

EV GROUP® | Products // Bonding // Permanent Bonding GEMINI® Series















Introduction

Aligned wafer bonding has become a key technology in the semiconductor industry, enabling advanced integration of electronic and photonic devices. The GEMINI is a state-of-the-art, fully automated wafer bonding system, designed for high-volume manufacturing. It integrates wafer-to-wafer alignment and bonding processes in a modular design, offering full process flexibility, and supports a variety of bonding processes.

The GEMINI system is particularly suited for next-generation MEMS (Micro-Electro-Mechanical Systems) manufacturing up to 300 mm, offering exceptional performance in wafer-level vacuum and overpressure encapsulation but also in advanced system integration.

EVG has over 30 years' experience in building wafer bonders and the GEMINI system stands out as the global industry standard for permanent wafer bonding in high-volume manufacturing.

Unique Features

- Fully automated and integrated wafer bonding platform
- Field-proven SmartView[®] bond alignment system
- Newly designed high-force bond chamber (for 300 mm platform)
- High bond pressure uniformity
- Rapid heating and cooling
- Optimized temperature uniformity
- Accurate chamber pressure control
- Modular concept for full process flexibility
- Smart process control and data analysis

Bond chucks

Bond chucks are used to safely and securely transport aligned wafer pairs to the bond chamber and to remove the bonded wafer pair from the bond chamber. Up to 10 bond chucks can be buffered in the system which allows for high throughput and redundancy in high volume manufacturing. Also the option to buffer different bond chucks for different bond applications enables R&D without changes to the system. Highly flexible bond chuck designs and materials enable optimization for the chosen bonding process or system customization for special applications.

Modular Concept

The modular design of the GEMINI enables maximum flexibility to meet both current and future customer needs. With up to 4 bond modules, alignment verification and various pre-processing options, the system enables configurations optimized for both High Volume Manufacturing (HVM) and R&D. The modules support a wide range of processes, including metal, anodic, glass-frit, fusion, and adhesive bonding.

Example configurations:

- 4x Bond modules
- Alignment verification module
- 1x Bond module
- LowTemp[™] plasma activation modules
- Wafer cleaning modules
- 4x Bond modules
- Coat modules
- Bake modules



HVM metal bonding with in-situ post-bond alignment control



Enable fusion and hybrid bonding as well as cavity fusion bonding



Turns the GEMINI into a HVM adhesive bond cluster

GEMINI® Automated Production Wafer Bonding System

The GEMINI[®] Automated Production Wafer Bonding System is designed to meet the most demanding requirements of semiconductor manufacturing. It supports up to 4 bond modules and, with its modular design, offers flexible configurations for both R&D and HVM. The system is equipped with Smart View[®] NT2 alignment achieving alignment accuracies of <200 nm (pre-bond).

Optional features include an ISO 3 mini environment and ionizer bars for ESD-sensitive products. The wafer handling system operates independently from the bond chuck handling system, enhancing operational efficiency. Additionally, the system features up to 2 mobile user interfaces with touchscreens and a compact footprint compared to stand-alone systems.



200 mm GEMINI®

- Wafer sizes from 100 mm to 200 mm
- EVG load ports or SMIF load ports
- Bond force up to 100 kN
- Overpressure capability up to 3000 mbar
- Different system layouts with up to 4 pre-process module slots



300 mm GEMINI®

- Wafer sizes from 200 mm to 300 mm
- FOUP load ports (optional adapter for 200 mm substrates)
- EFEM
- Bond force up to 350 kN
- Overpressure capability up to 2000 mbar
- Different system layouts with 2 to 6 pre-process module slots

Bond Module Options

200 mm GEMINI®

Bond Module Force Options	10 kN	20 kN	60 kN	100 kN			
Force Range	100 N – 10 kN	200 N – 20 kN	700 N – 60 kN	1,5 kN – 100 kN			
Substrate Size	100 mm – 200 mm						
Gas pressure range	5x10 ⁻⁶ mbar – 3000 mbar abs.						
Max. Temperature	550 °C						



300 mm GEMINI®

Bond Module Force Options	10 kN	20 kN	60 kN	100 kN	200 kN	350 kN			
Force Range	100 N – 10 kN	200 N – 20 kN	700 N – 60 kN	1,5 kN – 100 kN	10 kN – 200 kN	10 kN – 350 kN			
Substrate Size	200 mm – 300 mm								
Gas pressure range		5x10⁻ ⁶ mbar – 1	5x10 ⁻⁶ mbar – 2000 mbar abs.						
Max. Temperature	550 °C				450 °C				

Modules

Bond Module Supports all mainstream bonding processes other than UV adhesive bonding.

SmartView[®] NT2 Wafer-to-wafer alignment prior to wafer bonding.

Cleaning Module Efficient particle removal and dehydration for fusion bonding.

LowTemp[™] Plasma Activation Module LowTemp[™] plasma activation for fusion bonding.

Alignment Verfication Module IR light wafer alignment verification after permanent bonding.

Spin Coat Module Application of adhesive layers prior to wafer bonding.

Bake/Chill Module Processing adhesive layers after coating and before bonding.

UV-Bond Module Supports UV initiated adhesive bonding.

De-bond Module De-bonding of temporary bonds and fusion bonds.

IR Inspect Module Bond void inspection after fusion bonding.

Software and Support

The customized machine software EVG CIMFramework 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.































Process Results



Cross section of a Cu:Sn bonding layer Courtesy of Siemens



Low-temperature Cu-In-Sn wafer level Solid Liquid Interdiffusion (SLID) bonding at 170 °C Source: EV Group Publication (DOI: 10.109/TCPMT.2021.3111345)



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



SEM image of a MEMS device bonded to an ASIC using Al-Ge eutectic bonding system Courtesy of Chipworks



Al-Ge eutectic bonding in the structure part of a multilayer stacked MEMS device Source: EV Group Publication (DOI:10.1109/ECTC51529.2024.00342)



Glass-frit bond interface Courtesy of ST Microelectronics

Alignment Capabilities

The GEMINI provides a SmartView[®] bond alignment system with multiple options. Its proprietary face-to-face alignment method enables high-precision alignment of non-transparent substrates with keys in the bond interface. In addition, transparent face-to-face and backside alignment is supported. Optionally, the SmartView[®] system can be equipped with a mechanical alignment station.





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