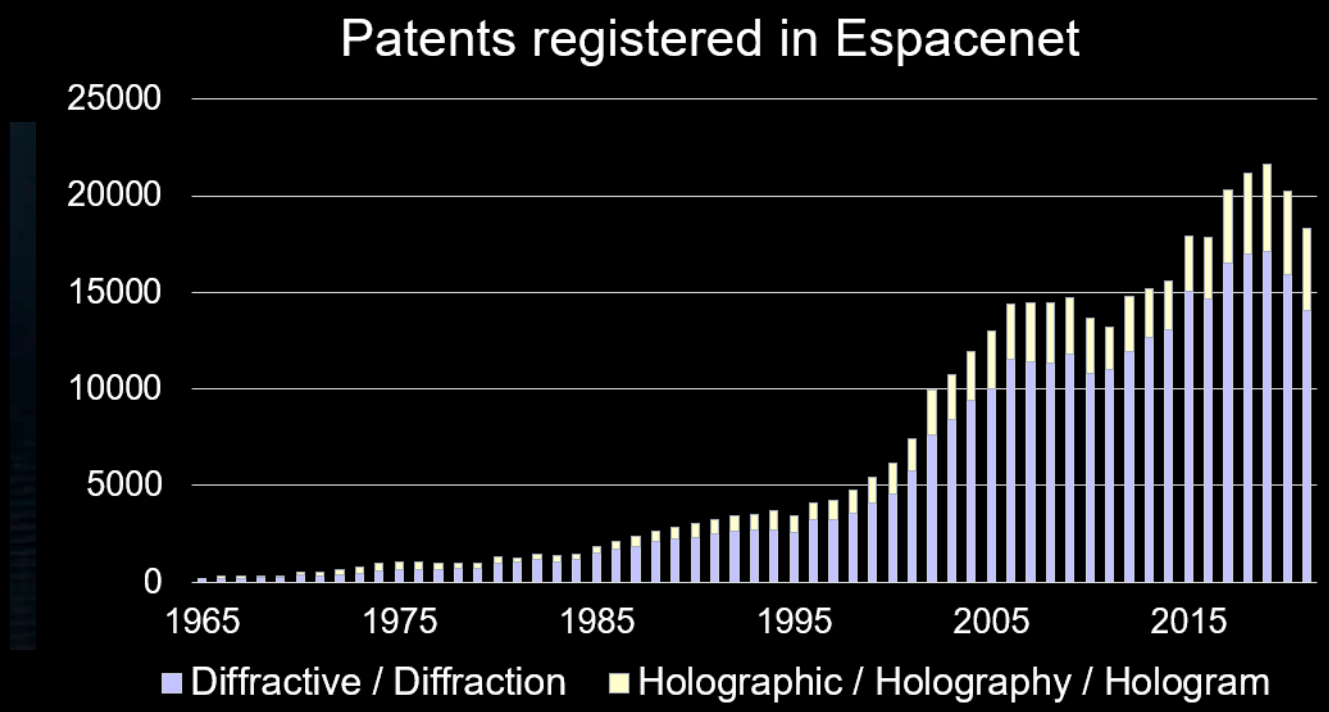
→ number of publications in OPTICA online journals



Development trends and innovative applications

Product oriented developments with diffractive optics

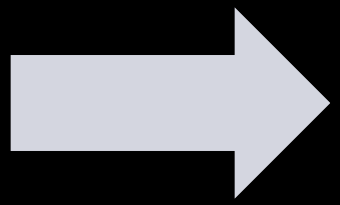
→ Number of patents registered in the Espacenet database



Development trends and innovative applications

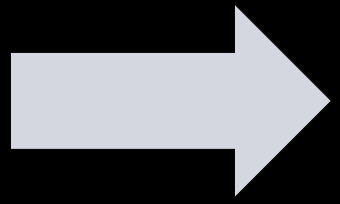
Most registrations with patent main group „optical components“

Imaging Optics
- Detection & sensing
- Medical devices
- Display
- AR/ VR
- Security / Tags
- Information storage
- Communication
- Projection



- Extented or variable focal depth
- 3D imaging
- Light pattern and image projection
- 3D sensing (e.g., LiDAR)

Illumination
- Illumination aparatus
- Lighting systems

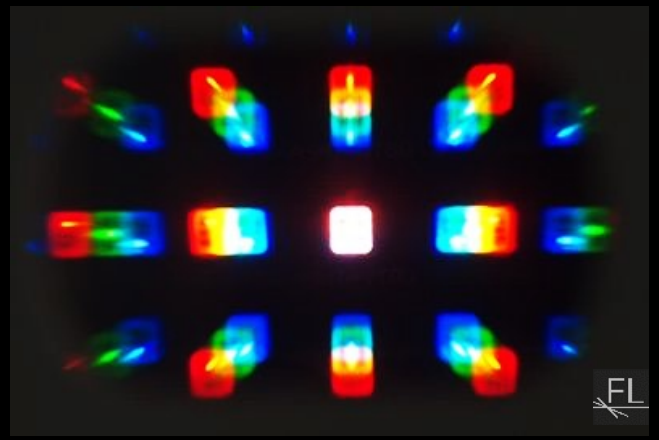


Illumination for sensing

Focus topic: automotive applications

Requirements for diffractive optical components

→ Usage of LED light sources (narrow and broad band)

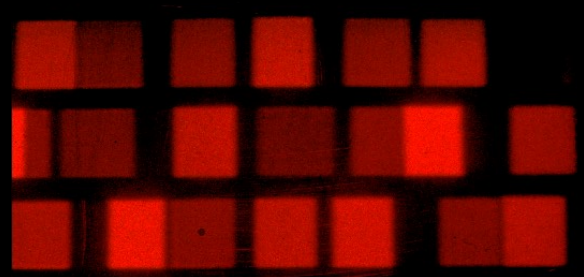


Focus topic: automotive applications

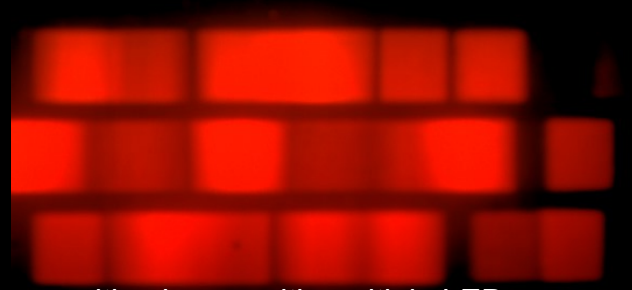
Requirements for diffractive optical components

→ Usage of LED light sources (narrow and broad band)

→ Usage of multiple LEDs



resulting image with one LED



resulting image with multiple LEDs

D. Karthaus, C. Bungenstock, M. Giehl: *Challenges of the illumination of holograms with narrow-band LEDs in automotive applications.* ISAL, Darmstadt, 2019

Focus topic: automotive applications

Requirements for diffractive optical components

→ Usage of LED light sources (narrow and broad band)
→ Usage of multiple LEDs
→ Data handling for large-scale optics
→ Fabrication of large-scale optics

Focus topic: automotive applications

Requirements for diffractive optical components

→ Usage of LED light sources (narrow and broad band)
→ Usage of multiple LEDs
→ Data handling for large-scale optics
→ Fabrication of large-scale optics
→ Cost effective mastering and series production
→ Usage of automotive certified materials (s. next slide)

Focus topic: automotive applications

Requirements for diffractive optical components

→ Usage of LED light sources (narrow and broad band)
→ Usage of multiple LEDs
→ Data handling for large-scale optics
→ Fabrication of large-scale optics
→ Cost effective mastering and series production
→ Usage of automotive certified materials (s. next slide)
→ 2D-, 2.5D- and 3D-curved substrates

M. Mügge: *Diffraktive Diffusoroptiken als Ersatz für Volumenstreuer.*
8. VDI Fachtagung: Optische Technologien in der Fahrzeugtechnik, Karlsruhe, 2018

Focus topic: automotive applications

Requirements for diffractive optical components

→ Usage of LED light sources (narrow and broad band)
→ Usage of multiple LEDs
→ Data handling for large-scale optics
→ Fabrication of large-scale optics
→ Cost effective mastering and series production
→ Usage of automotive certified materials (s. next slide)
→ 2D-, 2.5D- and 3D-curved substrates
→ Cleaning
→ Interface to design and simulation tools

Focus topic: automotive applications

Requirements for optical materials and material bonds

- No deformation
- No delamination
- No yellowing or turbidity

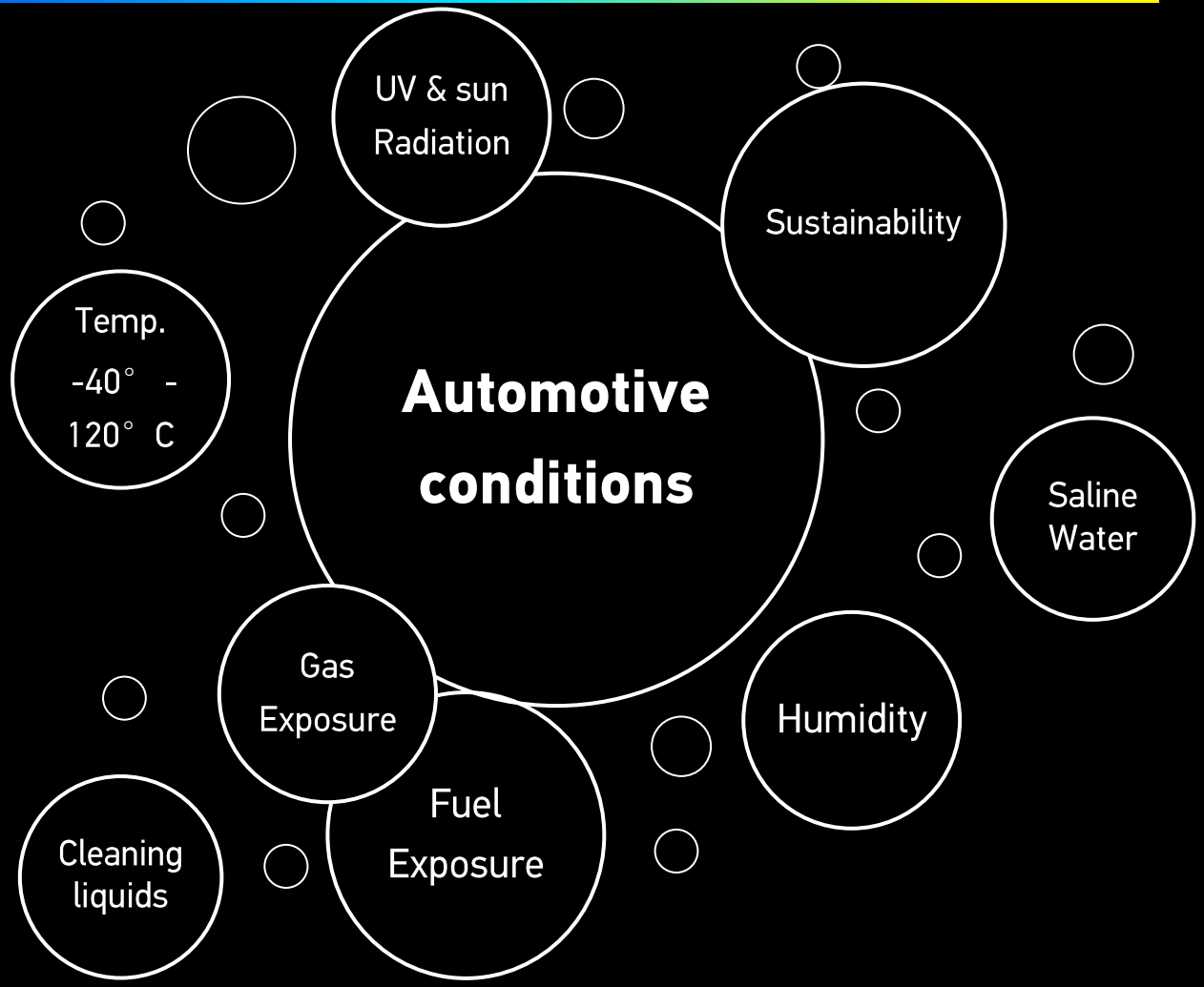


Image based on: B. Willeke: *freeform micro-optics for automotive applications.* SIA Vision conference 2021

Focus topic: automotive applications

Potential applications with diffractive optics

- Diffusor optics

Focus topic: automotive applications

Potential applications with diffractive optics

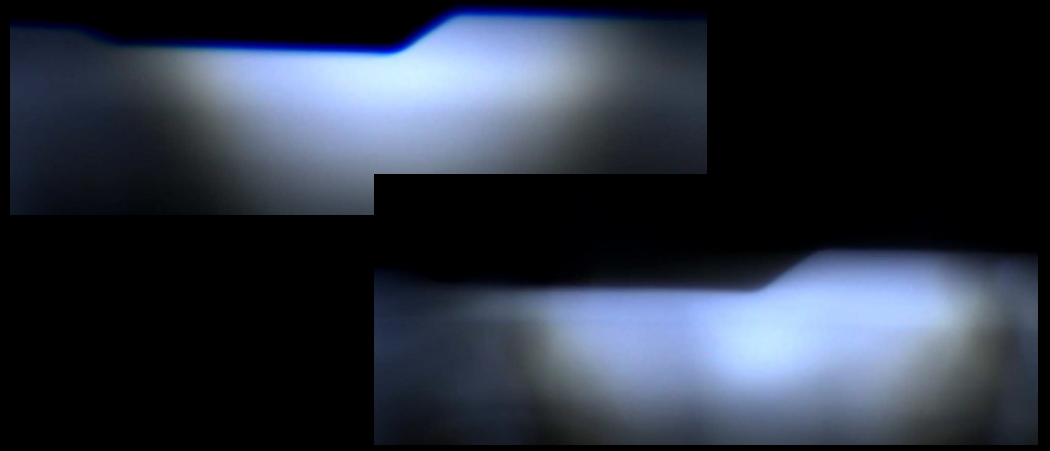
- Diffusor optics
- Beam shaping optics

M. Mügge: *Potentials of Diffractive Diffusor Optics*. ISAL, Darmstadt, 2019

Focus topic: automotive applications

Potential applications with diffractive optics

- Diffusor optics
- Beam shaping optics
- Compensation of color abberation

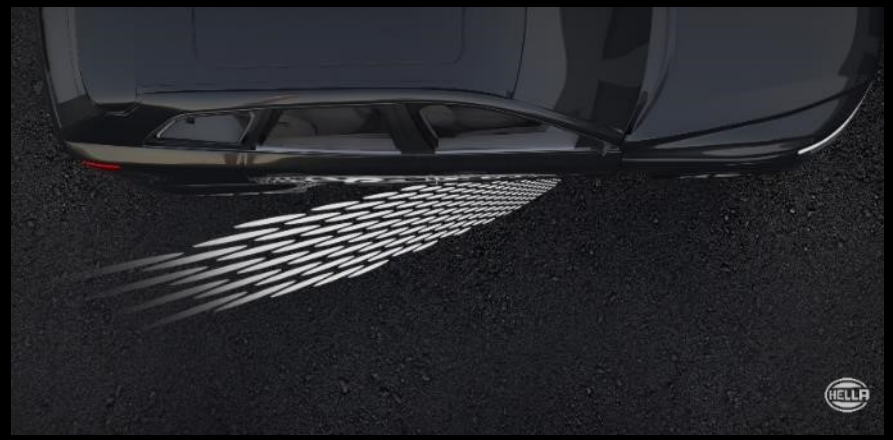


M. Schöne: „Diffraktive Optiken im Automobil“, Dissertation, Karlsruhe, 2017

Focus topic: automotive applications

Potential applications with diffractive optics

- Diffusor optics
- Beam shaping optics
- Compensation of color abberation
- Projection optics



Focus topic: automotive applications

Potential applications with diffractive optics

- Diffusor optics
- Beam shaping optics
- Compensation of color abberation
- Projection optics
- Optics for sensors

Focus topic: automotive applications

Potential applications with diffractive optics

- Diffusor optics
- Beam shaping optics
- Compensation of color abberation
- Projection optics
- Optics for sensors
- Displays / HUDs
- …

Conclusion

Key Technology

- for laser & imaging optics
- for research (measurment) instruments
- for „high price“ products
- for constant conditions

~~Hype~~ Potential with challenges

- for illumination optics
- for one-to-one replacement of large-scale refractive optics
- for cost-sensitive applications
- for strongly changing conditions

Thank you

Daniela Karthaus
Optics Engineer

Mobile phone +49 174 63 75 159
Daniela.Karthaus@hella.com
www.hella.com