EPIC Meeting on Advanced Microoptics: Simulation, Fabrication & Characterization at Nanoscribe

Monolithic Molding of Freeform Glass Microstructures

Andrea Kneidinger | Business Development Manager

EV Group | At A Glance

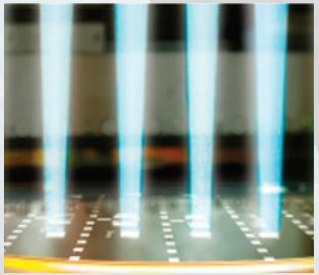
Leading supplier of wafer processing equipment for the nanotechnology, MEMS and semiconductor markets

Founded in 1980 by DI Erich and Aya Maria Thallner. More than 1000 employees worldwide

Headquarters in Austria, with fully owned subsidiaries in the USA, Japan, South Korea, China and Taiwan

Recent Developments

GEMINI® FB
Hybrid Bonding



EVG® MLE™
Maskless Exposure Technology

Nanoimprint Lithography (NIL) Developments

EVG® HERCULES® NIL
SmartNIL® HVM
Up to 300 mm

EVG® 770 NT
S&R NIL System

EVG® 7300
SmartNIL® and WLO
Up to 300 mm

EV Group | Focus on Nanoimprint Lithography (NIL)

Main Driving Markets

Augmented Reality

Biomedical

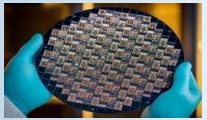
Source: Butterfly Network

Optical Sensors

ADAS & Automotive Lighting

Source: ams

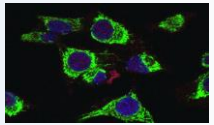
Photonic Packaging



Holographic Displays

Metalenses

Raman Spectro.



NIL is a cost-effective and flexible technology to enable nanostructured surfaces as well microstructures on wafer-level

- Volume-proven wafer level imprinting technology
- Parallel processing of hundreds or thousands of micro- and nanostructures
- High degree of flexibility in optical designs

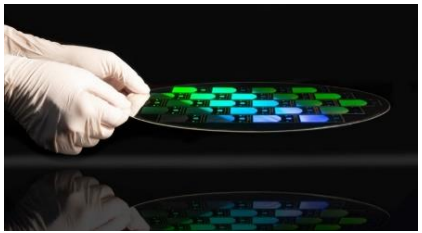
EVG NIL equipment and dedicated process capabilities → Leading NIL equipment supplier with worldwide largest install base

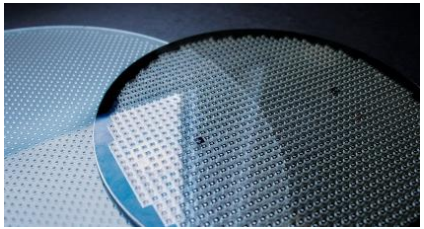
- Step-and-Repeat Mastering
- SmartNIL®
- Lens Molding

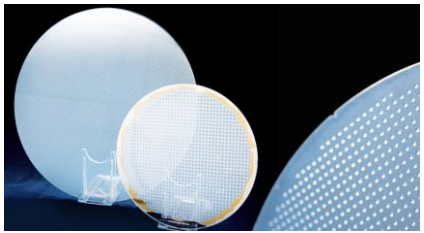
→ Tools from R&D to fully automated HVM

NIL Photonics Competence Center → Innovation Incubator

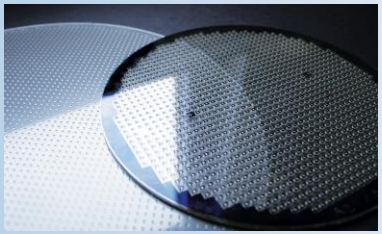
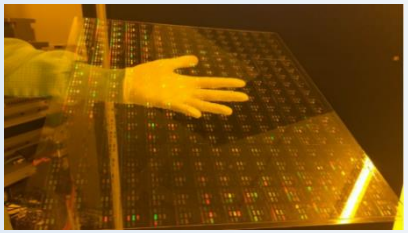
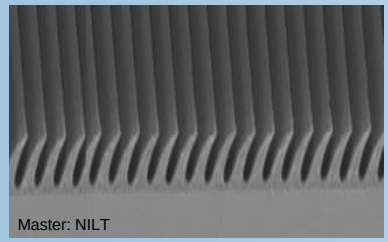
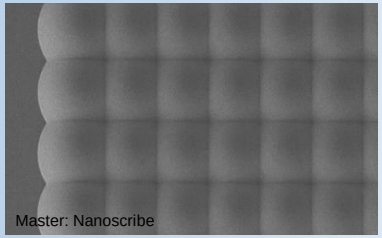
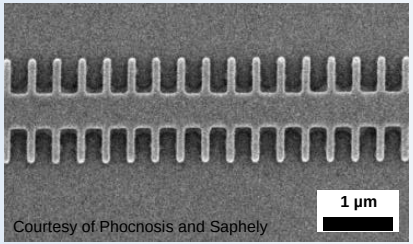
- Helping to ramp up
- 1.300 m³ class 10 – 100 cleanroom space & application labs







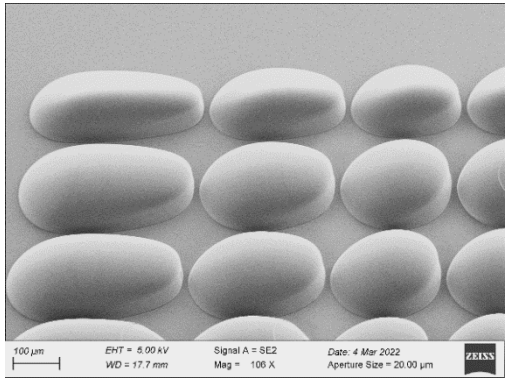
EV Group | Dominant Share in NIL Photonics Key Markets

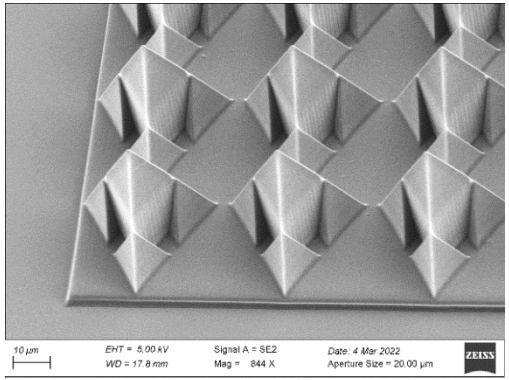
	Displays & Augmented Reality	Sensors & Wafer Level Optics	Biomedical Applications
Application			
Wafer			
Structures	 Master: NILT	 Master: Nanoscribe	 Courtesy of Phocnosis and Saphely

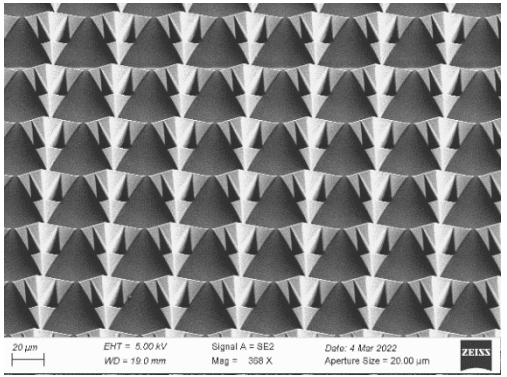
Challenge: HVM manufacturability combined with design and material flexibility

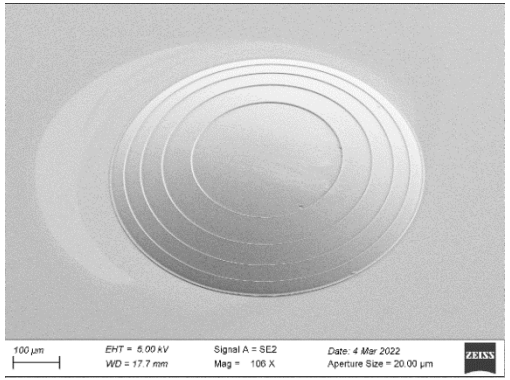
Freeform Microstructures | Results

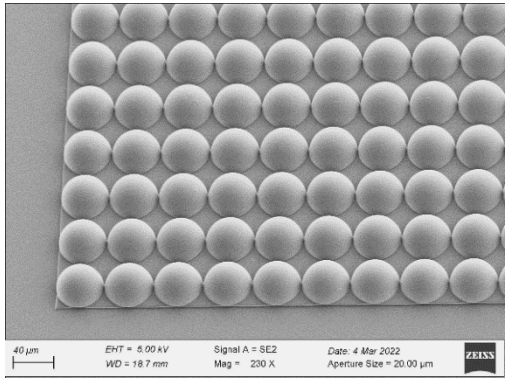
Challenge addressed: Highly flexible freeform microstructures made by NIL with dedicated materials

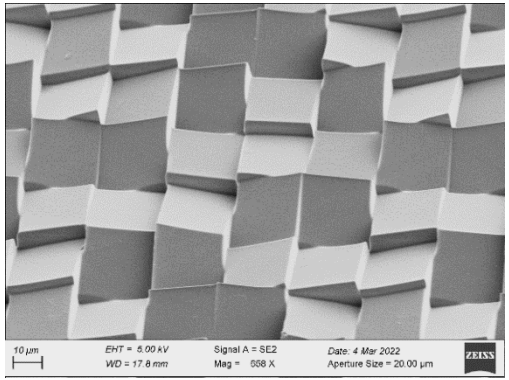












Highly flexible freeform microstructures made by NIL

How it works

Freeform Microstructures | From Master Template to Multiple Imprints

Template	200/300 mm Master	Multiple Imprints
		
Single-die freeform master made by 2GL	Fully populated S&R Master by made EVG770	Multiple imprints from working stamps made by EVG7300

Freeform Microstructures | From Master Template to Multiple Imprints

S&R process

Single DIE Master

EVG®770 S&R System

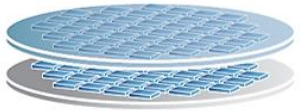
Cure imprint polymer and de-emboss template

Move to next DIE and imprint again

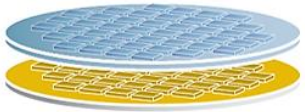
S&R Master

NIL imprint process

Working Stamp



Multiple Imprints



EVG®7300

HERCULES® NIL

Freeform Microstructures | From Master Template to Multiple Imprints

S&R process

Single DIE Master

EVG®770 S&R System

Cure imprint polymer and de-emboss template

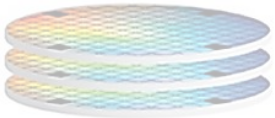
Move to next DIE and imprint again

S&R Master

NIL imprint process

Working Stamp

Multiple Imprints



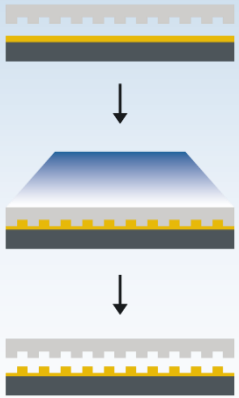
EVG®7300

HERCULES® NIL

Freeform Microstructures | Saving Costs by Scaling

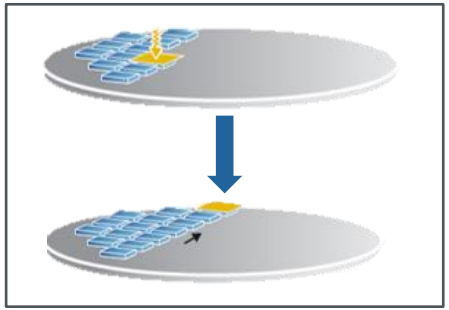
Template | 200/300 mm Master | Multiple Imprints

UV Molding



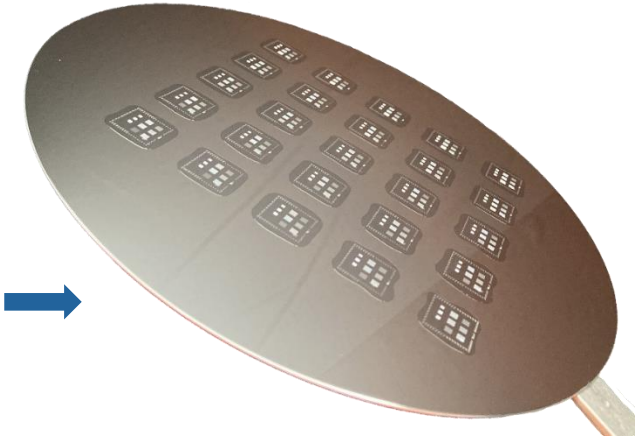
From single die to fully populated 200 mm or 300 mm master by step and repeat

Single-die freeform master made by 2GL



Step and Repeat Process

EVG®770 S&R System



Fully populated S&R Master

Freeform Microstructures | From Master Template to Multiple Imprints

S&R process

Single DIE Master

EVG®770 S&R System

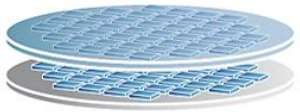
Cure imprint polymer and de-emboss template

Move to next DIE and imprint again

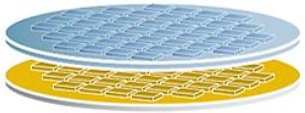
S&R Master

NIL imprint process

Working Stamp



Multiple Imprints



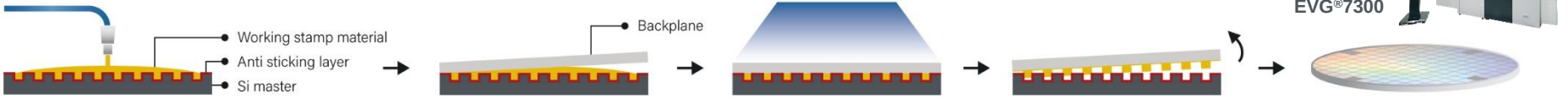
EVG®7300

HERCULES® NIL

Freeform Microstructures | From Master Template to Multiple Imprints

Template | **200/300 mm Master** | **Multiple Imprints**

SmartNIL® - Stamp fabrication



Spin coat of stamp material on master stamp

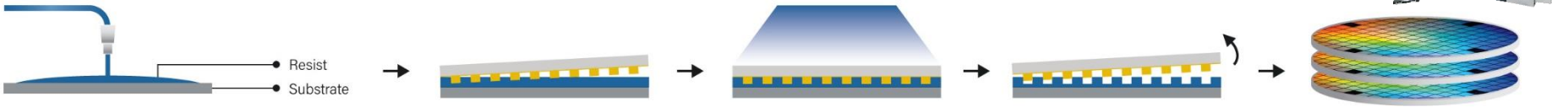
Attaching backplane on coated master

Curing of stamp material

Release of working stamp from master

Unique working stamp

SmartNIL® - Imprint



Spin coat of resist on substrate

Attaching working stamp on coated substrate

Curing of resist by UV exposure

Release of working stamp from product

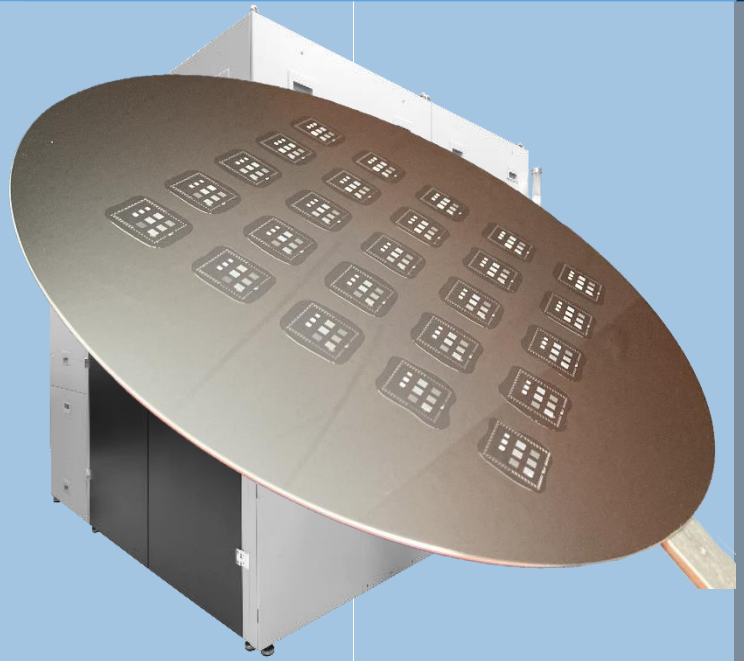
Multiple Imprints

Working stamp manufacturing and imprinting is performed in the same equipment

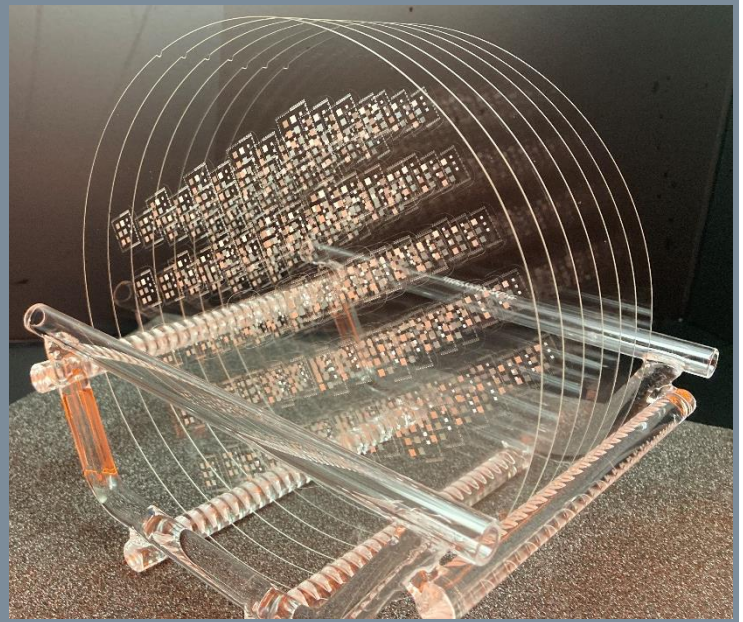
Freeform Microstructures | From Master Template to Multiple Imprints

Template	200/300 mm Master	Multiple Imprints

Single-die freeform master made by 2GL



Fully populated S&R Master by made EVG770



Multiple imprints from working stamps made by EVG7300

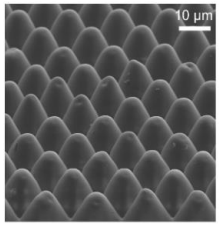
Monolithic Molding of Freeform Glass Microstructures

Results

Freeform Glass Microstructures | Used Material

Glassomer “pre-glass” materials → processing glass like polymers

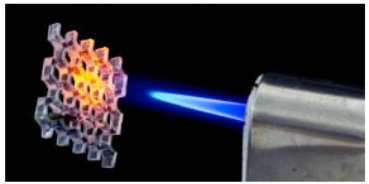
- Glassomer photocurable materials can be structured via NIL, 3D printing, injection molding, …
- After this polymer processing Glassomer is turned into **optical grade fused silica glass** during a final heat treatment
- Result: same optical transparency as commercial fused silica and a smooth surface with a roughness of a few nm
- Refractive Index: 1.4589 ± 0.0002
- Abbe Number: 67.1 ± 1.1



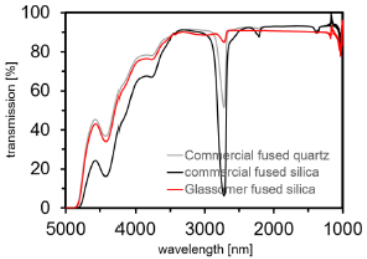
Microstructures for Solar Cells


Microfluidics

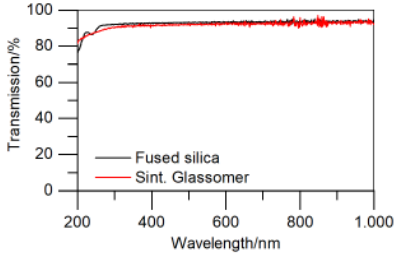
Thermal Resistance



IR Transparency

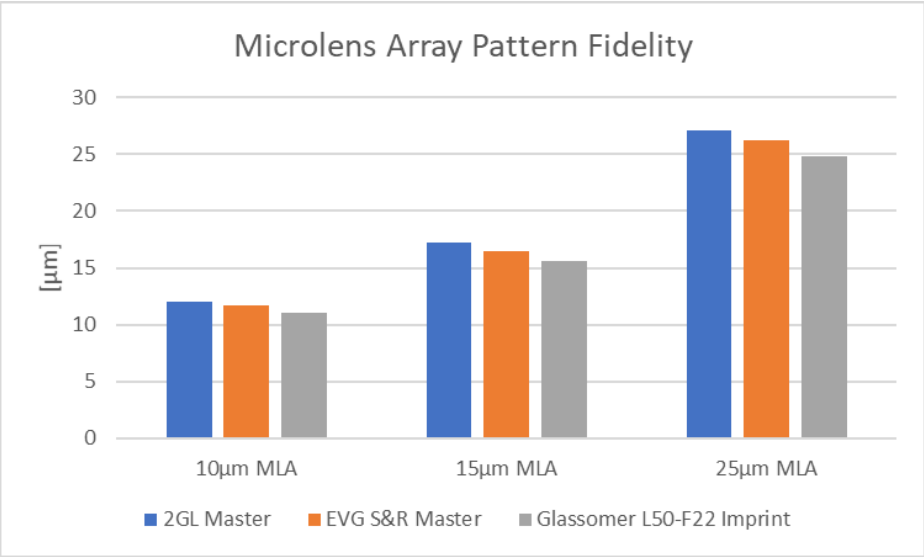


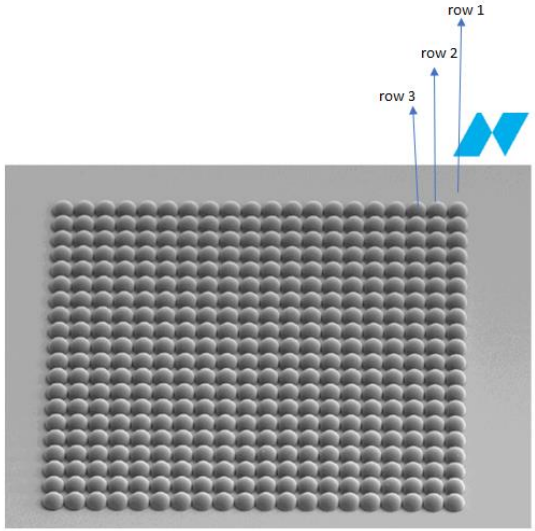
UV/VIS Transparency



High durability, high transparency, low thermal expansion, long-term clarity without yellowing or scratches
→ Perfectly fitted for harsh requirements

Freeform Glass Microstructures | Results: Pattern Fidelity





Process Chain	Height Value White Light Interferometry		
Height of 2GL master	12.07	17.21	27.04
Height of S&R master	11.69	16.48	26.18
Height of Glassomer Imprint (not sintered)	11.01	15.65	24.84

Whole process chain height value

~ 8.5 % height loss from 2GL master to imprinted glass material

→ Due to material shrinkage

→ Factor is considered when creating the master design

→ **Highly reproducible NIL replications**

Monolithic Molding of Freeform Glass Microstructures
Using NILPhotonics® Competence Center

Freeform Glass Microstructures | From Master Template to Multiple Imprints

Template | 200/300 mm Master | Multiple Imprints

Source: Adobe Stock

Materials

Master Templates

nanoscribe

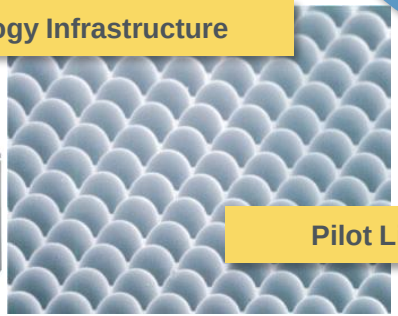
NILPhotonics™ Competence Center

EVG

Process Development

Glassomer

Metrology Infrastructure



Pilot Line Production

Sample Processing

R&D and HVM NIL Equipment

Monolithic Molding of Freeform Glass Microstructures

Summary & EPIC Questions

NIL at EVG | Summary and EPIC Questions

Nanoimprint equipment based manufacturing technologies enable next-generation freeform micro- and nanostructures

- Waver-level based manufacturing → large scaling factor
- Full know-how from single master die to the whole module → processing wafers up to 300 mm
- SmartNIL® Technology → highly flexible and insensitive to shapes and size
- Open materials platform
- NILPhotonics® Competence Center: Innovation Incubator → helping to ramp up

What can we do for you?

→ World Class Facility for…

- Customer demonstrations
- NIL Process development
- Joint R&D with partners
- Small volume pilot line production
- S&R mastering service
- NIL Process training

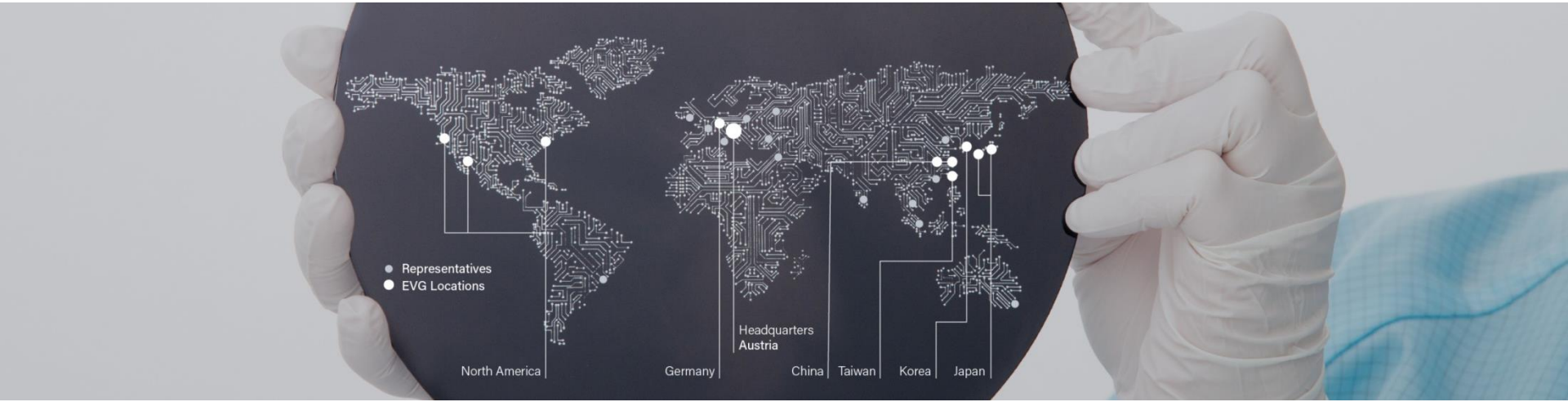
What we are searching for?

→ Collaboration Partners for…

- Materials
- Mastering
- Design
- New customer challenges ☺

Thank you!

Andrea Kneidinger, Business Development Manager



May 2022