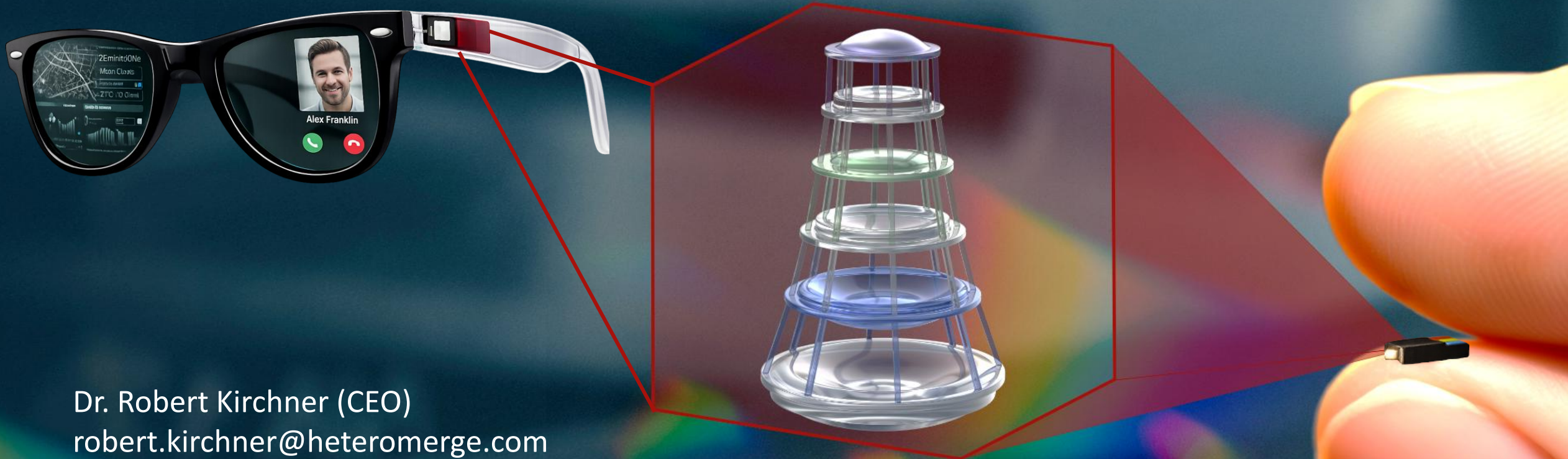


SELF-ALIGNED OPTICAL ASSEMBLY USING A SINGLE FREEFORM 3D PRINTING PROCESS

EPIC Technology Meeting on Photonics for AR: the Tipping Point at EssilorLuxottica | 14.10.26



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Individual lens production, mechanical assembly and optical alignment

DESIGN & TOOLING

-  **01 Requirements**
FoV, aperture, image metrics, ...
-  **02 Optical & mechanical design**
Lens shapes, materials, tolerances
-  **03 Mold fabrication**
Machine precision mold inserts

LENS FABRICATION

-  **04 Lens molding**
Replicate by injection molding
-  **05 Surface coating**
ARC, ghost images suppression
-  **06 Lens inspection**
Surface shape, dimensions, defects.

ASSEMBLY & VERIFICATION

-  **07 Lens-stack assembly**
Stack lenses, spacers, apertures
-  **08 Objective testing**
MTF across the image field
-  **09 Alignment & bonding**
Actively align objective/ sensor
-  **10 Module calibration**
Focus, shading, stabilization
-  **11 Final testing**
Verify image quality

KEY ISSUES

- Tooling for every lens design
- Complex process chain
- Assembly tolerance control
- Miniaturization challenging



Multimaterial 2PP on the sensor / fixed-focus architecture assumed



1 Design optics

Optimize and compensate for print deviations



2 Locate actives

Register position to the active elements plane.



3 Print stack

Lenses and supports in one coordinate system.



4 Develop & finish

Remove resin and complete coatings



5 Test & calibrate

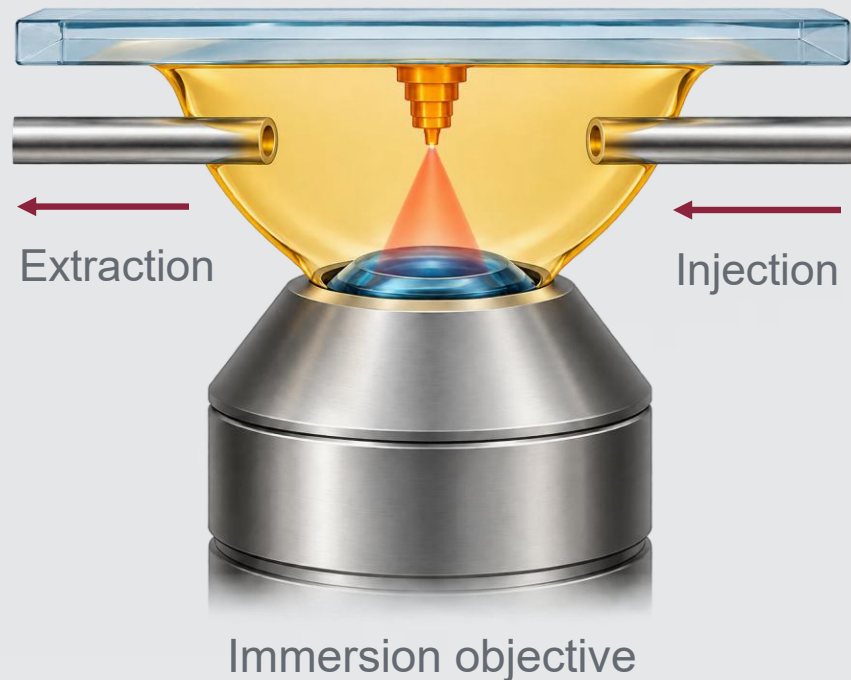
Verify MTF and calibrate the completed camera.



BENEFITS

- No precision molds, faster design iteration
- Fewer parts, handling, and assembly operations
- Common print reference, less assembly tolerances
- Multimaterial optics w/ chromatic correction

01 Print material A



Print initial component

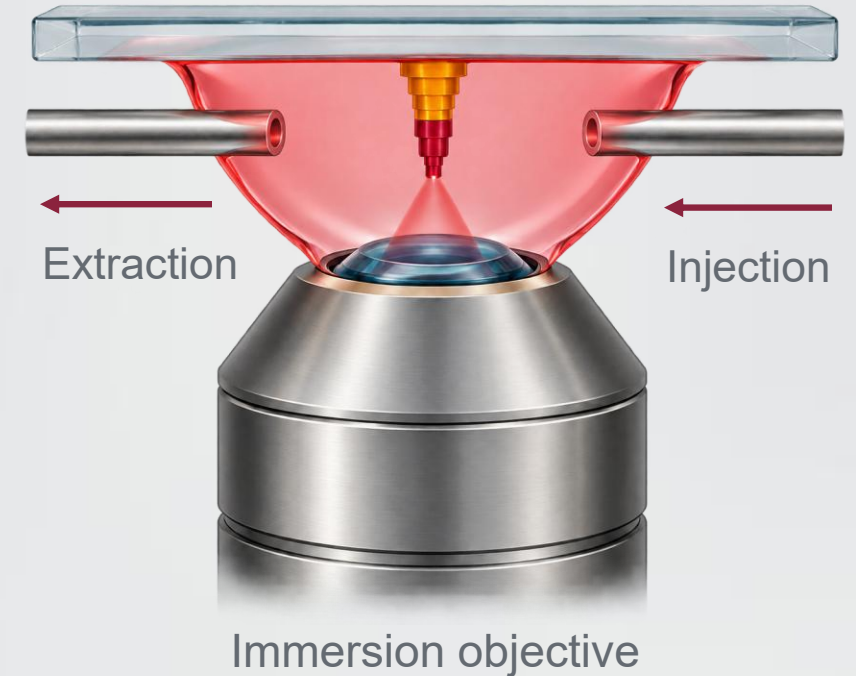
02 Exchange



Real process, top view



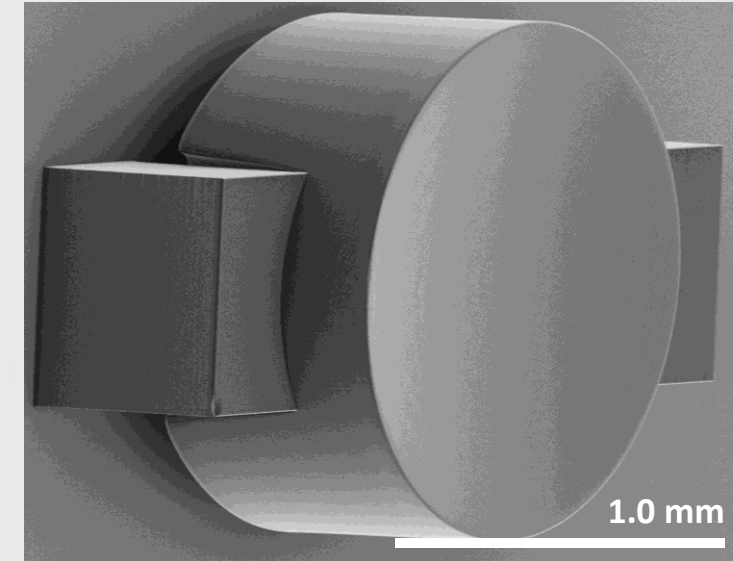
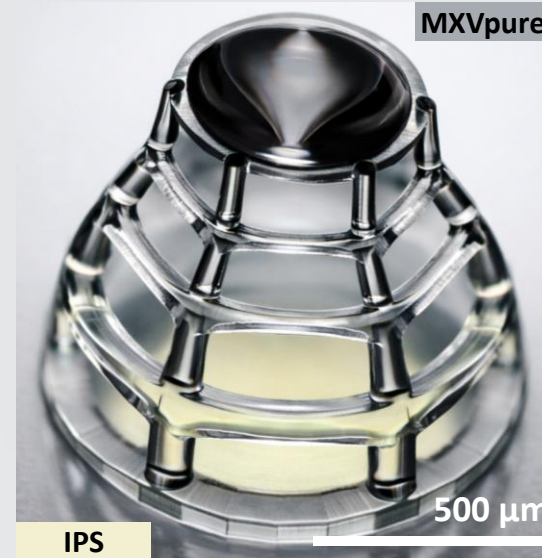
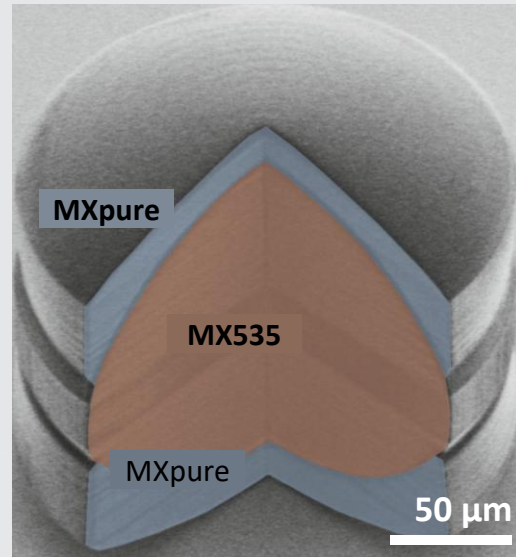
03 Print material B



Self-aligned print for any subsequent component

HETEROMERGE core technology

Monolithic optics
from small to large
fabricated by HETEROMERGE*



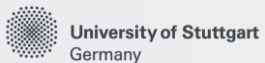
Key specifications

> 50 nm decenter | < 20 nm roughness | freeform precision

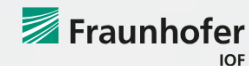
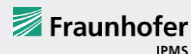
Customer benefits

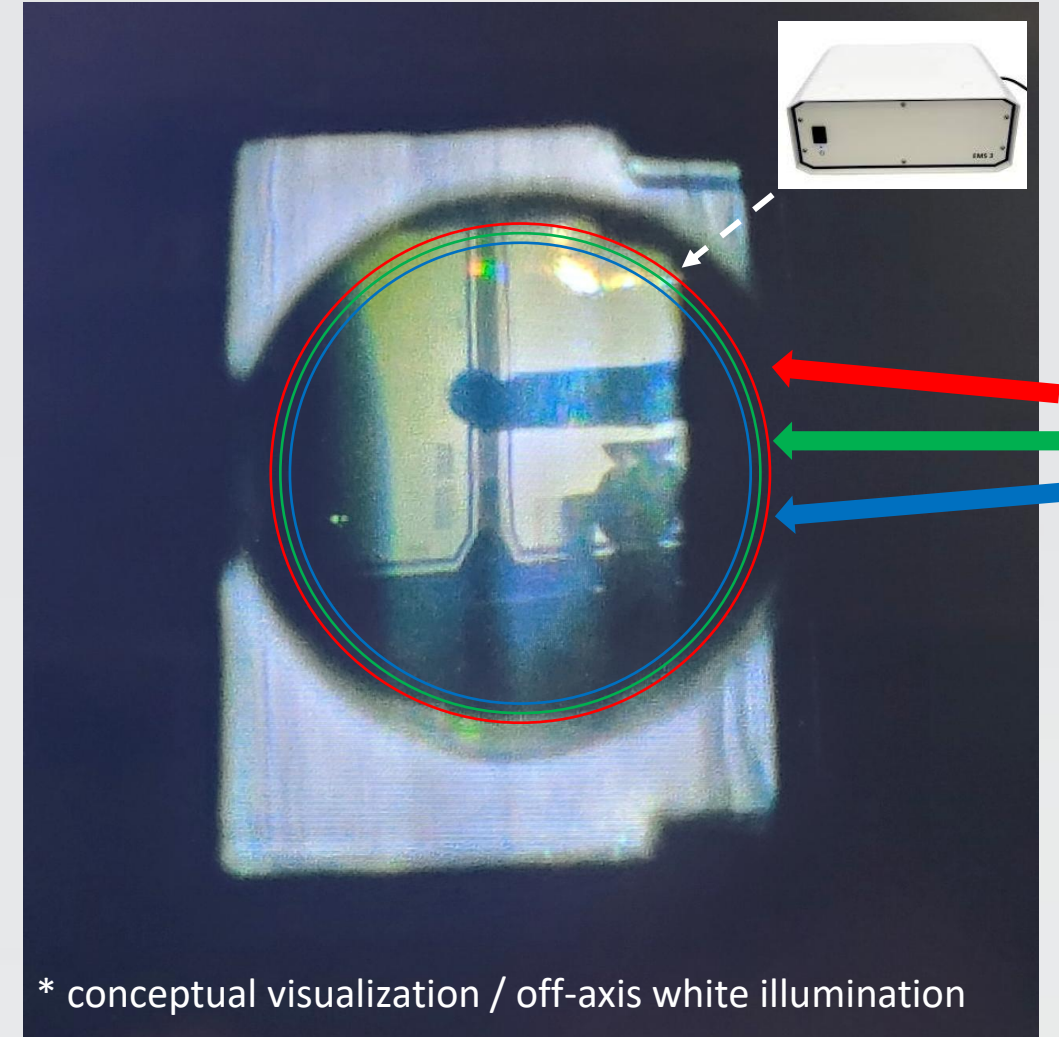
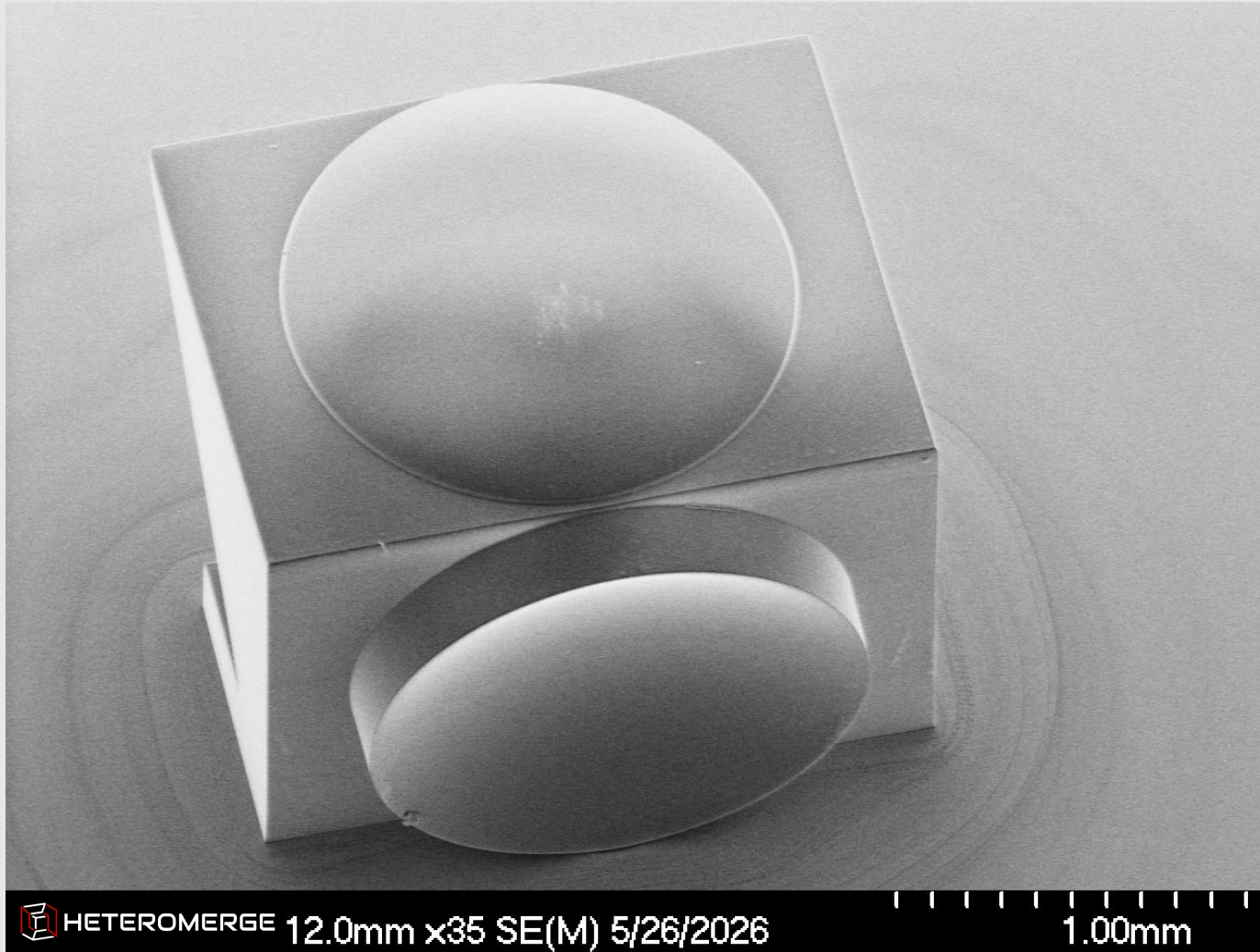
full integration | cost savings | low/high volume

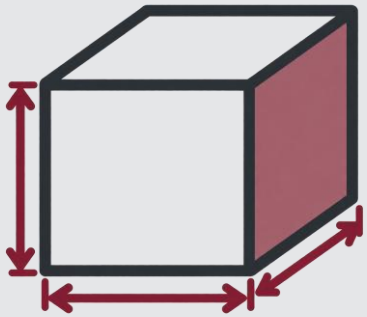
Patented, customer-proven technology with highly awaited deployment!



UNIVERSITY OF TWENTE.







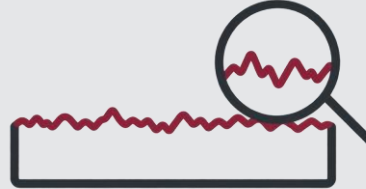
Build volume

2 mm (4 mm)



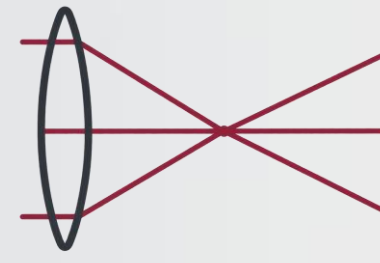
Deviation

$< 2 \mu\text{m}$



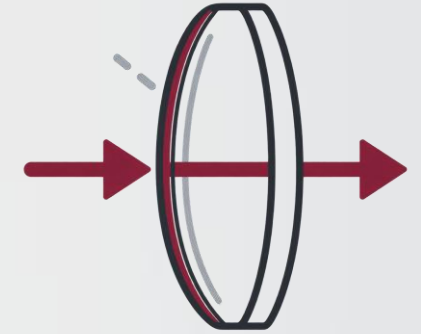
Roughness

$> 10 \text{ nm RMS}$



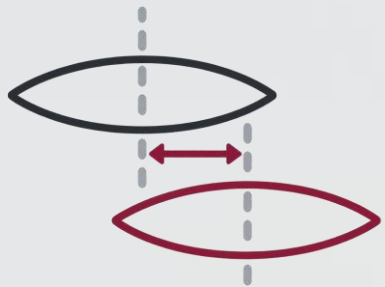
Defocus

Zernike Z_2^0



Single AR process

$< 2\%$ reflection



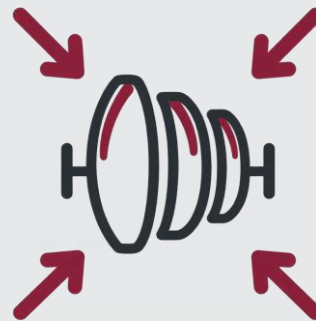
Decenter

$< 500 \text{ nm}$



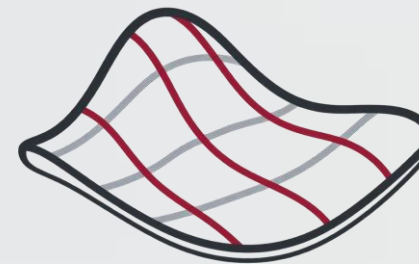
Fast iterations

Scalability



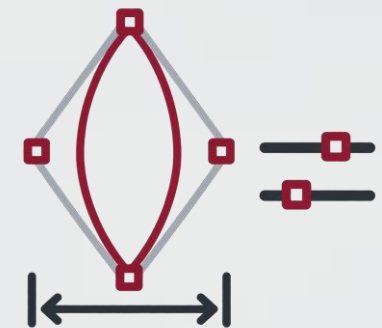
Compact systems

$> 20\%$ reduction



Free-form optics

Off-axis systems



Fully parametric

Flexibility

HETEROMERGE®
enables the AR glasses
customers actually want.

