

NextGen Reflex Micro-Optics

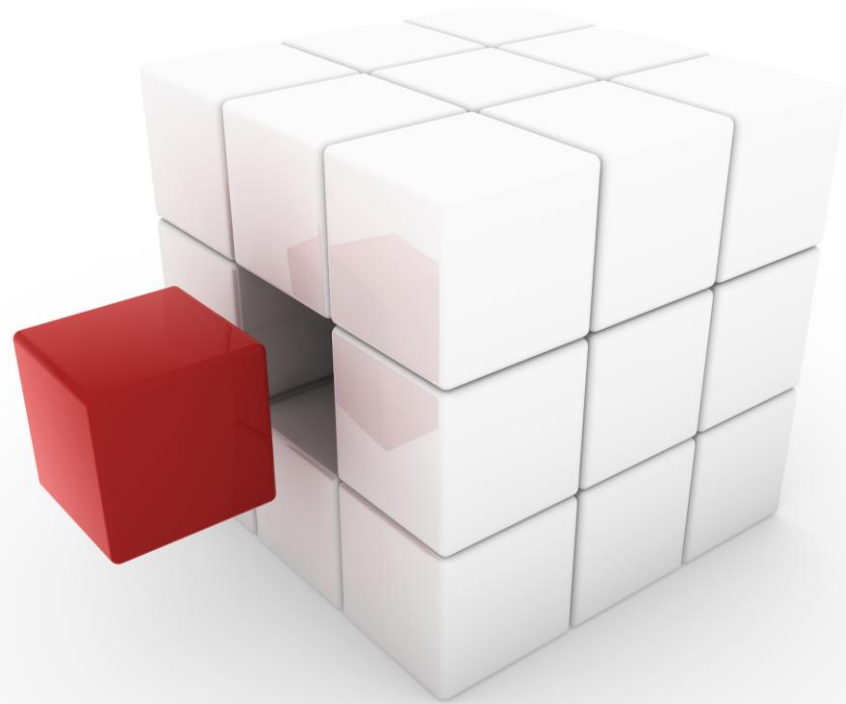
Breakthrough in Design Possibilities



Dr. Albert Krammer



PHABULOUS Webinar on
Micro-Optics in Automotive
30.11.2025



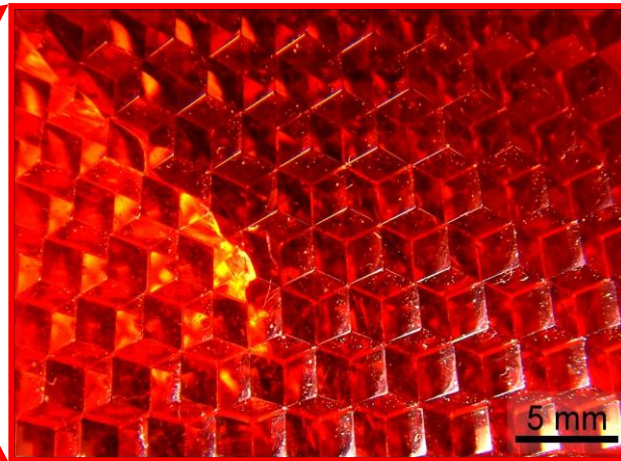
WIR BRINGEN IHRE POTENTIALE AUF DEN ■

CURRENT SITUATION ON THE MARKET

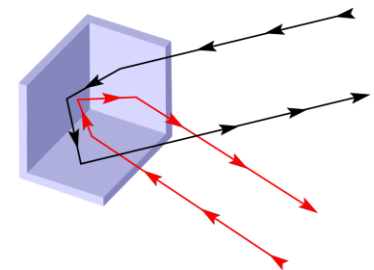
- **Orange/red** retroreflectors for headlamps and rear lamps are **compulsory** in **north America (Europe, only rear lamps)**
- Minimum surface of **$\sim 25\text{cm}^2$** with optics **2-3mm** is needed to achieve the legally required values
- Optical surfaces are sensitive, each surface is a single pin in the injection moulding tool
- No micro optics seen on the market



Source: <https://usedparts.mercedes-benz.com/a/headlamp-left-static-led>



Optical principle

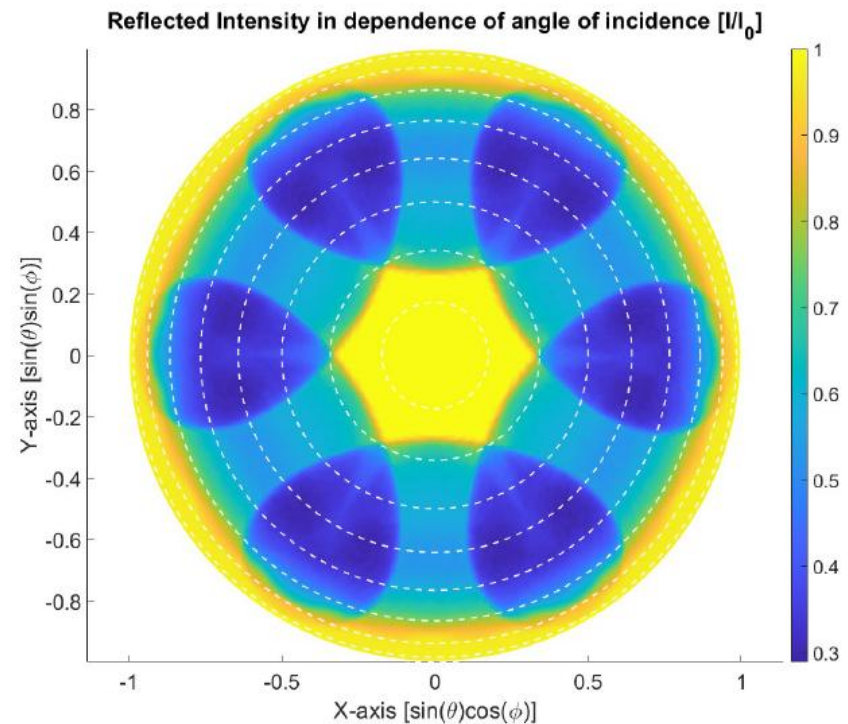
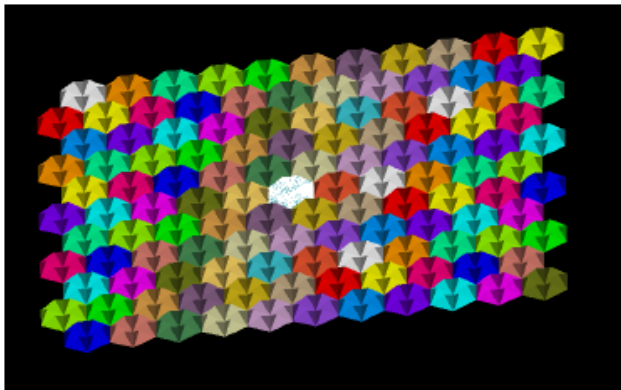


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Simulation



- Evaluation, how many rays are reflected or transmitted
- Used rays: 10k per angle
- Especially up to 20° angle, the reflectance is close to 100%.

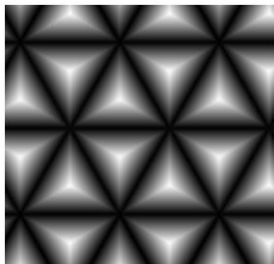


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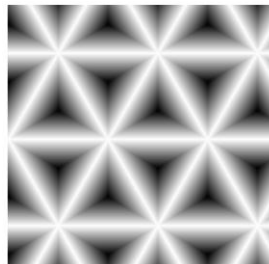
Design by Joanneum Research



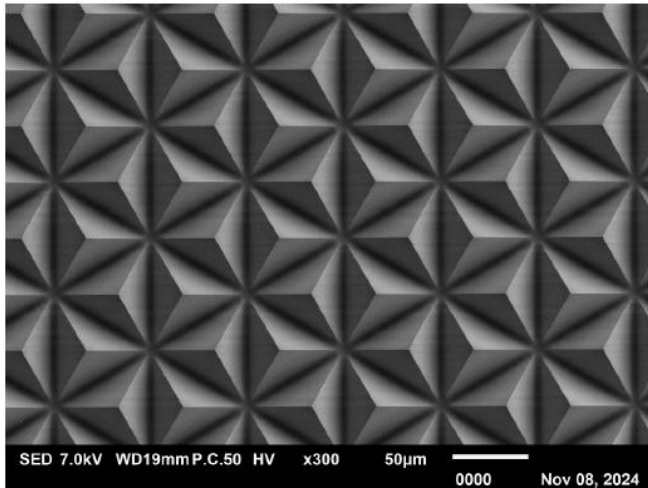
- Target: *pyramid reflective microstructures*
- Maximum height of one structure is *30 μm on a 1 cm² sample plate*
- Origination of the structures is carried out using *Grayscale Laser Lithography*



Structure design



Invers design for grayscale
laser lithography



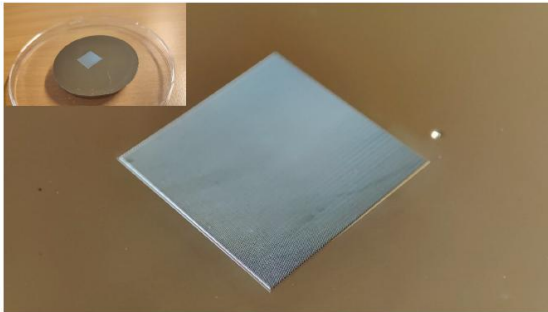
SEM of pyramid reflective
microstructures mastered by
Maskless Grayscale Laser
Lithography (MALA) on the resin

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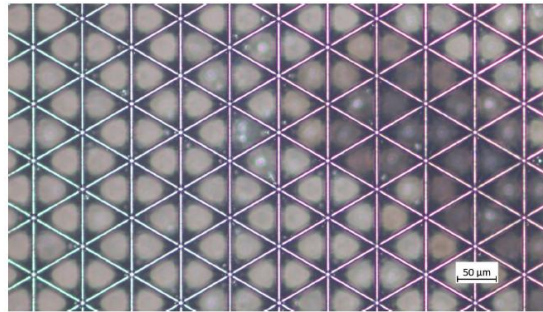
Fabrication by Joanneum Research



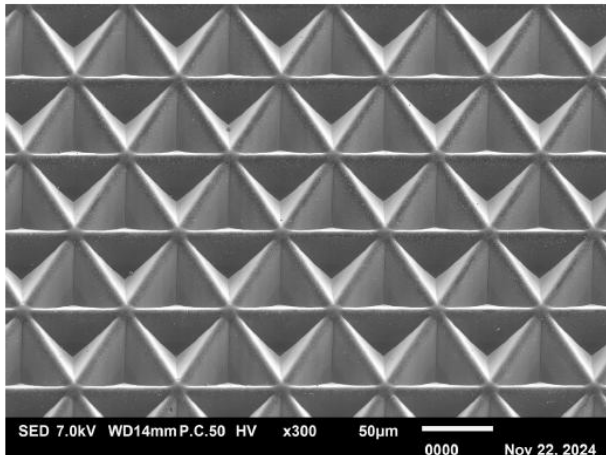
- The Grayscale Laser Lithography structure was **coated by Nickel** – resulting in a **stable stamp/master**
- The dust particles were removed before **UV imprint (replication)**



Metalized master (inverted structure)



Microscopic image of the retroreflecting structures on the metalized master

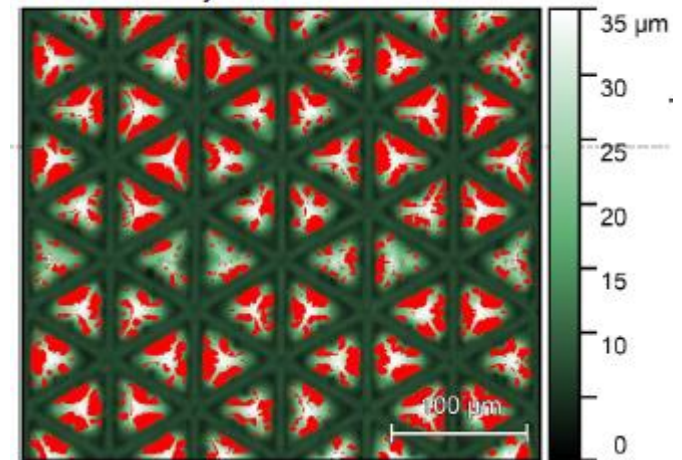


SEM image of the metalized master (inverted structure)



- Compared to the Ni-Stamp, the inclination angles are increased
- Slope of the pyramid flanks are steeper
- Different lengths/height of pyramidal structures
- Will lead to a deviation in the measurement

Marked Pyramid Flanks



4 different samples were investigated

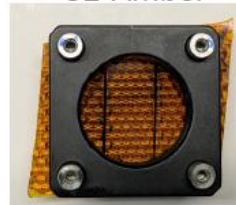
1. *ideal mirror*
2. *3M white tape*
3. *Amber Reference Sample G2*
4. *JR-NIL - expected retroreflection not fully realized (theta angles 64°, but 54° needed)*

Samples:

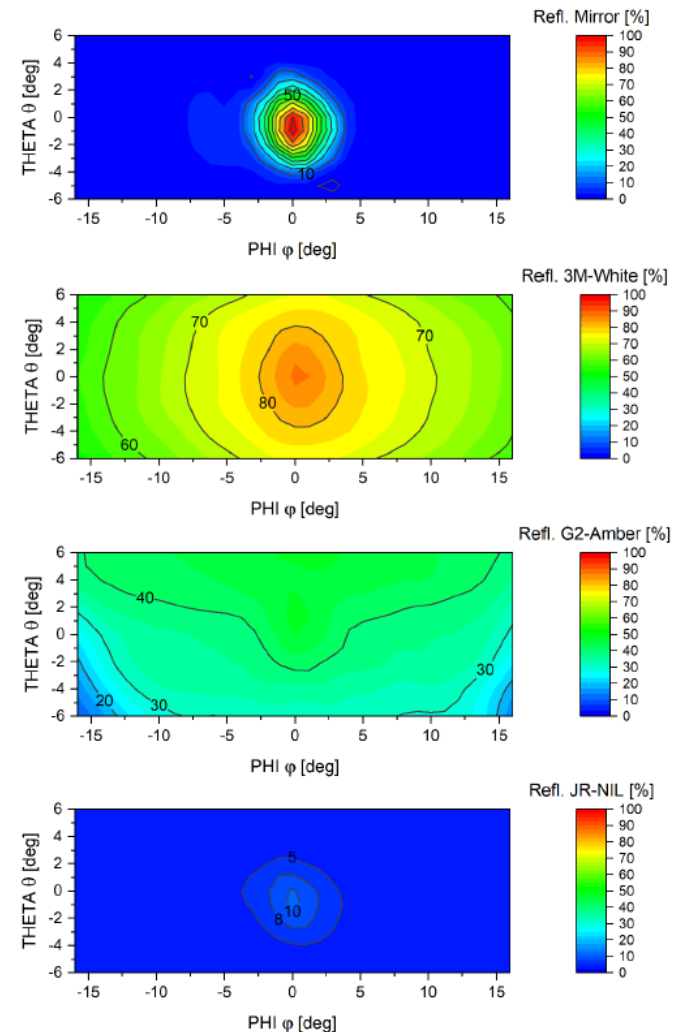
3M-White



G2-Amber



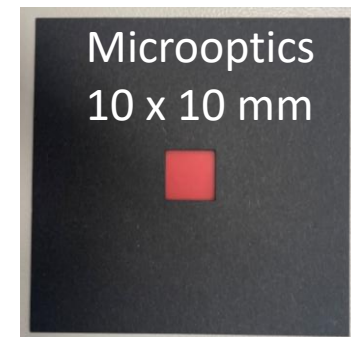
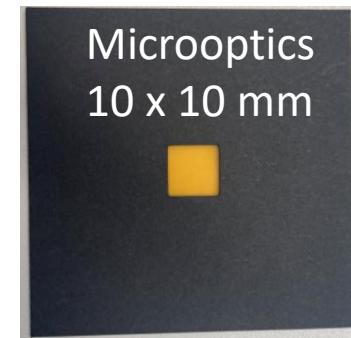
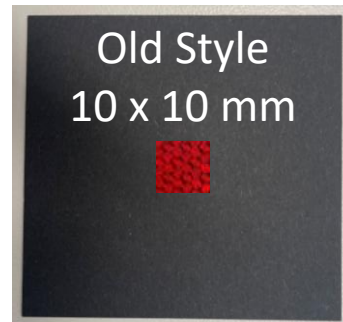
JR-NIL



Conclusion and public demonstrator

- Optical simulation confirmed **functionality** for 30µm structures
- Microstructures were **successfully fabricated**
- Expected retroreflection **not fully realized**
- Reason for insufficient results: **incomplete MALA calibration due to time and cost constraints**

Old Style Reflex Example



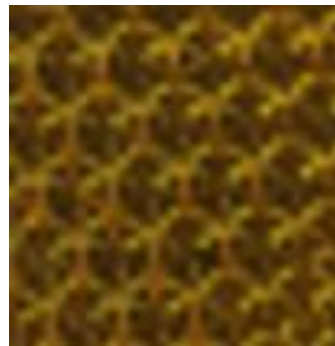
Where bold optics meet flawless design



Source: [Werkstoffe im Automobil - LED-Leuchten mit hohen Anforderungen](#) - Kunststoff Magazin



Source: [FORVIA HELLA announces Market Launch of FlatLight Technology as Daytime Running Light](#) | FORVIA



NextGen Reflex Micro-Optics

Innovation Award



G² Industrial Engineering GmbH emerged as the winner in the category "*Innovative Services*" at the Burgenland **Innovation Award 2025** for the "NextGen Reflex Micro-Optics project".

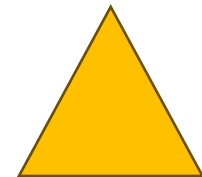


Thanks to:



Next Steps

1. Re- Calculation of algorithm to design correct angles
2. Supplier identification
 - Tooling (experience diamond turning and ruling)
 - Injection molding (micro injection molding)
3. Pre-series, flat square prototype (50x50mm)
 - Sample tool & mold inserts
 - Small production
 - Characterization
4. Full scale production, triangle with surface area ($>100 \text{ cm}^2$)
 - Master diamond machining
 - Nickel shim for inversion of the structure
 - Manufacturing of the injection molding tool
 - Molding of the parts
 - Validation





Thank you for your attention!

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