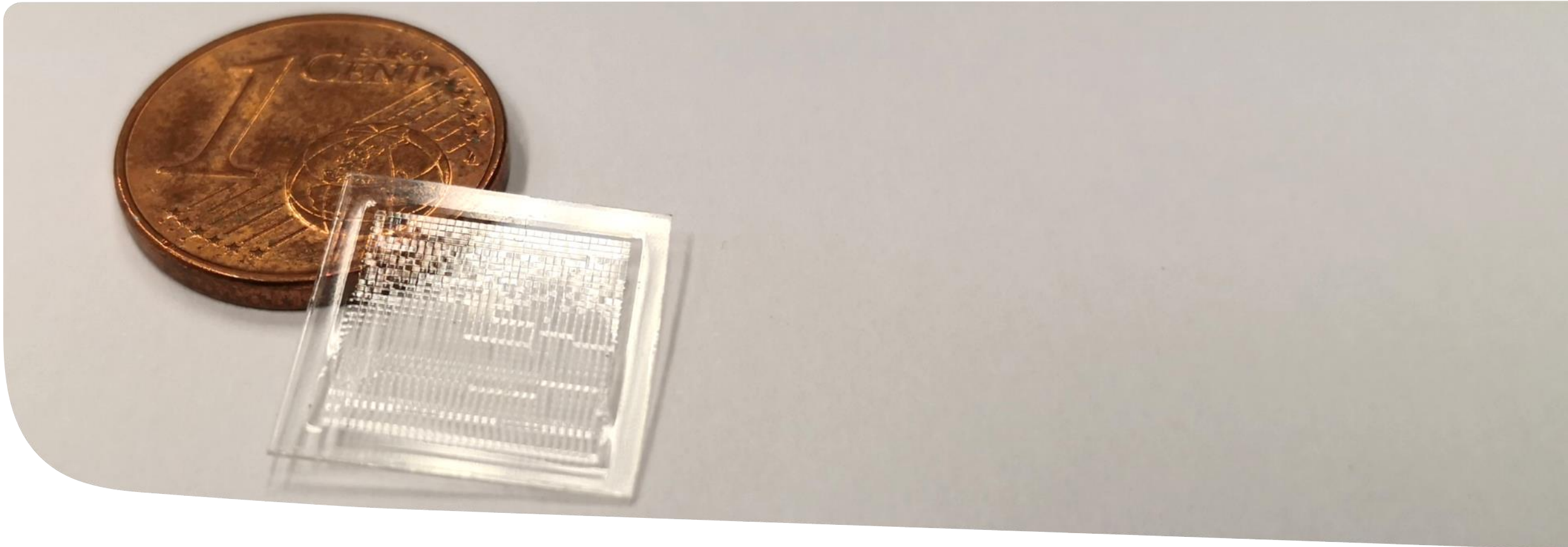


Micro- and Nano-Optics in Automotive Exterior Lighting Applications

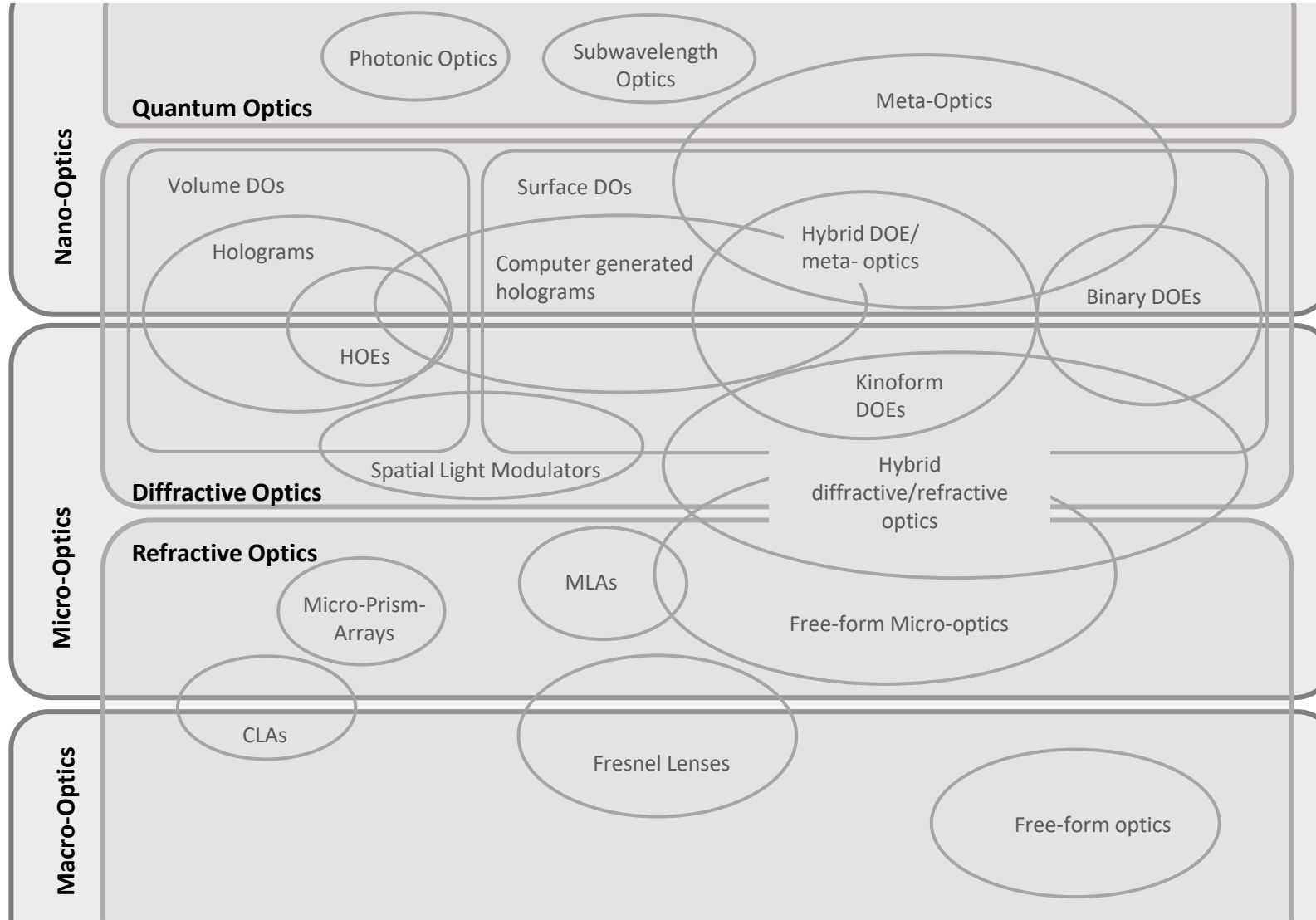
Blockers and Enablers for Widespread Use

Dr.-Ing. Daniela Karthaus | Innovation Management and Scouting



Micro- and Nano-Optics in Automotive Exterior Lighting Applications

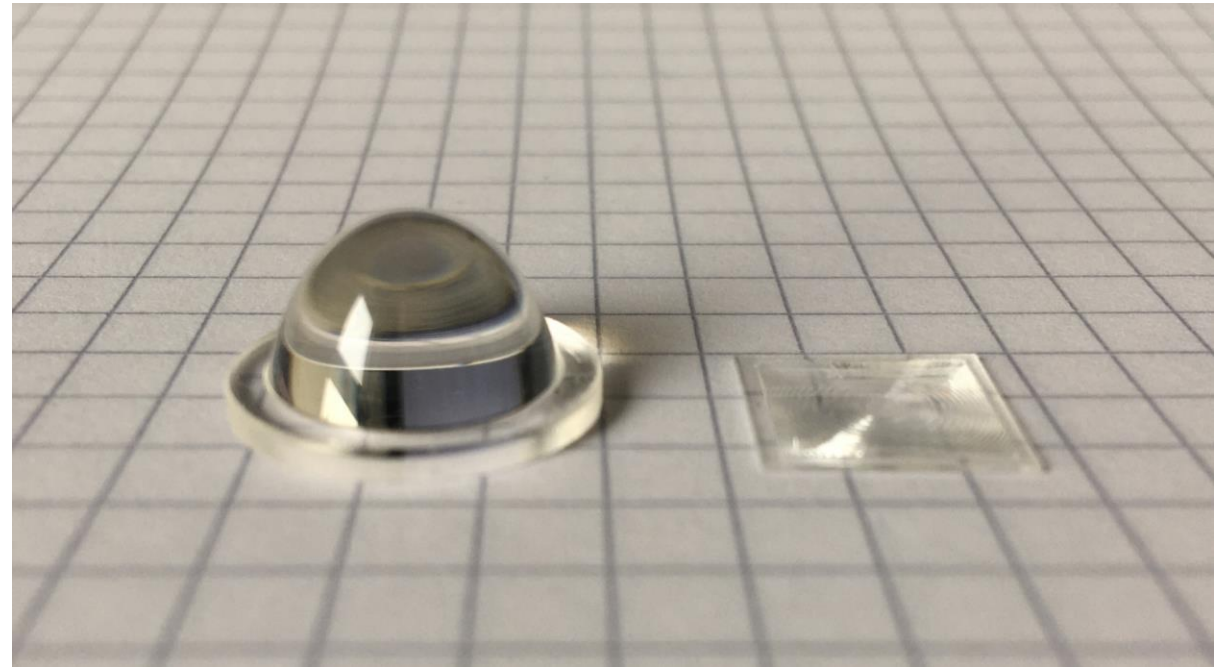
Categories



Micro- and Nano-Optics in Automotive Exterior Lighting Applications

Enablers

- Low volume, low material consumption
 - Small / “invisible” structures sizes
 - High efficiency
 - Wide range of functionalities, e.g., illumination and imaging
- **Exclusive characteristics compared to macro-optics**



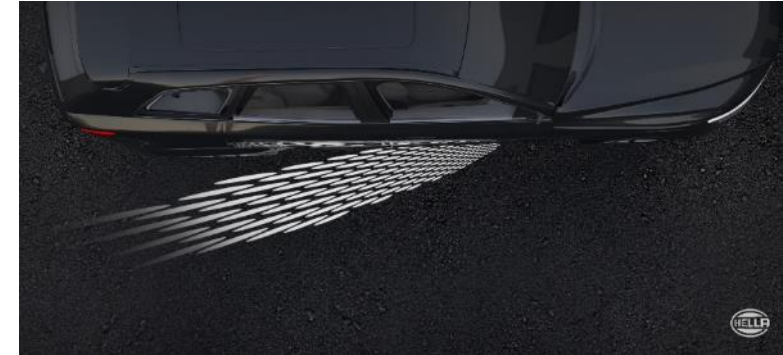
Micro- and Nano-Optics in Automotive Exterior Lighting Applications

Enablers

- Low volume, low material consumption
 - Small / “invisible” structures sizes
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 - Wide range of functionalities, e.g., illumination and imaging
- **Exclusive characteristics compared to macro-optics**

Potential applications

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



Micro- and Nano-Optics in Automotive Exterior Lighting Applications

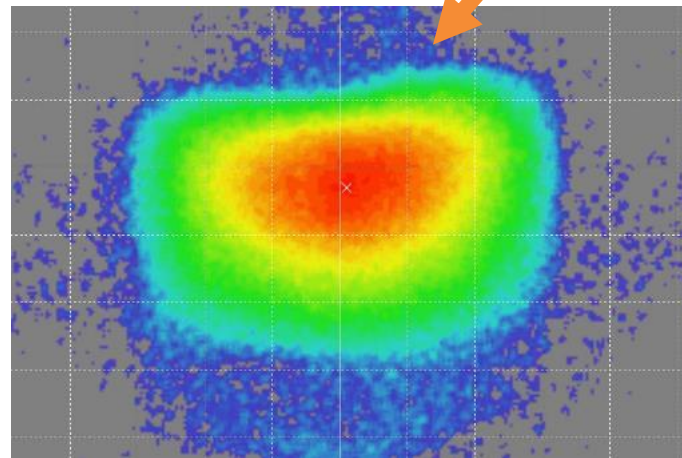
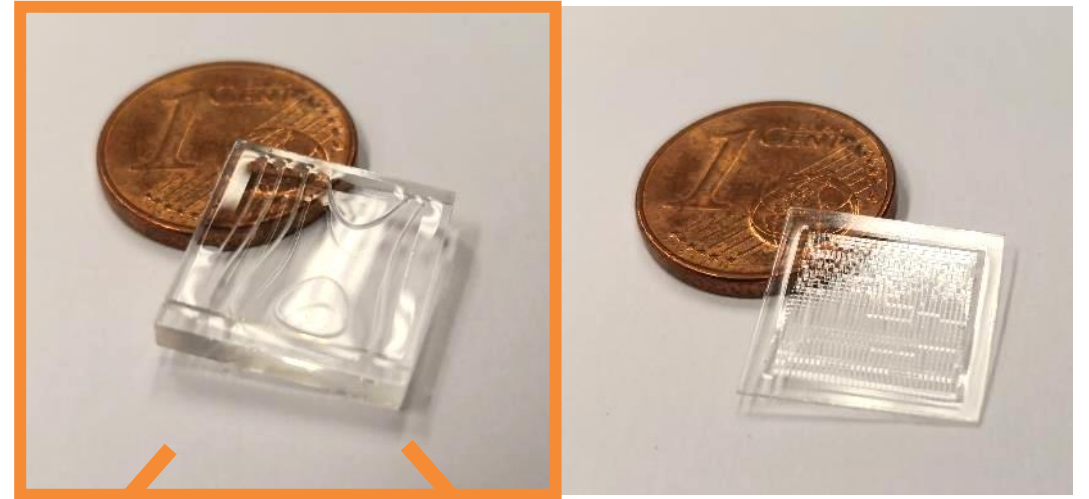
Recent Developments @HELLA

Micro- and Nano-Optics in Automotive Exterior Lighting Applications

Recent Developments @HELLA

> PHABULO μ S

- Development of free-form micro-optics (FFMOs) for headlamp applications
- Small headlamp modules for low and high beam
- Modularized concept with single optics of 10 x 10 mm²



Micro- and Nano-Optics in Automotive Exterior Lighting Applications

Recent Developments @HELLA

> PHABULO μ S

> FlatLight

- Thin modules for signal and tail lighting applications
- Highly efficient with a homogeneous appearance
- Usage of optical stacks with different micro-optical elements
- Combinable with display technologies
→ HELLA Digital FlatLight

HELLA FlatLight | μ MX



HELLA Digital FlatLight

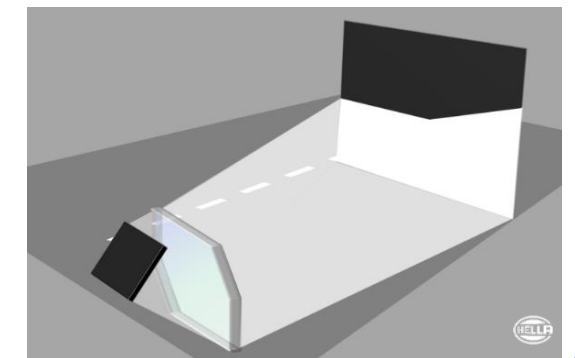
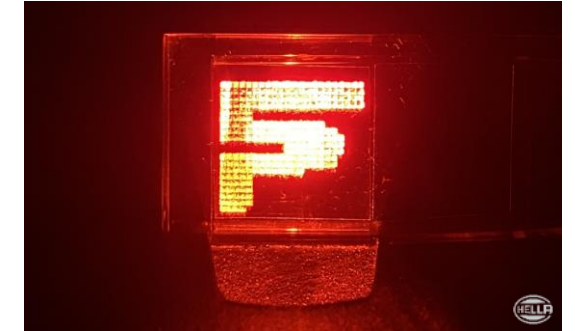


Micro- and Nano-Optics in Automotive Exterior Lighting Applications

Recent Developments @HELLA

- › PHABULO μ S
- › FlatLight
- › Holography

- Holograms as decorative and/or functional elements
- Holograms for headlamp applications / generation of main light functions
→ Lukas T. Hiller / L-LAB

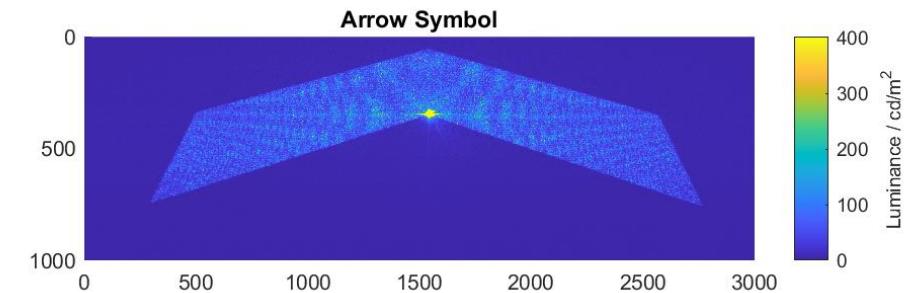
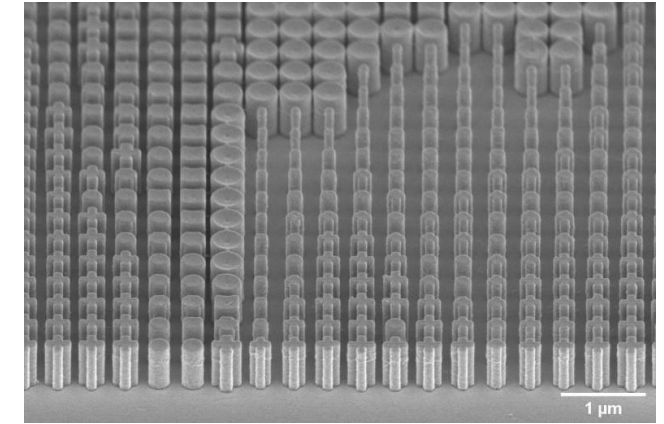
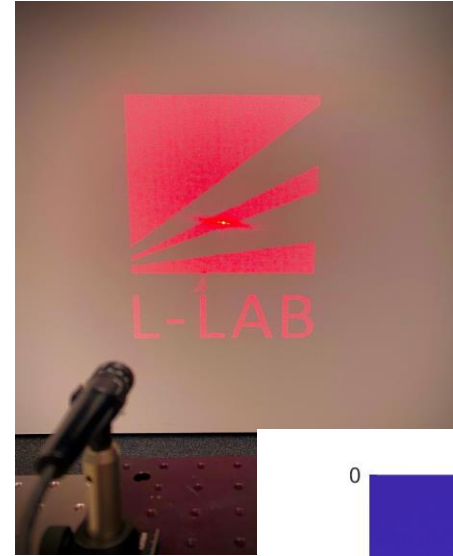


Micro- and Nano-Optics in Automotive Exterior Lighting Applications

Recent Developments @HELLA

- › PHABULO μ S
- › FlatLight
- › Holography
- › Meta-Projector

- Generating phase-holograms with meta-optics
- Usage for road projection
- Highly efficient systems that can increase the visibility of road projections at daytime



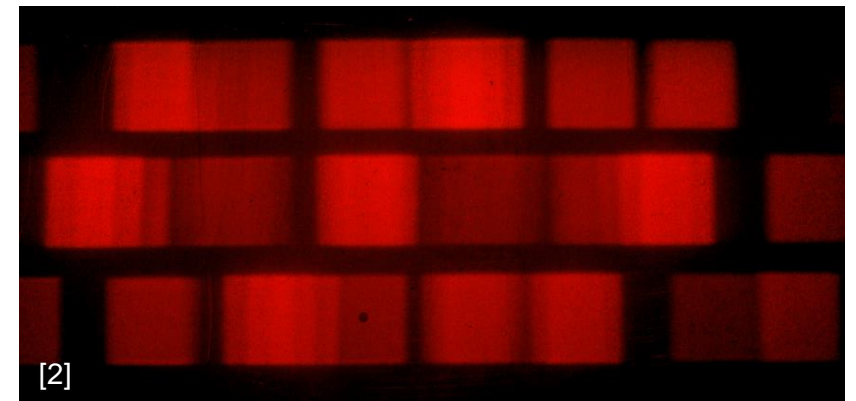
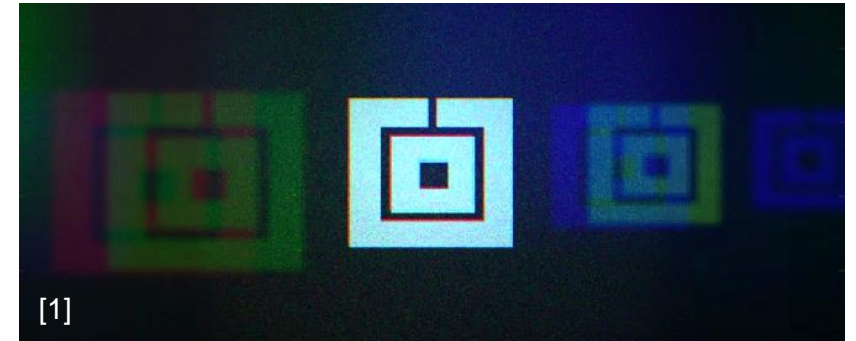
Images:
Lukas T. Hiller et al.:
Metaoptic Based Static Symbol
Projection for eHMI.
ISAL 2023 proceedings

Micro- and Nano-Optics in Automotive Exterior Lighting Applications

Challenges

LED characteristics vs. optics characteristics:

- › Polychromatic spectrums vs. wavelength selectivity / dispersion
- › LED chip sizes vs. optics sizes
- › Lambertian radiator vs. design for point or parallel light sources
- › Usage of multiple LEDs vs. design for single sources



[1] D. Karthaus, O. Sandfuchs, S. Sinzinger: Transmission Holograms for White Light Illumination. ISAL 2017

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

Micro- and Nano-Optics in Automotive Exterior Lighting Applications

Summary and Outlook

- › specific properties of specific micro- and nano-optics types need to be considered for evaluations
- › HELLA's developments confirm the suitability of micro-and nano-optics for automotive applications
- › conflicts between LED and optics characteristics prevent a widespread use of micro- and nano-optics
 - new design approaches are required for the design of micro- and nanooptics for LED illumination
 - the development of miniaturized light sources will (again) lead to more ideal emission characteristics

FORVIA

