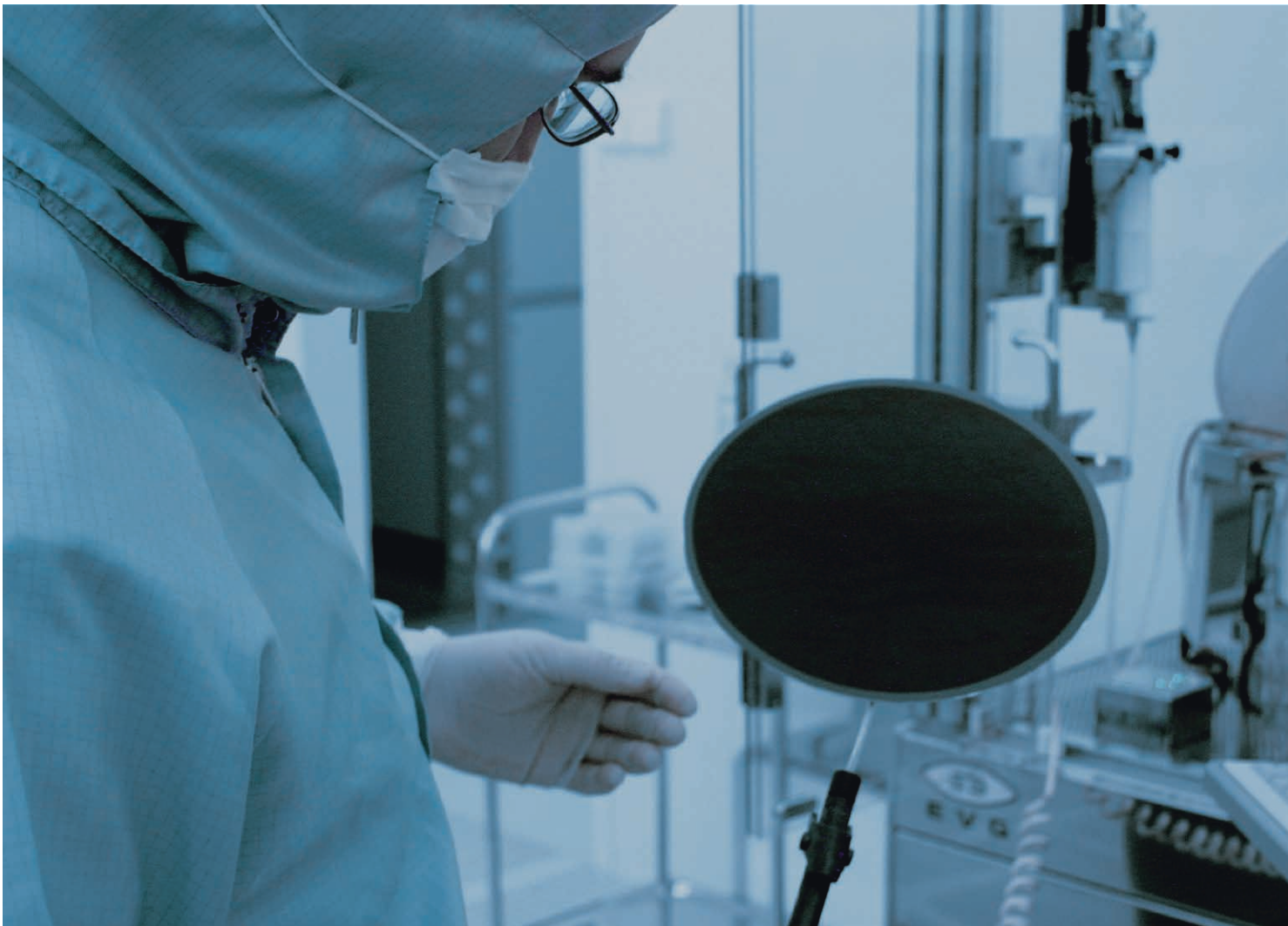




EV GROUP® | Products

Solutions for R&D



Introduction

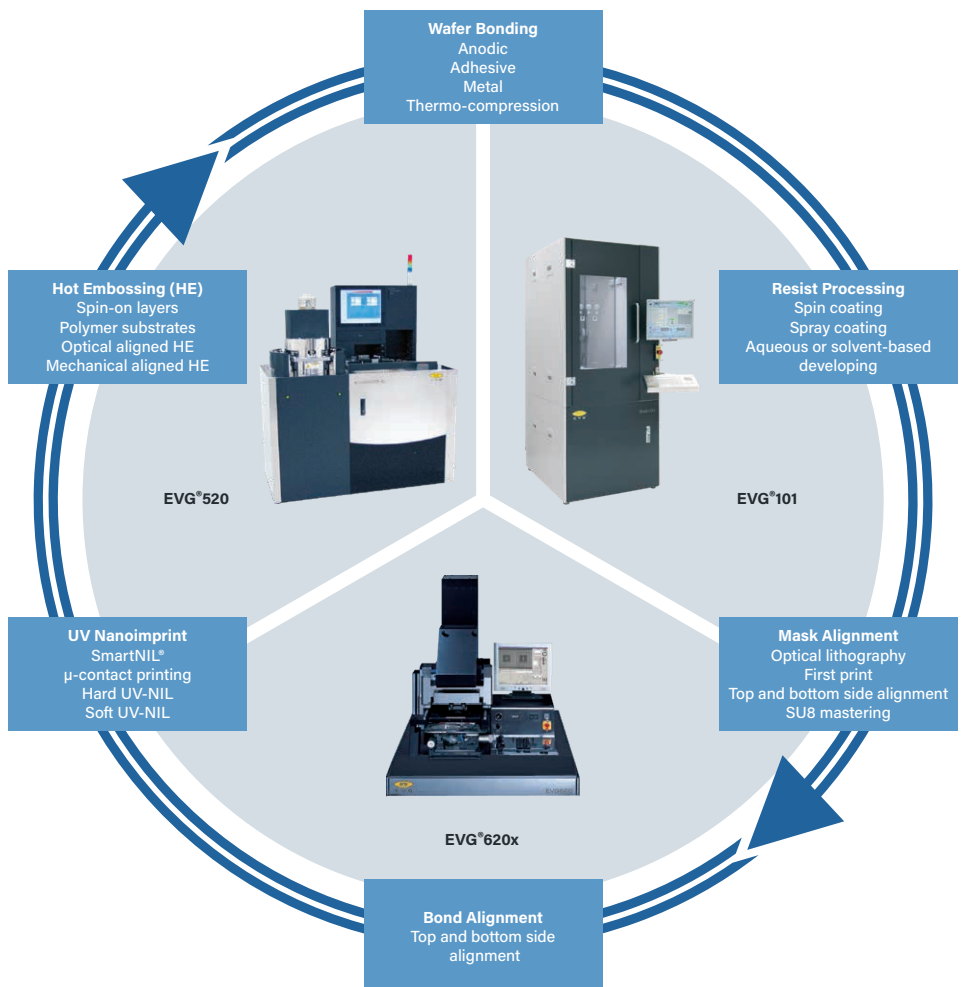
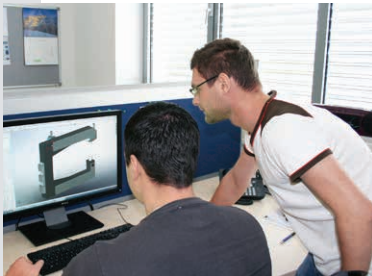
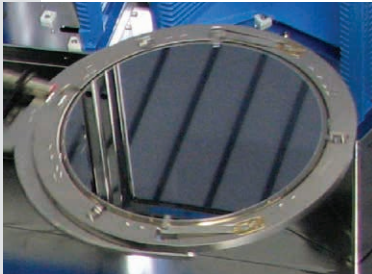
As a technology and market leader in wafer processing solutions for semiconductor, MEMS and nanotechnology applications, EVG supports partners and customers to make their ideas a reality.

EVG's track record of innovations in the field of micro- and nano-fabrication technologies is unique. We realize our vision of being the first in exploring new techniques and serving next-generation applications of micro- and nano-fabrication technologies through intensive R&D collaborations. On average, EVG participates in more than 10 European cooperative R&D projects and cooperates on several joint development programs with R&D institutes worldwide every year.

EV Group has been working with research facilities for more than 40 years, giving us insight into their unique requirements. Our dedicated R&D tools provide superior technology combined with maximum flexibility, enabling universities, research institutions and technology development partners to scale processes across multiple research projects and applications.

What's more, the R&D equipment integrates seamlessly with EVG's core technology platforms, which span the entire manufacturing chain from R&D all the way to small-scale and high-volume production. Full software and recipe compatibility between R&D and full-scale production systems enables researchers to migrate their processes to volume-production environments.

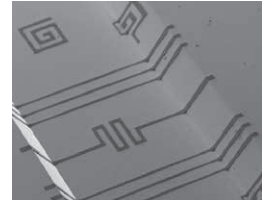
Multiple Use Systems for R&D or Pilot Line



Resist Processing

EVG®101

- Automated spin or spray coating or developing with manual wafer load/unload
- Easy process transfer from research to production utilizing modular design
- Syringe dispense system for utilization of small resist volumes, including high viscosity resists
- Small footprint while maintaining a high level of personal and process safety

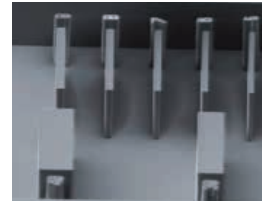


Patterned, spray coated resist layer in anisotropically etched cavity
Courtesy of TU-Delft DIMES

Lithography

EVG®620 NT / EVG®6200 NT

- Top side alignment accuracy up to $\pm 0.5 \mu\text{m} / 3\sigma$ ($\pm 0.1 \mu\text{m}$ in R&D)
- Bottom side alignment accuracy up to $\pm 1.0 \mu\text{m} / 3\sigma$
- Substrate size from pieces to 150 mm (100 mm to 200 mm in EVG®6200 NT)
- Optional bond alignment
- Thin or warped wafer handling
- Manual R&D systems and volume production types and are available

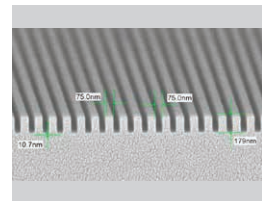


80 μm SU-8 resist features with sidewall angles approaching 90°
Courtesy of DALSA Corporation

Nanoimprint Lithography (NIL) & Hot Embossing (HE)

EVG®620 NT / EVG®720 / EVG®500 Bonder series with hot embossing and de-embossing tooling

- Nanoimprint lithography enables simple replication of various kind of structures, shapes and sizes - nanoscale structures can be achieved without sophisticated and expensive optics
- EVG®620 NT covers all common imprinting techniques, including proprietary SmartNIL® technology
- EVG®720 is the dedicated SmartNIL® system for advanced process development and pre-commercial upscaling
- EVG®500 can provide for simultaneous replication of micro- and nanostructures, imprinting into bulk polymer materials or glass and suitable for spin-on thermoplastics



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

Bonding

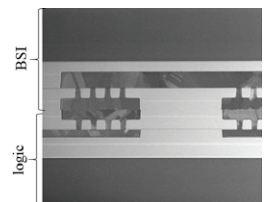
EVG®501 / EVG®510 / EVG®520 IS Bonders for R&D

Wafer Bonding

- Anodic
- Adhesive
- Eutectic
- Transient liquid phase
- Thermo-compression

Features

- Substrates up to 200 mm
- Forces up to 100 kN
- Temperatures up to 550°C
- Vacuum down to $1 \cdot 10^{-6}$ mbar
- Other options: anodic, UV curing, 650°C heaters



Hybrid Bonding of a daisy chain with 4.4 μm pads*
©STMicroelectronics
Used with permission.

* S. Lhostis et al., "Reliable 300 mm Wafer Level Hybrid Bonding for 3D Stacked CMOS Image Sensors", 2016 IEEE 66th Electronic Components and Technology Conference

Process Services

Wafer processing services on any EVG equipment, including special processes such as

- Plasma activated direct bonding
- ComBond® - conductive bonding of Si and compound semiconductors
- High-vacuum aligned bonding
- Temporary bonding and thermal, mechanical or laser debonding
- Hybrid bonding
- Adhesive bonding
- Collective D2W bonding
- Permanent wafer bonding
- Lithography
- UV-NIL on large substrates
- Lens molding
- Master stamp and working stamp fabrication for SmartNIL®
- Resist Processing

Benefits

Multiple Equipment Functionalities / Multi-Purpose Equipment

EVG®610, EVG®620 NT, EVG®6200 NT

- Lithography
- Nanoimprinting
- Bond alignment

EVG®510, EVG®520

- Bonding
- Hot embossing

EVG®101

- Spin coating
- Spray coating



Multiple Process Capabilities

Nanoimprint Lithography (NIL)

- SmartNIL®
- Hard UV-NIL
- Soft UV-NIL
- Micro contact printing
- Lens molding

Bonding

- Metal (transient liquid phase, eutectic, thermo-compression)
- Glass frit
- Anodic
- Adhesive
- Temporary adhesive

Coating

- Spin coating
- OmniSpray®
- Conformal coatings of topography
- Uniform thick resist coatings for high topography
- Adhesive coating for bonding



Process Services

- Access to industrial equipment and processes
- Customer tailored evaluation programs
- Very small batches possible
- High success rate for sample processing
- Access to EVG's service providers



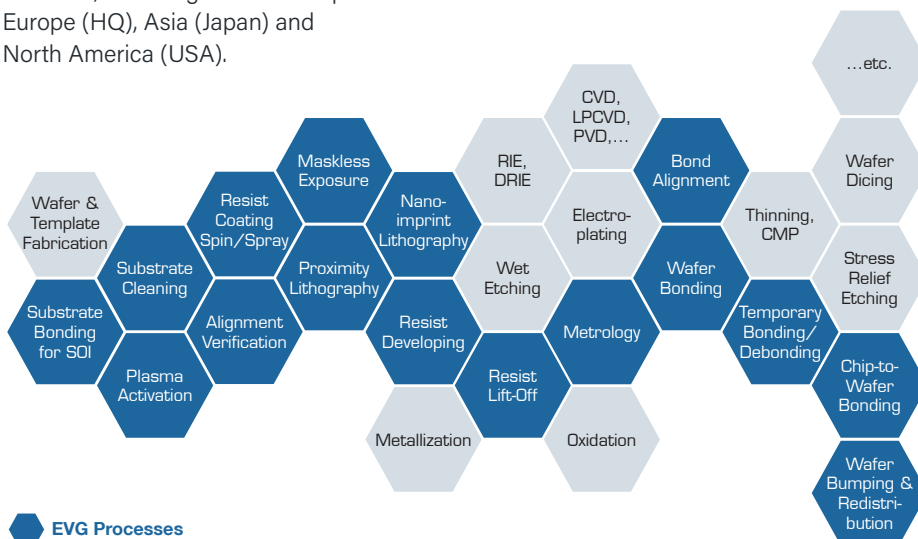
R&D Cooperation

- Application and market expertise
- Industrial partner network
- Consulting and proof of concepts
- Upscaling processes
- Implementation of engineering concepts and solutions in equipment and tooling
- Industrial qualification of processes and equipment



Software and Support

The Windows-based, graphical user interface is designed with a strong focus on user-friendliness, and easily navigates the operator through each process step. Multi-language support, individual user account settings and integrated error logging / reporting and recovery can simplify the user's daily operation. All EVG systems can also communicate remotely. Thus, our service includes field-proven, real-time remote diagnostics and troubleshooting via secured connection, phone or email. EVG's experienced process engineers are ready to support you anytime thanks to our de-centralized worldwide support structure, including cleanroom space on three different continents: Europe (HQ), Asia (Japan) and North America (USA).

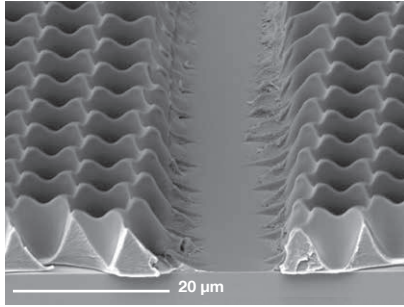


Emerging Technologies - Shaping the Future

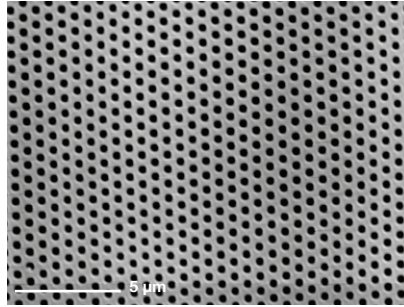
Being the first in exploring new techniques and serving next-generation applications of micro- and nano-fabrication technologies enables our customers to successfully commercialize their new product ideas.

Nanotechnology for Various Applications

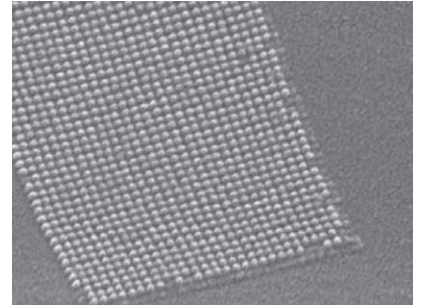
EVG process technologies like nanoimprinting, hot embossing, micro-contact printing as well as adhesive bonding enable the production of device structures with feature sizes from 100 μm to 10 nm. Application areas are bio- and medical devices, sensors, MEMS and photonic structures.



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



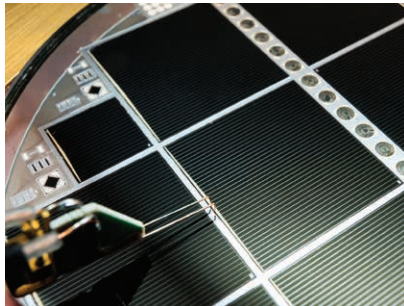
Photonic crystals for light extraction of LEDs



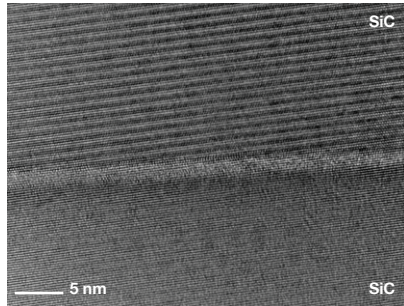
12.5 nm dots

Bonding «Anything on Anything» EVG® ComBond®

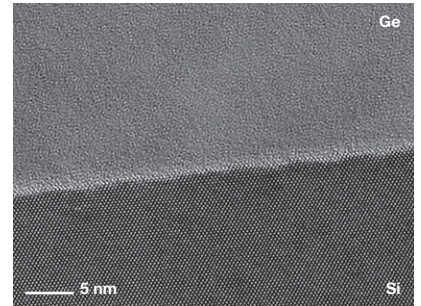
The EVG ComBond platform combines several technology breakthroughs to enable the formation of bond interfaces between heterogeneous materials at room temperature while achieving excellent bonding strength and electrical conductivity. The novel oxide-free bonding technique is particularly beneficial for silicon photonics, high-vacuum MEMS packaging, and compound semiconductor and other advanced engineered substrates for “beyond CMOS” applications such as high-mobility transistors, high-performance/low-power logic and radio frequency (RF) devices. The ComBond masters the crucial surface preparation steps that are needed to ensure contamination- and oxide-free bonds at room temperature.



Wafer-bonded III-V / Si multi-junction solar cell with 33.3 percent record efficiency
Courtesy of Fraunhofer ISE/A. Wekkeli



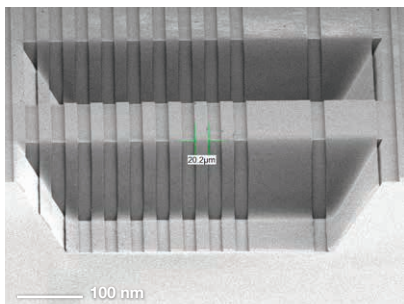
SiC - SiC Bond Interface



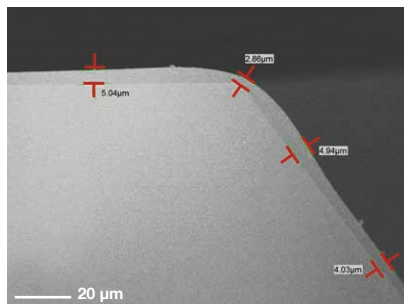
Ge - Si Bond Interface

Topography Coating

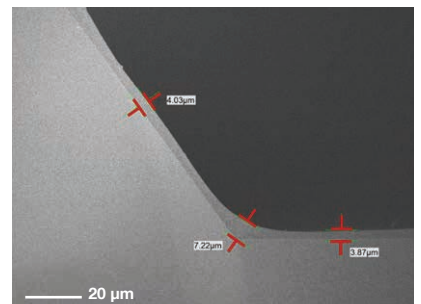
EVG has developed spray-coating technologies and equipment for topography coating, which is an essential process in 3D integration and wafer-level packaging applications. Examples are conformal coating of high aspect ratio structures like TSVs, conformal via lining for dicing streets and MEMS-cavity coatings.



High depth of focus exposure on EVG®620 NT of KOH etched cavities with a depth of 150 μm
Source: EVG



Coating of 100 μm deep cavities with 350 x 350 μm opening





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