



Displacement Talbot Lithography: A high-throughput, high-fidelity optical lithography solution for manufacturing AR waveguides

Kelsey Wooley & Harun Solak
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Eulitha – Lithography for Photonics

- Equipment and solutions provider
 - Application-focused R&D department
 - Continuously innovating to match growing photonics markets
 - Recently expanded DEMO lab for lithography services and development projects
- Global customers and support
 - +50 systems world-wide
 - Zurich, Switzerland (headquarters), Seattle, US, and Beijing, China



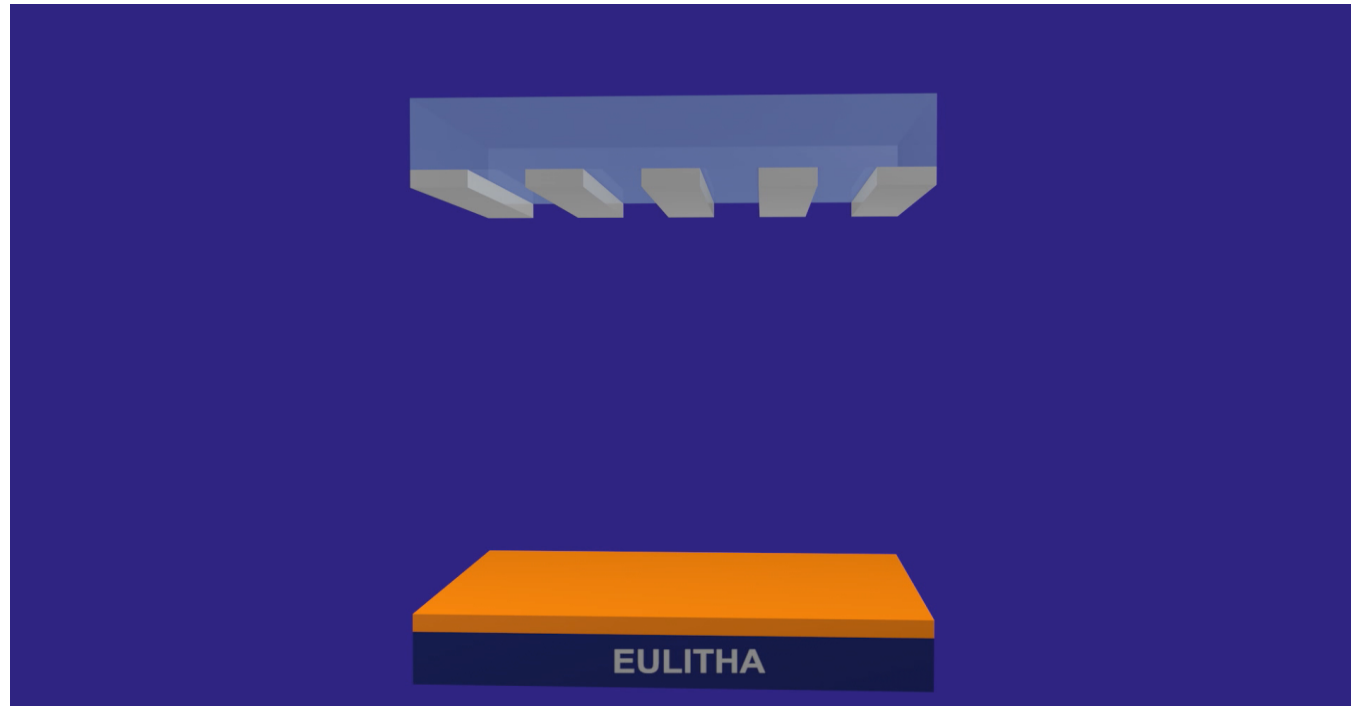
Eulitha US



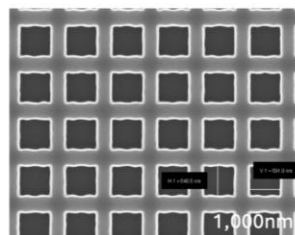
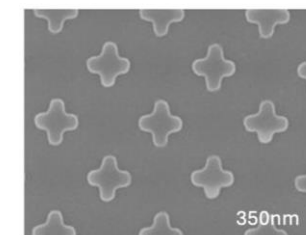
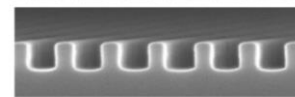
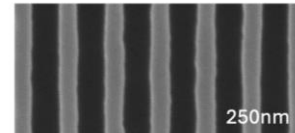
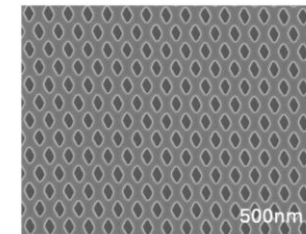
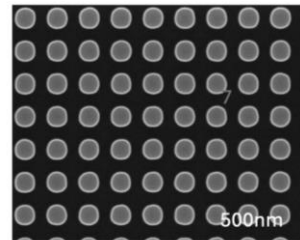
Eulitha China



Eulitha Headquarters

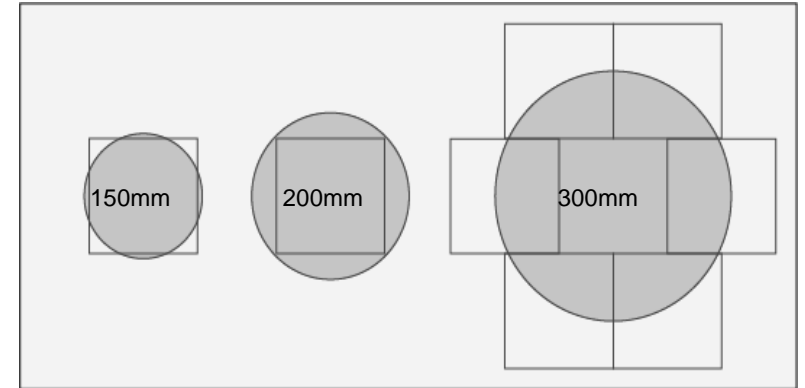


- Pitch doubling of grating from mask to substrate
- 3D interference pattern translates to large depth of focus
- No reduction of exposure field, matches mask
- Very tight design control and low LER
- Requires pattern to have local periodicity



Advantages of DTL for manufacturing AR Waveguides

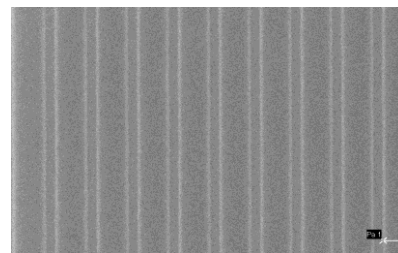
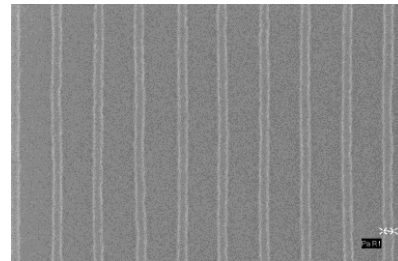
- Seamless device printing, 140x140mm² exposure fields for large-area devices
- Capable of a wide 2D duty cycle range and warped gratings
- Large depth of focus allows printing on curved surfaces as well as low TTV substrates



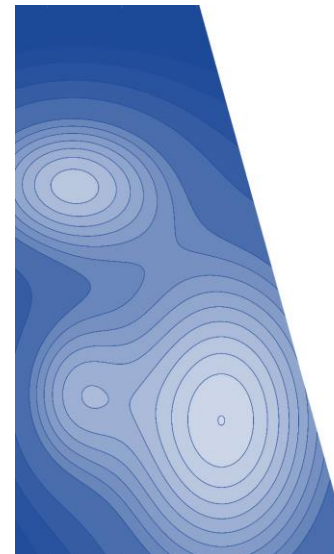
140x140mm² exposure fields overlaying a 6in, 8in, and 12in substrates



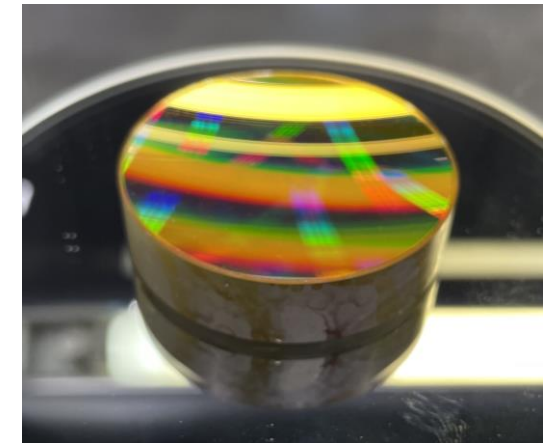
Illustration of warped grating pattern



Ex. 350nm pitch 25%-75% Duty Cycle



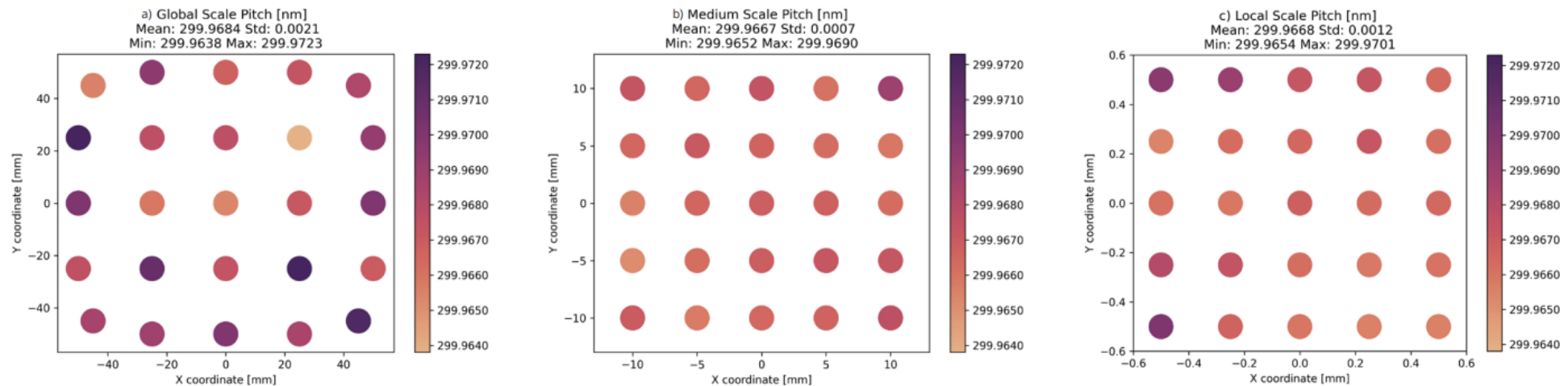
Illustrated 2D duty cycle map over a grating area



Lens with 2mm of concave curvature patterned with DTL

Advantages of DTL for manufacturing AR Waveguides

- Mask-locked design:
 - Within large exposure field, all types of structures pattern simultaneously
 - Locked grating orientations
 - Excellent pitch control, uniformity tested in collaboration with Optofidelity



Littrow diffractometer measurements of grating pitch non-uniformity range of a) 8.5pm on global scale, b) 3.8pm on medium scale and c) 4.7pm on local scale

Displacement Talbot Lithography Platforms



PhableR

- Up to 150mm substrates
- Manual wafer processing
- Manual mask loading
- Manual alignment
- Single exposure field



PhableX

- 150-200mm substrates
- ✓ Automatic wafer processing
- Manual mask loading
- ✓ Automated alignment
- Single exposure field

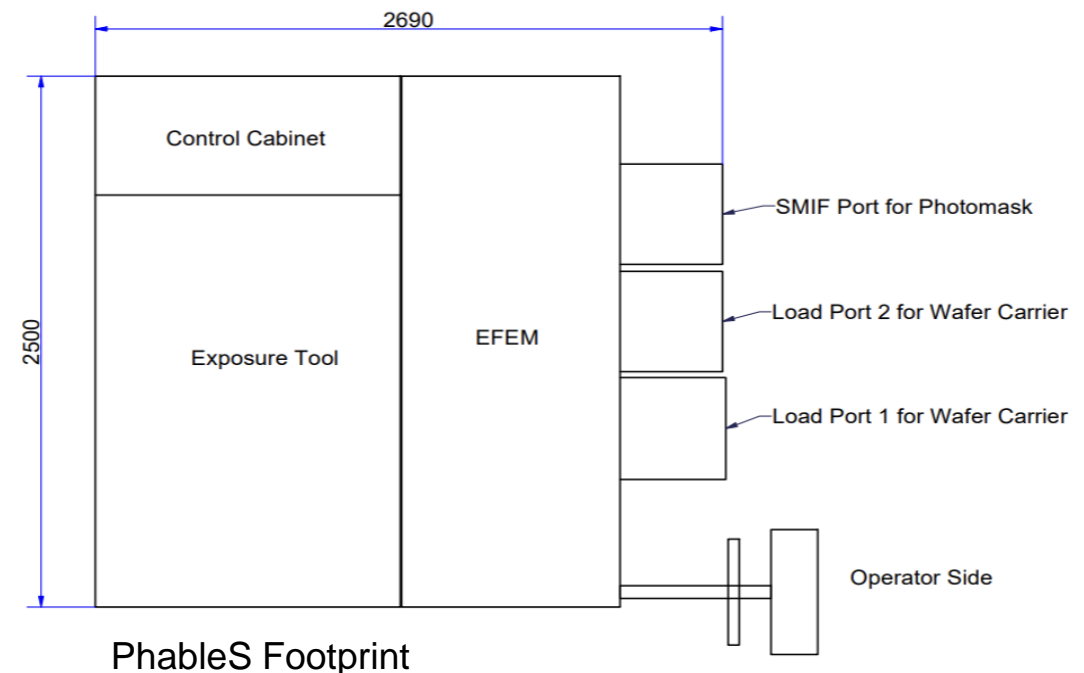
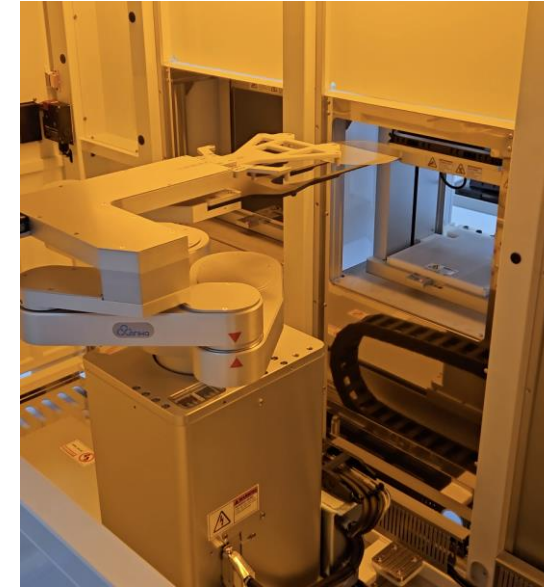


PhableS

- ✓ 200 - 300mm+ substrates
- ✓ Automatic wafer processing
- ✓ Automatic mask loading
- ✓ Automated alignment
- ✓ Step and repeat coverage

Advantages of High-Volume DTL

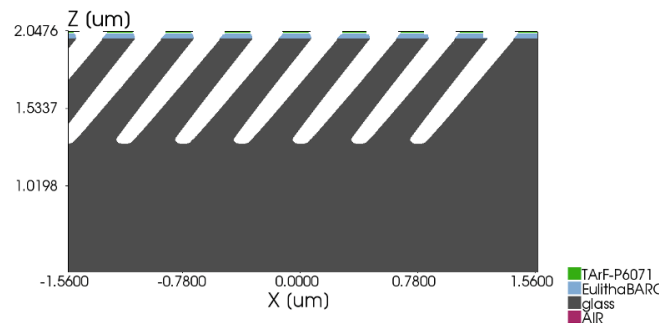
- Affordable, high-resolution patterning
- High yield
 - Low defectivity; non-contact, automatic mask loading and wafer processing
 - Low variation, high repeatability
- Highly customizable
 - Resolution-driven source selection (UV or DUV)
 - Substrate size, weight, thickness, and shape
 - Polarization control and proximity exposure mode
 - Module configuration: PEB plate, track compatibility



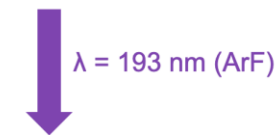
Integration of Displacement Talbot Lithography

- DTL leverages the mature semiconductor industry
- Industry standard 6in high-resolution masks
- Standard PTD and NTD photoresists, AR coatings, and developers
- Highly scalable technology, ~40 wafer per hour for 300mm patterning
- End-to-end manufacturing simulation software through partner, Synopsys

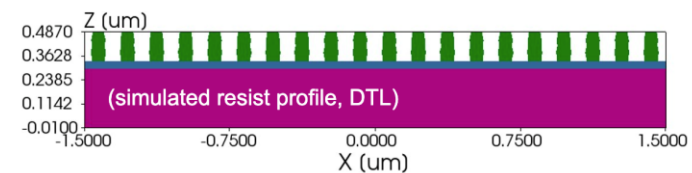




Stack and Process



$\lambda = 193 \text{ nm (ArF)}$



DUV Resist: 150 nm,
n=1.67, k=0.015

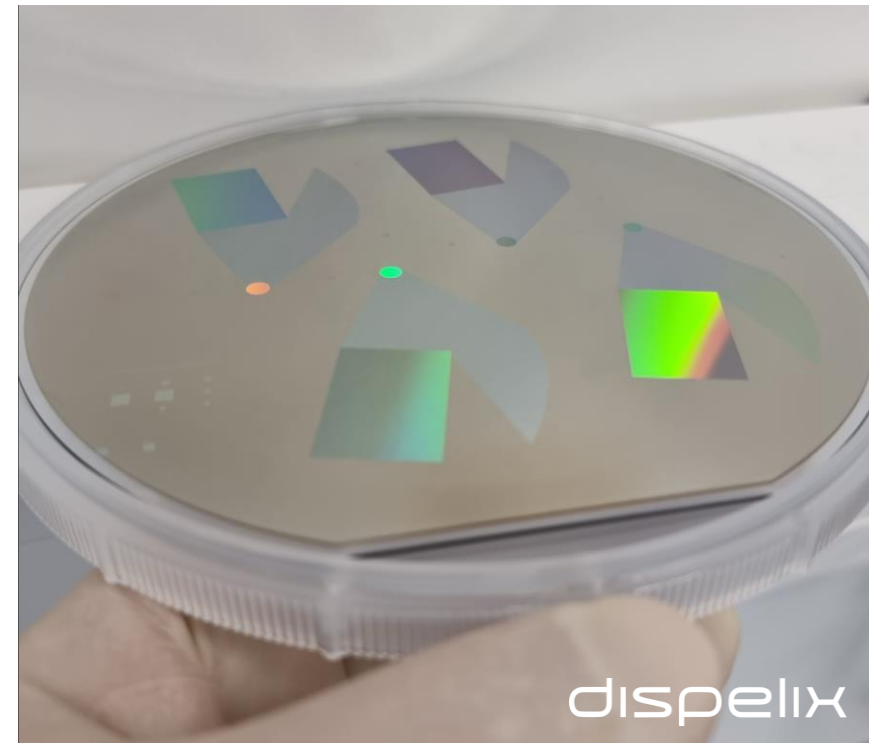
BARC: 37 nm,
n=1.67, k=0.3

SiO₂: 300 nm
n=1.563, k=0

Simulation using SLitho's DTL module

Fabrication Demonstration: Augmented Reality Waveguide

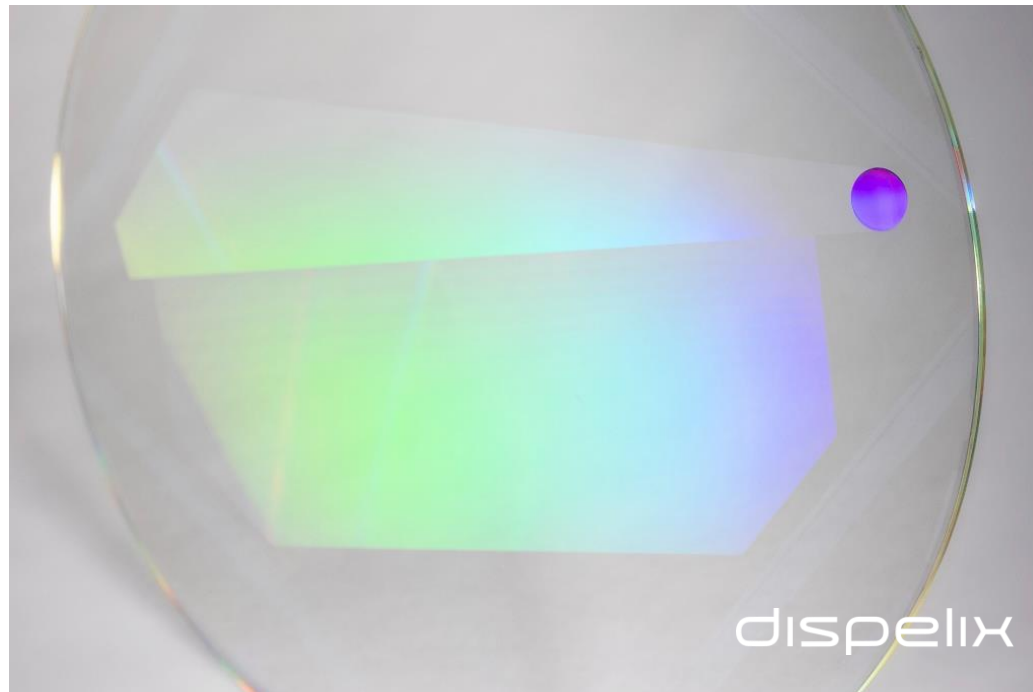
- Substrate is 150mm high index glass wafer
- Stitching free, single exposure of mask-locked design
- Patterns developed in photoresist subsequently etched into optical films



Augmented reality waveguides on 6in transparent substrate

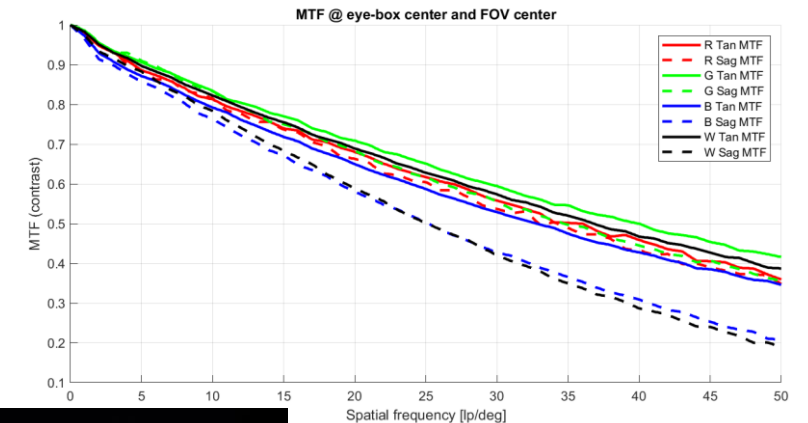
Fabrication Demonstration: Heads Up Display

- Substrate is 200mm high index glass wafer
- Combiner gratings printed seamlessly in a single exposure
- Image sharpness through HUD proves high fidelity of the grating structures



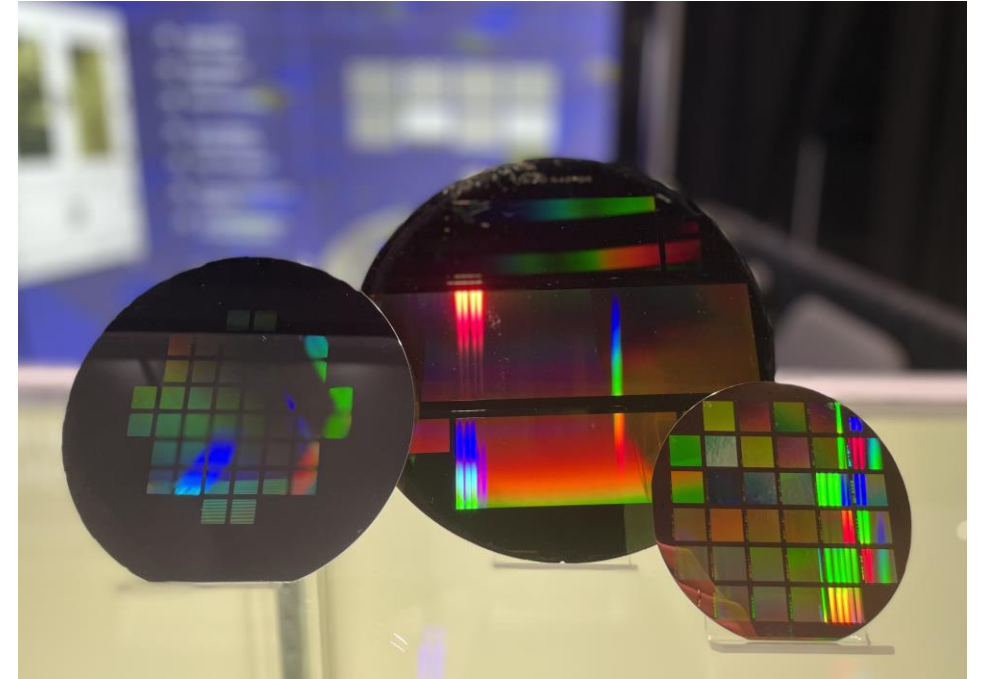
HUD waveguide printed on 200mm-diameter glass substrate

Out-Coupler grating seen diffracting visible light



Summary: Innovative Patterning for AR Waveguides

- Advantages of non-contact exposures, long lifetime masks, low-defectivity, and seamless device printing
- Leverages semiconductor industry knowledge, masks, resists, scaling, and simulation packages
- Eulitha's customer support: Internal simulation, process development, demo lab capabilities, and equipment services
- DTL is a high-resolution, low-cost optical lithography solution for manufacturing AR waveguides





Demonstration of DTL-based augmented reality glasses

dispelix

 Eulitha