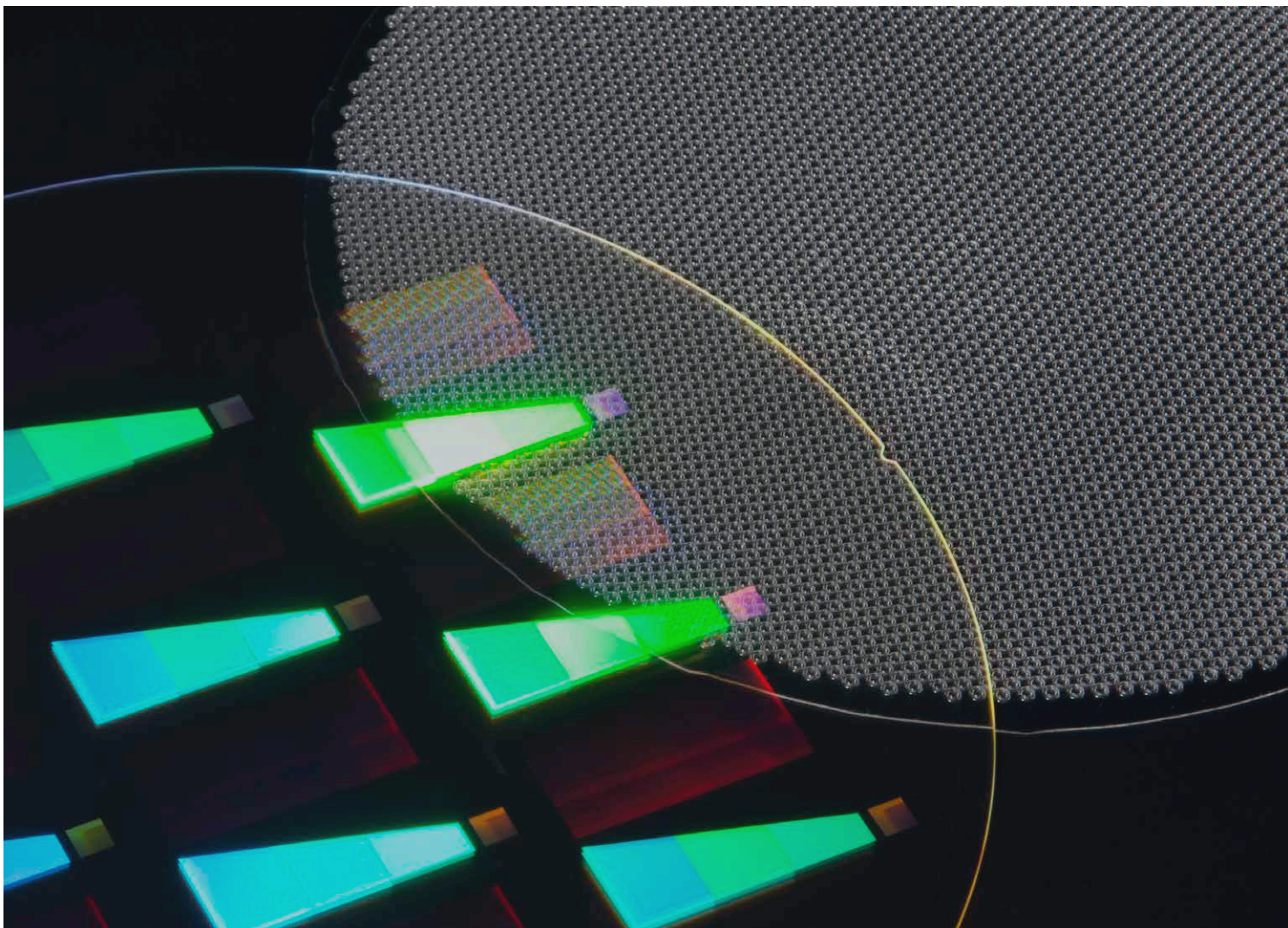




EV GROUP® | Products // Nanoimprint Lithography

Solutions for Nanoimprint Lithography





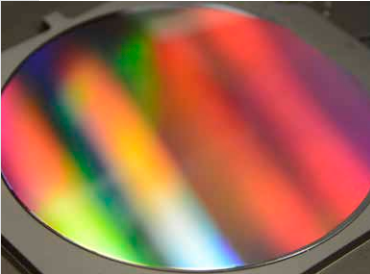
Introduction

EV Group is the market-leading equipment supplier for nanoimprint lithography (NIL). Pioneering this non-conventional lithography technique for many years, EVG mastered NIL and has implemented it in volume production on ever-increasing substrate sizes. EVG's proprietary SmartNIL technology is optimized by years of research, development and field experience to address nanopatterning requirements that cannot be supported by conventional lithography. SmartNIL provides superior conformal imprint results down to 40 nm.



UV Nanoimprint Lithography

EV Group provides a complete product line for UV-based nanoimprint lithography (UV-NIL), including different full-area imprinting systems, large-area imprinters, microlens molding equipment as well as step-and-repeat systems for efficient master fabrication. Besides soft UV-NIL, EVG offers its proprietary SmartNIL technology with multiple-use polymer stamp technology. The efficient and robust SmartNIL process provides high pattern fidelity, highly uniform patterned layers and minimum residual layers, combined with easy scalability in wafer size and production volume. EVG's SmartNIL redeems the long-term promise of nanoimprinting being a high-performance, low-cost and volume-capable manufacturing technology for mass production of micro- and nanoscale structures.



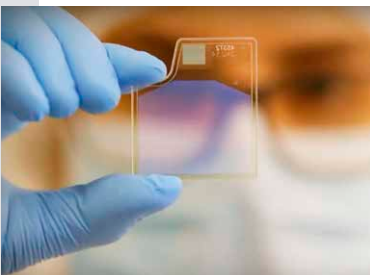
SmartNIL®

SmartNIL is a full-field imprint technology based on UV exposure, providing a powerful next-generation lithography technique with almost unlimited structure size and geometry capabilities. Since SmartNIL incorporates multiple-use soft stamp processing, it also enables unmatched throughput with considerable cost-of-ownership advantages while preserving scalability and maintenance-friendly operation. In addition, the lifetime of the master template is extended to periods comparable to masks used for optical lithography.



Lens Molding

Wafer-Level Optics (WLO) manufacturing is supported by EVG's high precision polymeric lens molding and stacking equipment up to 300 mm. Lens patterns are transferred into optical polymer materials by soft UV imprint lithography using working stamps replicated from the wafer-size master stamps. EV Group offers hybrid and monolithic microlens molding processes, which can be easily adapted to various material combinations for working stamp and microlens materials. EVG systems are our customers' first choice for high-volume wafer-level lens replication.



Panel-Size Large-Area Nanoimprinting

Recent advances in EVG's proprietary and volume-proven SmartNIL technology have enabled implementation of nanopatterning on panel-size substrates up to Gen 3 (550 mm x 650 mm). For applications such as displays, wire grid polarizers, biotechnology and photonic elements, which cannot be reduced in size, it is crucial to increase substrate utilization efficiency by increasing the pattern area. NIL has proven to be the most cost-efficient way to enable fabrication of nano patterns on large areas as it is not limited by optical systems and can provide the best pattern fidelity for the smallest structures.

Step-and-Repeat UV-Nanoimprinting

The EVG770 NT is a versatile platform for step-and-repeat (S&R) nanoimprint lithography for efficient master fabrication or direct patterning of complex structures on substrates. This approach allows uniform replication of templates from small dies up to 30 cm². The S&R process allows to replicate those dies multiple times over large areas up to Gen2 panel-size substrates. In combination with diamond turning or direct writing methods, S&R imprinting is frequently used to efficiently fabricate masters required for wafer-level optics manufacturing or EVG's SmartNIL process. Thus, it is often a crucial prerequisite for high volume manufacturing of augmented reality waveguides, optical sensors, diffractive optics, metasurfaces or biomedical devices.



UV Nanoimprint Lithography Systems



EUV®610 / EVG®620 NT / EVG®6200 NT

Universal mask alignments systems with UV-nanoimprint capability

- High-precision alignment stage
- Automated wedge error compensation mechanism
- Motorized and recipe-controlled exposure gap
- Supports the latest UV-LED technology
- Minimized system footprint and facility requirements



EUV®720 / EVG®7200 / EVG®7200 LA

Automated full-field nanoimprint solution up to Gen 3 substrates

- Volume-proven imprinting technology with superior replication fidelity
- Proprietary SmartNIL® technology with multiple-use polymer stamp technology
- Integrated imprinting, UV curing, demolding, and working stamp fabrication
- Automated cassette-to-cassette handling plus semi-automated R&D mode
- Open platform for all commercially available imprint materials



EUV®7300

Multifunctional UV Nanoimprint Lithography system up to 300mm

- Featuring SmartNIL® technology, lens molding and lens stacking in one tool
- Advanced Alignment Capabilities
- Precisely controlled multistep imprint process including alignment, contacting and UV-curing
- Low-force automated stamp detachment for SmartNIL® and WLO
- Standalone module, as well integration into HERCULES® NIL



HERCULES® NIL

Fully integrated nanoimprint lithography solution for high-volume manufacturing up to 300 mm

- Volume manufacturing of structures down to 40 nm and smaller (resolution dependent on process and template)
- Combines pre-processing (clean / coat / bake / chill) and SmartNIL®
- Fully automated imprinting and controlled low-force detachment for maximum working stamp reusability
- Includes working stamp manufacturing capability

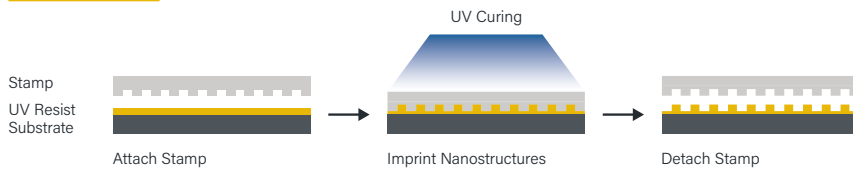


EUV®770 NT

Step-and-repeat nanoimprint lithography for efficient master fabrication

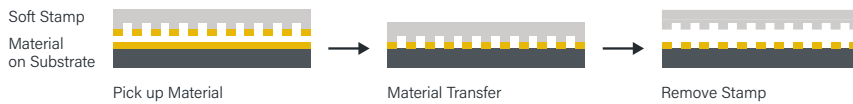
- High-quality master fabrication of microlenses for wafer-level optics down to nanostructures for SmartNIL®
- Efficient scaling to large substrate sizes up to panel size
- Simple implementation of different types of masters
- Variable resist dispense modes
- Live image during dispensing imprinting and demolding
- In-situ force control for imprinting and demolding

UV-Imprinting



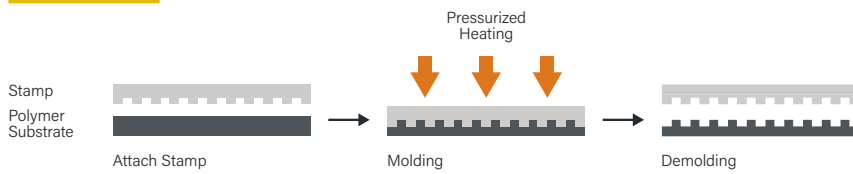
A substrate is spin-coated or drop-dispensed with a UV-curable resist. Subsequently, a stamp is pressed into the resist and cross-linked by UV light while still in contact.

μ-Contact Printing



A pre-inked stamp is used to transfer materials onto a substrate in a distinct pattern. This technique is used for local modification of surface chemistry or precise placement of capture molecules in biosensor fabrication.

Hot Embossing



A polymer sheet or spin-on-polymer is heated above its glass transition temperature, transforming the material into a viscous state. A stamp is then pressed into the polymer with sufficient force.

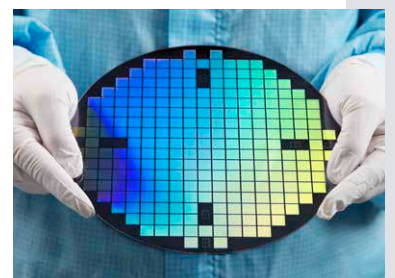
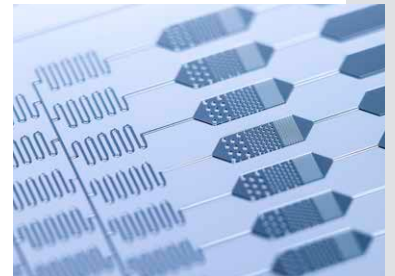
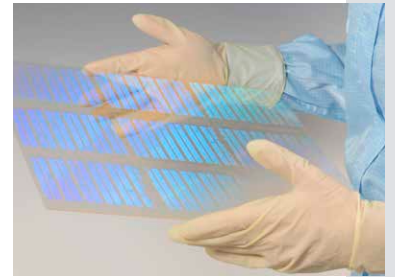
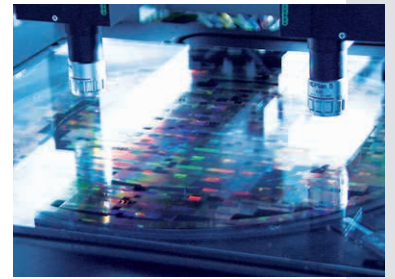


EV Group's series of high-precision hot embossing systems are based on the company's market-leading wafer bonding technology. Excellent pressure and temperature control as well as uniformity over large areas allow for high accuracy imprints. Hot embossing is a cost-effective and flexible fabrication technology with very high replication accuracy for feature sizes down to 50 nm. The systems are well suited for embossing complex micro- and nanostructures and high-aspect ratio features into a wide range of polymer substrates or spin-on-polymers.

NILPhotonics® Competence Center - Support and Development

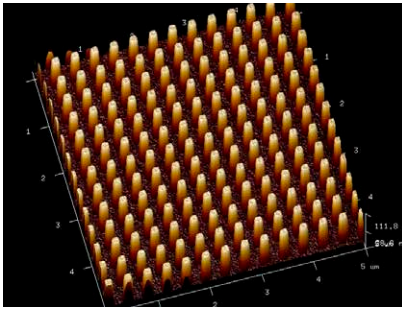
The NILPhotonics Competence Center is a proven innovation incubator.

- | | |
|---|--|
| <ul style="list-style-type: none"> ■ Customer demonstrations ■ Process development ■ Materials testing ■ Joint R&D with partners ■ Funded projects ■ Small-volume pilot-line production ■ IP management ■ Process technology licenses ■ Process training | <ul style="list-style-type: none"> ➔ World-class cleanroom infrastructure ➔ State-of-the-art equipment ➔ Technology experts ➔ Dedicated metrology ➔ Process know-how ➔ Applications know-how ➔ Chemistry know-how related to working stamp materials and surface chemistry aspects of NIL |
|---|--|

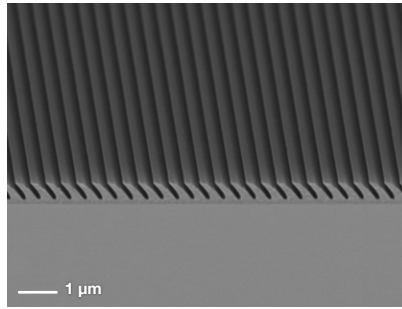


Process Results

New application developments are often closely linked to advances in equipment capabilities. EVG's NIL solutions are able to produce a multitude of different sized and shaped patterns with nanometer resolution and enable many new innovations in displays, biotechnology and photonic applications.



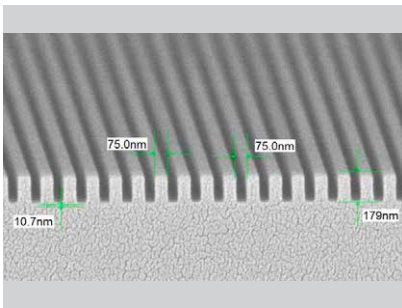
AFM image of a single pixel on HRI SmartNIL® imprint



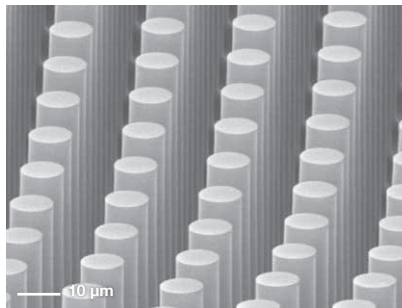
SEM image of slanted gratings
Source: EVG in collaboration with NILT



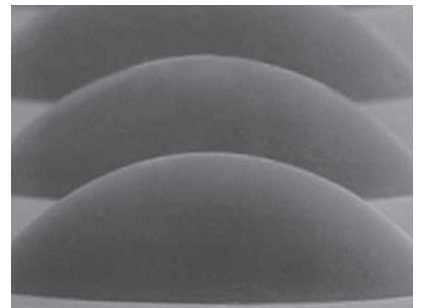
Microfluidic chips replicated in PMMA by hot embossing
Source: EVG



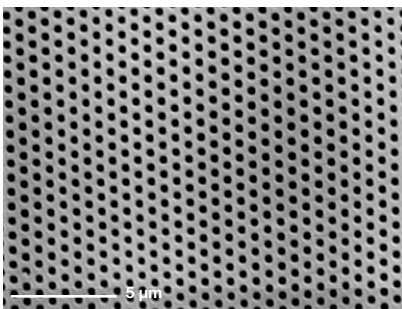
L/S grating with optimized residual layer with approximately 10 nm thickness
Source: EVG



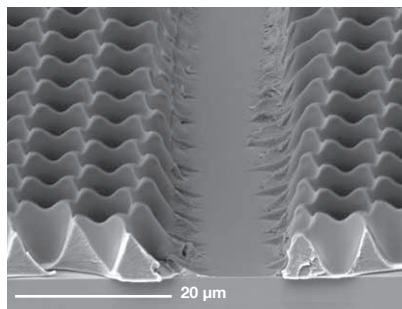
10 µm pillar arrays with high aspect ratio (7:1)
Courtesy of National Research Council Canada



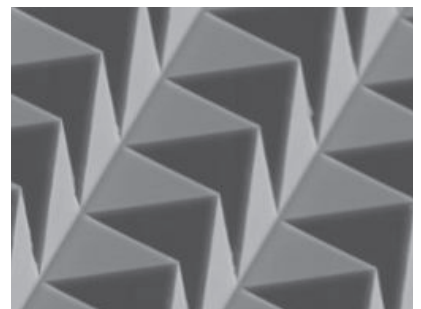
UV-molded lenses 300 µm
Source: EVG



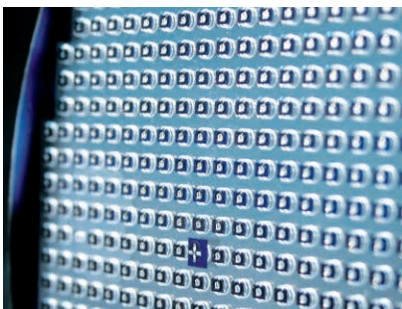
Photonic crystals for light extraction of LEDs



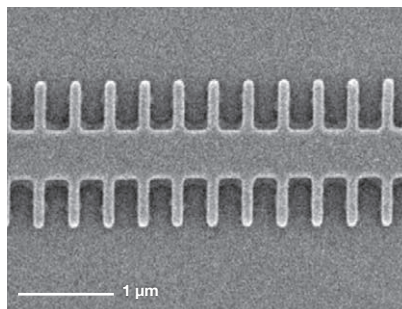
Honeycomb texturing of Multicrystalline Silicon (mc-Si)
Courtesy of Fraunhofer ISE



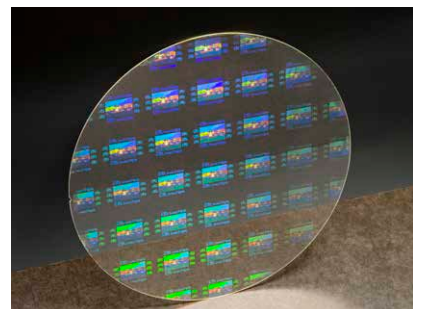
Pyramidal structures 50 µm
Source: EVG



Wafer-level packaging of the optical modules with smallest form factor
Source: EVG



Photonic bandgap sensor grating
Source: EVG (EU Project Saphely)



Full wafer photography of HRI SmartNIL® imprint under bright light illumination
Source: EVG



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