Optical components for waveguides

Scaling reflective Waveguides

John E. Freiermuth

Director of Business Development Augmented Reality

Agenda

1

WAVEGUIDES ARE AR

2

REFLECTIVE WAVEGUIDES ARE REAL

3

DIFFRACTIVES NEED REALVIEW®

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WAVEGUIDES ARE AR

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REFLECTIVE WAVEGUIDES ARE REAL

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DIFFRACTIVES NEED REALVIEW®

Different use cases are emerging

The Professional

The wearable AI companion

The immersive computer

Different use cases are emerging

The Professional

The wearable AI companion

The immersive computer

Industry Tools

Consumer Electronics

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Different use cases are emerging and their priorities are diverging

The Professional

The wearable AI companion

Fashionable
Outdoor
Very light weight
Very low energy
Small FOV
SmartWatch price

The immersive computer

Large FOV
Binocular
3D
High Image quality
Flagship SmartPhone price

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Wearability

Performance

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Waveguides offer the flexibility to accommodate the different priorities for all use cases.

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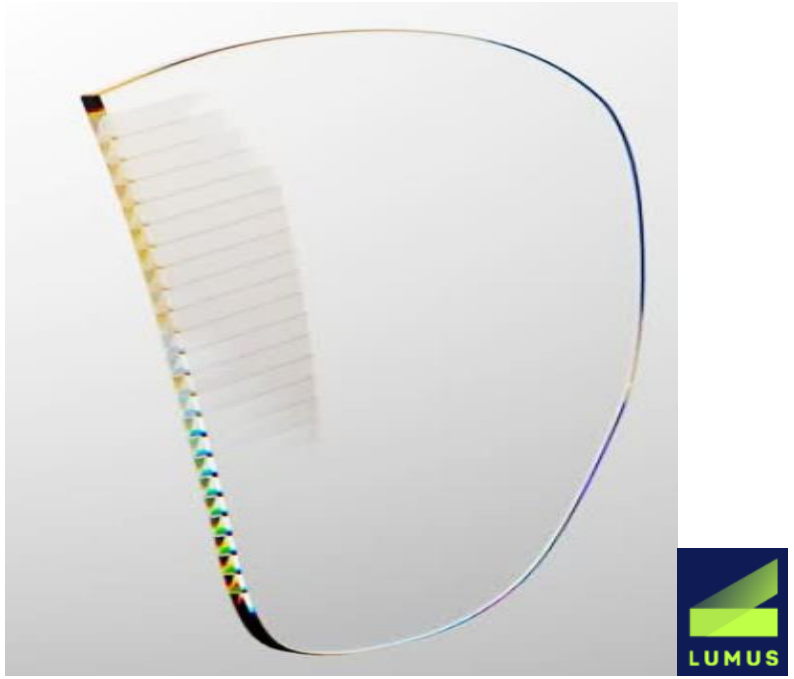
Waveguides are at the core of SCHOTT's product strategy

RealView® Ultra-flat Wafers

- High refractive index options
- Low density options
- Coatings and other



Reflective Waveguides

- FoV options
- Eye-box options
- Contour, thickness, etc. options

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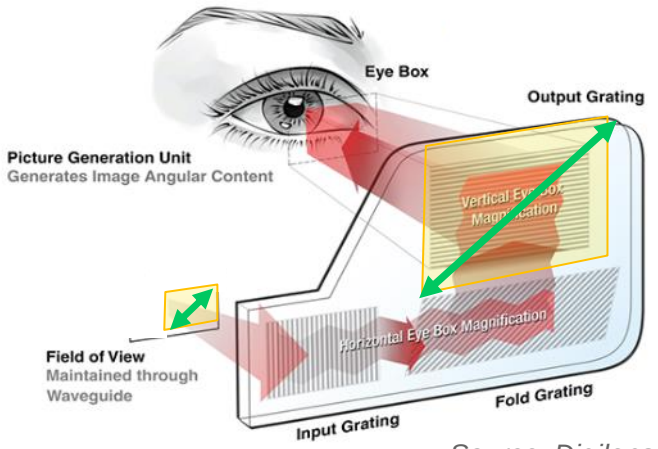
What do waveguides do?

Waveguides have two jobs

1. **Transport**
2. **Expand**



Source: Digilens

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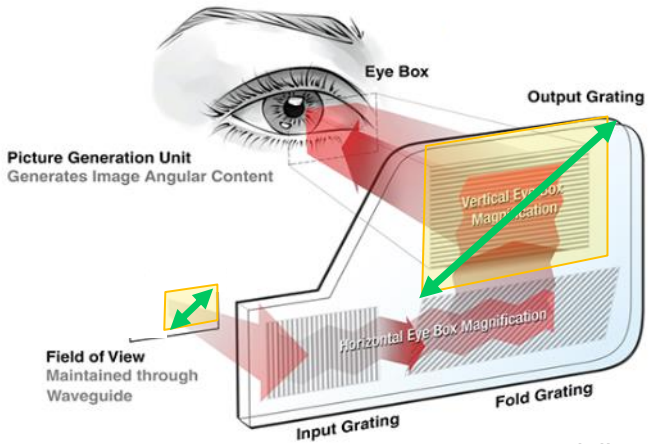

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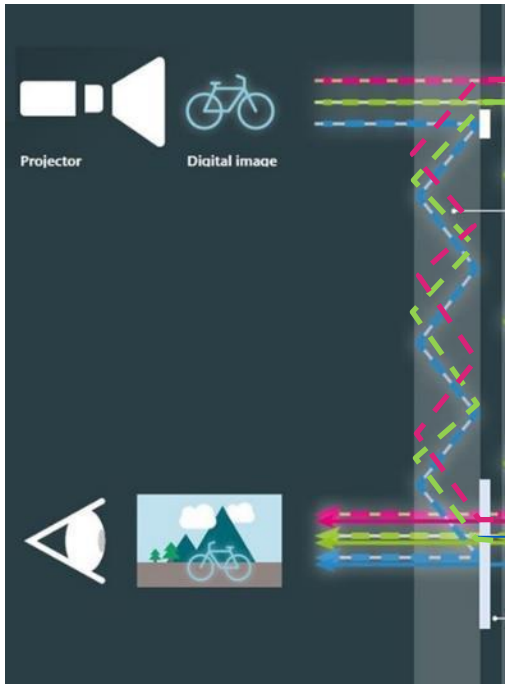
Transport

- **Total Internal Reflection**



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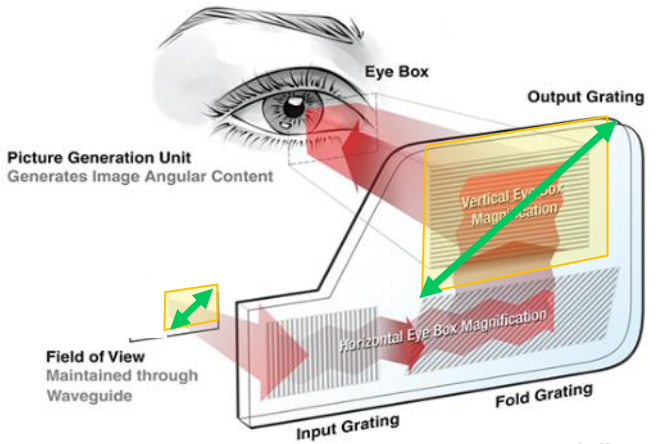

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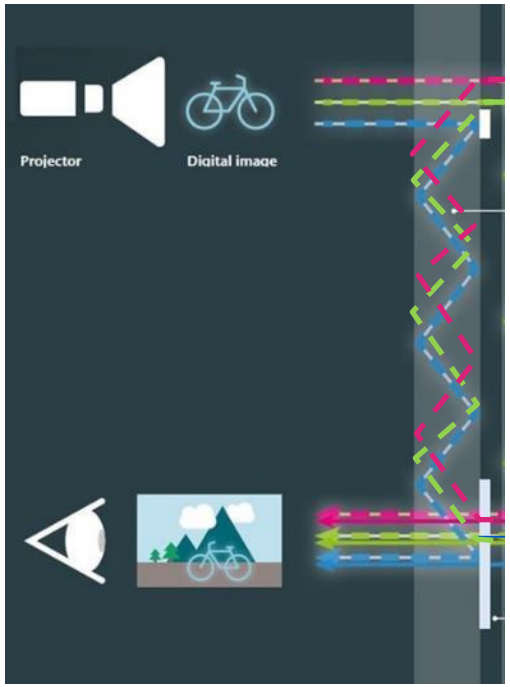
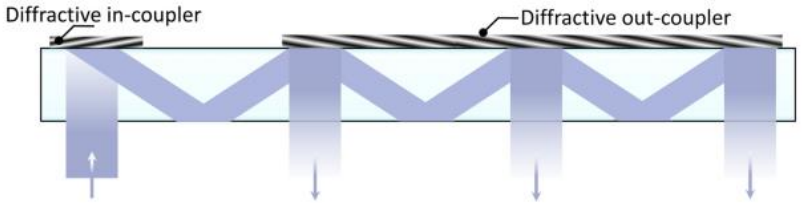
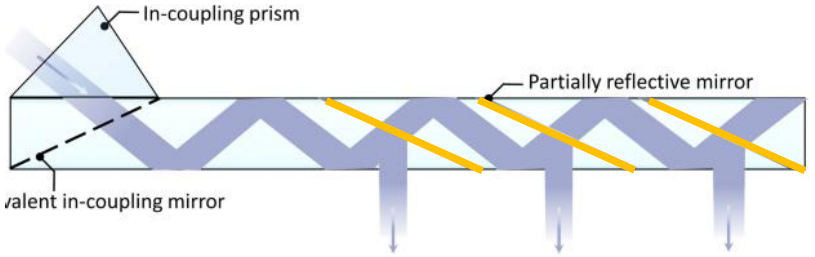


Expand

1. **Nano-sized diffractive gratings**
   on top / inside the waveguide



2. **Reflective optical coatings**
   inside the waveguide



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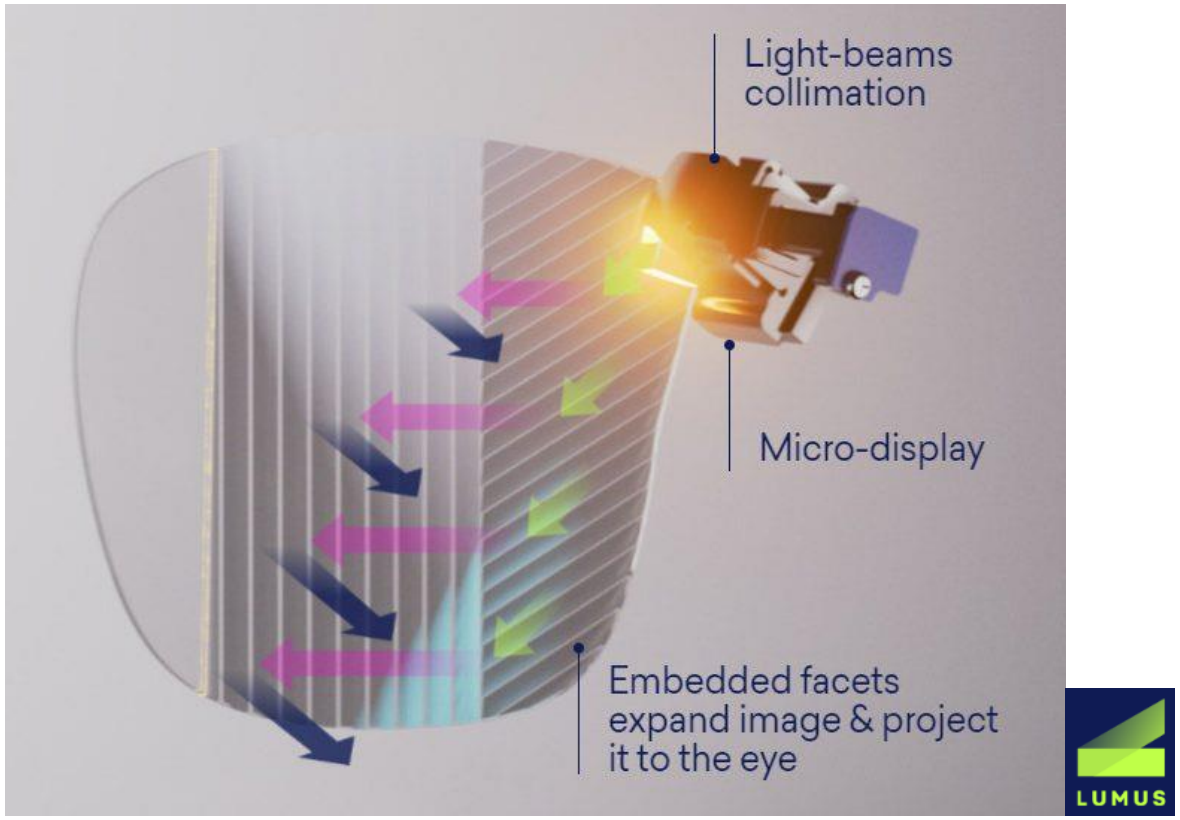
Reflective waveguides with the latest Z-Lens architecture

- Waveguide 2D principle



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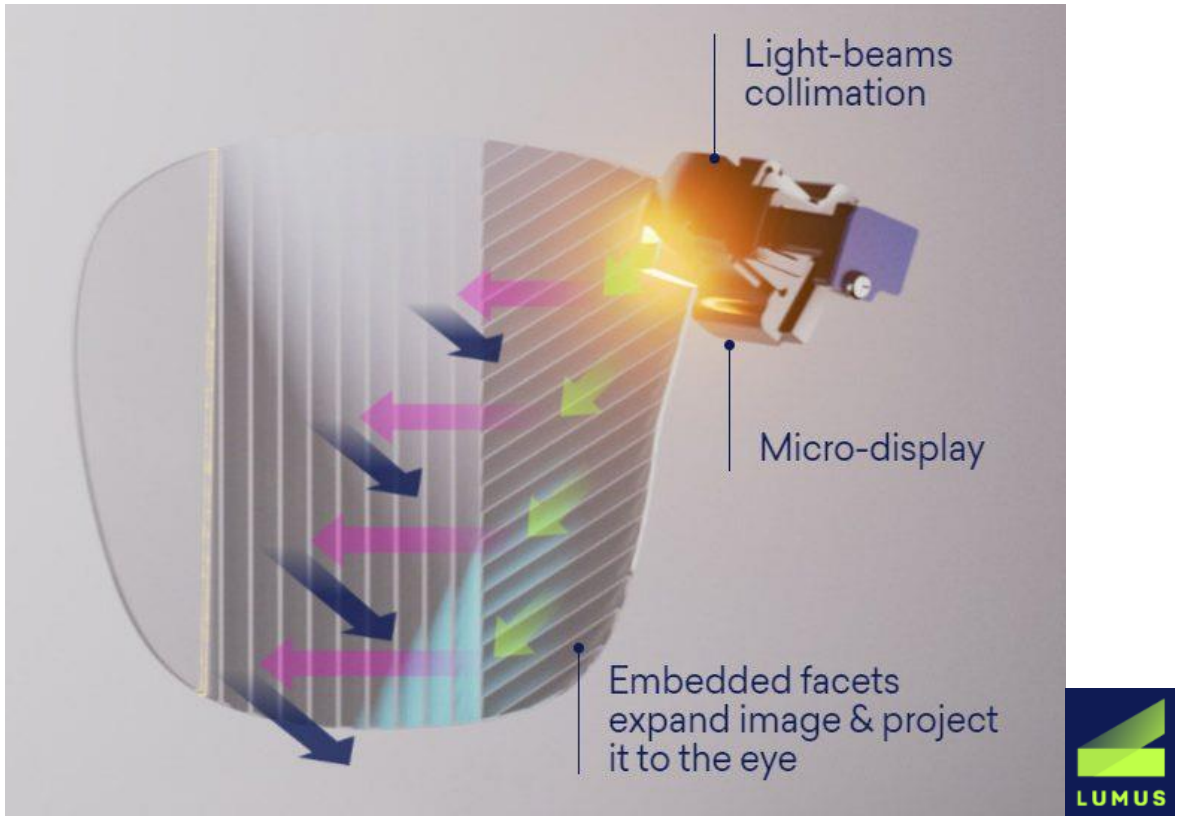

Customized by
LUMUS

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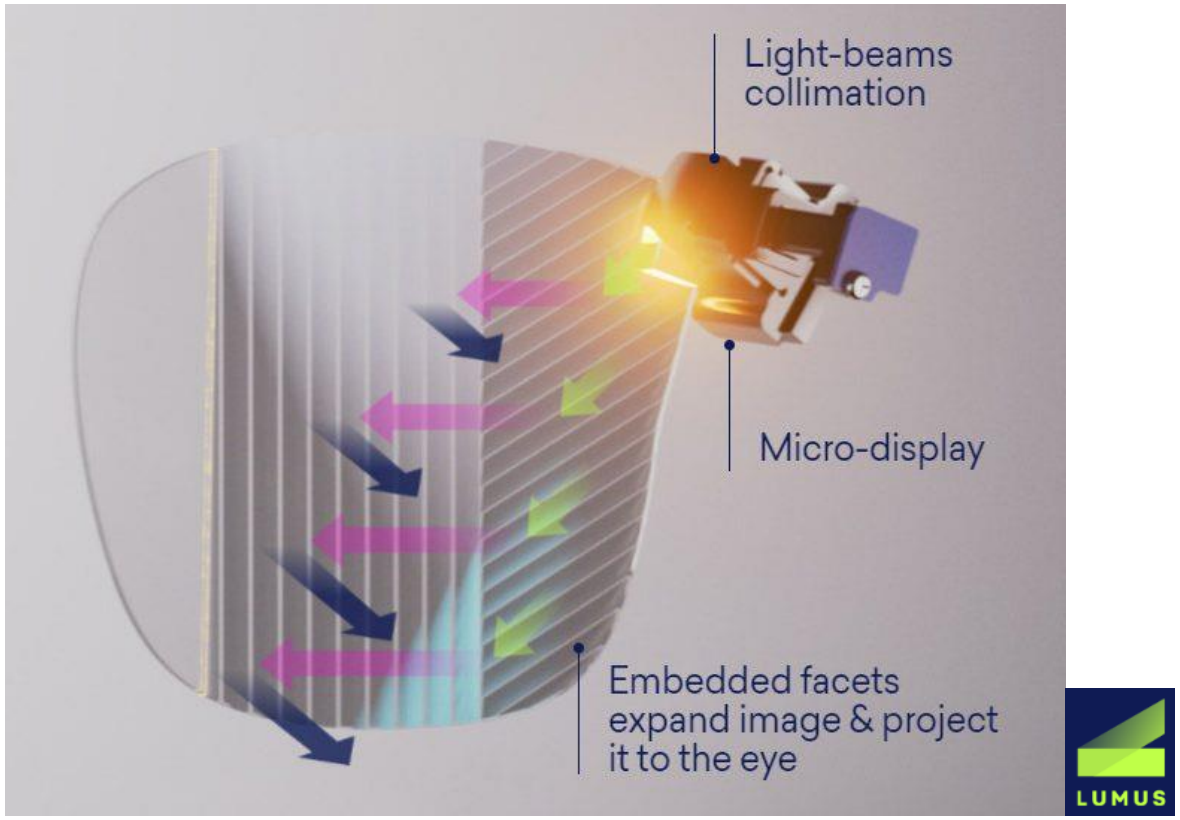

Customized by
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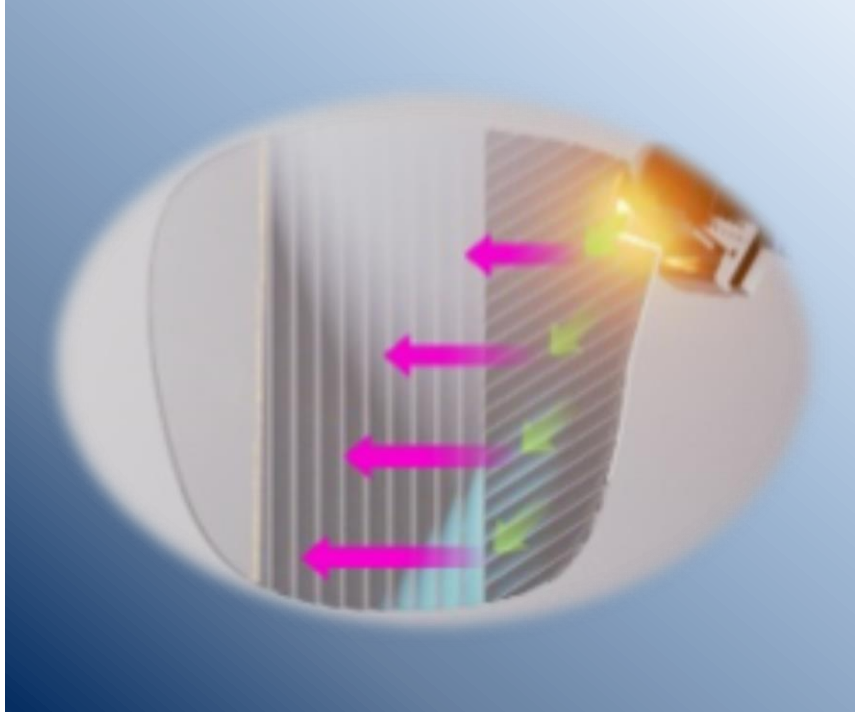
Manufactured by
SCHOTT

Customizable specification

Specs

Performance	✓ Wide range of FoV 15° - 70° ✓ High brightness
Wearability	✓ Compact 2D pupil expansion ✓ Lightweight with thin & low-density glass ✓ High power efficiency
Rx integration	✓ No air gap needed
Modular	✓ Integration of other features possible



Customizable specification & Standardized manufacturing

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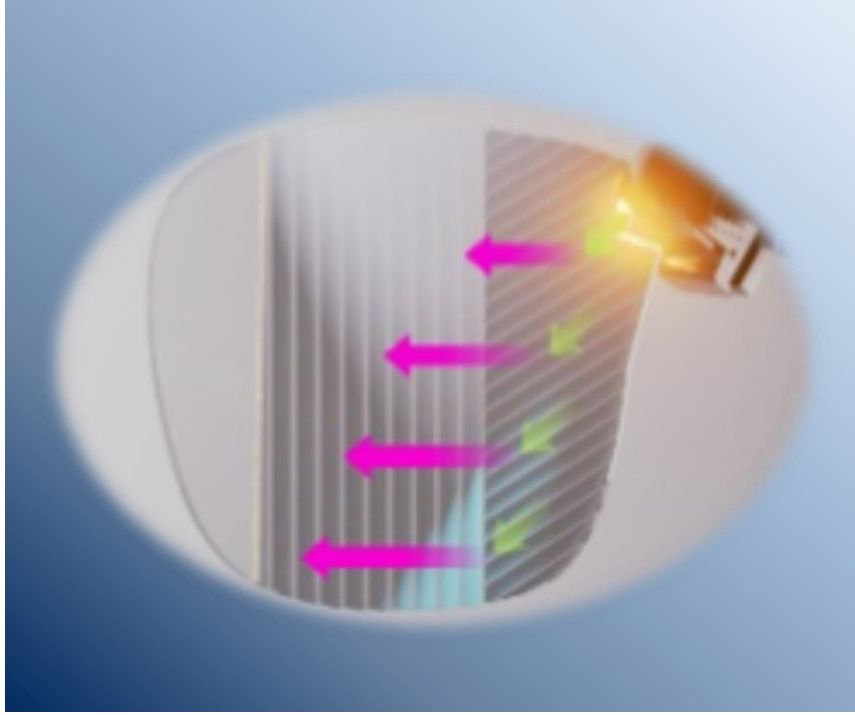
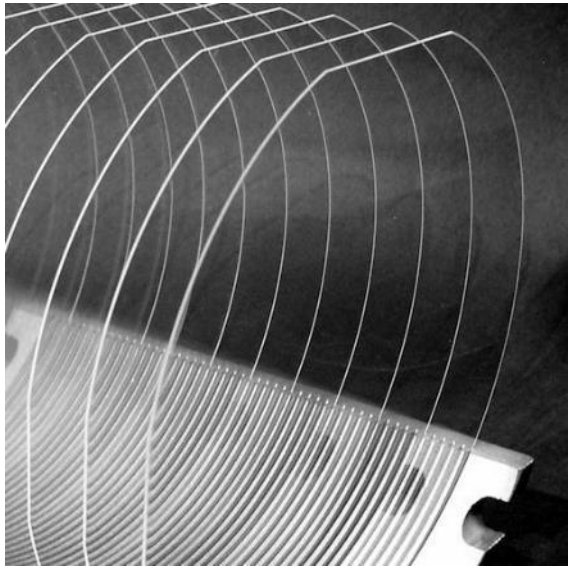


Standardized manufacturing

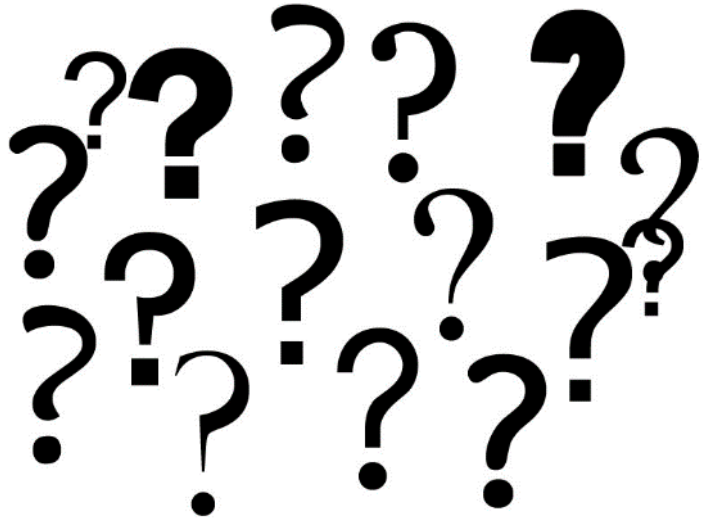
Process Technology	✓ SCHOTT optical glass processing heritage ✓ Custom MP equipment for critical process steps ✓ Standard MP equipment for everything else
Process Flow	✓ Split into work-cells for functional blocks ✓ In-house developed in-line metrology ✓ Scalable, robust and efficient ✓ Full traceability

How to convert a piece of glass into a waveguide?

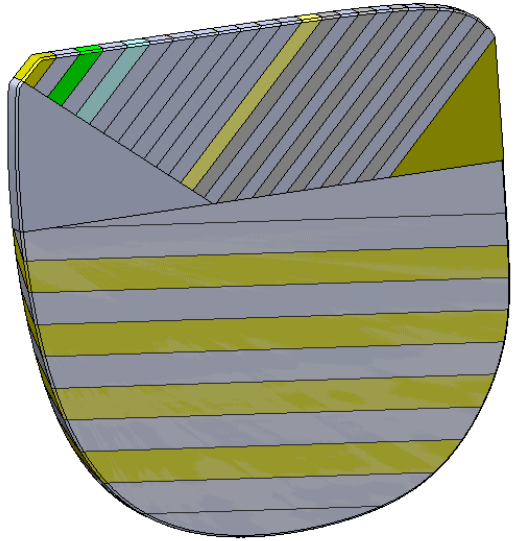
Glass substrate



Processing



Final waveguide



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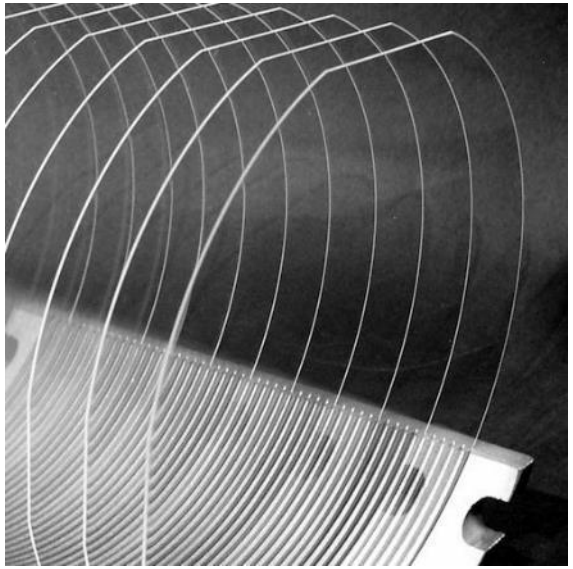
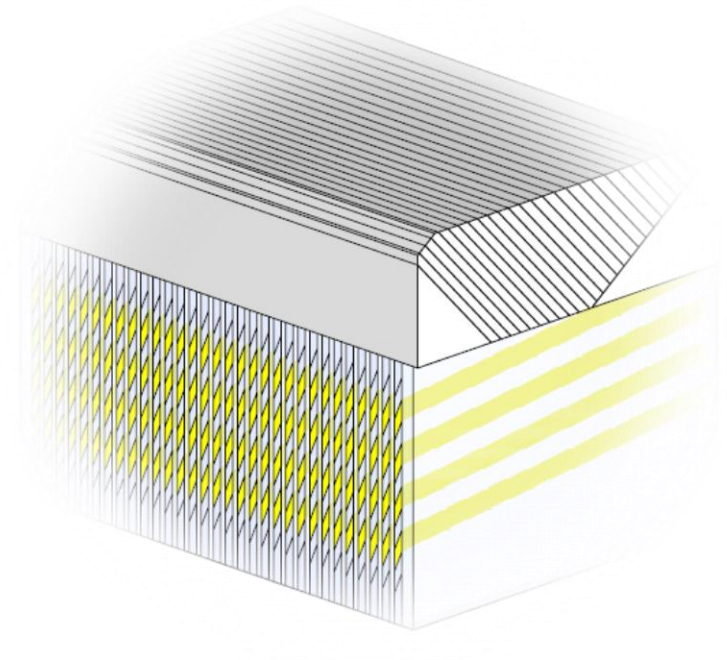


Processing

“Batch-processing” a Master Block



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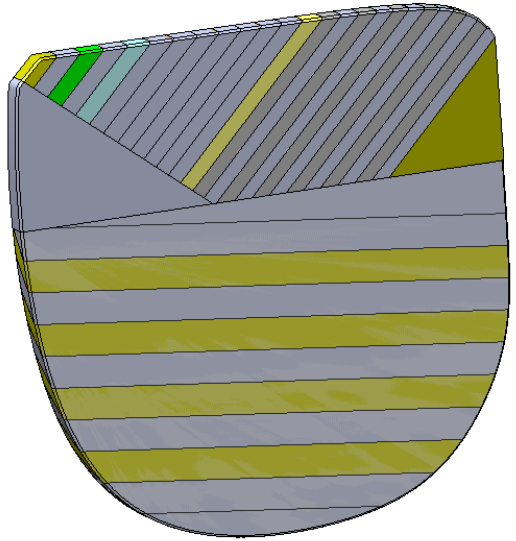
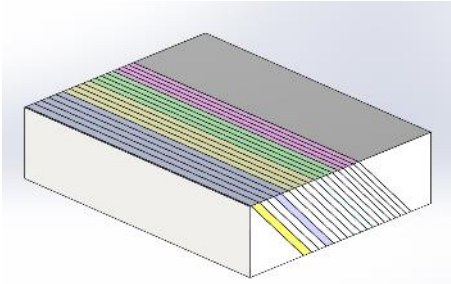
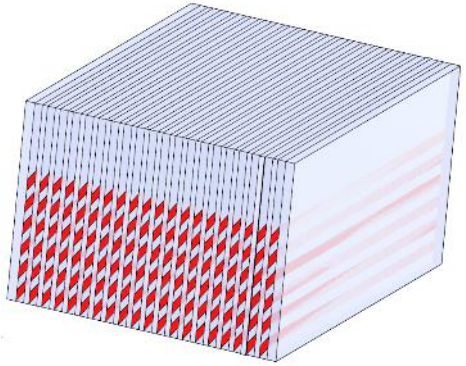


Different functional segments are built

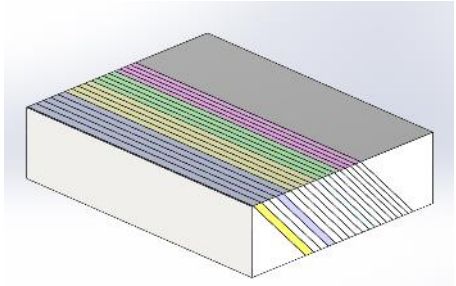


Redirection segment



Outcoupling segment

Different functional segments are built and assembled into one Master Block



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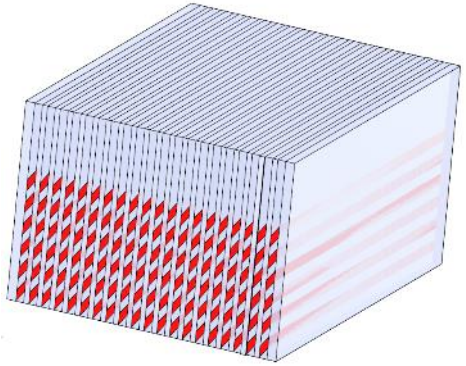

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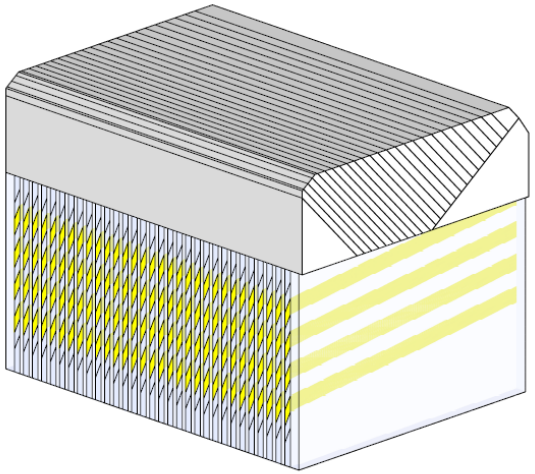
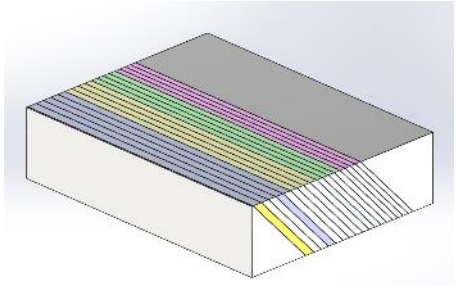


Master block

Different functional segments are built and assembled into one Master Block and then sliced into waveguides



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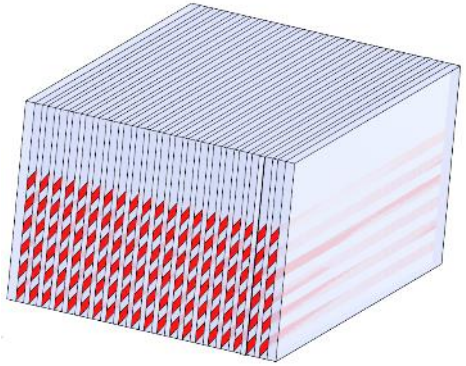

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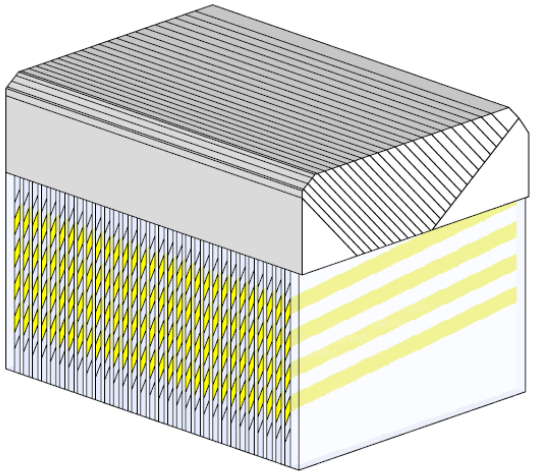

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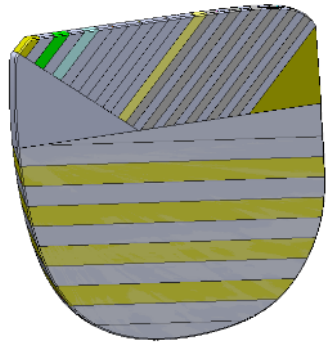
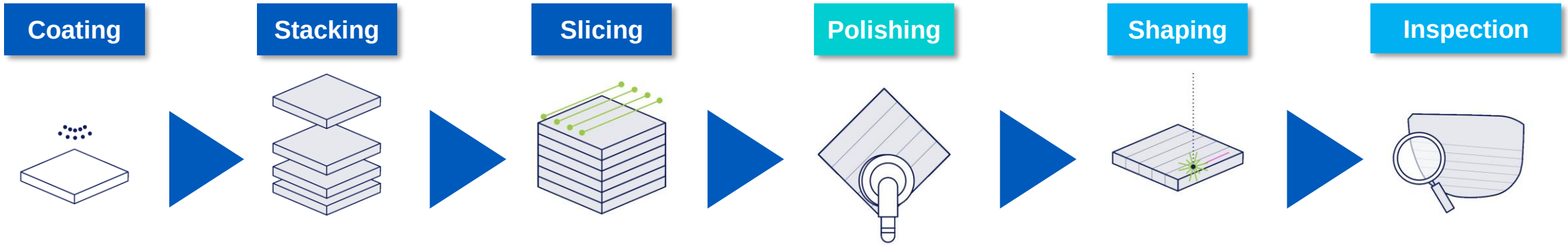


2D waveguide

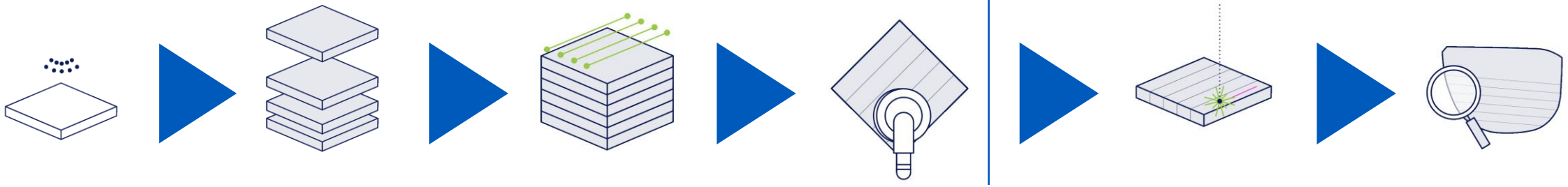
Only a limited number of different process technologies are found in waveguide manufacturing



Only a limited number of different process technologies are found in waveguide manufacturing

CORE PROCESS STEPS
- Critical to quality
- Leveraging SCHOTT core know-how and heritage

Coating → **Stacking** → **Slicing** → **Polishing** → **Shaping** → **Inspection**



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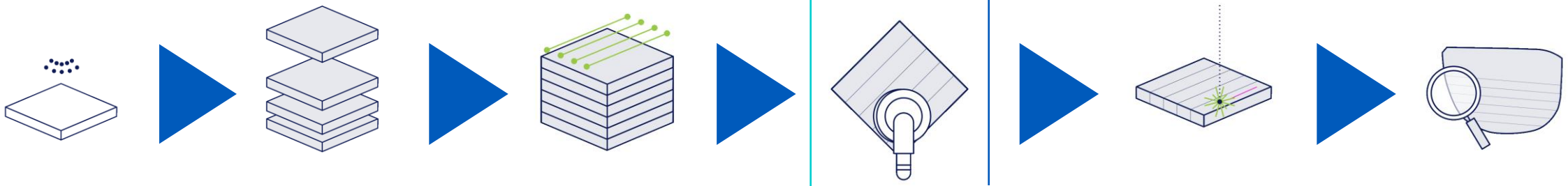
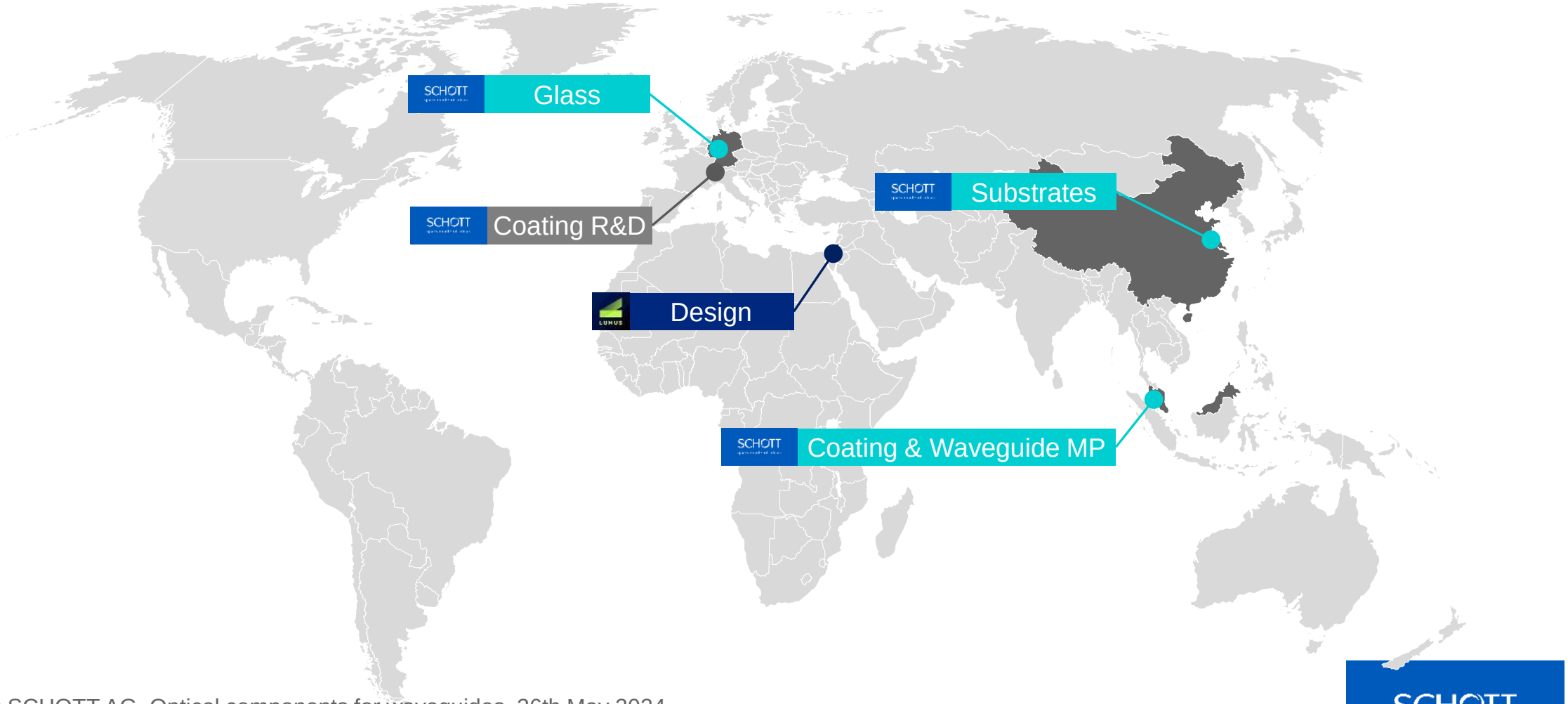


RealView® Wafer

SCHOTT’s integration from “sand” to finished waveguide

Reflective Waveguides Ecosystem – Serving Customers Worldwide



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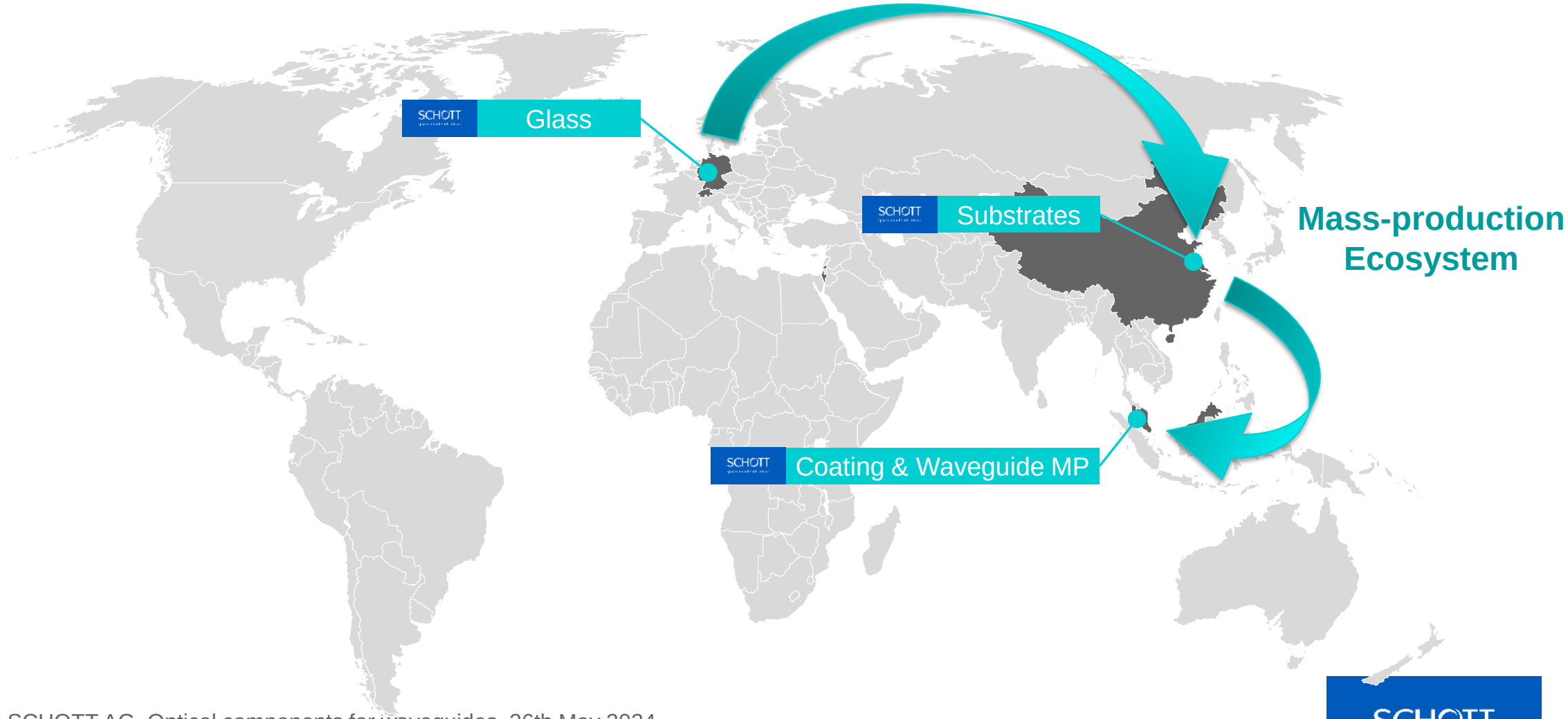

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Expanding manufacturing footprint Malaysia

- **SCHOTT in Malaysia since more than 50 years**
  - Mass production hub for optical components

    Reflective waveguides

- **Serving global value chains**
  - Consumer electronics, automotive, medical

    Augmented Reality

- **Leveraging our integrated global network**
  - Glass Germany
  - Wafers China

    Integrated in-house value chain

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DIFFRACTIVES NEED REALVIEW®

RealView® Wafer innovation for Diffractive Waveguides

AR design target for diffractives and wafer requirements

Wearable 20-30° FoV, single layer

Full Immersion 50+° FoV, single/double layer

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RealView® Wafer innovation for Diffractive Waveguides that benefits wearable devices

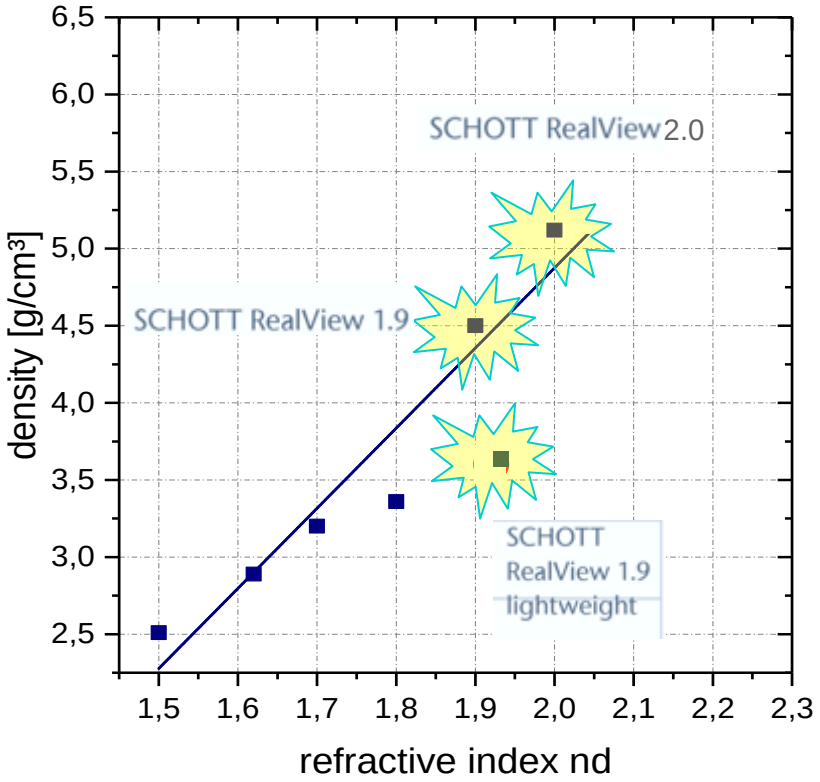
AR design target for diffractives and wafer requirements

Wearable 20-30° FoV, single layer

- n_d = 1.9 – 2.0
- ρ = 3.5 – 5 g/cm³
- Thickness = 350 - 500 µm

Full Immersion 50+° FoV, single/double layer

SCHOTT's commercial material portfolio



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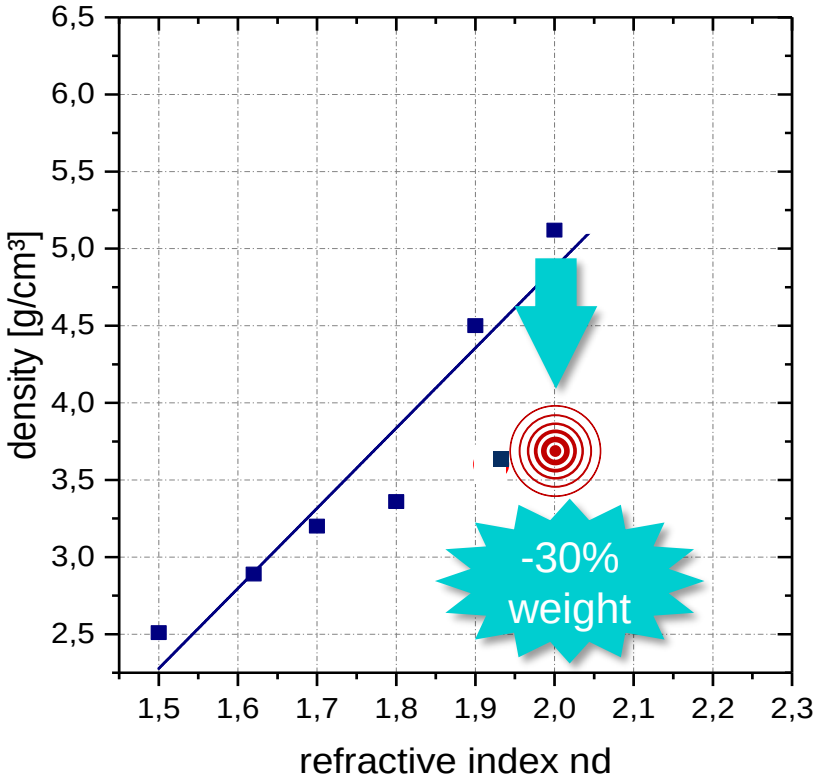
SCHOTT's R&D pipeline materials



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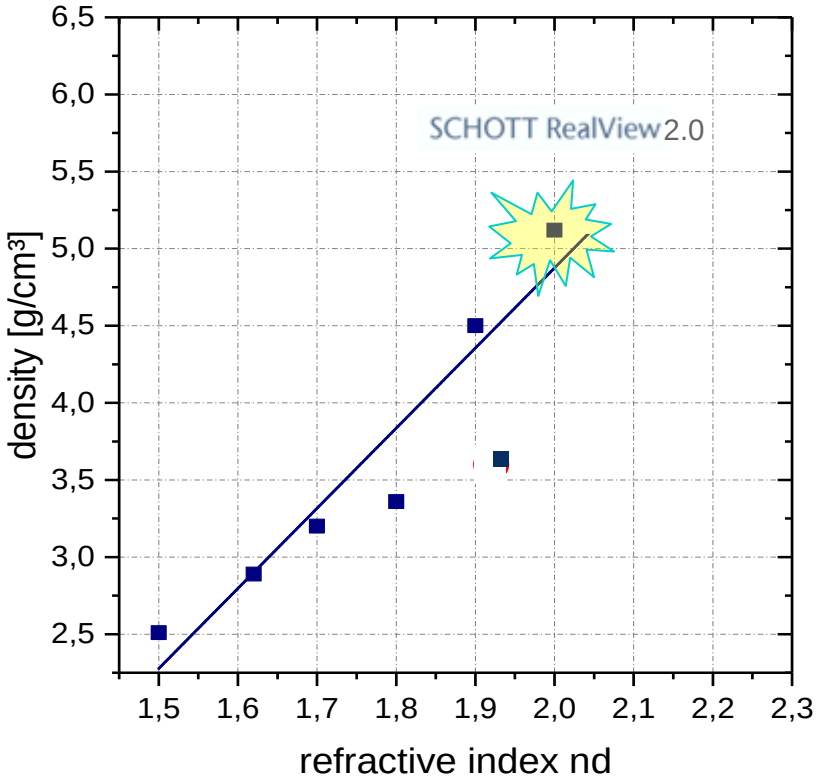

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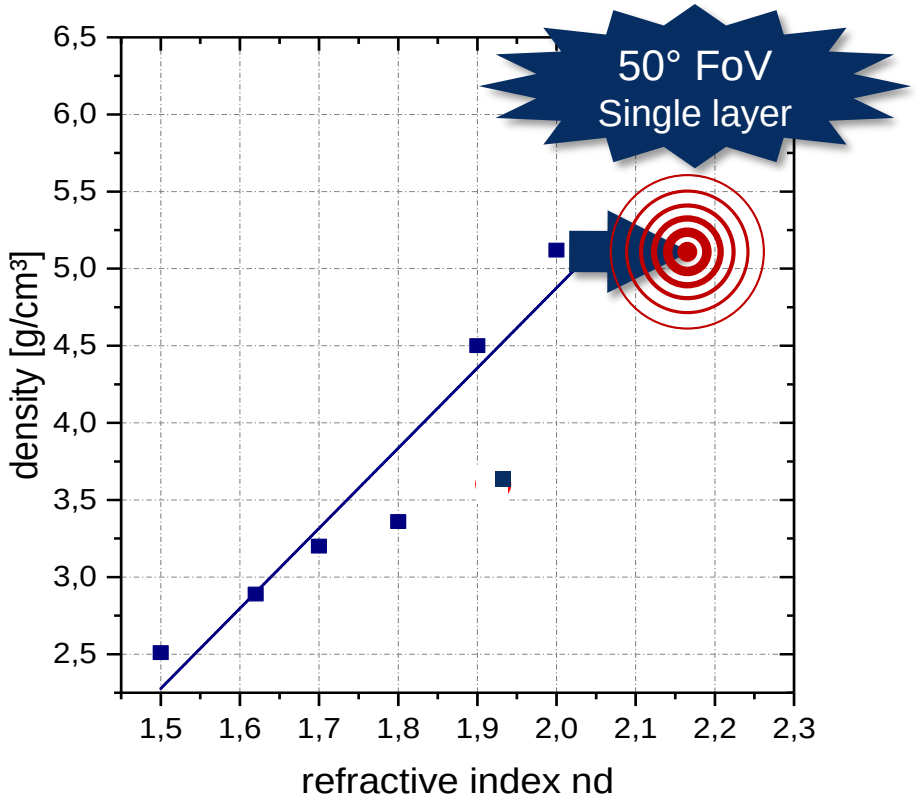

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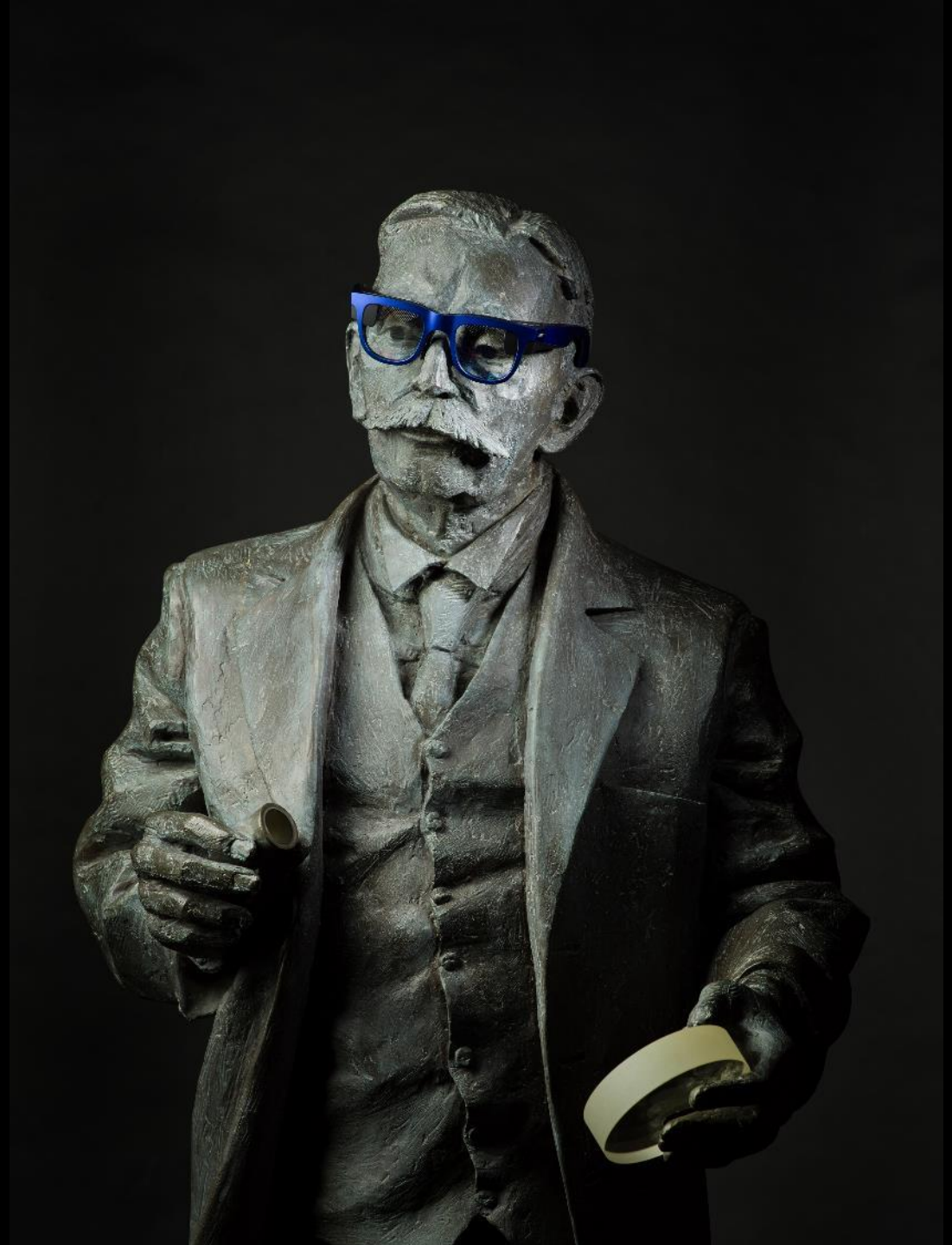
GLASS MADE OF IDEAS



Contact

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More information: www.schott.com/realview