



MORPHOTONICS
Nanoimprint technologies

AR at Crossroads: Paving the Path to Mainstream Adoption

September 2025

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Short introduction to AR Waveguides



Image from Medium.com

- A projector projects image to the incoupling area, placed at the side
- Through waveguiding image is transferred to the outcoupler, in front of your eye
- (mostly with use of expander)
- Complex optical textures (diffractive gratings) are used

Photonics in optima forma!

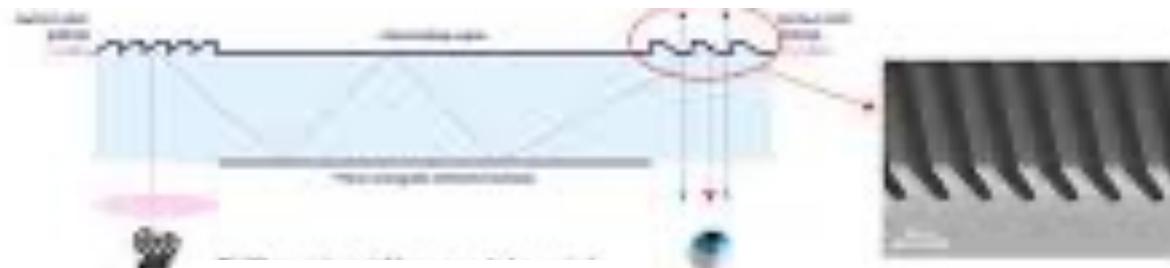


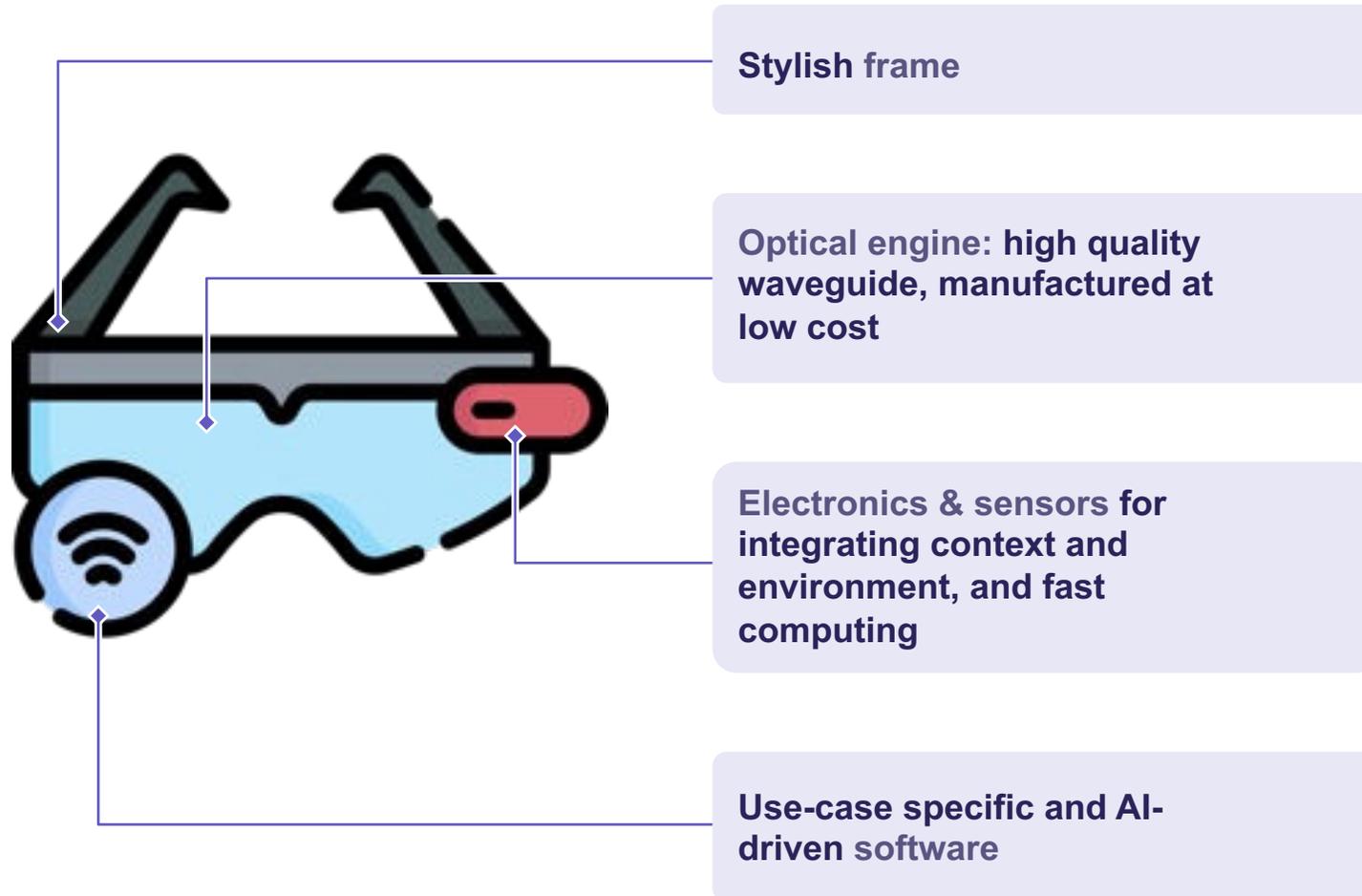
Image at courtesy of Radiant

Strong uses cases in industrial market





Manufacturing smart glasses is complex, so were TVs, phones, smart watches...



Industry challenge: how to mass manufacture affordable, high quality optical engines?

Lightweight?

Apps?

Micro-sized electronics?

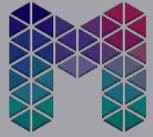
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The tipping point for AR is near



- Early past: expensive, bulky, limited apps
- **2023–2025: improved design**, early productivity & entertainment uses (Ray-Ban/Meta ramp up)
- Price trend approaching **\$500–\$1000**, expected announcement Meta on Hypernova (1 eye-display)
- Sweet spot: sub-\$500 models + killer apps → **mainstream adoption by 2028-2030 anticipated**
- Key Drivers: price drop, smartphone (AI) integration, enterprise to consumer shift and good enough technology

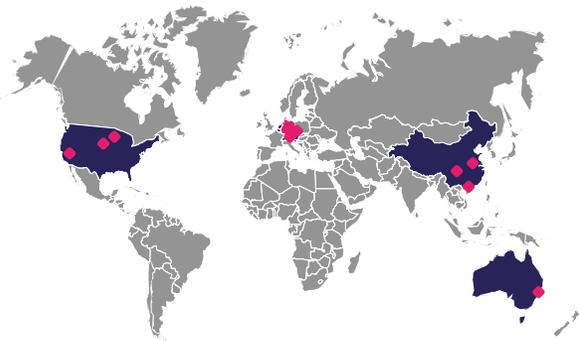


How Morphotonics is enabling mass manufacturing in AR

Company | Morphotonics



Solution | Nanoimprint Lithography (NIL) based on proprietary Roll-to-Plate (R2P) technology, started in 2014 building on >10 years of research



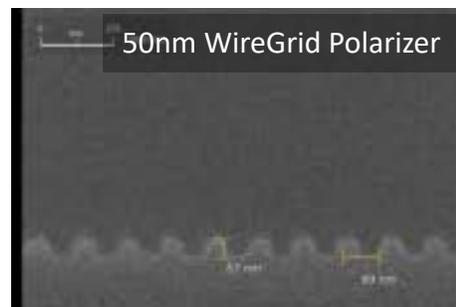
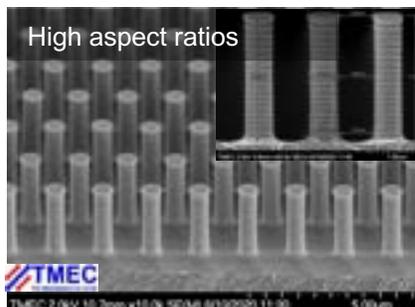
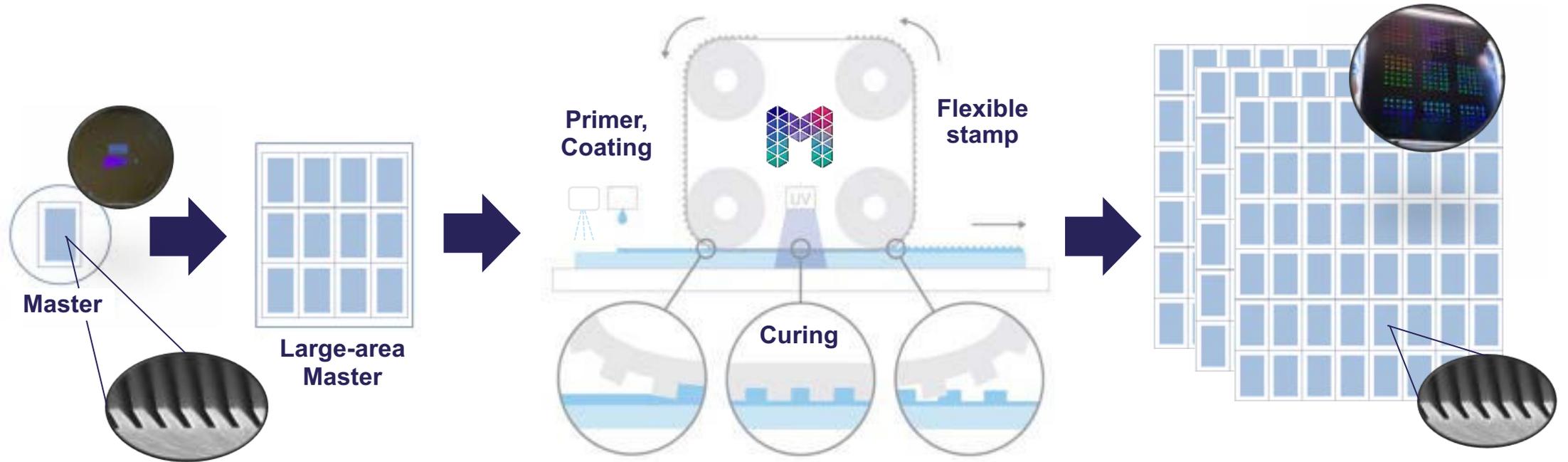
Team | Diverse team of 50 employees with various backgrounds, steered by experienced MT and backed by Top-Tier Deep Tech investors



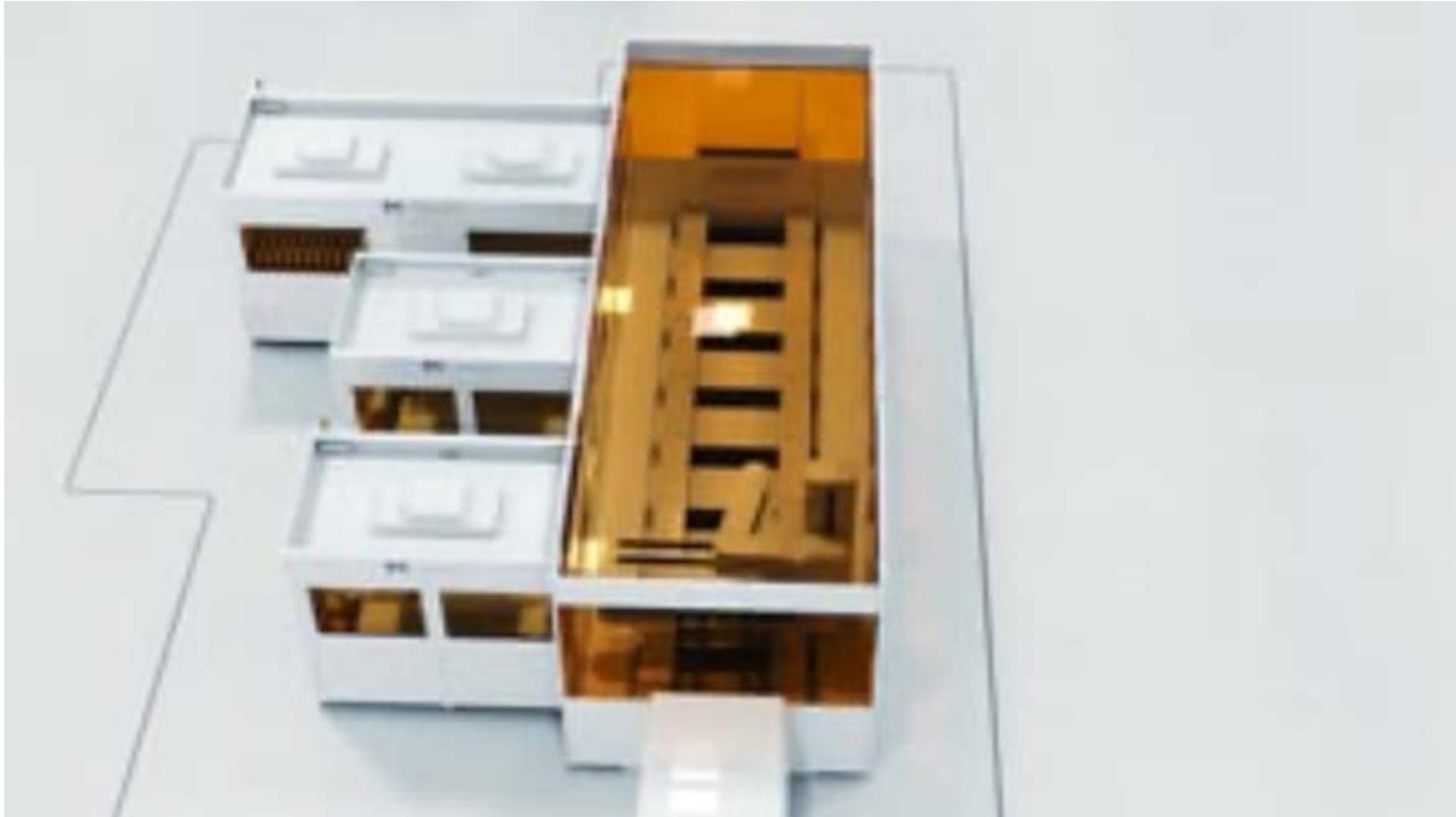
Ecosystem | World-class ecosystem of local and global partners in place to deliver growth plans,



Scaling to large-area as path to mass production

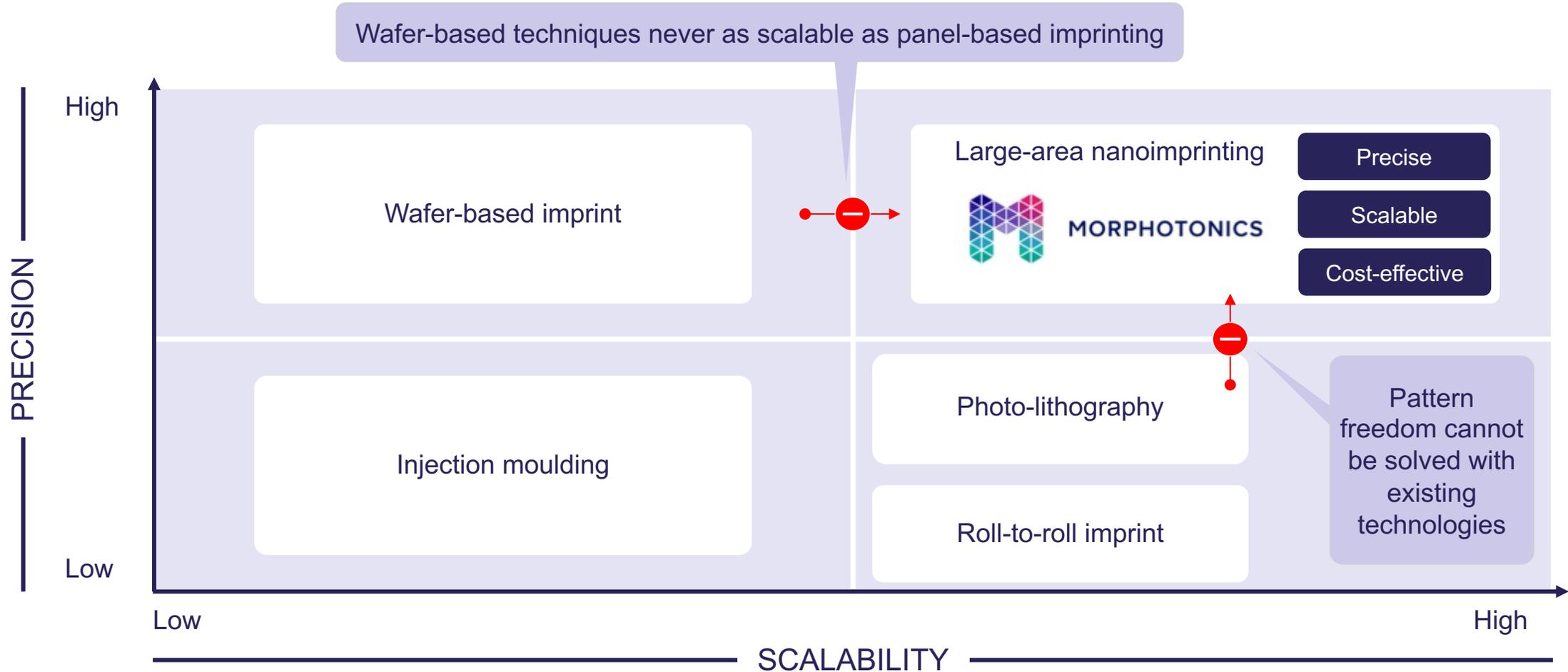


Fully automated Display production line along with process and materials



Combining precision and scalability

Making highly accurate waveguides scalable at low cost

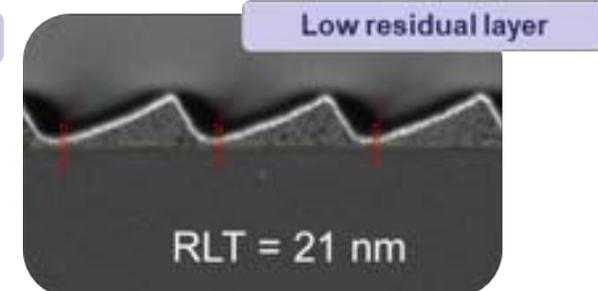
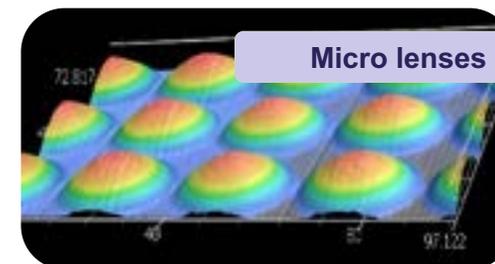
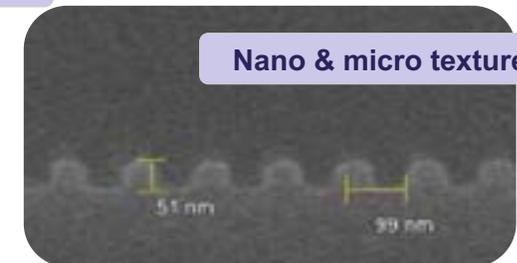
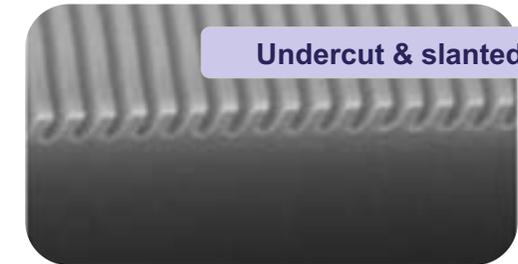
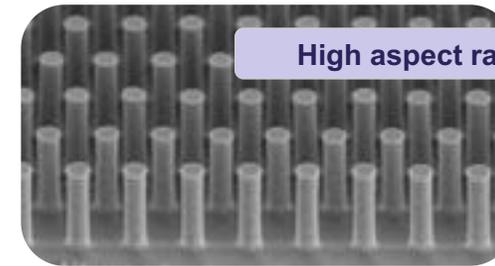


Design freedom in textures



EXAMPLES OF DESIGN FREEDOM

- **Different textures for different applications**
 - Micro-gutters for biosensors
 - MLA's and 3D lenses for displays
 - Slanted gratings for AR glasses
- **Substrate:**
 - Glass, Polymer, metals; Square or round
- **Etching in glass or metal layers**
 - High-end optics or electronics
- **Materials**
 - Morphotonics provides imprint resins (tuned RI $n=1.45-1.6$, hard-coat, outdoor)



Designing for AR Waveguide Production



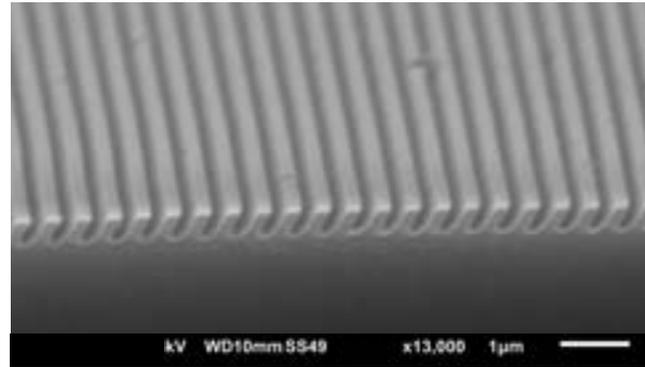
Scalability



Large area imprinting:

- Handling multiple wafers
- Uniformity over large area
- Reproducibility
- Long flex-stamp lifetime

Precision



Accuracy and consistency:

- Thin residual layer thickness
- Precise replication
- Conformal imprinting
- Pitch accuracy
- Functional tests

Cost-efficiency



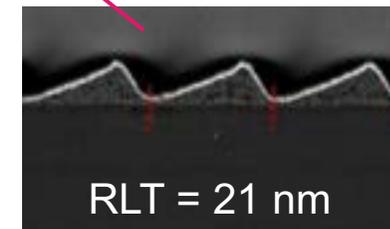
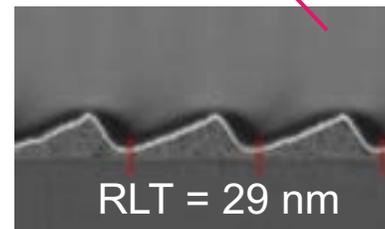
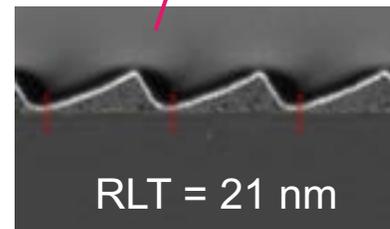
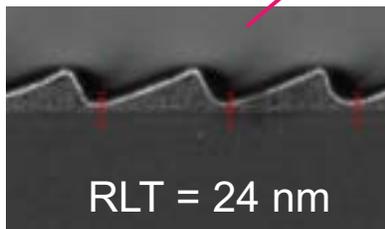
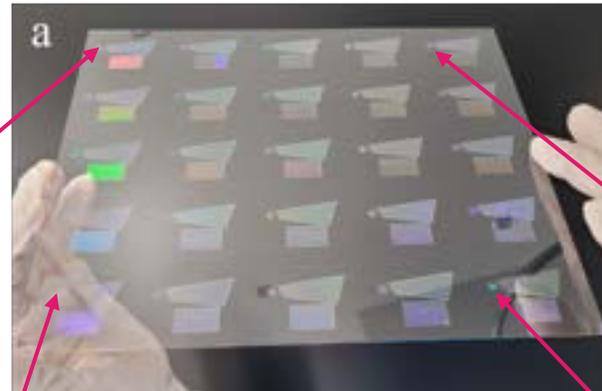
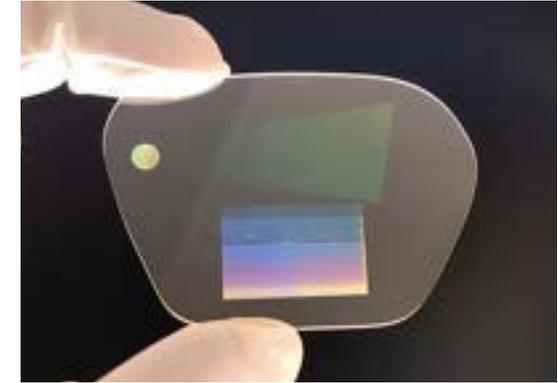
Cypris X600 for mass production:

- Fully automated system
- Multi-wafer handling system
- No defects added by NIL
- Downstream compatibility

Controlling residual layer thickness

Inkjet printing & large-area imprint process are scalable:

- 25-up inkjet print + imprint demonstrated
- Further RLT reduction to 25 nm
- Reproducible RLT between 1st and 25th eyepiece
- Possible to further scale to multiple-up wafers
- Reproducible over consecutive imprints

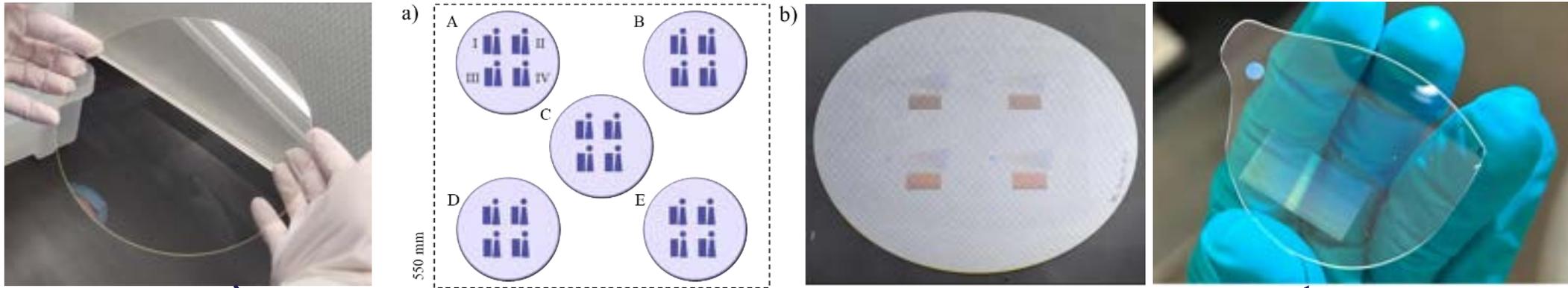


Co-funded by
the European Union

Dedicated equipment for smart glasses

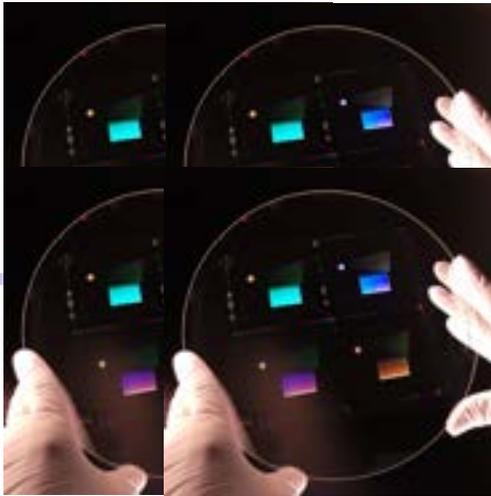


We use wafer carriers for imprinting multiple wafers in one imprint cycle to combine high throughput with round wafer scale compatibility.

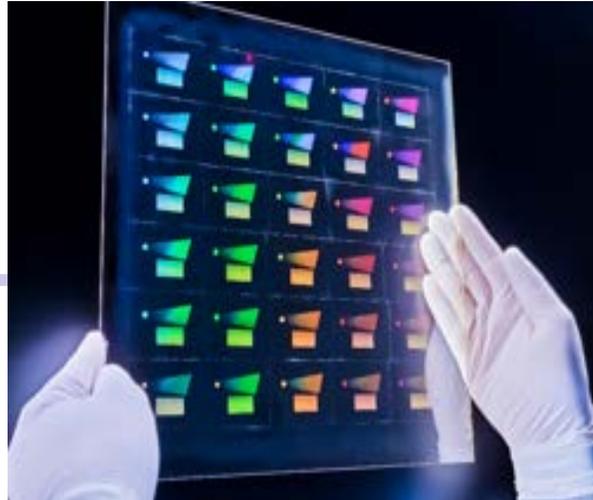


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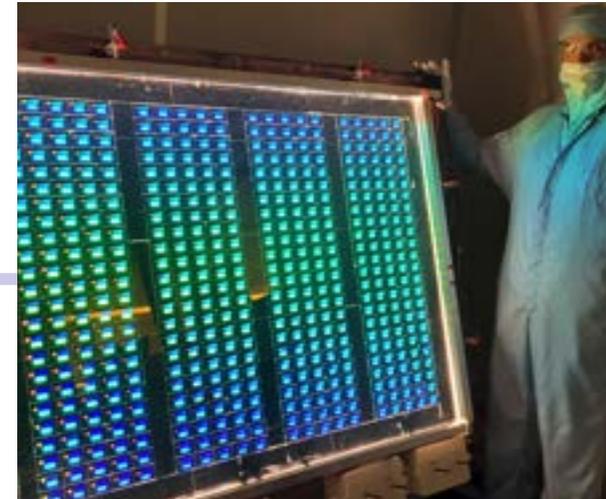
Path to mass manufacturing



4-up*: 1 machine to process 4 wafers (300mm)



Square panel: +25-50% more surface and +25-50% more products



Large panel: 1 machine to process with highest loading density

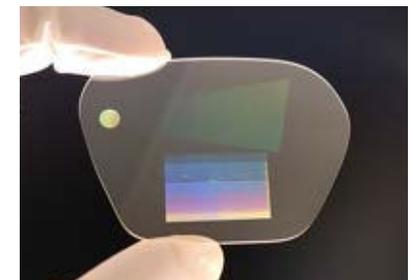
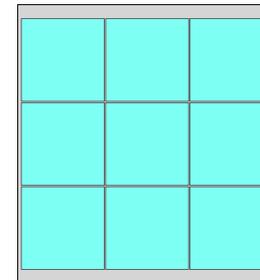
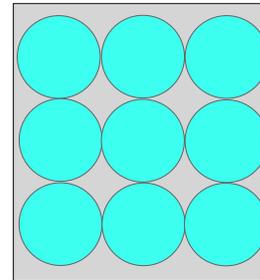
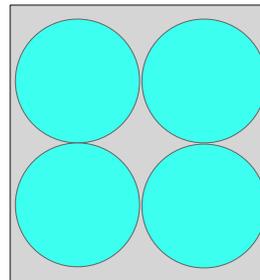
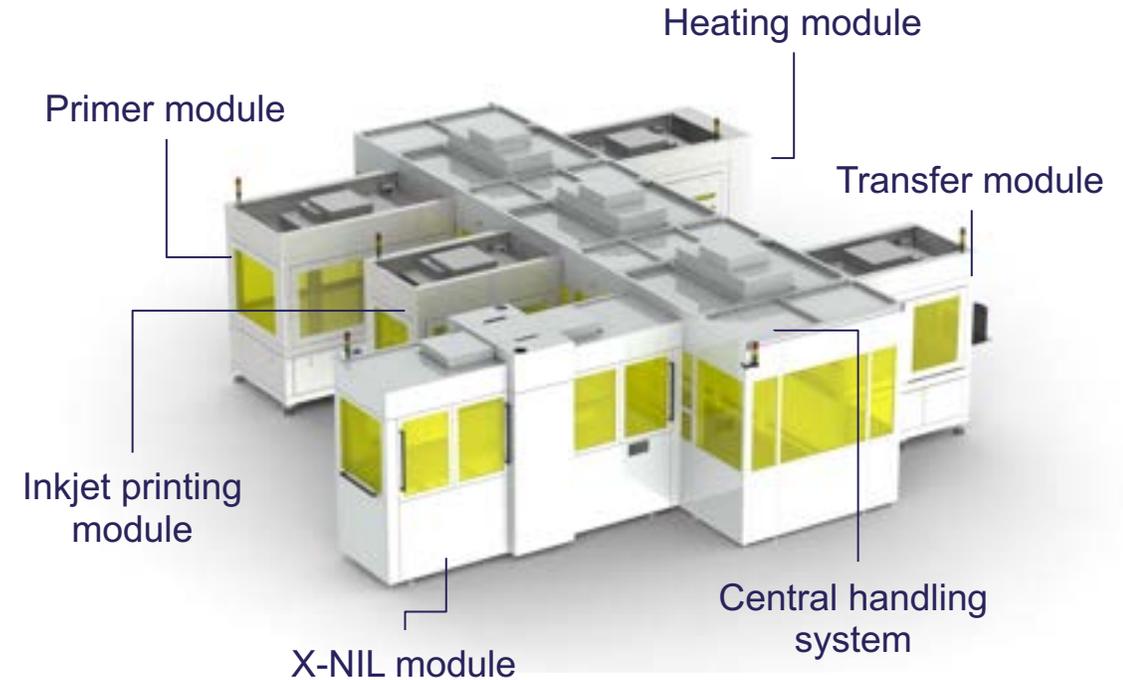
- Cost effective production by scaling
- Need for dedicated smart glasses production line, able to handle wafers & panels.
- Aligned imprinting required to match Ink-jet printing & imprinting
- Opportunity for other high-end applications (MLA's aligned to display, LabOnChip, backend packaging)

High Level Concept and Impression



Fully automated large-area nanoimprint equipment for waveguide production

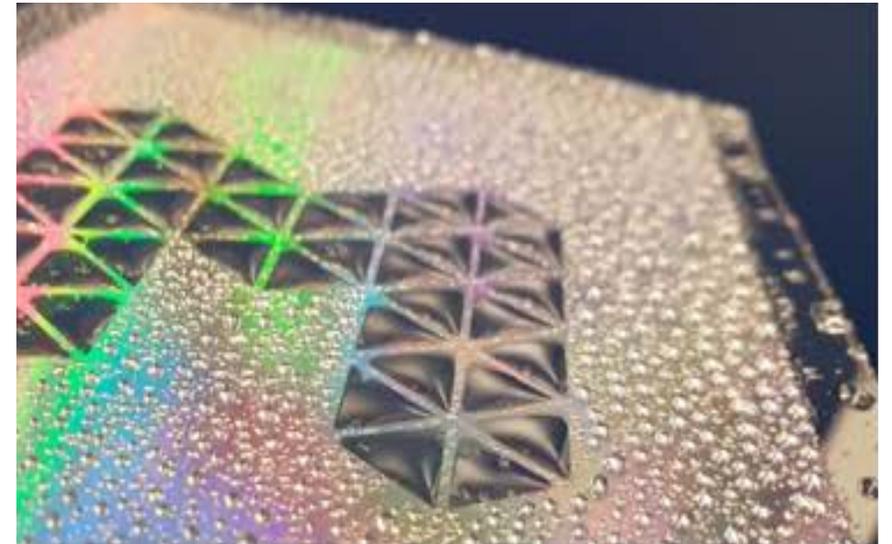
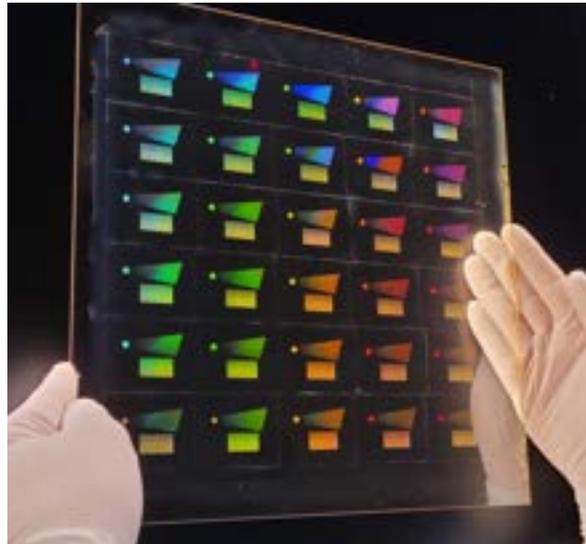
- Multiple-wafer handling with carrier
 - Round wafer - 4 x 300 mm or 9 x 200 mm
 - Squared glass capable (+ 25-50% area advantage)
- Handling sizes up to 600 x 650 mm
- Modular equipment design:
 - Primer, Inkjet Printer, Imprinter, Baking & Robot handling
- X-NIL imprint module with single-digit micron alignment
- Target annual capacity of up to 6M eyepieces
 - 180 wafers/hr & 20 carriers/hr

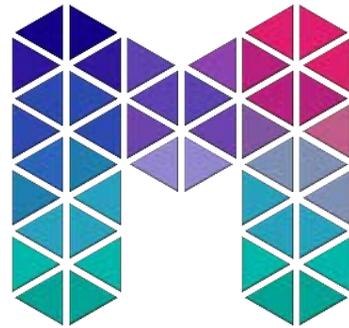


Summary



- Large-area NIL is the path to mass-manufacturing of AR waveguides
- Precise replication with extremely thin residual layer thickness is available
- Highly uniform and reproducible imprinting with multiple wafers on a carrier
- Precise large-area nanoimprinting enables other photonics applications
- Cypris X600 automated production line available in 2026





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