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Why Micro-optics Is the Future of (Automotive) Lighting

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Automotive Lighting Expert

Micro-optics Summit, Amsterdam, 2 December 2024

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- Focuslight Overview
- Light sources
- Manufacturing
- Styling
- MLA performance
- Conclusion

Focuslight Overview

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- Founded in 2007 by Dr. Victor X. Liu, headquartered in Xi'an, China.
- A fast-growing company that develops and manufactures:
  - **High-power diode laser components and materials** (Photon Generation)
  - **Laser optics components** (Photon Control)
  - **Photonics module and system solutions** (Application Solutions) focusing on optical communication, automotive, pan-semiconductor, and medical and health applications.
- A **global photonics foundry** offering process development and manufacturing services to the global photonics community.
- Publicly listed in the Shanghai Stock Exchange (Ticker Symbol: 688167).

Key Facts & Figures

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Employees

>1,000

Yearly Revenue Proportion Invested into R&D

~16%

Last Year (2023) Revenue

561M RMB

Patents Valid Worldwide

>610

Facility Worldwide

>48,000m²

Clean Room Worldwide

>14,000m²

ISO 9001
ISO 14001
ISO 45001
IATF 16949
Certified

Markets

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Be the global trusted photonics solution provider

through innovation, manufacturing excellence and fast response

Automotive Solutions

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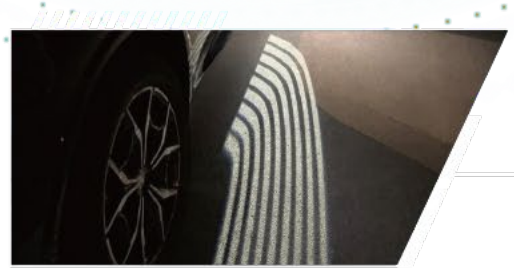
Automotive LiDAR

Driver Monitoring System

Smart Headlight

AR HUD



Automotive Projected Lighting

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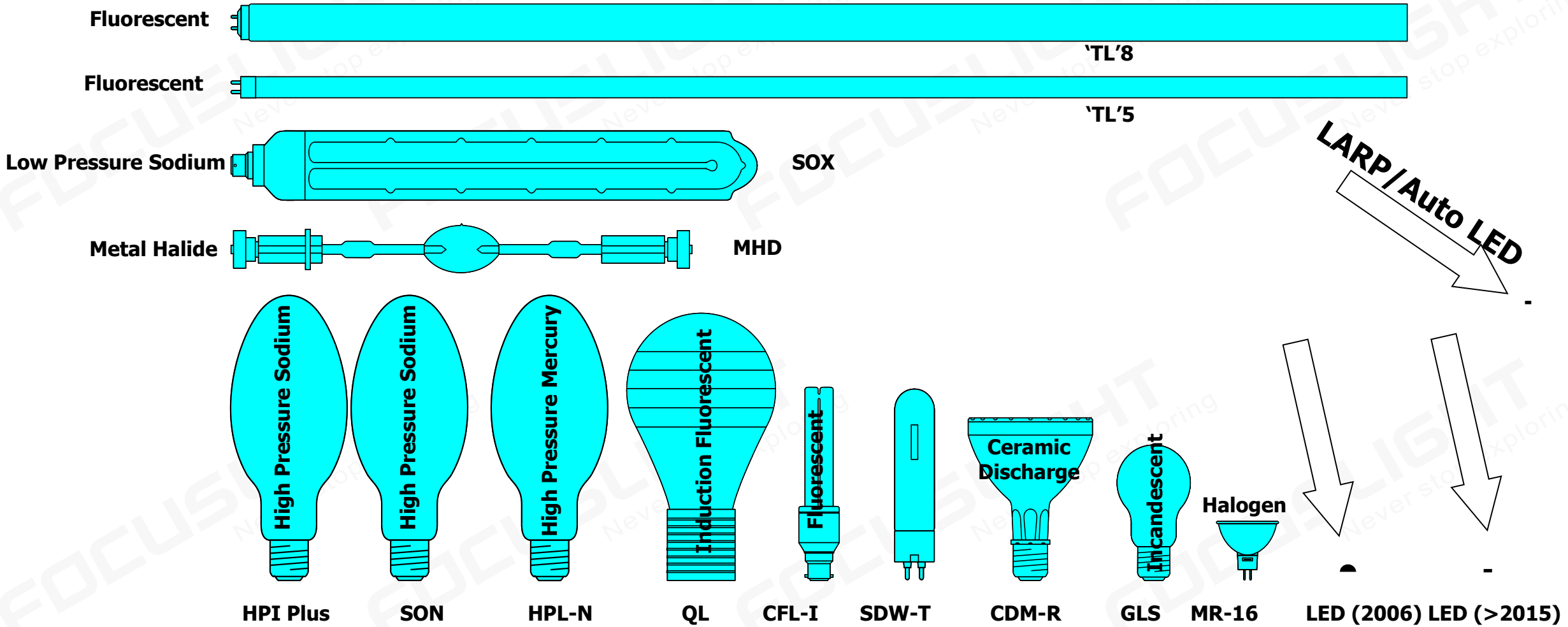
Light sources

Size of the light source determines size and capability of the optics!



* To illustrate relative sizes. Does not equate to performance

Light sources

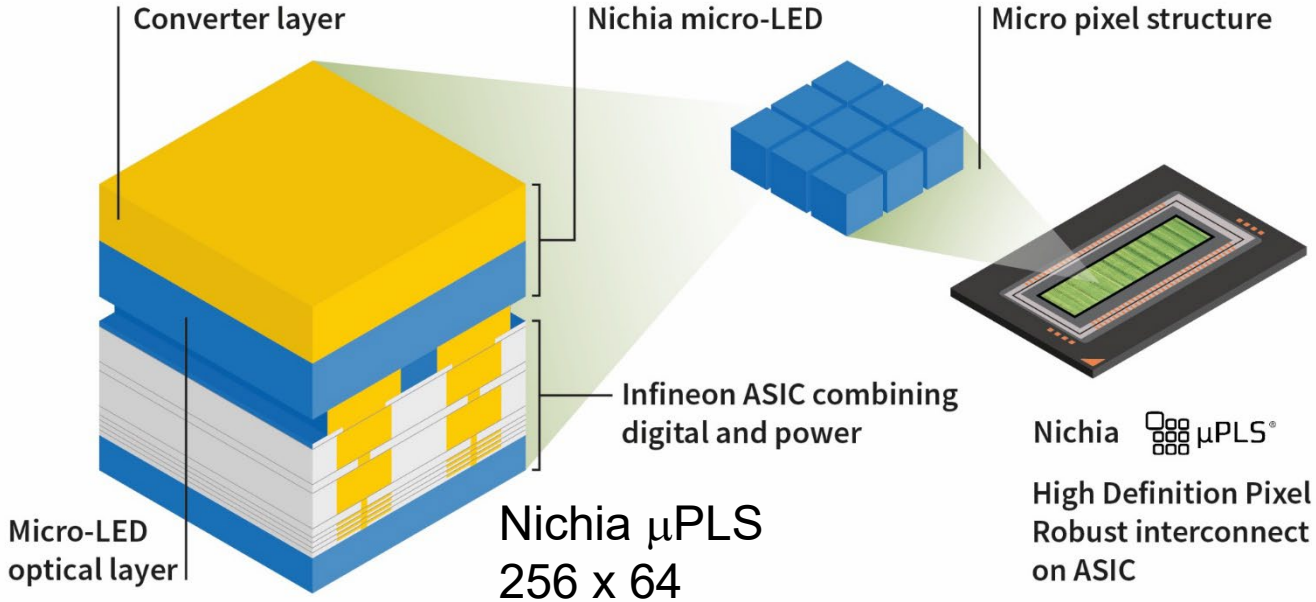
The size of optical elements scales with the light source size – Etendue!

Light sources

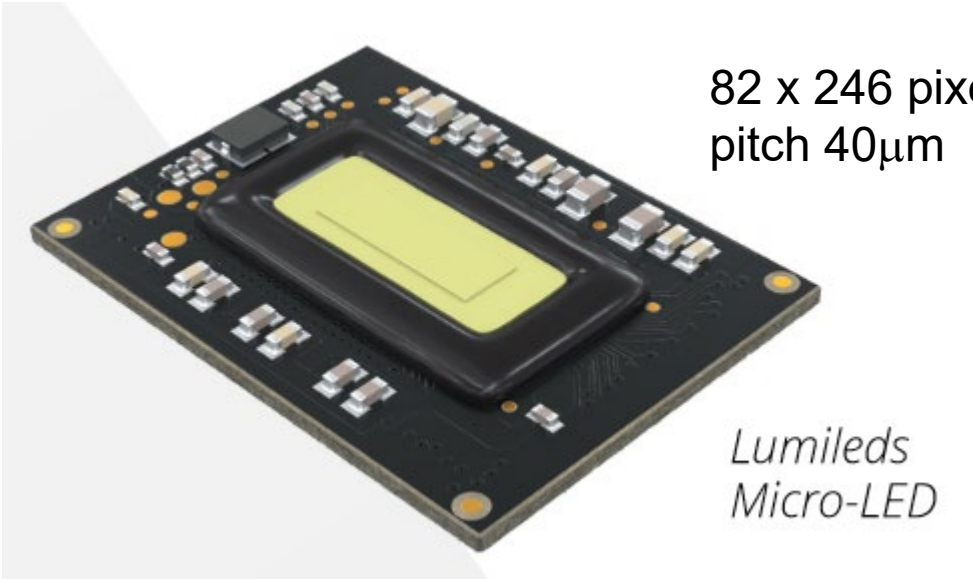
μLED-arrays

- Pixel sizes / pitch typically 40-50μm
- Relatively high resolution (~20 k)
- In essence, very large pixelated LED

Osram Eviyos:
240/320 x 80
pitch 40μm



Nichia μPLS
256 x 64
pitch 50μm

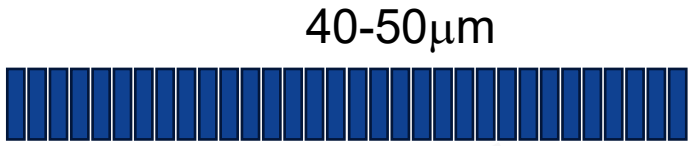


82 x 246 pixel
pitch 40μm

Light sources

Ever smaller avalable sizes

- Smaller light sources have become available due to demand from the automotive industry
- The origin of the demand was to enable slimmer headlamps



Automotive μLED light source

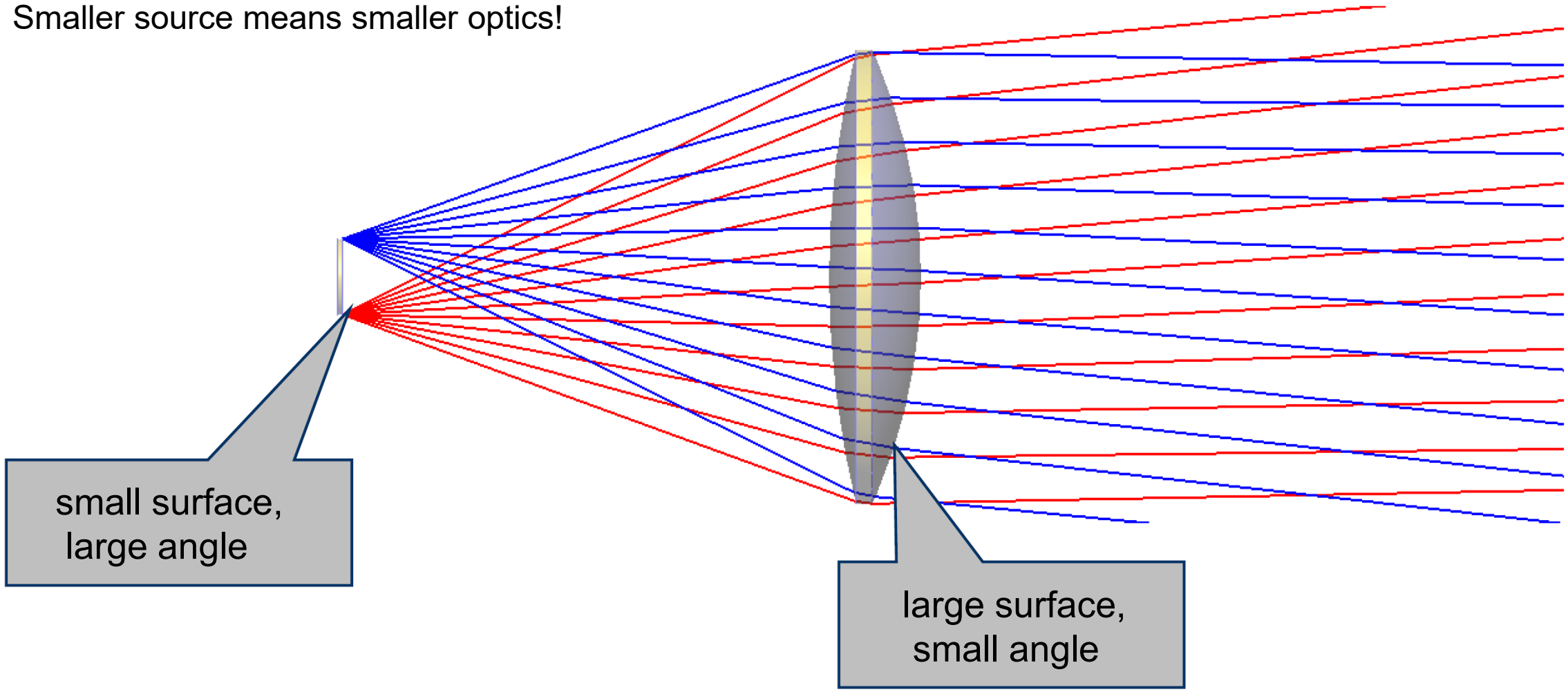
Display μLED light source (but much lower luminance for now)

- Especially μLED light sources could easily be scaled down to any desired multiple of pixel size
- This would enable further size reduction of optical elements

Light sources

Source sizes and emission angles

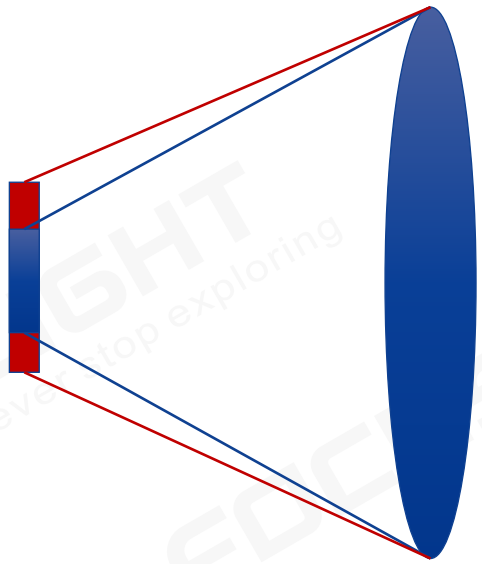
- Smaller source means smaller optics!

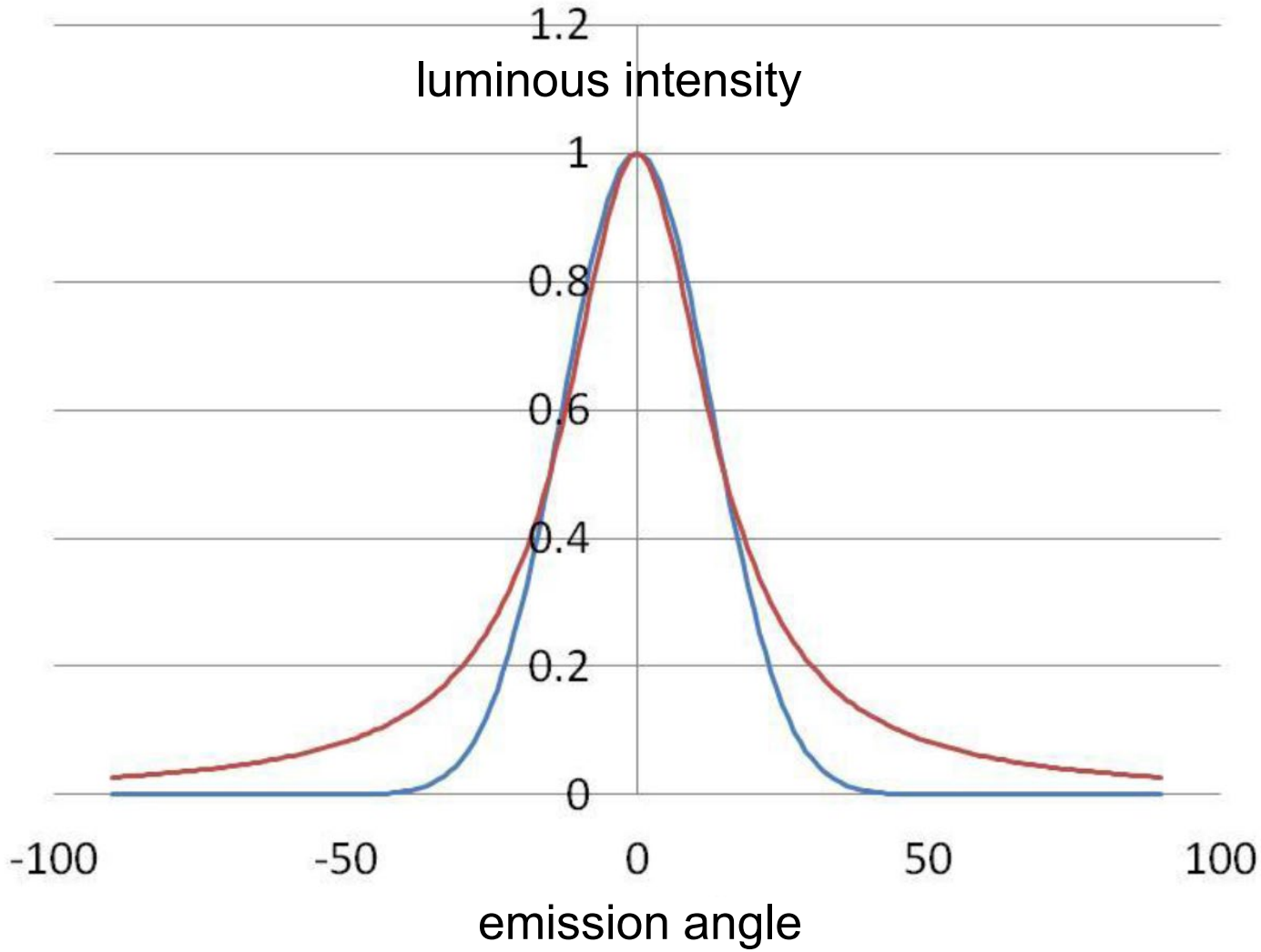


Light source

Source size and emission angles

- Same performance only if ratio between source size and optics size remains constant!
- Smaller source will deliver less light!
- Use more (individual) sources





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Manufacturing

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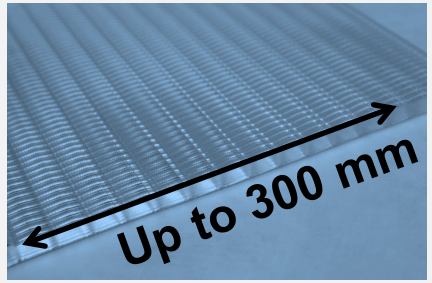
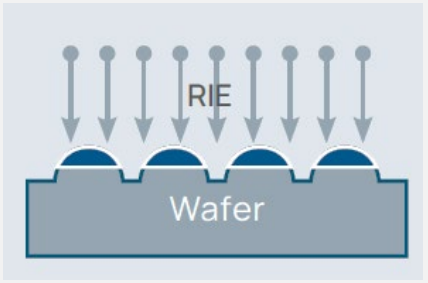
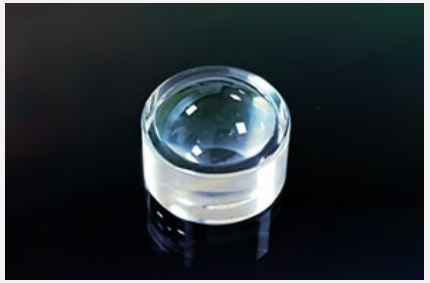
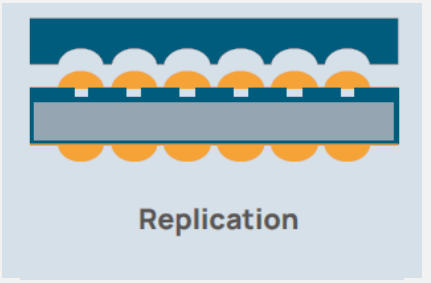
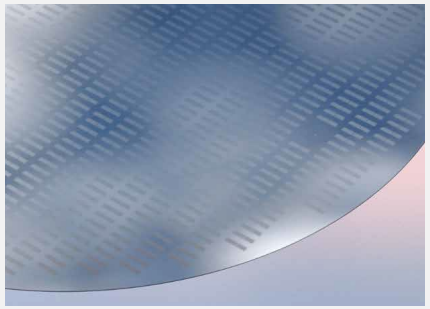
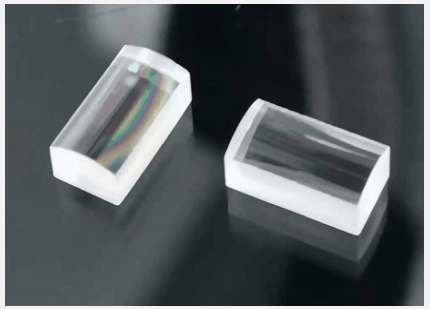
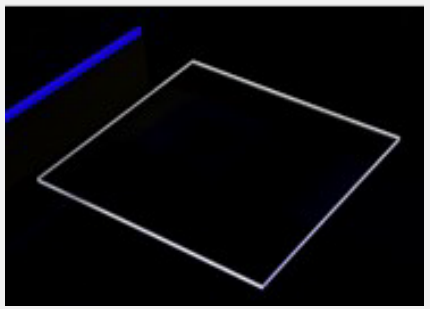
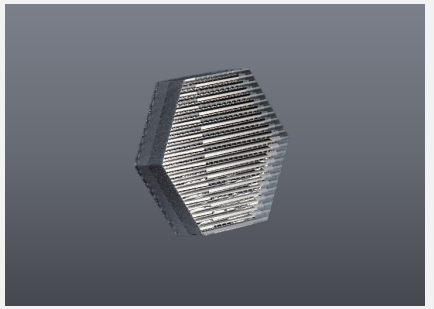
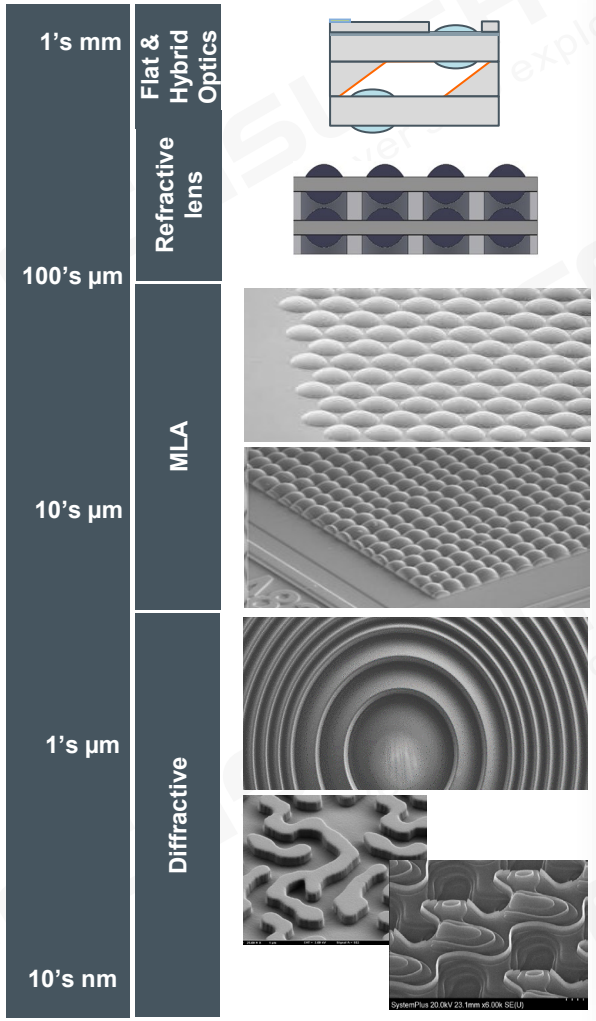
Optical components

Wafer Level Simultaneous Structuring	Wafer Level Photolithography-RIE (reactive ion etching)	Precision Glass Molding	Cold Processing	Imprinting
				
				
	With inorganic materials: Glass, Fused Silica, Silicon, CaF_2			With polymer on glass

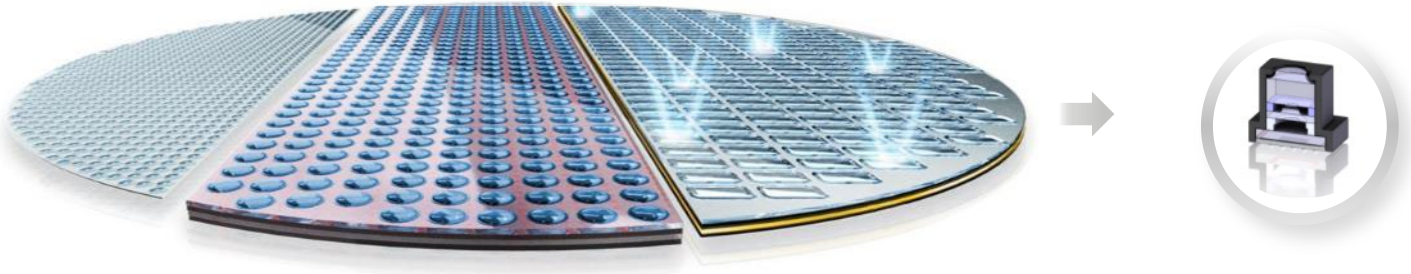
High LIDT Optical Coating: Anti-reflection, high-reflection, beam splitter, band filter, and various customization (UV, VIS, IR)

Manufacturing

Wafer Level Optics and Stacking



Wafer-Level Optics, Electronics, Packaging, Integration, Testing and Processing



Wafer-level imprinted optics from mm down to nm-scale

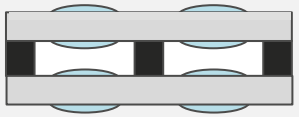
WLO
(Wafer Level Optics)

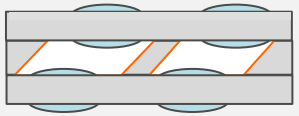
WLO

VIM-optics

Diffractive & refractive optics, MLAs, diffusers

WLS
(Wafer Level Stacking)

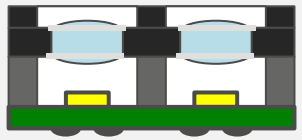




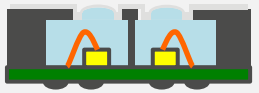
Folded path

Imaging lenses, projector lenses

WLI
(Wafer Level Integration)



stacked



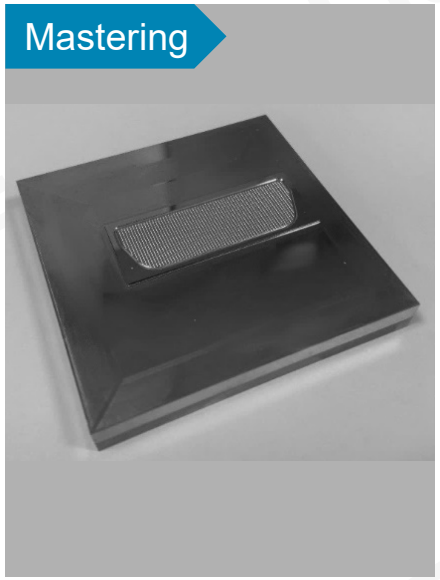
VIM-module

Optical sensor & illumination modules

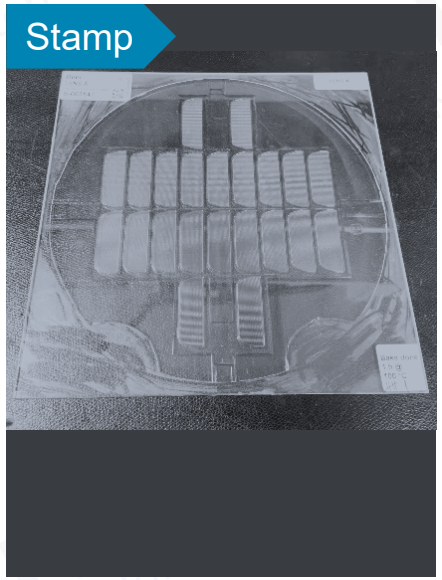
Manufacturing

Imprinting Processing

Mastering



Stamp



Imprint

Testing

Singulation

Imprinting Processing:
Manufacturing Capacity > 15K wafers / year or > 30M pcs lenses / year

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The Trend: Ultra Slim Automotive Headlight

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https://www.carscoops.com/2021/05/design-trends-super-slim-headlights-are-taking-over/

The Trend: Ultra Slim Automotive Headlight

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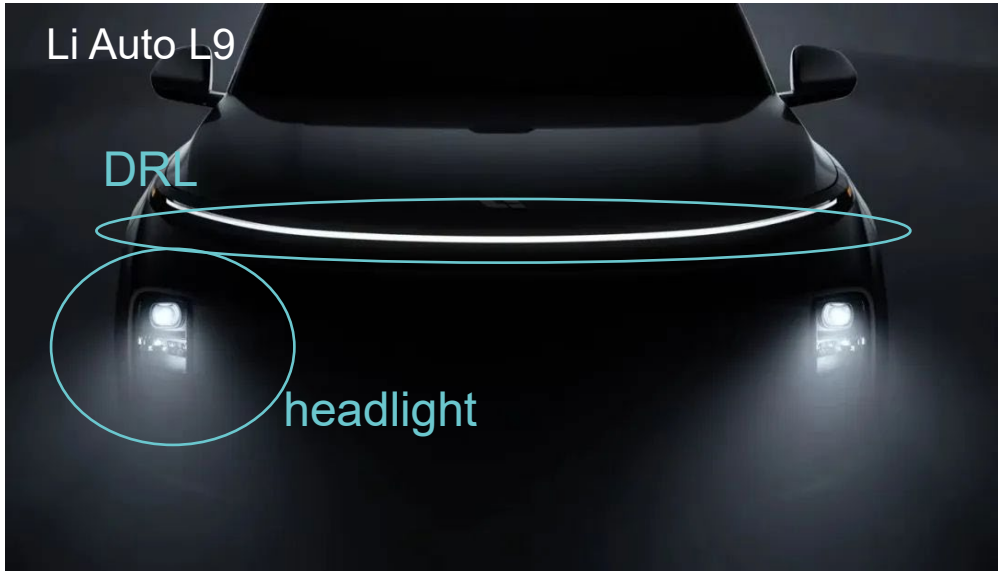

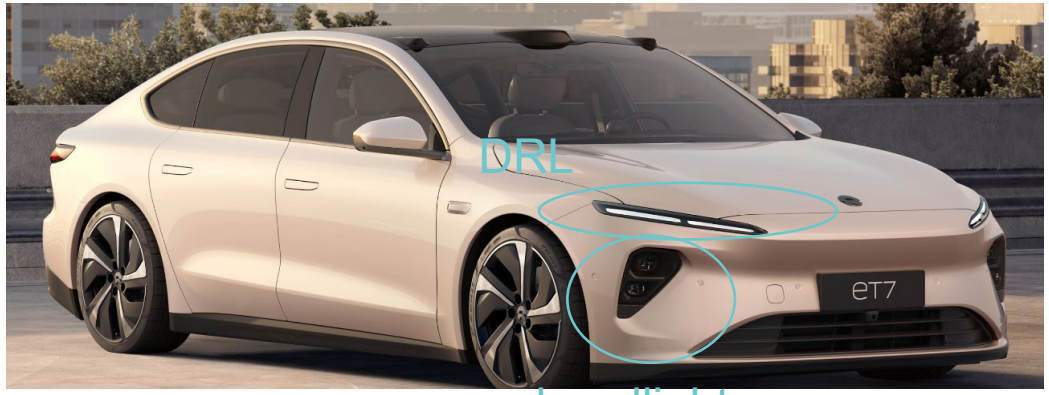

https://www.carscoops.com/2021/05/design-trends-super-slim-headlights-are-taking-over/

The Trend: Ultra Slim Automotive Headlight

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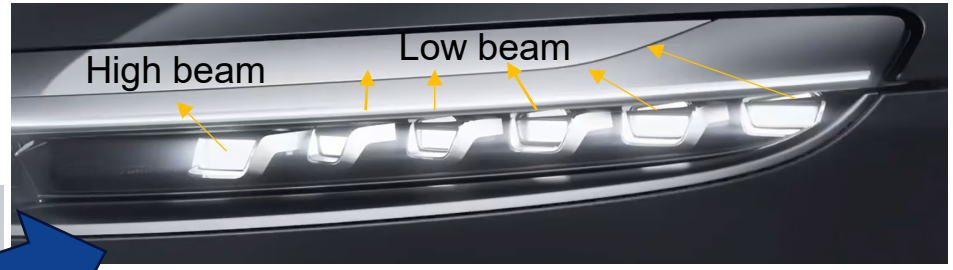
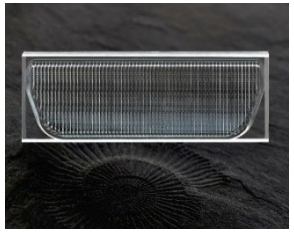
Leaving the «face» expression behind,
towards a novel styling paradigm!

Ultra Slim headlight Enabled by **MLA**

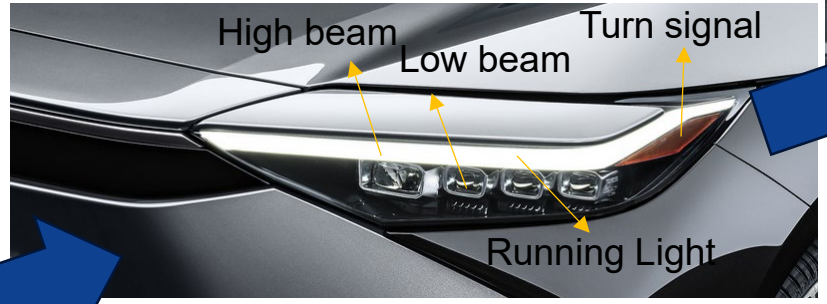


Height: <15mm



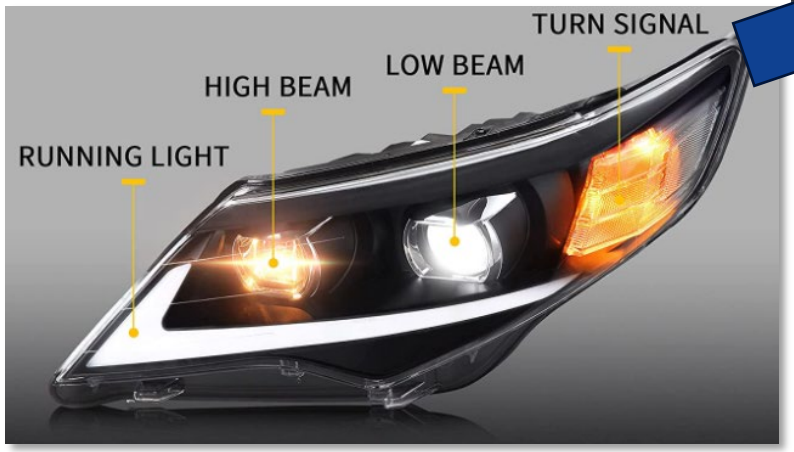
MLA

Narrow / Slim LED headlight



Height: <40mm

Conventional / Popular LED headlight



Height: >40mm

- **Ultra slim headlight**
  - A new headlight design genre and trend gaining popularity.
  - High beam & low beam unified with slim DRL styling.
  - A design trend for premium cars and gradually also for medium-end cars.
  - Best implemented with MLA (Microlens Array) technology.

Design examples: on the road

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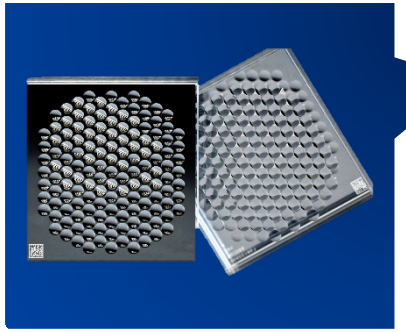
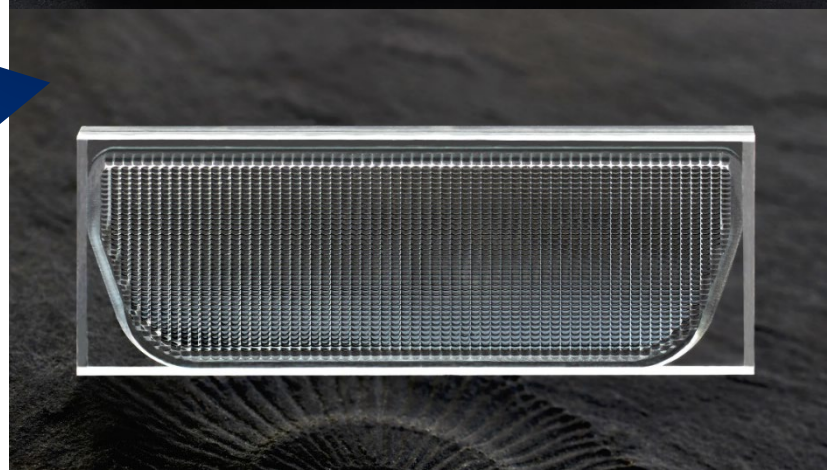


Source: Lucid.com



Source: genesis.com

TWO HEADLAMP GENERATIONS

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Genesis G90 (2020) - CONVENTIONAL

V.S.

Genesis G90 (2021) – MLA HEADLAMP

MLA technology enables ultra slim, modularized headlight design!

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Automotive Lighting

Micro-Optics enables car designs of the future

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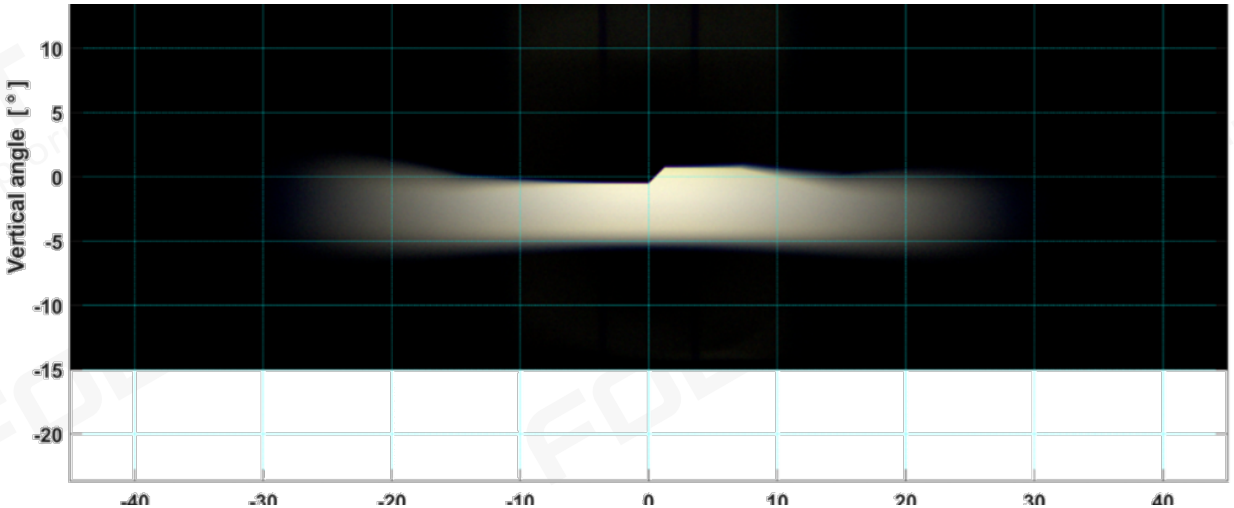
MLA Performance

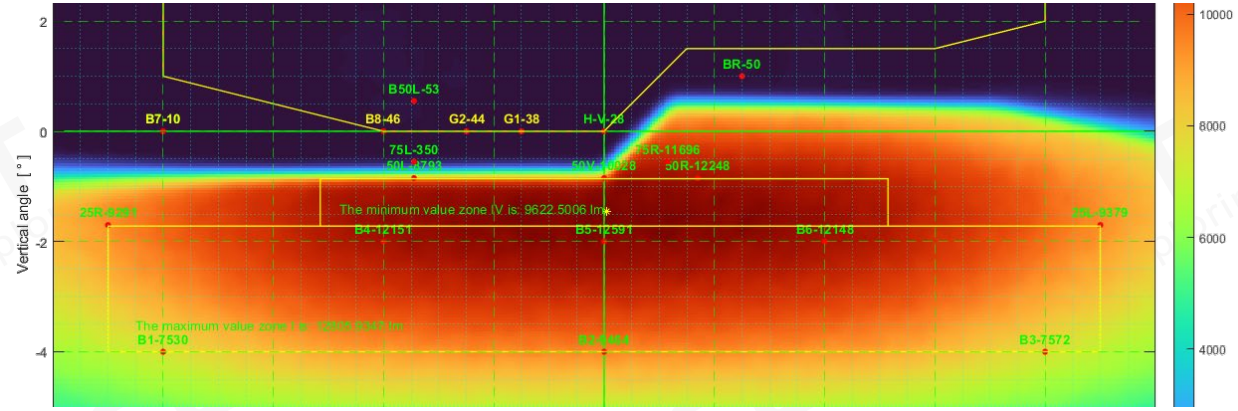
Miraluz®1.1 Focuslight reference design



Test conditions:

- 350 lumen per LED output
- 3 LED dies per MLA

Component	Optical efficiency
Collimator	70%
MLA (without shield)	95%
MLA (with shield)	65%
Full system	**Above 40%**



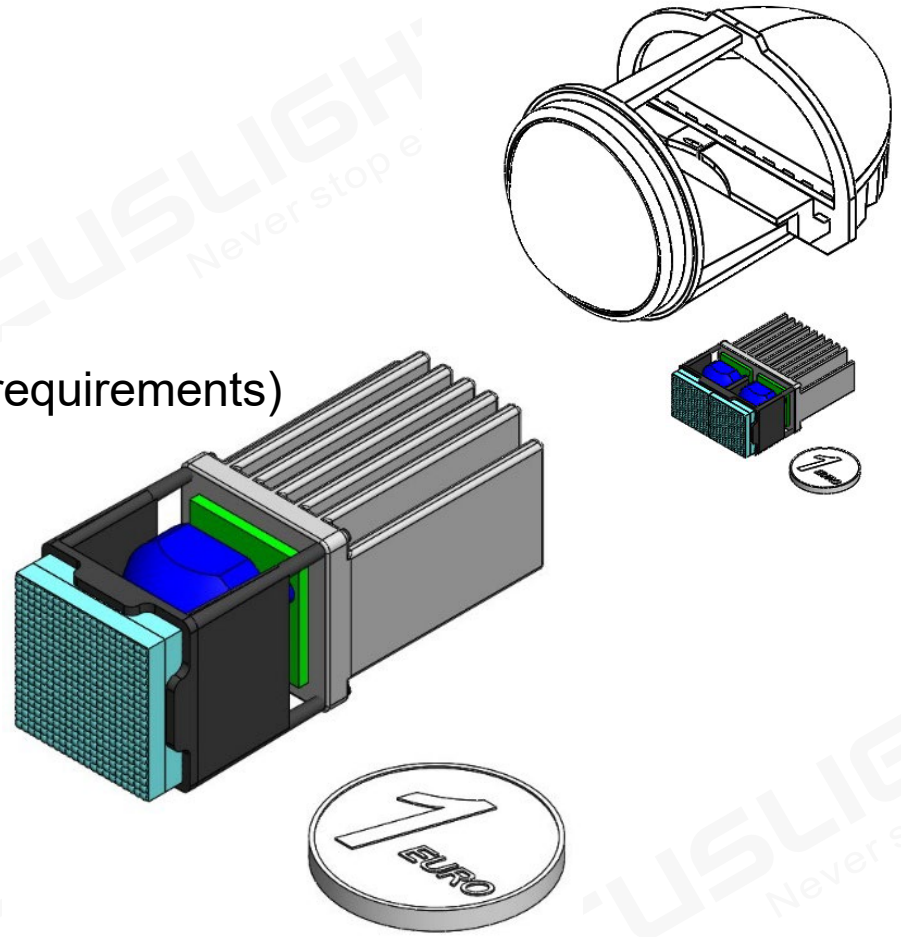
Emax: 12’800 Cd (with 1 module)

MLA Performance

Miraluz®1.1 Focuslight reference design

Achieved performance:

- System efficiency above 40%
- Uses 1mm² chip size LEDs
- All legal requirements met
- LB functionality achieved with 1 module (minimum legal requirements)



Basic setup:

- 1 MLA dedicated for LB projection
- 1 MLAs dedicated for HB static projection

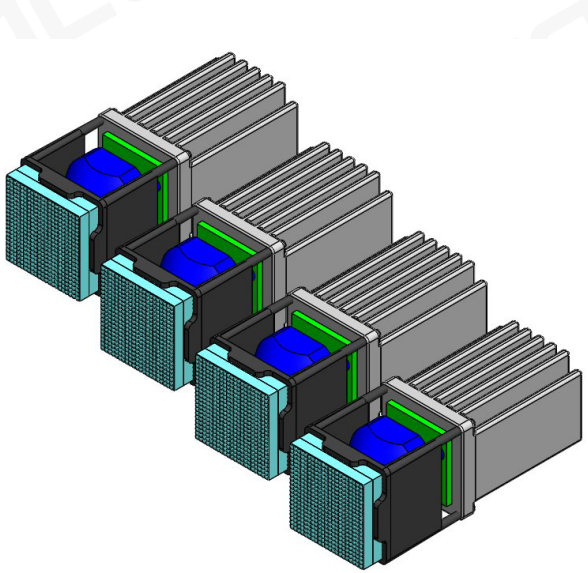
- Option for city cars or 2-wheelers

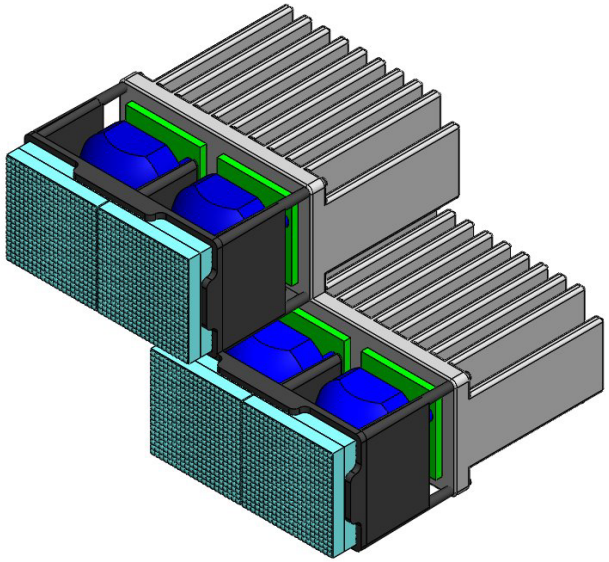
Low beam performance at the market expectations with multiple design options

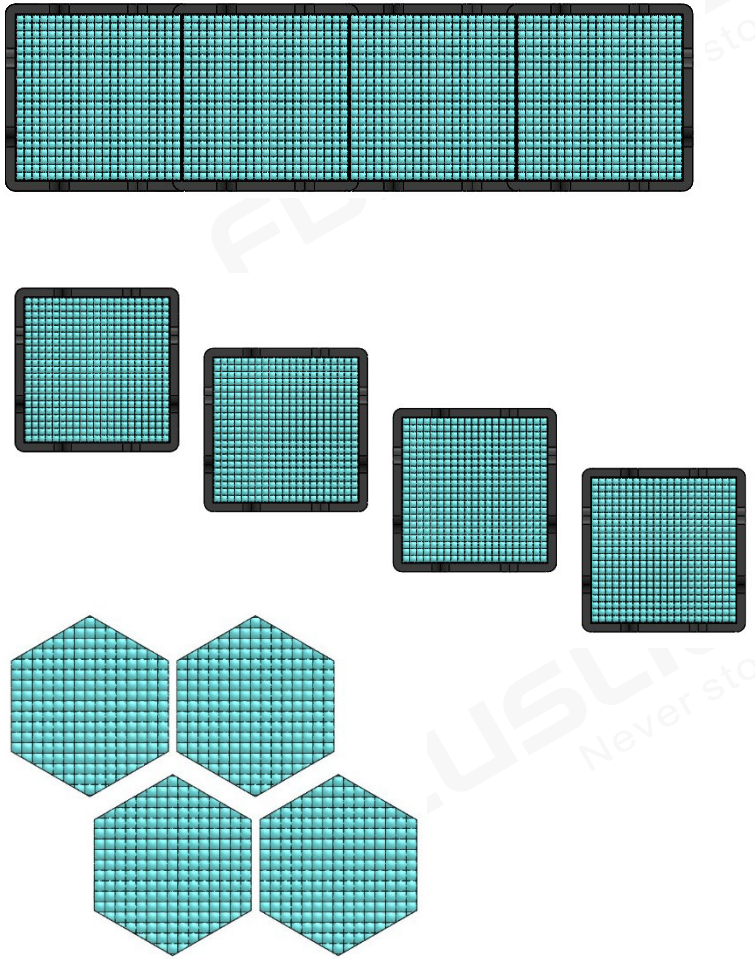
MLA Performance

Miraluz® flexible use of multiple modules

- 17 mm x 70 mm x 22 mm







The Future of Automotive Lighting: Micro-optics

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Light sources will shrink further

- Provides flexibility for sizes of optical elements
- mm-size lenses can handle well 40μm sized light sources

The industry gathers manufacturing experience

- Scale effects and experience will drive cost down
- Wafer level optics imaginable

Styling

- Electric and autonomous cars need new differentiators and expression
- Smooth and slim looks, «flat» solutions preferred over complex, techno 3D styles, main functions hidden

MLA performance

- Performance on par with conventional solutions, while being more compact
- Could become platform product for standard low-beam or other functions

THANK YOU

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www.focuslight.com

www.hptg.com