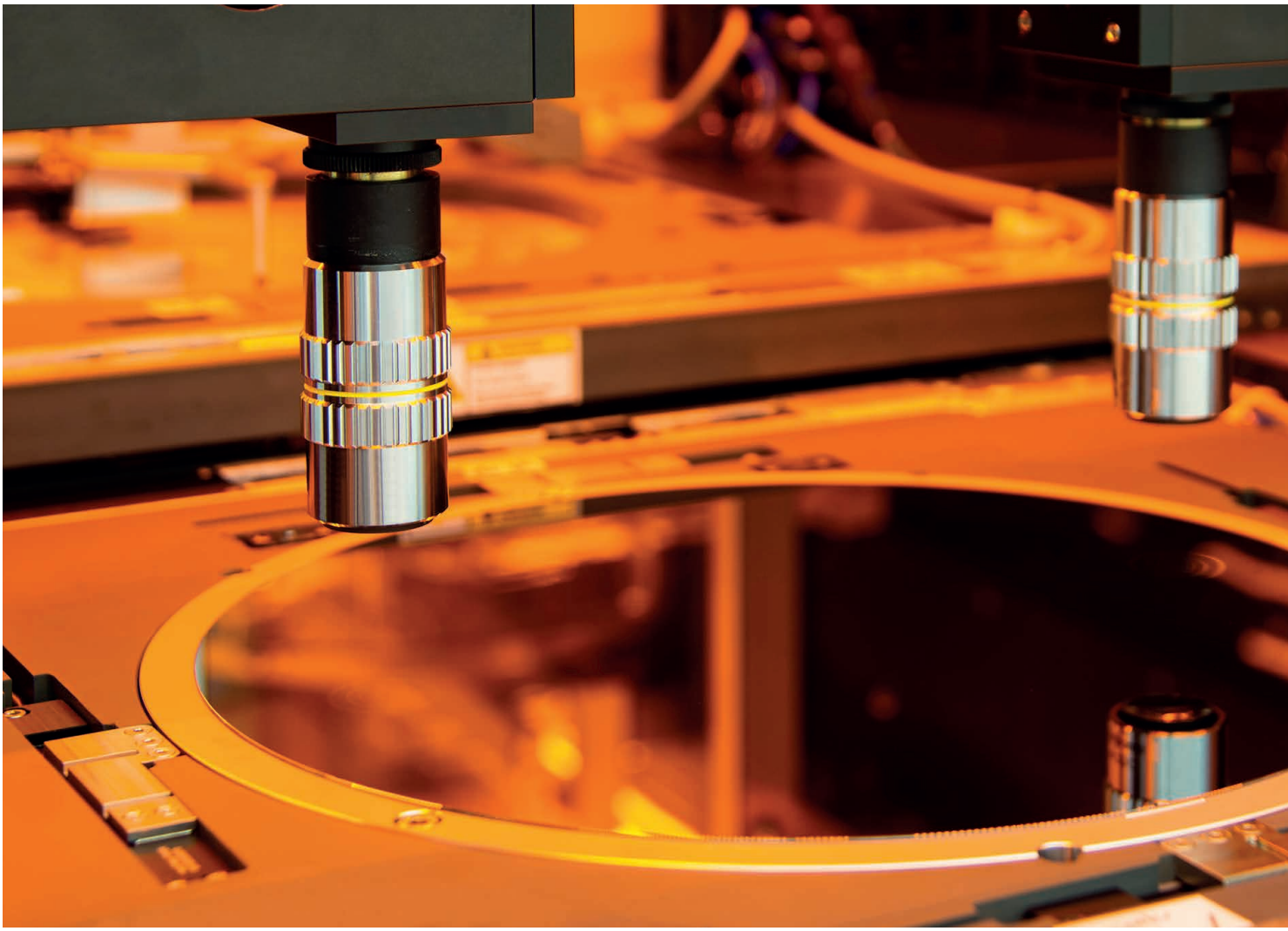
EV GROUP® | Products // Bonding // Hybrid and Fusion Bonding

GEMINI® FB BONDSCALE®



Introduction

Hybrid and fusion wafer bonding are key technologies breathing new life into semiconductor scaling. Stacked image sensors, 3D NAND, DRAM, Backside Power Delivery Network (BSPDN) and many other devices and innovative architectures use these technologies to step up their performance by stacking dies made at different manufacturing processes and specialized for unique functionalities.

GEMINI FB and BONDSCALE are state-of-the-art, fully automated wafer bonding systems engineered for high-volume manufacturing (HVM). These advanced platforms combine precise wafer-to-wafer alignment and bonding in a modular architecture – delivering exceptional process flexibility and making them ideal for diverse semiconductor applications.

EVG has over 30 years of experience in building wafer bonders and our HVM systems stand out as the global industry standards for permanent wafer bonding.

Unique Features

- Fully automated and integrated wafer bonding platforms
- State-of-the-art overlay performance
- Industry-leading throughput per fab area
- Modular concept for full process flexibility
- Smart process control and data analysis
- Edge void suppression technology
- Solutions of choice among the leading semiconductor R&D institutes and HVM fabs
- High-resolution in-situ bond wave sensing technology

Software and Support

The customized machine software EVG CIM Framework offers a variety of features that optimize your production processes and increase efficiency. The user-friendly interface allows for quick familiarization. Specifically, the intuitive recipe functionality simplifies the configuration of machine operations and process steps. The software is Microsoft® Windows based and seamlessly communicates via SECS/GEM with the factory hosts. It enables smooth and secure data exchange and integration into the existing infrastructure.

Our experienced support team is here to assist you with any questions or issues including field-proven, real-time remote diagnostics via secured connection. Cleanroom space on three different continents (Europe – HQ, Asia – Japan, North America – USA) and a decentralized worldwide support structure underline this.

In addition, our new innovative data analysis platform EVG Analytics enables you to intelligently analyze your machine data and gain valuable insights. Whether you want to perform time series analyses, process quality assessments or application-specific analyses, our product provides you with the tools to use your machine data efficiently.

Modular Concept

The modular design enables maximum flexibility while minimizing process development and ownership costs. A large number of processing modules are shared between the systems. Thus, the hardware configuration can be tailored for both HVM and R&D environments.

EVG GEMINI® FB

Technical Data	
Wafer diameter (substrate size)	300mm – SVA NT3 / 200mm – SVA NT2
Max. number of process modules	6 + SmartView® NT
Optional Features	Debond Module

EVG's GEMINI FB integrated bonding system extends current standards and combines higher productivity with improved overlay accuracy for applications requiring hybrid and aligned fusion bonding. The system is capable of achieving sub-50-nm alignment accuracy and extreme bonding fingerprint repeatability. Our chucks enable asymmetric scaling control that ensures high-precision bonding even for challenging applications involving asymmetrically warped wafers like 3D NAND.

Features

- Fully automated hybrid and aligned fusion wafer bonding applications
- New SmartView® NT3 face-to-face bond aligner with sub 50 nm wafer-to-wafer alignment accuracy
- Advanced overlay process control with in-situ measurements-based alignment feed-back
- XT Frame concept for highest throughput with EFEM (Equipment Frontend Module)
- Alignment verification and debonding modules for effect wafer rework

Shared Modules and Technologies

EVG BONDSCALE®

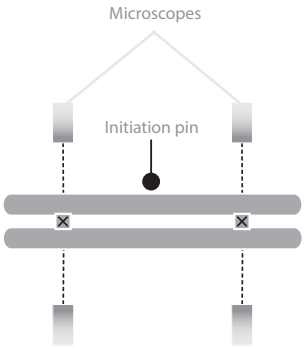
Technical Data	
Wafer diameter (substrate size)	300mm
Max. number of process modules	8
Throughput	up to 40 wafers per hour
Handling system	4 loadports
Features	■ Up to eight pre-processing modules like clean module, Low Temp™ plasma activation module available ■ XT Frame concept for highest throughput with EFEM (Equipment Fronted Module) ■ Optical edge alignment module: Xmax/Ymax = 18 µm 3σ

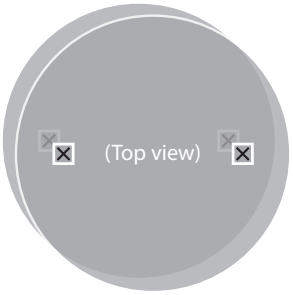
EVG's BONDSCALE integrated fusion bonding system is optimized for layer transfer applications ensuring high throughput and low cost of ownership for specific applications like BSPDN. R&D facilities report superior post-bonding lithography overlay using this solution. Applications like BSPDN and advanced memory manufacturing process flows benefit from its performance.

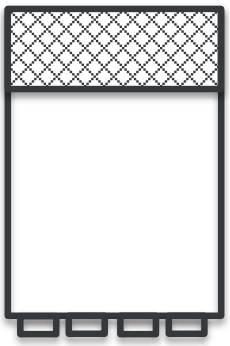
Features

- Fully automated fusion/molecular wafer bonding applications on 300-mm substrates
- Direct wafer bonding with plasma activation for heterogeneous integration of different materials, high-quality engineered substrates as well as thin-silicon-layer-transfer applications
- Edge alignment module ensuring high throughput with minimum cleanroom footprint

Smart-View® Aligner

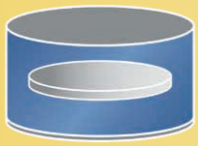






Schematic view of Smart-View NT 3 aligner inside of EVG GEMINI FB

- Smart-View NT3 aligner is the current market standard for automated bond alignment
- Leading bonding overlay spec driving R&D roadmap
- Best throughput per clean room footprint
- Advanced overlay process control
- In-situ bond wave monitoring

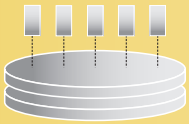


LowTemp™ Plasma Activation Module

Dual frequency technology augmented with dose monitoring ensures high stability, outstanding actuation uniformity and long-lasting adhesion.

Cleaning Module

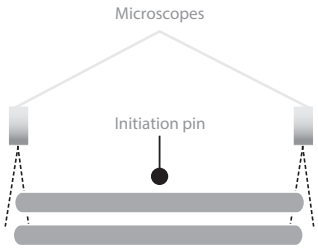
Efficient particle removal and dehydration. Advanced design enables tight front-end-of-line particle and metal cleanliness specs.

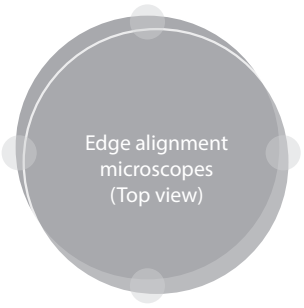


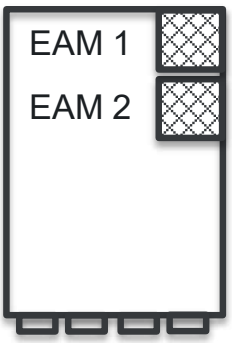
Bondwave Monitoring

High resolution bond wave sensing technology uses multiple sensors integrated into the chucks to evaluate the bond front in real time.

Edge Alignment Module



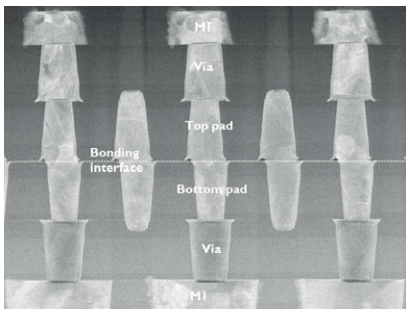




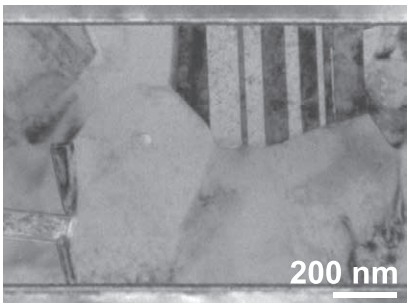
Schematic view of two edges alignment modules inside of EVG Bondscale

- Leading post-bond lithography overlay
- Smallest aligner fingerprint due to small stroke design
- Proprietary in-house advanced chuck design and manufacturing
- High fingerprint stability for efficient per-lot lithography corrections
- Edge alignment system enabling low cost of ownership and high throughput

GEMINI FB Process Results



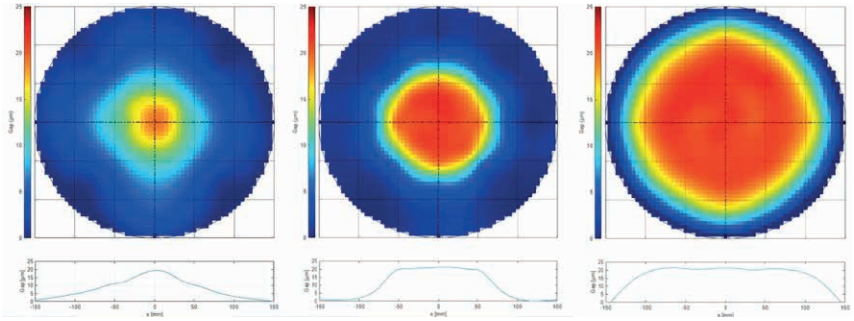
TEM of Daisy Chain structure on 300-nm pad grid with equal hybrid pad size, 20% designed Cu density. Courtesy of imec, presented at ECTC, May 2025.
(DOI:10.1109/ECTC51687.2025.00100)



Grain-growth over the initial Cu-Cu bond interface. EV Group Publication
(DOI: 10.1063/1.4932146)

High-resolution in-situ bond wave sending technology

Wafer plots illustrate bondwave propagation based on dynamic wafer gap measurements. Three key stages shown: bond initiation, several seconds into the process, and upon completion. A cross-sectional view of the wafer gap along the X-axis is displayed at the bottom of each plot.

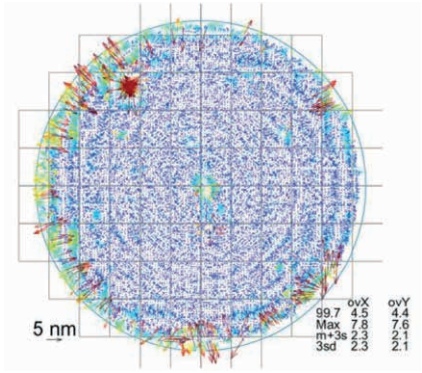


Real-time bondwave monitoring not only enables instant detection of process anomalies yet also advanced dynamic recipe control, ensuring high yield and fast reaction to the incoming processes variation. The This feature can be integrated into both EVG Gemini FB and EVG Bondscale chucks.

Bonding Fingerprint Repeatability

Wafer bonding introduces unavoidable mechanical distortions of the wafers. The reproducibility of distortion behavior is critical especially in high-volume manufacturing environments where efficiency of lot-based overlay corrections depends on the consistency of process signatures. Sub-nanometer stability over both global and localized distortions ensures that post-bond processing steps remain within tight overlay specifications, minimizing scanner non-correctables and safeguarding device performance.

BONDSCALE Process Results



Post-bond lithography corrections overlay residuals.The data illustrates the bonding-induced error correspondent to Back Side Power Delivery (BSPDN) process flow.

CPE33 actuation ability of EUV scanner of ASML is used, super high density overlay measurements with a 3mm edge exclusion.

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