

# EV Group

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 35 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.



## Benefits

### Multiple Equipment Functionalities / Multi-Purpose Equipment

#### EVG®620 / EVG®6200, EVG®610

- Lithography
- Nanoimprinting
- Bond alignment

#### EVG®520, EVG®510

- 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

## Multiple Use Systems for R&D or Pilot Line



## Process Services

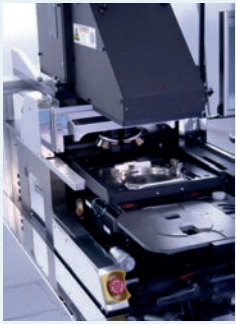
Wafer processing services on any EVG equipment including special processes such as

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

Customer tailored evaluation programs

- NIL stamps and materials
- Bonding processes
- Bonding adhesives
- Resist processing
- Debonding processes

## Lithography

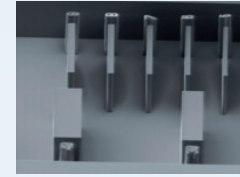


Mask aligner tooled as bond aligner

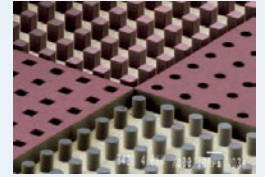
### EVG®620 / EVG®6200

- 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)

### Exposure Results

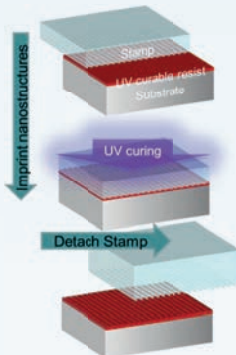


80  $\mu\text{m}$  SU-8 resist features with sidewall angles approaching 90°. Courtesy of DALSA Corporation.



SEM image 100  $\mu\text{m}$  tall SU-8 structures

## Nanoimprint Lithography (NIL)

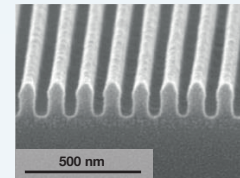


UV-NIL Process

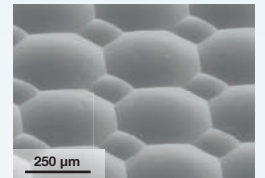
### EVG®620 / EVG®720

- 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 covers all common imprinting techniques including proprietary SmartNIL® technology
- EVG®720 is the dedicated SmartNIL® system for advanced process development and pre-commercial upscaling

### Structure Replication



Nanostructures



Microlenses

## Bonding



Chucking for alignment and bonding

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

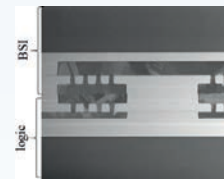
#### Wafer Bonding

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

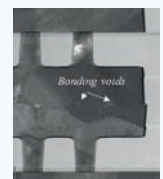
#### Features

- 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

### Interface Analysis



Hybrid Bonding of a daisy chain with 4,4  $\mu\text{m}$  pads

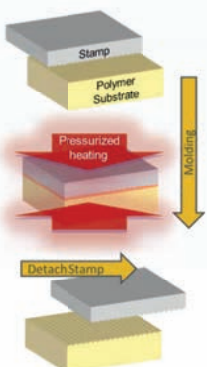


Cu-Cu bond interface

© 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

## Hot Embossing (HE)

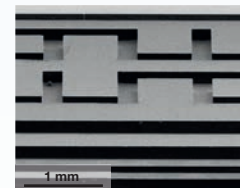


Hot Embossing Process

### EVG®500 Bonder series with hot embossing and de-embossing tooling

- Simultaneous replication of micro- and nanostructures
- Imprinting into bulk polymer materials or glass
- Suitable for spin-on thermoplastics
- Low residual stress
- High replication accuracy down to 50 nm
- High aspect ratio features

### Micro- and Nano Channels



100  $\mu\text{m}$  wide hot embossed microfluidic channels



Meander test structures (200 nm)

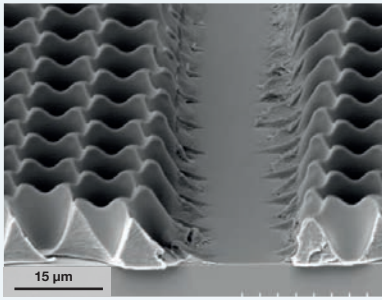


## Emerging Technologies - Shaping the Future

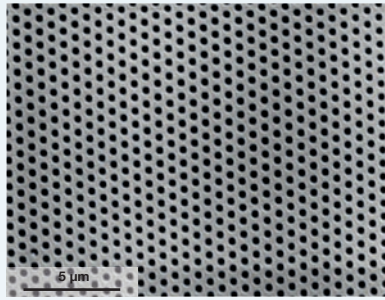
Being the first in exploring new techniques and serving next-generation applications of micro- and nano-fabrication technologies enables our customers to successfully commercialize their new product ideas.

### Nanotechnology for Various Applications

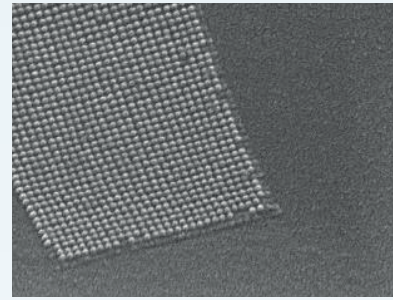
EVG process technologies like nanoimprinting, hot embossing, micro-contact printing as well as adhesive bonding enable the production of device structures with feature sizes from 100 micrometers to 10 nanometers. Application areas are bio- and medical devices, sensors, MEMS and photonic structures.



Honeycomb texturing for Photovoltaics  
(Courtesy of Fraunhofer ISE)



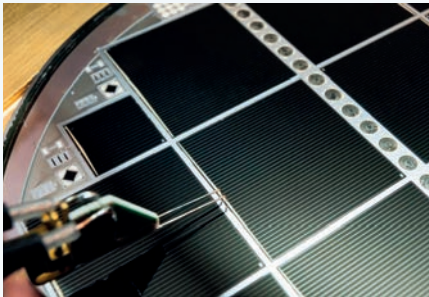
Photonic crystals for light extraction of LEDs



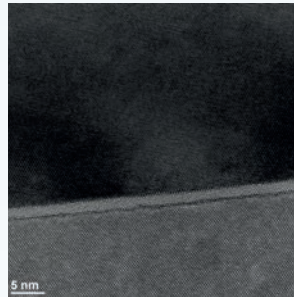
12,5 nm dots (Cooperation with IMS)

### Bonding «Anything on Anything» (EVG® ComBond®)

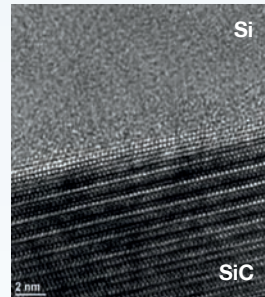
The EVG ComBond platform combines several technology breakthroughs to enable the formation of bond interfaces between heterogeneous materials at room temperature while achieving excellent bonding strength and electrical conductivity. The novel oxide-free bonding technique is particularly beneficial for 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 EVG580 ComBond masters the crucial surface preparation steps that are needed to ensure contamination- and oxide-free bonds at room temperature.



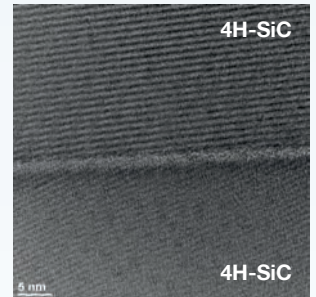
Wafer-bonded III-V / Si multi-junction solar cell with 30.2 percent efficiency ©Fraunhofer ISE/A. Wekkeli



Amorphous Layer ~1- 1,2 nm  
GaAs/Si bond



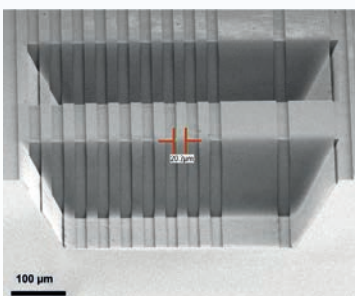
SiC/Si and SiC/SiC bonding interfaces



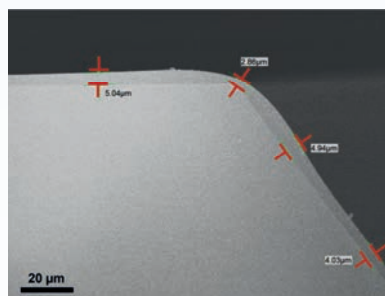
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### Topography Coating

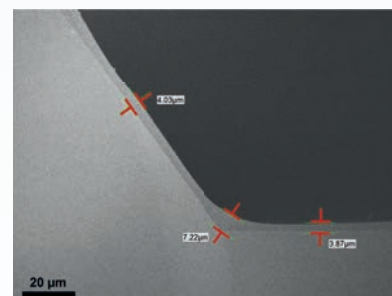
EVG has developed spray-coating technologies and equipment for topography coating, which is an essential process in 3D integration and wafer-level packaging applications. Examples are conformal coating of high aspect ratio structures like TSVs, conformal via lining for dicing streets and MEMS-cavity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



Sidewall Line/Space patterns



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



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