

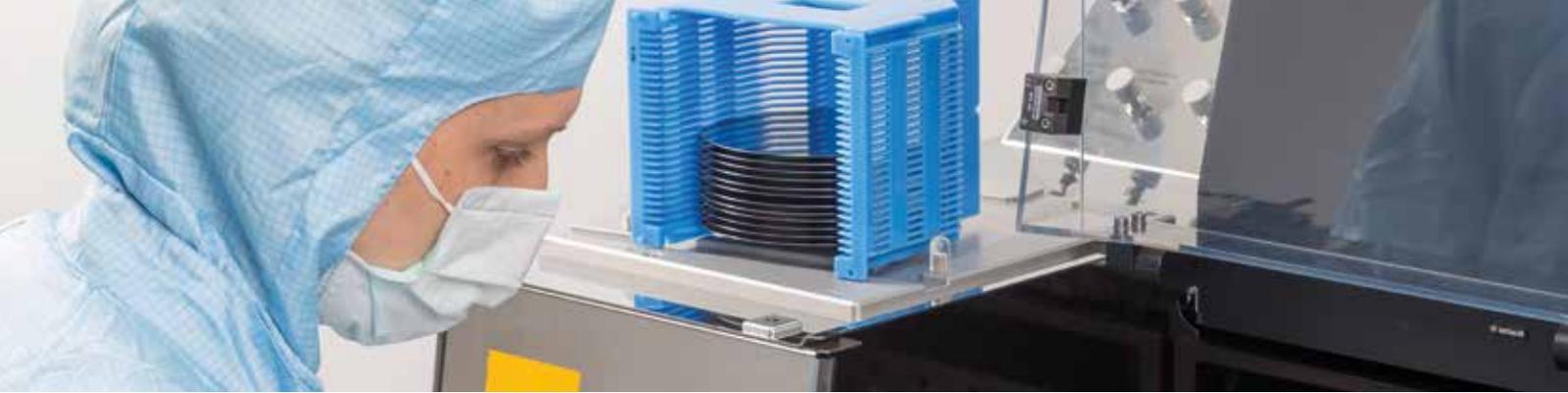
SEMI-AUTOMATED MASK ALIGNER

SUSS MA/BA Gen4 Series

COMPACT MASK ALIGNER PLATFORM

FOR RESEARCH AND LOW-VOLUME PRODUCTION





SEMI-AUTOMATED MASK ALIGNER

SUSS MA/BA Gen4 Series

SMART FULL-FIELD EXPOSURE TOOL

The MA/BA Gen4 series represents the latest generation of SUSS MicroTec's semi-automated Mask and Bond Aligner introducing a new platform system. There are two platform types that differ in configuration. The MA/BA Gen4 is suited for standard processes and the MA/BA Gen4 Pro Series is designed for advanced and high-end processes.

The MA/BA Gen4 series is the entry-level model, available as MA/BA6 Gen4 and MA/BA8 Gen4. With its enhanced ergonomic and user-friendly design, cost efficiency and reduced footprint, it is the perfect tool for use in research and low-volume production.

SUSS MicroTec's MA/BA Gen4 series is setting a new benchmark in full-field lithography for academia, MEMS & NEMS, 3D integration and compound semiconductor markets. It is also prepared to handle processes like bond alignment, fusion bonding and SMILE imprint.

Processes developed on the MA/BA Gen4 series can be quickly transferred onto SUSS MicroTec's automated mask aligner platforms for high-volume production.

OPTIONS

- + High precision wafer-to-wafer alignment
- + Imprint lithography for full-surface patterning (SMILE)
- + Fusion bonding
- + Bond Alignment
- + LAB Simulation Software
- + Source-Mask Optimization



MA/BA Gen4 Series HIGHLIGHTS

- + High level of automation
- + Superior top-side, bottom-side, and infrared alignment technologies
- + Handles multiple substrate shapes and sizes
- + Reliable processing of fragile, warped or uneven surfaces
- + Enhanced ergonomic design



APPLICATIONS IN RESEARCH AND PRODUCTION



MEMS

The highly uniform, light-shaping exposure optics of the MA/BA Gen4 series is ideal for processing thick-resist MEMS applications. Features like bottom-side or infrared alignment (transmission or reflective illumination), bond alignment and the capability to process any type of substrate make the platform an enabling lithography tool for development and low-volume production of MEMS devices.



ACADEMIA

The MA/BA Gen4 series is versatile and easy to use, which makes it the tool of choice for research applications. Whether deployed for nanoimprint lithography, bond alignment or thick-resist lithography applications, changeover to different processes is quickly executed, guaranteeing high flexibility. Optional add-ons such as auto and direct alignment offer special guidance and assistance for inexperienced operators.



3D STRUCTURING

The MA/BA Gen4 series can optionally be equipped with SMILE (SUSS MicroTec's Imprint Lithography Equipment), an imprint lithography technology that allows very precise replication of both micro- and nanopatterns. SMILE is used in the field of 3D structures and optical lenses for wafer-level-cameras.



PRECISION — RELIABLE

ALIGNMENT METHODS

TOP-SIDE ALIGNMENT (TSA)

The MA/BA Gen4 series can be equipped with a highly precise top-side alignment system. It reliably supports an alignment accuracy down to $0.25\mu\text{m}$ (requires certain parameters), supported by auto or direct alignment.

BOTTOM-SIDE ALIGNMENT (BSA)

Many applications such as MEMS packaging require alignment on both sides of the substrate. The MA/BA Gen4 series can optionally be equipped with bright-field bottom-side microscopes, providing for alignment accuracy of $< 1\mu\text{m}$.

INFRARED ALIGNMENT (IR)

Infrared alignment allows for processing opaque, yet IR-transparent materials such as GaAs, InP, silicon or adhesives, as used in thin wafer handling or encapsulation applications. The MA/BA Gen4 series is optionally equipped with either a transmissive or reflective IR toolset attached to the standard BSA microscopes.

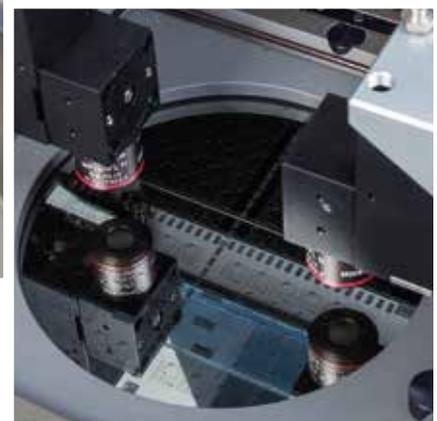
ALIGNMENT UNIT

FACE-TO-FACE MICROSCOPES

Alignment accuracy benefits from a very stiff mechanical design allowed by TSA and BSA being mounted on the same rail, enabling reduced movement of the microscope unit. Another benefit from this new compact design is the small footprint.

DIGITAL MICROSCOPES AND CAMERAS

Alignment is based on high-resolution digital microscopes and cameras achieving excellent alignment results. The state-of-the-art digital vision systems of the MA/BA Gen4 series allow for a very large field of view, making direct viewing redundant. A mechanical magnification switch is no longer required.



ABILITY — EASE OF USE

ALIGNMENT

MODES

MANUAL ALIGNMENT

This mode is based on manual operation of alignment via joystick. The operator himself decides on the quality of the process.

AUTO ALIGNMENT

The COGNEX®-based system not only automatically recognizes wafer and mask target locations but also controls the movement of the alignment stage. The alignment runs fully automated without operator intervention.

DIRECTALIGN®

The software-assisted operation mode works with live images instead of stored alignment targets and reliably achieves accuracies down to 0.25 μm . DirectAlign is recommended where high demands are made on alignment accuracy.





OPTICS AND LAMP HOUSE

TAILORED SOLUTIONS FOR ANY REQUIREMENT

UV-LED LAMP HOUSE

The UV-LED lamp house concept of the MA/BA Gen4 series is highly efficient - UV-LED light sources reach many times the service life of conventional mercury vapor lamps. Moreover, they no longer need to warm up and cool down since the LED is only switched on during exposure. These factors significantly contribute to comparatively low energy consumption.

Compared to conventional mercury vapor lamps, LED light sources not only work more efficiently but are also much more flexible to use. The UV-LED lamp house generally covers the same spectral region as mercury vapor lamps. The difference is that the UV-LED allows to switch specific wave lengths on and off according to process requirements. This eliminates the need to optically filter the light outside of the lamp house. Spectral settings can be easily handled via standard recipe parameters without filter change or recalibration.

The operation of the MA/BA Gen4 series significantly reduces the operating cost of the system. The service life of an LED exceeds that of conventional lamps many times over, thereby lowering costs generated by changing light bulbs. Downtimes, acquisition of new lamps, adjustments and disposal of old material belong to the past. Working with the LED lamp house is both safe and environmentally sound and is a major step up in health and occupational safety, as well as in environmental protection.

MO EXPOSURE OPTICS® (MOEO)

SUSS MO Exposure Optics is based on unique high-quality microlens arrays that are combined with an exchangeable Illumination Filter Plate (IFP). These simulate changing exposure optics, thus making the use of additional optics components redundant. The optical system excels in light uniformity.

MO Exposure Optics additionally allows customized illumination through modification of the IFP and enables use of enhanced lithography techniques such as Source-Mask Optimization (SMO) or Optical Proximity Correction (OPC).



EXPOSURE

UNIQUE ILLUMINATION OPTICS FOR MAXIMUM FLEXIBILITY

EXPOSURE MODES

The MA/BA Gen4 series provides various exposure modes to meet requirements for a broad range of applications. Soft, hard and vacuum contact printing is used to achieve highest resolution down to submicron range. Proximity printing is used to avoid any mask/wafer contact. Preventing mask contamination directly translates into higher yield and lower cost.

The MA/BA Gen4 series can be equipped with either a 350W lamp house or with a UV-LED lamp house equivalent to a 1000W UV400 mercury lamp.

EXPOSURE MODE	UV400		UV300	UV250
	150	200		
Vacuum Contact	<0.8 μm	<1.5 μm	<0.7 μm	<0.6 μm
Hard Contact	<1.5 μm	<2.0 μm	<1.0 μm	-
Soft Contact	<2.5 μm	<3.0 μm	<2.0 μm	-
Proximity (20 μm)	<3.0 μm	<3.5 μm	<2.5 μm	-

Line, Space resolution achieved on 150/200mm Si-wafer in 1.2 μm thick resist AZ 4110 (UV400, UV300) and 0.8 μm thick resist (UV6, UV250) respectively.

Achievable resolution depends on wafer size, wafer flatness, resist type, clean room condition, and therefore, might vary for different processes.



WAFER LEVELING AND EXPOSURE GAP CONTROL

PRECISION FOR HIGHEST RESOLUTION

Accurate leveling and gap control of mask and wafer is essential for optimum CD control. It ensures the parallelism of mask and substrate during alignment and exposure, as well as precise gap control, to avoid parallax errors and to achieve higher resolution. The leveling and gap calibration system of the MA/BA Gen4 series is designed to fulfill the highest demands for accuracy and reliability.



OPTIONS

OPTIONAL ENHANCEMENTS

BEYOND LITHOGRAPHY

BOND ALIGNMENT

The MA/BA Gen4 series can be configured as a mask and bond aligner combination or as a bond aligner only. The BA Gen4 bond aligner aligns wafers and clamps them in fixtures to maintain position during manual transfer to SUSS wafer bonders. The innovative system meets customer needs for high precision, flexibility and repeatability, as well as low cost of ownership.

The highly rigid and stable alignment stage of the bond aligner in combination with auto alignment options ensures reliable and accurate alignment of substrates. The proven SUSS MicroTec wedge error compensation system guarantees high planarity between wafers. The BA Gen4 series accommodates even the most demanding alignment processes in MEMS and LED production and growth markets like 3D integration.

FUSION BONDING

Fusion bonding refers to spontaneous adhesion of two planar substrates. The preceding pre-bonding process is also accomplished in the bond aligner. After completing precise wafer-to-wafer alignment, the two wafers are brought into direct contact, thus initiating the fusion bond process in the bond aligner.



OPTIONS

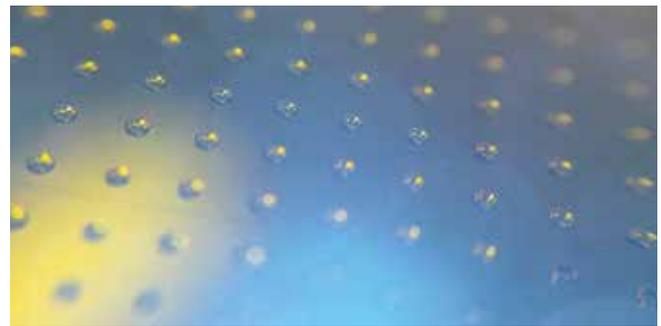
OPTIONAL ENHANCEMENTS BEYOND LITHOGRAPHY

SUSS MICROTEC IMPRINT LITHOGRAPHY EQUIPMENT (SMILE)

For the transfer of patterns in the micro to nanometer region the MA/BA Gen4 series offers SMILE technology.

There are two process types, of which the use depends on the desired resolution:

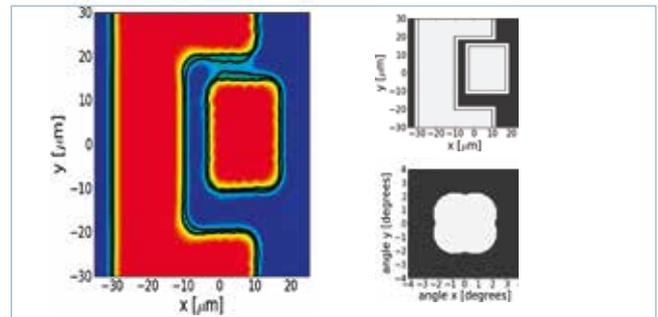
- + For imprinting of micro structures, the photosensitive polymer is deposited in the center of the substrate and then radially spread to its outer edge, filling the stamp cavities. The active control over the exact positioning of the process gap via closed feedback loop leads to high reliability in targeting residual layer thickness.
- + To imprint nanostructures, a flexible stamp is used to contact the center of a coated substrate and the contact is then radially widened.



Both processes allow for very precise replication of both micro- and nanopatterns, offering a great variety of application possibilities. SMILE is used, for instance, in the production of 3D structures and optical lenses for wafer-level cameras.

LAB® SIMULATION SOFTWARE

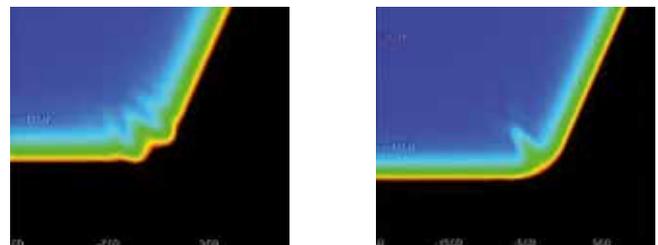
SUSS version of LAB lithography simulation software incorporates all SUSS MicroTec optics solutions, such as HR-, LGO and MO Exposure Optics, including their individual characteristics. The software reduces the need for experimental layout optimization and simplifies process development. Together with MO Exposure Optics, LAB simulation software is the enabling technology for mask aligner source-mask optimization.



Software simulation of critical features and shortenings, optimized with customized illumination and OPC. Courtesy: FhG IISB

SOURCE-MASK OPTIMIZATION

Source-mask optimization is an illumination concept that combines best possible uniformity with flexibility to support target-adapted process solutions. It helps to reduce image errors due to diffraction or process effects. A two-pronged approach of customizing illumination filter plates and mask structure adaption helps to bring extended functionality to both, contact and proximity lithography processes.



Structures before and after process optimization with sourcemask optimization



SUSS MA/BA Gen4 Series

TECHNICAL DATA

MASK AND WAFER / SUBSTRATE

Wafer Size	1" to 150 or 200 mm
Max. Substrate Size	150 x 150 mm
Min. Pieces	5 x 5 mm
Wafer Thickness	max. 10 mm
Mask Size	standard 2" x 2" up to 7" x 7" (SEMI) or up to 9" x 9" (SEMI)

EXPOSURE MODES

Contact	soft, hard, vacuum
Proximity	exposure gap 1–300 µm
Gap Setting Accuracy	1 µm
Vacuum Contact	adjustable to -80 kPa
Modes	constant power, constant dose
Options	flood exposure, split exposure

EXPOSURE OPTICS

Resolution	see page 8
Wavelength Range	UV400 350–450 nm UV300 280–350 nm UV250 240–260 nm
Exposure Source	Hg lamp 350 W HgXe lamp 500 W UV LED lamp house
Intensity Uniformity	< 2.5 % (200 mm)

ALIGNMENT METHODS

Top-Side Alignment (TSA)	accuracy < 0.5 µm
Bottom-Side Alignment (BSA)	accuracy < 1.0 µm
TSA Focus Range	40 mm
BSA Focus Range	11 mm

ALIGNMENT STAGE

MA Movement Range	X: ±5 mm Y: ±5 mm θ: ±5°
BA Movement Range	X: ±3 mm Y: ±3 mm θ: ±3°
Resolution	0.04 µm

TOPSIDE MICROSCOPE (TSA)

Movement Range	6"	8"
	X: -10–100 mm Y: ±22 mm (optional: ±70 mm)	X: -10–125 mm Y: ±22 mm (optional: ±70 mm)

BOTTOMSIDE MICROSCOPE (BSA)

Movement Range	6"	8"
	X: -10–100 mm Y: ±22 mm	X: -10–125 mm Y: ±22 mm

GRAPHICAL USER INTERFACE

Windows 7
Storage of Recipes
Remote Access Available

UTILITIES

Vacuum	<-0.8 kPa
Compressed Air	0.6–0.8 MPa
Nitrogen	>0.5 MPa

POWER REQUIREMENTS

Power	voltage AC 230V ± 10 % frequency 50–60 Hz
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PHYSICAL DIMENSIONS

Width x Depth	1173 x 1000 mm = 1.12 m ²
Height	1860 mm
Weight	~ 300 kg

OPERATOR SAFETY AND ERGONOMICS

SEMI S2 Certificate
SEMI S8 Certificate
EMC
CE Compliant

Data, design and specification depend on individual process conditions and can vary according to equipment configurations. Not all specifications may be valid simultaneously. Illustrations, photos and specifications in this brochure are not legally binding. SUSS MicroTec reserves the right to change machine specifications without prior notice.

NORTH AMERICA

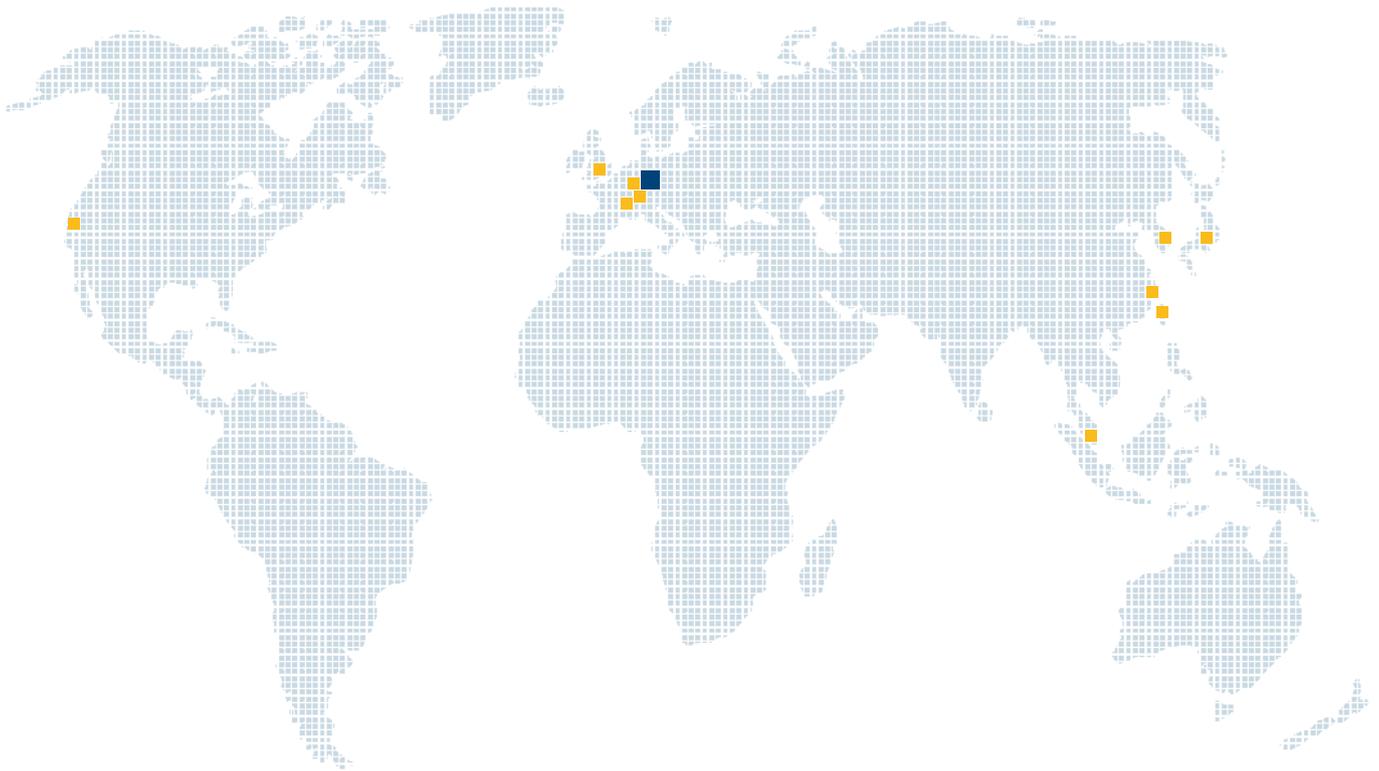
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