Perform comprehensive characterization with highest resolution

ZEISS GeminiSEM FE-SEM Family

Physical analysis and routine measurement
for semiconductor coupon, wafer, or package

zeiss.com/geminisem

Seeing beyond

Resolve your biggest challenges with nanometer-scale precision

In the competitive semiconductor industry, market viability demands constant improvements in efficiency, performance, and yield. Physical analysis is a critical step in realizing these improvements, and is frequently used throughout development and manufacturing processes. Engineers face challenges of material complexity, increasing interconnect density, and shrinking feature size – at both the wafer level and in the assembled semiconductor package.

Your trusted ally in navigating complex challenges

Scanning electron microscopes support problem-solving throughout the semiconductor value chain, from die-level yield challenges on mid-process coupons to reliability challenges during burn-in of advanced packages, and root cause analysis of field returns.

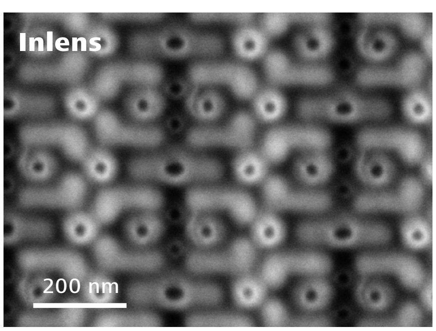
200 mm wafer capable chamber option

As the size and complexity of devices increase, there is a need to accommodate ever larger samples without compromising microscope performance. ZEISS GeminiSEM FE-SEM family rises to the challenge with a market-exclusive large chamber option that accommodates a 200 mm wafer. Its linear translation stage reaches any point on the wafer without rotation, simplifying workflows for metrology, defect review, or physical analysis. This feature ensures seamless microscopy workflows on complete wafers up to 200 mm, offering the full flexibility of a lab FE-SEM to find the optimal imaging recipe for your sample type. As advanced packages grow larger, ZEISS GeminiSEM accommodates physical analysis with minimal sample preparation, providing greater spatial context and enabling more frequent intermediate imaging steps.

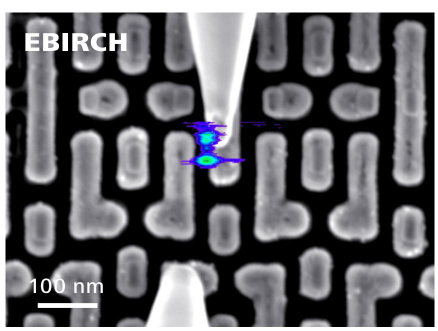
From low- to high-resolution imaging and uncompromised analytics with automation

For package-level analysis, GeminiSEM excels in surface-sensitive imaging and superior contrast, preserving device integrity while exploring complex packaging architectures automatically from extreme large field of view down to high-resolution imaging, e.g., detecting defects in package interconnects. Guided automated workflows can enhance efficiency and reduce time-to-results for such multi-scale correlative analysis.

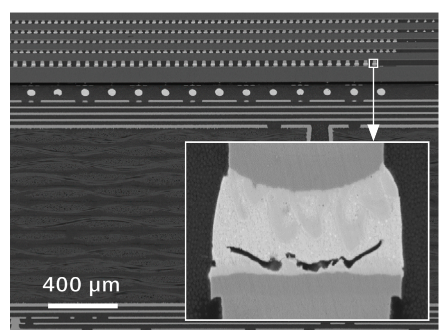
For die-level analysis, GeminiSEM FE-SEMs deliver high-resolution imaging essential for examining shrinking transistor sizes and beam-sensitive materials, utilizing low acceleration voltages and currents. Engineers can ensure precise die-level analysis by optimizing the working distance and selecting between Inlens and EsB detectors. Additionally, nanoprobing capabilities require low-kV beam energies and a magnetic field-free chamber, making GeminiSEM ideal for addressing fault isolation techniques.



***Die-level physical analysis** – Voltage contrast on a 5 nm logic device at contact layer. The Inlens detector provides a Passive Voltage Contrast (PVC) image of buried features in the sample.*



***Fault isolation** – Electron Beam Induced Resistance Change (EBIRCH) overlay image of a short. GeminiSEM imaging capabilities at ultra-low beam energies, combined with its magnetic field-free chamber design, make it superior for characterizing interactions between the e-beam and sample in a nanoprobing setup.*



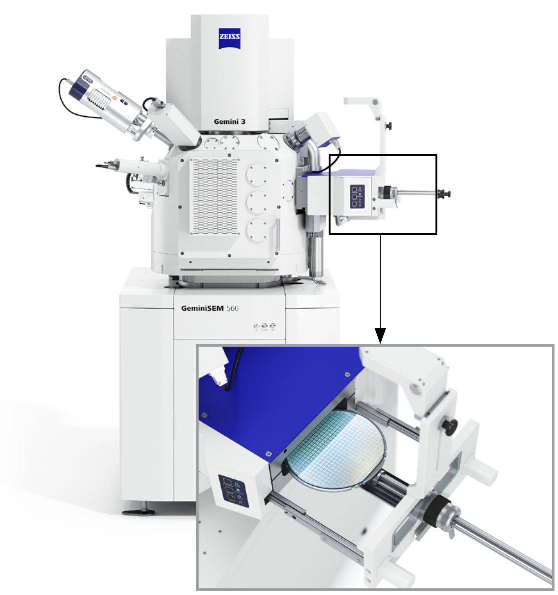
***Package-level and interconnect analysis** – Extreme field of view imaging of a cross-section showing 2.5D interposer package interconnects. Inset: close up shows a solder crack in 20 µm microbump. GeminiSEM can handle single frames of up to 50k x 50k pixels and can be equipped with powerful automation software for large area mosaic imaging.*

Key features & benefits

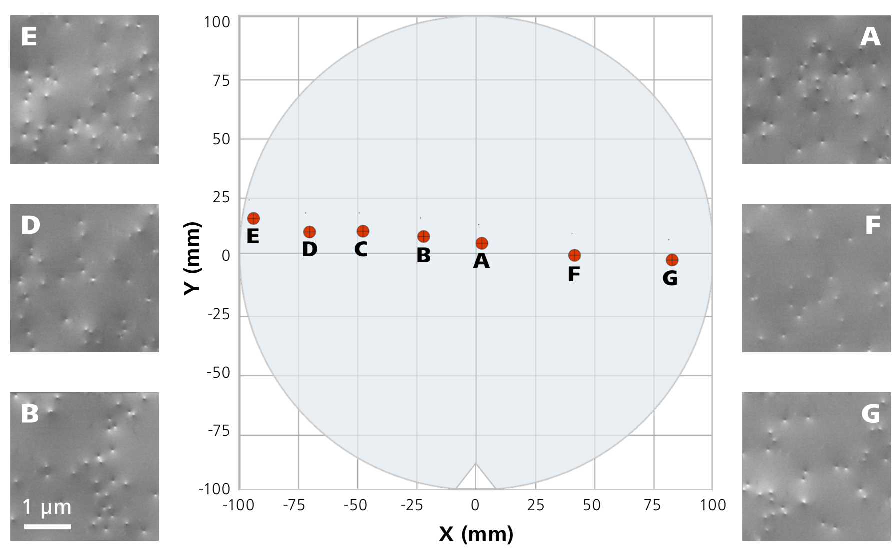
- **High-resolution imaging:** Enables detailed examination of shrinking transistor sizes and complex device structures, without residual electromagnetic interactions, beam damage, and frequent beam adjustments, addressing the challenge of diagnosing defects in miniaturized devices and package interconnects.
- **Flexible chamber options:** Standard chamber for coupon and die workflows, and small wafers up to 150 mm. Large chamber for up to full 200 mm wafer workflows and larger packages used in specialized applications such as high-performance computing. The high precision (HP) stage option for both chambers also includes linear translation across 200 mm area, ideal for metrology and easy navigation without sample rotation. Note: the large chamber can also load 300 mm wafers to enable investigation of a selective area near the center.
- **Outstanding contrast modes:** Unique electron columns (each optimized for its purpose), along with optimally positioned energy-selective in-column and chamber detectors provide high-fidelity imaging. Exceptional voltage contrast, surface, material and grain contrast, as well as electron channeling contrast, enables deep informational content for physical analysis.
- **Seamless integration of analytical techniques:** Supports comprehensive suite of analytical detectors, essential for both die-level and package-level analysis, streamlining correlative workflows.
- **Nanoprobing capabilities:** Utilizes low-kV beam energies and a magnetic field-free chamber for precise fault isolation, addressing the evolving challenges in modern die solutions.

Key applications

- Construction analysis and benchmarking
- Material and failure analysis
- Electrical fault isolation
- Large area automated imaging for advanced packaging
- Electron Channeling Contrast Imaging (ECCI)
- Passive Voltage Contrast (PVC)
- Advanced electrical characterization
- Electron Beam Induced/Absorbed Current (EBIC/EBAC)
- Electron Beam Induced Resistance Change (EBIRCH) and advanced nanoprobing



GeminiSEM for both high resolution imaging and sample flexibility, including full 200 mm wafer access through the airlock.



Multiple Electron Channeling Contrast Imaging (ECCI) views from a single 200 mm GaN-on-Si wafer reveal bulk dislocations. These images demonstrate the exceptional stage and imaging stability across the full range of travel avoiding stage rotation error sources.

Chamber specifications

	Large chamber (wafer and large packages)*	Standard chamber
Specimen chamber dimension	520 mm inner diameter and 307 mm height	330 mm inner diameter and 270 mm height
Free accessory ports	22 free ports for optional accessories	15 free ports for optional accessories
Stage options	6-axis super-eucentric stage	5-axis eucentric or 6-axis super-eucentric stage
Stage travel	202 mm x 202 mm stage travel	150 mm x 150 mm stage travel
Stage accuracy	3 µm (500 nm with HP stage option)	3 µm (500 nm with HP stage option)
Loadlock	200 mm	Optional 80 mm or 200 mm
Transfer rod	Heavy duty	Standard
Airlock rails	Extension	Standard
Camera add-ons	Extended navigation CCD at airlock (full FOV of 200 mm wafer)	Optional navigation CCD at airlock

* Chamber options for either die and coupon, or full 200 mm

Technical specifications

	ZEISS GeminiSEM 560	ZEISS GeminiSEM 460	ZEISS GeminiSEM 360
Resolution**	0.4 nm @ 30 kV (STEM)	0.6 nm @ 30 kV (STEM)	0.6 nm @ 30 kV (STEM)
	0.5 nm @ 15 kV	0.7 nm @ 15 kV	0.7 nm @ 15 kV
	0.4 nm @ 15 kV / DCV***	0.5 nm @ 15 kV / DCV***	0.5 nm @ 15 kV / DCV***
	0.7 nm @ 1 kV TD	1.0 nm @ 1 kV / 500 V TD	1.0 nm @ 1 kV TD
	0.8 nm @ 1 kV	1.1 nm @ 1 kV / 500 V	1.2 nm @ 1 kV
	0.7 nm @ 1 kV / DCV***	0.9 nm @ 1 kV / DCV***	1.0 nm @ 1 kV / DCV***
	1.0 nm @ 500 V	1.5 nm @ 200 V	—
Analytical resolution	—	2.0 nm @ 15 kV, 5 nA, WD 8.5 mm	—
Inlens BSE resolution	1.0 nm @ 1 kV	1.2 nm @ 1 kV	1.2 nm @ 1 kV
Resolution in NanoVP mode (30 Pa)	1.4 nm @ 3 kV	1.4 nm @ 3 kV	1.4 nm @ 3 kV
	1.0 nm @ 15 kV	1.0 nm @ 15 kV	1.0 nm @ 15 kV
Acceleration voltage		0.02 - 30 kV	
Probe current	3 pA - 20 nA	3 pA - 40 nA	3 pA - 20 nA
	(100 nA configuration also available)	(100 nA configuration also available)	(100 nA configuration also available)
Maximum field of view in high resolution mode	1.6 mm @ 1 kV and WD = 7 mm	5 mm @ 5 kV and WD = 8.5 mm	5 mm @ 5 kV and WD = 8.5 mm
Maximum field of view in overview mode	5.6 mm @ 15 kV and WD = 8.5 mm		
	130 mm @ max. WD (ca. 50 mm)		
Magnification	1 - 2,000,000	8 - 2,000,000	8 - 2,000,000

** Upon final installation, the resolution is proven in the systems acceptance test at 1 kV and 15 kV in high vacuum.
*** Digital resolution (deconvoluted)

Carl Zeiss Microscopy GmbH
07745 Jena, Germany
microscopy@zeiss.com
www.zeiss.com/geminisem

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