Lithography

Bonding

Wet Processing

Testing

MANUAL HIGH PRECISION MASK & BOND ALIGNER

MA/BA 6

MASK ALIGNER/BOND ALIGNER

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SÜSS MicroTec

Universal Full-Field Exposure Aligner

The SUSS MA6 Mask Aligner is regarded as the benchmark in semiconductor submicron research and 3D micro-system production. The innovative system meets customers needs for precision, flexibility and low cost of ownership.

The MA6 enables processes designed for a laboratory environment to be easily transferred to volume SUSS Production Mask Aligners (MA150) because they share key components.

The MA6 is designed for all standard lithography applications. For thick resist MEMS applications the MA6 offers high quality exposure optics for high resolution and optimum edge quality. The Bottom Side Alignment option allows for pattern printing on both sides of the substrate. In addition the MA6 offers tailored features for fragile III-V compounds, thinned or warped wafers, transparent substrates, as well as pieces or single dies.

The MA6 can be easily retrofitted with a bond aligning option, converting the system to a BA6 for high accuracy fixture or fixtureless bond alignment.

Features and benefits

- *Top / bottom side / infrared alignment*
- *Accurate and precise gap setting for higher yield*
- *High-quality, diffraction reduction exposure optics for high resolution*
- *Optimum edge quality with thick resist*
- *Reliable sub-micron printing*
- *Processing of fragile wafers and pieces*
- *High intensity light sources reduce process time*
- *High accuracy fixture and fixtureless bond alignment option*
- *Aligned cold embossing option for full wafer printing of geometries in nanometer range*
- *Near Field Holography option for one and two dimensional optical gratings*
- *For wafers from 2″–150 mm (substrates from 2″×2″ to 6″×6″)*
- *Pieces down to a few millimeters*

Exposure System

Full Field Exposure

The UV exposure optics of the MA6 offers full field exposure, which means it is capable of exposing the whole wafer in a single shot. The optical setup is optimized for steep wall slopes and high resolution.

Diffraction Reducing Exposure Optics

Diffraction effects at the mask feature edges usually limit the achievable resolution. As the only supplier worldwide SUSS offers a diffraction reducing exposure system, which performs simultaneous exposure with a discrete number of illumination angles that smoothen the printed features. A technology that causes significant improvement of resolution and yield steep walls.

Exposure Modes

The MA6 handles both proximity and (soft, hard, vacuum) contact printing, allowing for a resolution of 2.5 µm in proximity mode and sub-micron in vacuum contact mode. Depending on the optical wavelength.

Wafer Leveling

Accurate leveling of mask and wafer is essential for optimum CD-control. The leveling and gap calibration system of the MA6 is designed to satisfy highest demands regarding accuracy and reliability.

Alignment

Top Side Alignment

The MA6 is equipped with a motorized Topside Alignment System providing a high precision alignment accuracy of ±0.5 µm.

Bottom Side Alignment

Especially MEMS applications often need precise top and bottom side alignment. The MA6 can be equipped with bright-field bottom side microscopes, capable of achieving 1 µm alignment accuracy. The BSA microscope with Single and Splitfield features uses high resolution CCD cameras. The patented image storage and real-time viewing makes alignment more precise and faster than crosshair alignment.

Infrared Alignment

The MA6 can be equipped with an infrared transmitted and/or incident illumination, a practical alignment option where infrared transmission can be used.

Enhanced Image Storage System (EISS)

This PC based system satisfies highest alignment demands. Some of the features offered are SVGA resolutions; electronic brightness and contrast adjustment, contrast enhancement, adjustment of brightness ratio between stored and live image, etc.

MA6 Resolution	UV400	UV300	UV250
Vacuum Contact	0.7 µm 0.6 µm*	0.5 µm 0.4 µm*	< 0.5 µm 0.3 µm*
Hard Contact	1.0 µm	< 1.0 µm	–
Soft Contact	2.0 µm	< 2.0 µm	–
Proximity	2.5 µm	< 2.5 µm	–

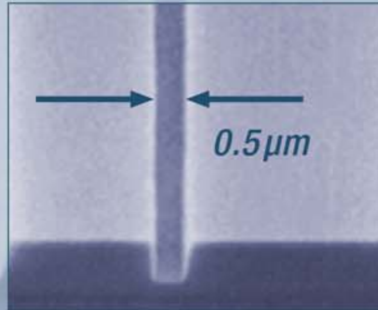
Achievable resolution depends on wafer size, wafer flatness, resist type, clean room class and, therefore, might vary for different processes. (1 µm thick Resist, Lines & Spaces)

*Special process conditions

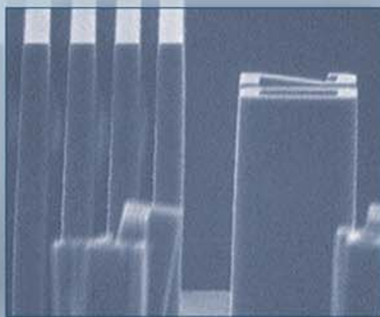
Near Field Holography

Production of optical, diffractive gratings with the MA6. Near Field Holography (NFH), coupled with mask aligners, offers a cost effective solution to produce gratings as small as 100 nm in high volumes.
For more information please refer to the SUSS NFH brochure

Submicron Printing



The MA6 is the ideal tool to manufacture integrated circuits. In order to precisely align these small geometries high magnification is needed. The SUSS AL400 Large Gap Alignment option is capable of providing a depth of focus up to 400 microns (average depth of focus for a 20× objective: appr. 3 µm). Multiple exposure modes, vacuum contact, and proximity are possible.

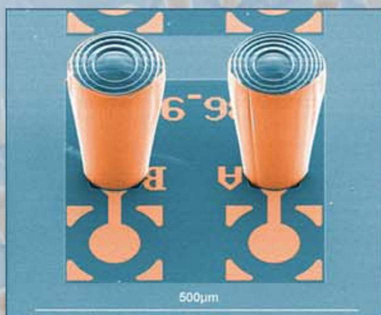


Thick Resist / High Topography

Thick resist patterning in high density interconnect and multichip module applications (MCM, CSP) need a higher exposure energy. The MA6 provides high intensity optics which are designed to increase throughput by reducing exposure time. The SUSS AL400 Large Gap Alignment option overcomes the challenge of high topography exposure by maintaining a safe working distance from the mask.

MA8

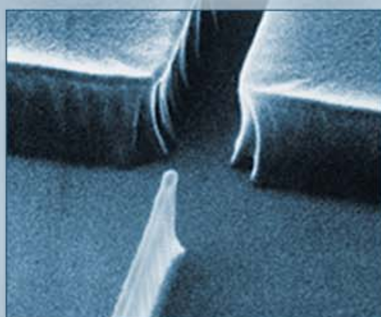
The SUSS MA8 is the system solution for lithography in R & D on substrate sizes up to 200 mm. Widely employed in development and pilot production of IC backend processes, the MA8 also provides full laboratory mask aligner versatility and flexibility.
The compatibility of the exposure modes allows processes to be developed on the MA8 which can then be run in production on any of the SUSS MA200 production mask aligners.
For more information please refer to the SUSS MA8 brochure



UV Embossing or Imprint Lithography

For aligned single- or multi-layer wafer level cold embossing the MA6 Mask Aligner was designed to produce optimal results for single or double sided embossing of micro optical elements. The MA6 is capable of printing resists thickness from < 0.1 micron to a few 100 microns. The structure resolution depends on the imprint stamp itself. In situ top or bottom side alignment and specific UV curing wavelengths can be selected naturally. The polymer Ormocer® allows a broad variety of possible applications for integrated- and microoptics at relatively low costs.

For more information please refer to the SUSS brochure on Nanoimprinting Lithography



Excimer Laser Option

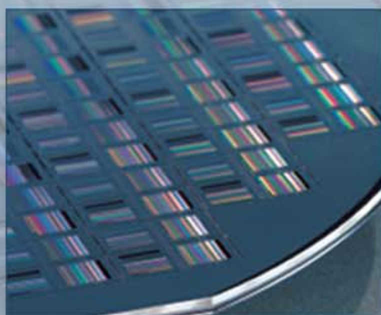
Excimer lasers offer three very important advantages for deep-UV lithography. The light source does not require any filtering, has a relatively high intensity and provides with ArF the shortest usable wavelength (193 nm) besides KrF (248 nm).

For more information please refer to the Excimer Laser datasheet

Laser Pre-Bonding

In dual or multiple stack designs for anodic bond applications with high demand on alignment accuracy, the substrates must be secured in their aligned position. Beyond the mechanical clamping tools, the patented laser pre-bonding system from SUSS allows the paired substrates to be quickly and conveniently welded while still on the alignment stage. The prebonded substrates can then be treated as a single wafer stack and transported to the bonding station. Laser Prebonding is based on the Bond Aligner. By exchanging the standard BSA microscope with the BSA Laser microscope a post bond accuracy of 1 µm can be achieved. A unique solution only from SUSS.

For more information please refer to the SUSS laser prebonding datasheet



Direct Bonding

A MA6 can also be configured to be a MA/BA6 providing flexibility as a mask aligner and/or bond aligner. The BA6 is especially designed to perform precision alignment of substrates utilizing top side, back side, intersubstrate or IR illuminated alignment methods. Additionally, the BA6 can be configured to allow room temperature direct (fusion) bonding to be achieved with post bond alignment accuracies of 0.5 µm.

For more information see next page

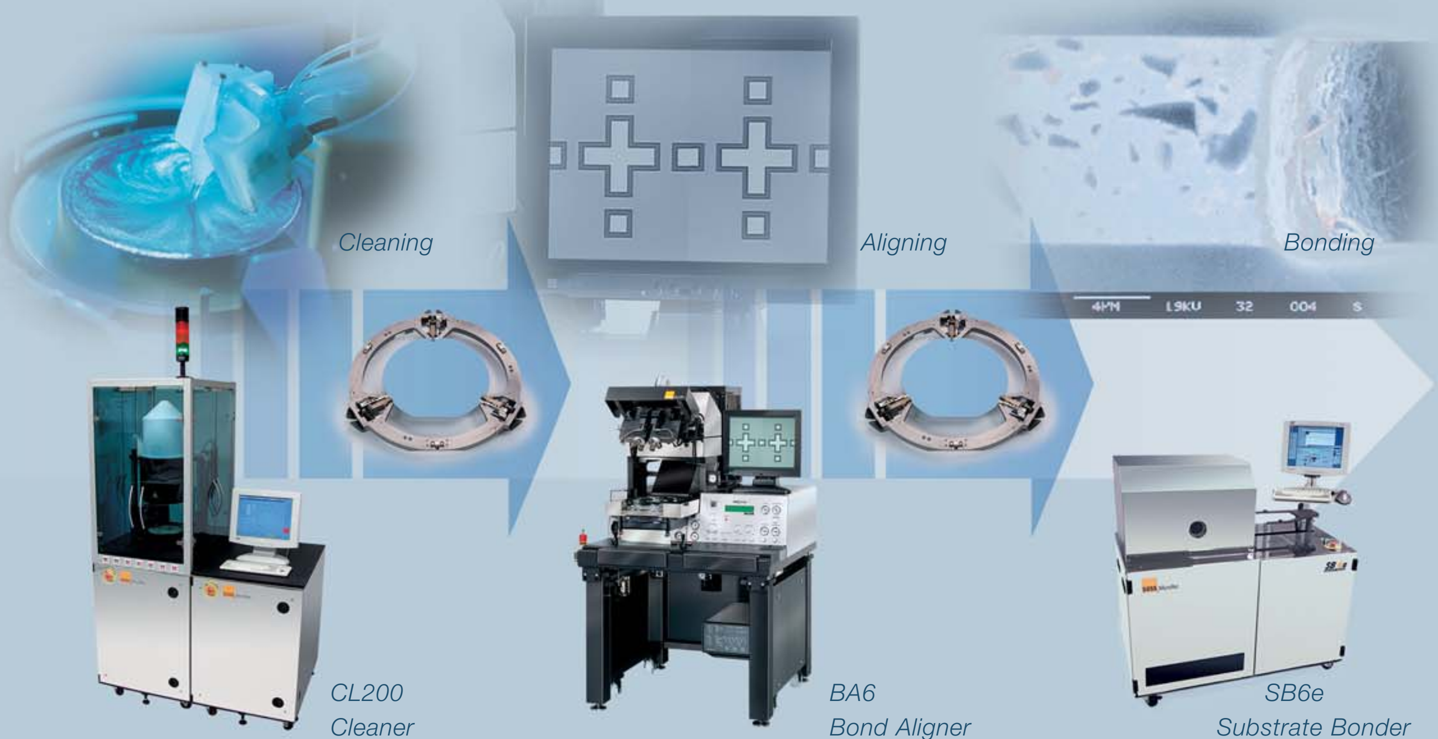
Bond Alignment

Precise bond alignment is indispensable for successful high accuracy wafer bonding. The BA6 Bond Aligner precisely aligns all wafers and substrates regardless of the bonding method used. Typical wafer to wafer alignment methods are either bottom side alignment (BSA) or IR alignment. Both methods use the SUSS enhanced image storage system (EISS) to give best flexibility and accuracy even in large alignment gaps. In case a controlled gap between the substrates needs to be maintained for a specific bond cycle so called spacers swing between the substrates prior to the clamping sequence.

Transport Fixture

The SUSS bond fixture provides the secure method for keeping the alignment during transfer from aligner to bonder no matter if the wafers are in direct contact or are separated by spacers. During the alignment sequence the bond fixture is integrated into the alignment system, while the wafers are secured by vacuum clamping. For the transport to the bonding station mechanical clamping is used. During the entire bond sequence the fixture remains inside the bond chamber and is afterwards used to unload the bonded wafer stack.

Optimal Alignment is the Key for High Accuracy Wafer Bonding



Technical Data

Mask and Wafer / Substrate

Wafer Size	up to 150 mm
Substrate Size	up to 6″×6″
Pieces	down to <5×5 mm
Mask Size	SEMI spec, standard up to 7″×7″

Exposure Modes

Contact	soft, hard, low vacuum, vacuum
Proximity	exposure gap 1–300 µm
Flood Exposures	
Gap Setting Accuracy	1 µm
Vacuum Contact	adjustable to 200 mbar abs

Exposure Optics

Resolution	(see page 3) down to 0.4 µm
Wavelength Range	UV400 350–450 nm UV300 280–350 nm UV250 240–260 nm
Excimer Laser Optics	e.g. KrF (248 nm) or ArF (193 nm)
Exposure Source	Hg lamps 200–1000 W (optional 1500 W) HgXe lamp 500 W
Intensity Uniformity	±5% (±3% 1.5 kW lamphouse)

Alignment Methods

Top Side Alignment (TSA); Bottom Side Alignment (BSA); Infrared Alignment (IR)

Dual Focus Alignment System AL400

Image Storage Alignment System

Accuracy TSA	down to 0.5 µm
BSA	down to 1 µm
Alignment Gap	1–1000 µm

Alignment Stage

Movement Range	X: ±10 mm Y: ±5 mm Θ: ±5°
Mechanical Accuracy	0.1 µm (step size)

TSA Microscope Stage

Single Field	X: ±25 mm; Y: +25/−75 mm
Split Field	X: ±25 mm; Y: +15/−75 mm; Θ: ±3° X: optional ±50 mm

Topside Microscope TSA

Single Field M500	up to 400×
Split Field M304	up to 375×
DVM6	up to 750×
IR DVM6	up to 750×

Objective Magnification 5×, 10×, 20× standard (2.5×, 40×, 5×IR, 10×IR, 20×IR)

Split Field Objective Separation: 32–160 mm (27–160 mm standard objectives w/o turret)

Bottomside Splitfield Microscope BSA

Objective Separation	15–100 mm (68–150 mm optional)
Movement Range	Y: +50/−20 mm
Magnification	up to 90×/290× (switchable)
Field of View	0.6 × 0.8 mm^2 (high magnification)

Utilities

Vacuum	<–0.8 bar, 200 mbar abs
Compressed Air	5 bar (75 psi)
Nitrogen	≥1 bar (15 psi)
with 350 W lamp with 1000 W lamp	0.4 m^3/h 0.6 m^3/h

Power Requirements

Power	Voltage AC 230 V
	Frequency 50–60 Hz
Consumption with 350 W lamp 500 W lamp 1000 W lamp	 1500 W 2000 W 2600 W

Physical Dimensions

H × W × D (Mask Aligner)	1554 × 1214 × 1105 mm
H × W × D (Bond Aligner)	1554 × 1214 × 1300 mm
Weight	360–396 kg

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

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