MASK ALIGNER
MA 6

A NEW SYSTEM SOLUTION

The SUSS MA6 Mask Aligner is the new benchmark in semiconductor submicron research and 3D micro-system production.

This innovative system meets customers' needs for precision, reliability and low cost of ownership. Flexibility in optics, exposure and bond capabilities aid configuration of the system according to actual needs and budget constraints.

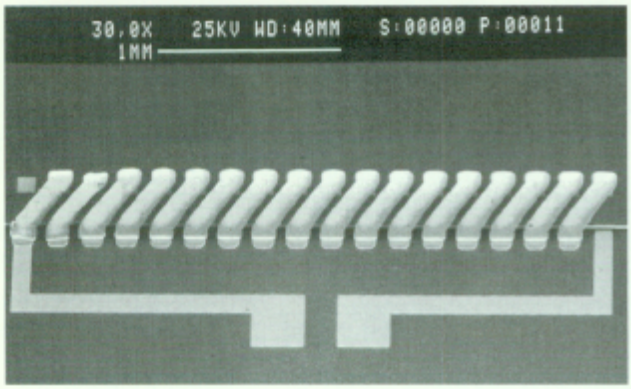
FEATURES AND BENEFITS

- **Accurate and precise gap setting** for higher yield.
- **Parameter storage** saves set-up time and improves process consistency.
- **High-quality exposure optics**: Diffraction reducing lenses provide high resolution and optimum edge quality with thick resists. Large gaps prolong mask life. High intensity light sources reduce process time.
- **Intelligent exposure control unit** monitors lamp intensity and life time.
- **Modular, expandable design** minimizes initial investment and offers a logical upgrade path for future system expansion, i.e. multiple lamp houses, viewing and exposure optics, microscope for bottom side viewing or substrate bonding capability.

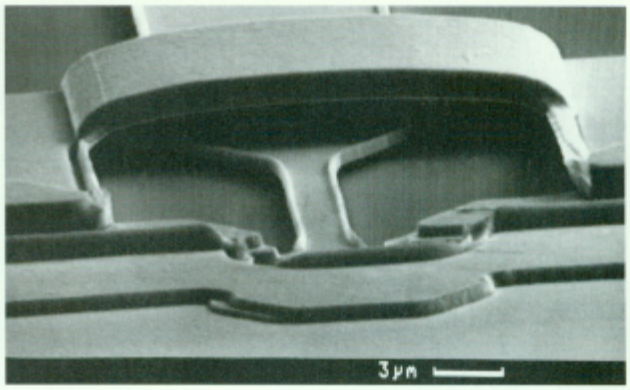
Karl Suss

CHALLENGES ...

MICROSYSTEM TECHNOLOGY (MST, MEMS)
GaAs-APPLICATIONS
SUBMICRON LITHOGRAPHY



3D microsystem application: Micro coils



Bridge structure

SOLUTIONS FOR MICROSYSTEM APPLICATIONS

The automotive industry and telecommunications are just two areas whose products contain components produced with microsystem technology.

Bottom side alignment capability is necessary whenever patterns are printed on both sides of the substrate. The SUSS bottom side alignment system (BSA) combined with the AL 300 Alignment System is the preferred solution. It consists of two independent video microscopes positioned below the substrate.

A patented technique using video frame storing is used for alignment.

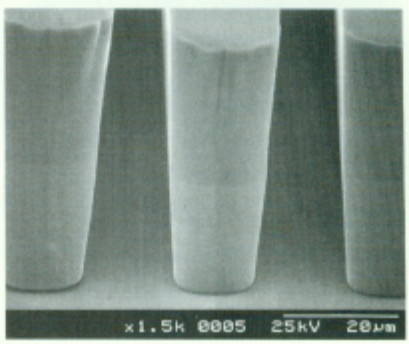
Alignment between mask and wafer is accomplished by overlaying the real time wafer image to the stored mask image. This method is faster and more accurate, a considerable improvement to previous designs which use crosshairs for reference.

For microsystem applications high resolution printing with good CD control is frequently required on much higher topography than that used in IC manufacturing. In order to manufacture larger three-dimensional metal structures features have to be patterned in extremely thick photoresist (50 µm and more).

The SUSS high quality exposure system with diffraction reducing optics provides excellent resolution, while maintaining steep resist side walls.

SUBSTRATE BONDING

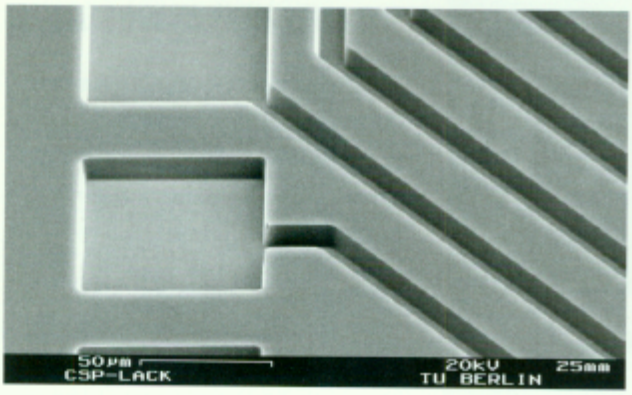
MST applications are often composed of two or more patterned substrates which are aligned and bonded to each other. The MA6 Mask Aligner can be equipped for bond applications.



Thick resist application

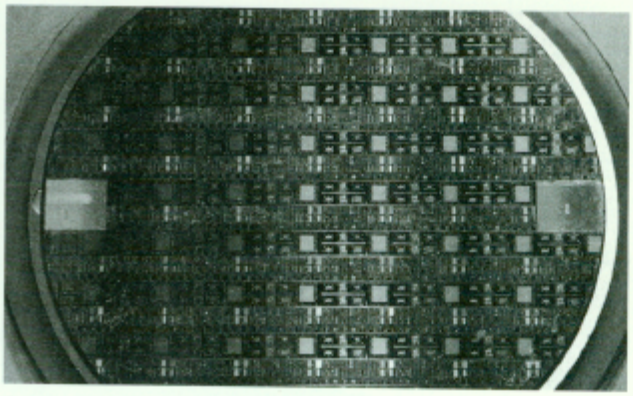
... AND SOLUTIONS

INTEGRATED CIRCUITS (IC)
MULTI CHIP MODULES (MCM)
CHIP SIZE PACKAGES (CSP)



CSP application

Courtesy FHG-IZM, TU Berlin



GaAs wafer (TRW INC.)

THICK RESISTS

Thick resist patterning in high density interconnect and multichip module applications (MCM, CSP) need a higher exposure energy. The MA 6 provides high intensity optics which are designed to increase throughput by reducing exposure time.

HIGH TOPOGRAPHY

The SUSS AL300 Large Gap Alignment option solves the problem of high topography by maintaining a safe working distance from the mask.

NON-FLAT SUBSTRATES

Substrates which tend to bow and warp can be handled by chuck designs that compensate for these tendencies by holding the substrate extremely flat.

FRAGILE MATERIAL

Important for delicate handling of fragile materials is the ability to adjust the contact pressure between mask and substrate. SUSS has extensive knowledge of processing III-V materials or the production of very fragile accelerator sensor structures.

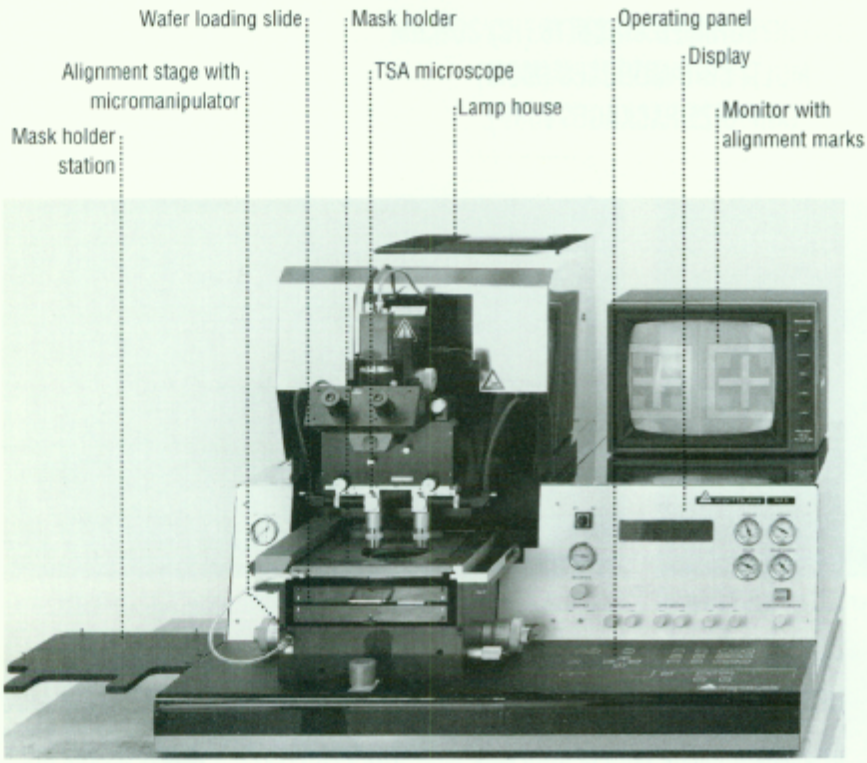
SUBMICRON

The SUSS MA6 is well suited to the manufacture of integrated circuits.

High magnification is necessary to align small geometries. Traditional manual alignment can be a tedious procedure, requiring constant readjustments which affect yield while increasing rework rates.

The AL 300 Large Gap Alignment option eliminates many of these problems. Increased "depth of focus" (up to 300 microns) is provided, whereas typical depth of focus for a 25x objective is approximately 3 microns.

Multiple exposure modes, vacuum contact, and proximity are possible.



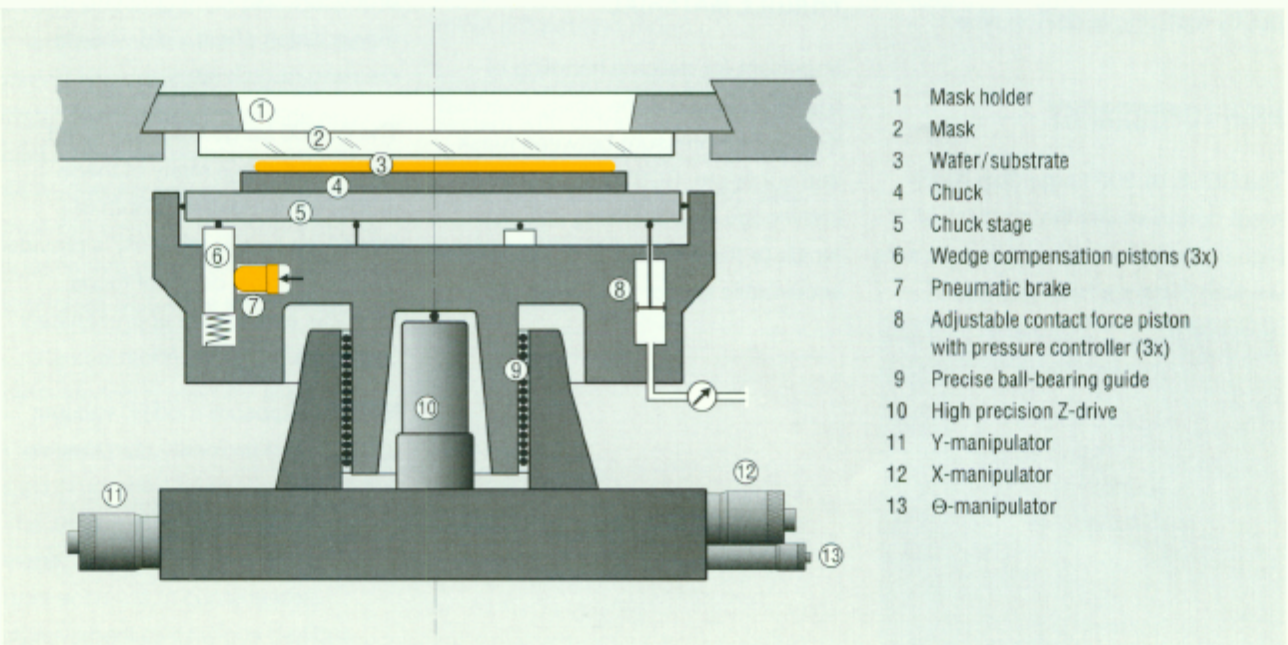
SUSS MA6 Mask Aligner

THE ALIGNMENT STAGE

The high precision alignment stage ensures reliable and exact alignment of mask and substrates.

The stage features three alignment axes (X, Y and Θ), all of which are equipped with preloaded, slack-free ball bearings. SUSS alignment stages are free of the notorious stick-slip effect associated with slide bearings.

Highly sensitive and precise axis movements are possible thanks to special micrometer screws with generous dimensions. Alignment accuracies of better than 0.5 µm are possible, if suitable alignment marks are used.

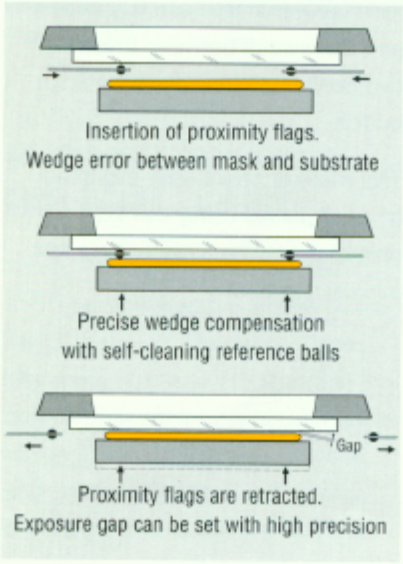


MA6 alignment stage with wedge compensation system

ACCURACY AT YOUR FINGERTIPS

WEDGE COMPENSATION

An efficient system to compensate substrate thickness variations and wedge errors is the key to perfect alignment and good exposure results. To avoid damage, any contact forces exerted on the substrates must be precisely adjustable and reproducable.



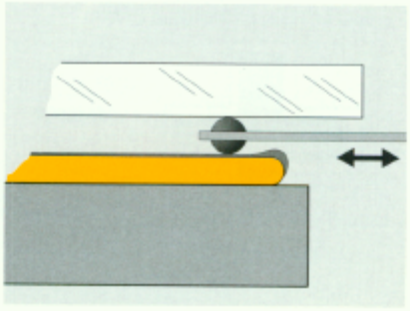
Wedge compensation and gap setting

The patented SUSS design perfectly meets these requirements; it offers the following advantages over conventional calotte or three-spindle drives:

- Featuring extremely low friction, the system delivers a sensitive compensation movement. All acting forces are orthogonal to the direction of alignment, so there are no uncontrolable friction effects.

High-sensitivity micrometer

- Slack-free Z axis guides ensure that the substrate can be lifted to the exposure position without shift effects after alignment. This is achieved by a design that separates the vertical travel and lateral guide functions. A central Z axis with massive preloaded ball bearings is responsible for vertical travel; it avoids all rotational errors or friction effects commonly associated with conventional three-spindle stages.
- A sensitive contact force setting is provided by three independent pneumatic pistons.



Selectable proximity flag position

PROXIMITY SYSTEM

The proximity system offers non-contact exposure at small gaps if the required exposure resolution permits using this operating mode.

The key to uniform exposure results is a constant exposure gap over the entire surface. The SUSS proximity system perfectly meets this requirement:

- Three reference balls with precisely matching diameters are placed near the edges of a wafer or substrate; together with the compensation system, they ensure that the mask-to-substrate gap is defined with high accuracy.
- The reference balls provide a punctiform contact area and self-cleaning action. The SUSS design avoids any deposition of resist particles on the balls, a problem often observed in other systems.
- The proximity flags can be positioned on the substrates, so that any contact in the resist edge bead area or the active area is avoided.

FLEXIBLE AND VERSATILE
THE VIEWING OPTIONS

The MA6 can be equipped to meet the special requirements of each application.

TOP SIDE ALIGNMENT (TSA)

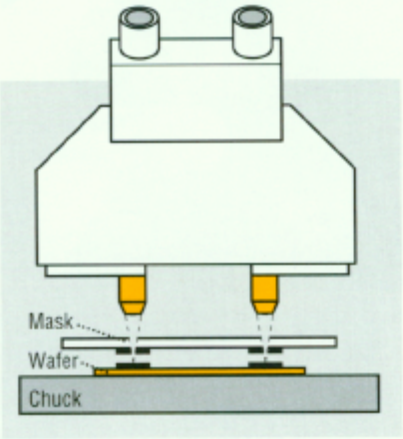
The MA6 can include a TSA microscope, an excellent utility for high-precision, top side alignment.
It can be combined with the patented AL300 Large Gap Alignment system for superior alignment performance at large gaps.

BOTTOM SIDE ALIGNMENT (BSA)

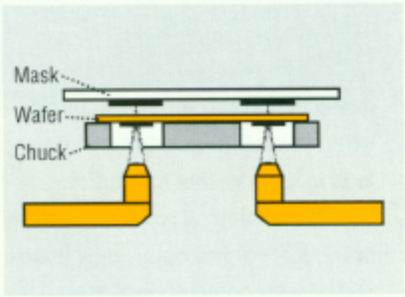
Microsystem technology applications often need precise top and bottom side alignment. The SUSS MA6 can be equipped with bright field bottom side microscopes, capable of achieving 1 µm alignment accuracy. The sharp and clear image created by high quality microscopes makes alignment ergonomic and easy.

The BSA microscope with the split-field feature uses high resolution CCD cameras and monitor for user-friendly, reliable alignment. The patented image storage of the alignment targets needs just one alignment step, and speeds up the alignment process while overcoming visibility limitations.

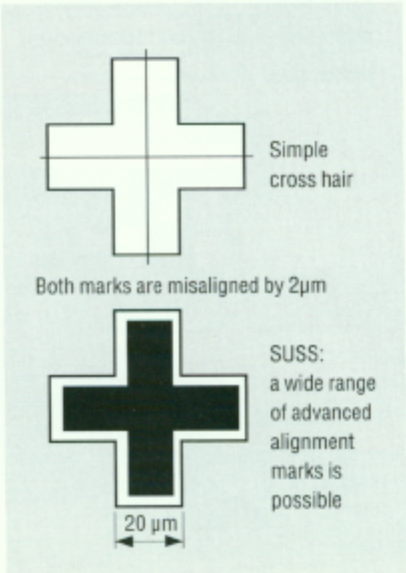
Real-time viewing of the alignment targets with the BSA microscope makes alignment more precise and faster than cross hair alignment.



Principle of TSA splitfield microscope



Principle of BSA splitfield microscope



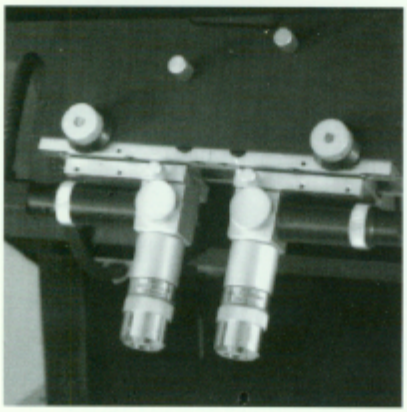
Ergonomic and precise alignment with SUSS

SET REFERENCE AND SCAN

In software controlled scan mode, both the TSA and BSA splitfield microscopes can be moved rapidly between two operator-defined positions.

The operator stores the first microscope position using the *Set Reference* program function. He then moves to the second position and can switch between these two positions by pushing the *Scan* button.

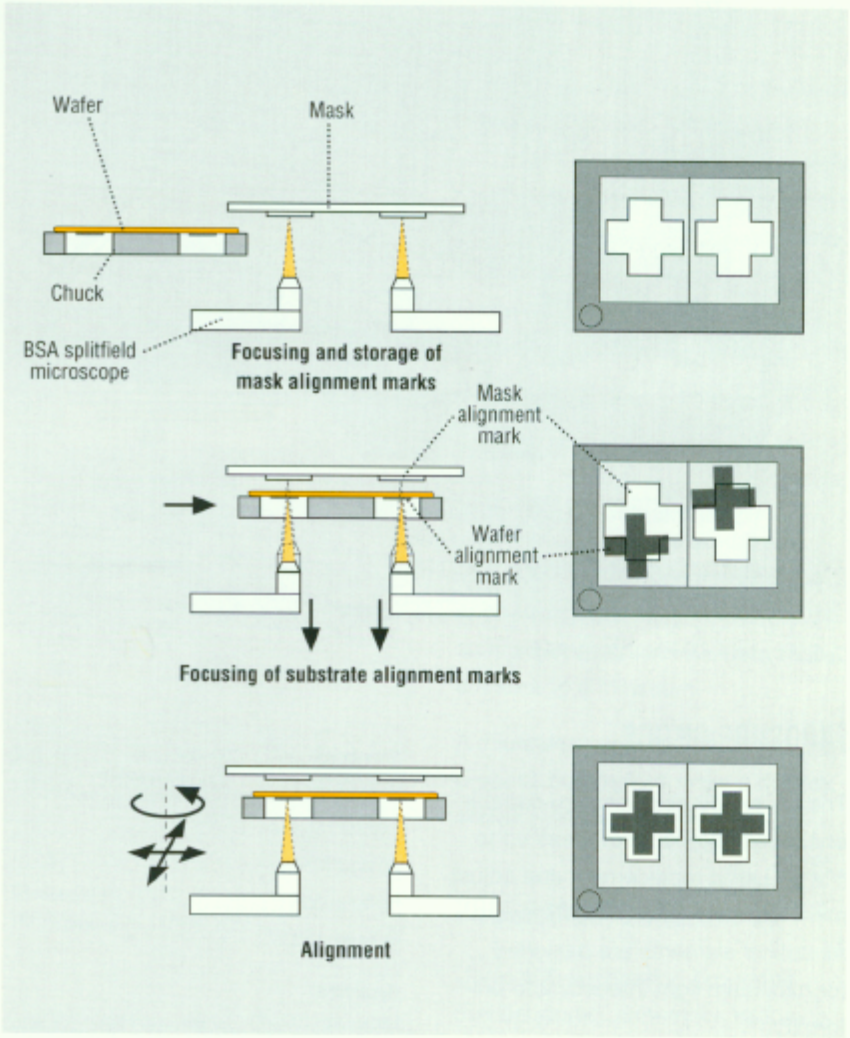
This method offers easy alignment of small pieces using a single objective or even a single field TSA micro-scope.



Topside splitfield microscope

MICROSCOPE POSITIONS DISPLAY AND STORAGE

As the microscopes move, their X and Y coordinates are displayed on the LCD screen. The microscopes' alignment positions are stored in the control data set for the current application. If this data set is accessed later, the microscopes will automatically move to the stored target positions.



SUSS bottom side alignment

DUAL FOCUS OPTION AL300

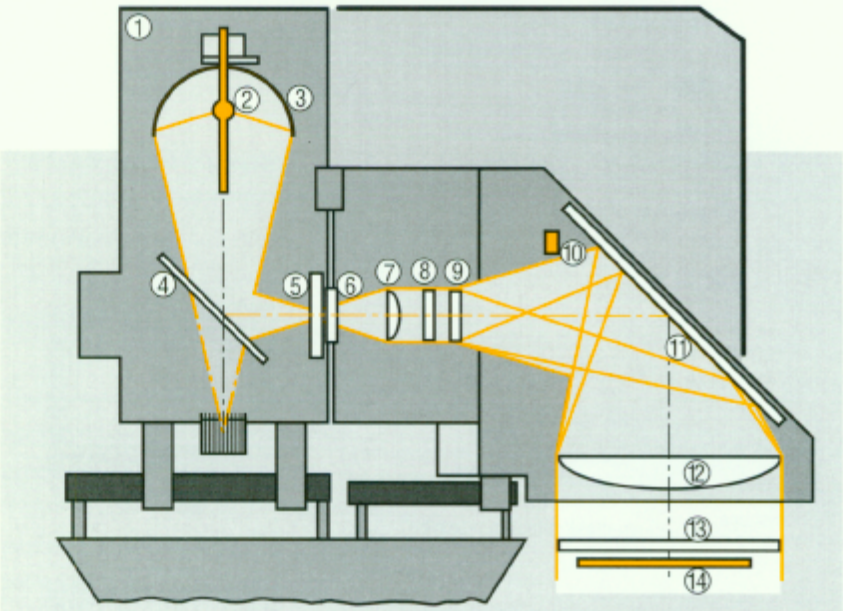
Any SUSS TSA microscope can be converted to a dual focus system using the SUSS AL300 Large Gap Alignment function.

With this unique approach, a quick and accurate alignment can be performed at gaps previously considered impractical due to depth-of-focus limitations. The patented design employs the same image storage unit used for the BSA system. It images the alignment targets as they would be displayed in real-time and eliminates the need to set cross hairs or to remember XY coordinates.

INFRARED ALIGNMENT

The MA6 can be fitted with a TSA microscope and infrared illumination, a practical alignment option where infrared transmission can be used.

EXPOSURE SYSTEM



1	Lamp house	6	"Fly's Eye"	11	Front mirror
2	High pressure lamp	7	Condensor lens	12	Front lens
3	Ellipsoid mirror	8	Lens plate 1	13	Mask
4	Cold light mirror	9	Lens plate 2	14	Wafer or substrate
5	Shutter	10	UV-sensor		

Optical system of the MA6 Mask Aligner

EXPOSURE OPTICS

The UV exposure optics are capable of full-field exposure of areas up to 6"x6". Lamp replacement and adjustment are quick and straightforward. All optical elements are designed for maximum light intensity and uniformity.

The optical setup is optimized for steep wall slopes and high resolution. The exposure unit design is also driven by maintenance and service considerations which dictate performance, robustness, and simplicity of adjustment. Optical adjustments can be performed in the field and do not require the extensive set up and maintenance which is characteristic of stepper technology.

Wavelength nm **Spectral Range**	350–450 UV400	280–350 UV300	240–260 UV250
Exposure Source			
Hg lamp 1000W	▲	▲	–
Hg lamp 350W	▲	▲	–
HgXe lamp 500W	–	–	▲
Resolution			
Large Gap (100 µm)	7 µm	< 7 µm	< 7 µm
Proximity (20µm)	2.5 µm	2 µm	< 2 µm
Soft Contact	2 µm	< 2 µm	< 2 µm
Hard Contact	1 µm	1 µm	< 1 µm
Vacuum Contact	0.7 µm 0.6 µm*	0.5 µm 0.4 µm*	< 0.5 µm 0.3 µm*

▲ available – not applicable
* special process conditions
All resolutions given are dependent on process conditions

Exposure systems and achievable resolution.

EXPOSURE MODES

▲ **Proximity**
A preselected gap is programmed between mask and substrate. The resolution obtained depends on the distance between mask and substrate. Larger exposure gaps facilitate longer mask life and lower defect rates.

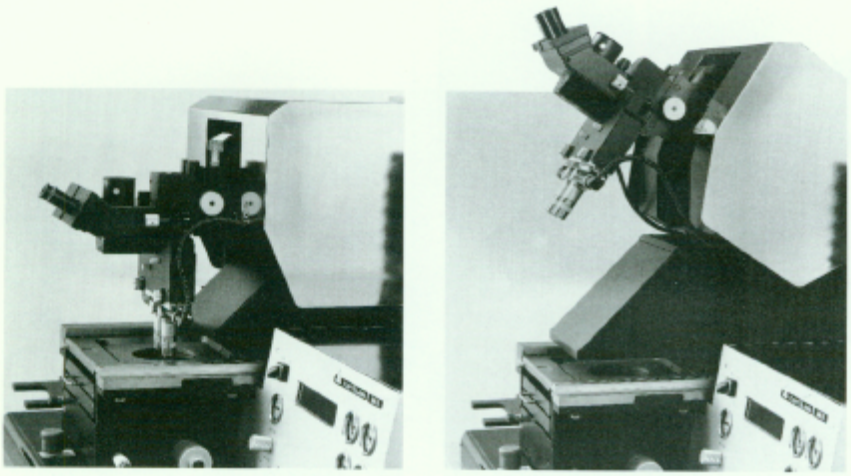
▲ **Soft Contact**
A slight mechanical pressure is used to produce contact, providing resolutions of 1 - 2 µm under good wafer topography conditions.

▲ **Hard Contact**
Like Soft Contact, but an additional nitrogen cushion is applied to produce contact.

▲ **Vacuum Contact**
The contact between mask and wafer is optimized by evacuating the gap. This technique allows considerably higher resolution than soft or hard contact.

▲ **Soft Vacuum Contact**
Contact at reduced vacuum with resolution close to vacuum contact takes care of mask and substrate.

EASY AND RELIABLE OPERATION



Alignment and exposure with SUSS MA6 Mask Aligner

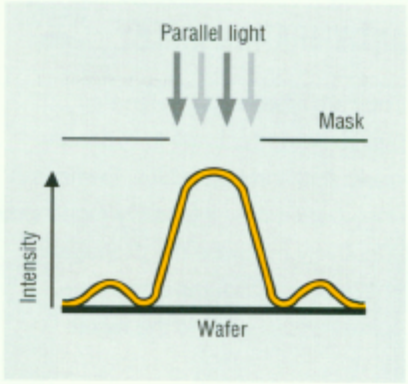
DIFFRACTION REDUCING EXPOSURE SYSTEMS

Diffraction effects at the mask feature edges limit the achievable resolution. SUSS has developed diffraction reducing exposure systems, which allow significant improvement of resolution and yield steep walls.

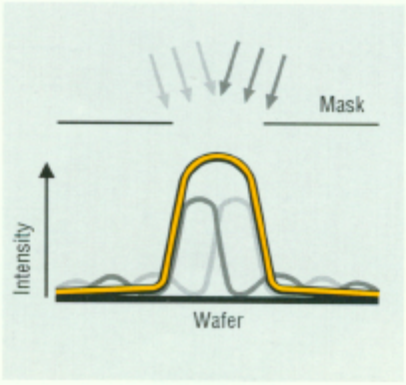
The diffraction reducing system is optimized for the particular spectral ranges and exposure processes employed.

EXPOSURE SYSTEMS

Exposure optics can be supplied for UV400, UV300 and deep UV250 spectral ranges. Lamps from 350 to 1000 W are available.



Conventional setup:
Diffraction with parallel light



SUSS diffraction reducing exposure system:
steep edges, reduced diffraction effects

INTENSITY CONTROLLER

The UV exposure lamps are controlled with the SUSS CIC500 or SUSS CIC1000 Constant Intensity Controller. The CIC is designed to compensate-intensity lost due to lamp aging and to keep the exposure dose on the substrate on the preset level. Between exposures, the CIC reduces the lamp power and helps to greatly prolong lamp life.

MA6 USER INTERFACE

The SUSS MA6 offers the user the optimum in operating comfort and safety. Control panel function keys are kept to a minimum.

A microprocessor monitors important process parameters while a display shows system operating status.

PROGRAM STORAGE

Up to 100 application programs can be stored in memory, reducing setup time and simplifying operation. Standard and special process parameters may be recalled at any time.

OPTIONS AND ACCESSORIES

The MA6 system can be used for a wide range of applications. A variety of options and accessories make future applications possible. The MA6 is easily field-upgradable.

WAFER BONDING OPTION

For MST (MEMS) applications the MA6 can be retrofitted with a wafer bonding option. The option converts the MA6 to a combined system, able to perform precise alignment and pre-bonding of two substrates directly on the MA6 stage.

Conversion from mask aligner to bond aligner is quick and easy. The newly designed adapter system allows instant conversion in both mechanics and user interface.

Quick conversion from mask aligner to bond aligner

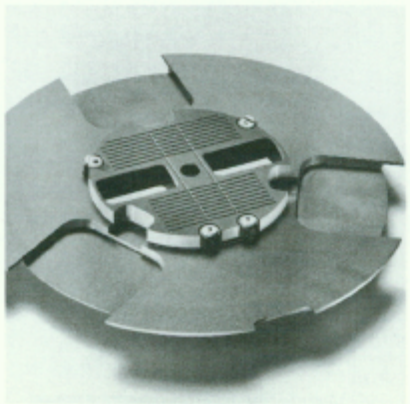
ANTIVIBRATION TABLE

They are often underestimated but play an important role in everyday work: Antivibration tables. Dedicated absorbers below the heavy stone slab effectively minimize the propagation of vibrations from the floor. Safe, uninterrupted work is the result.

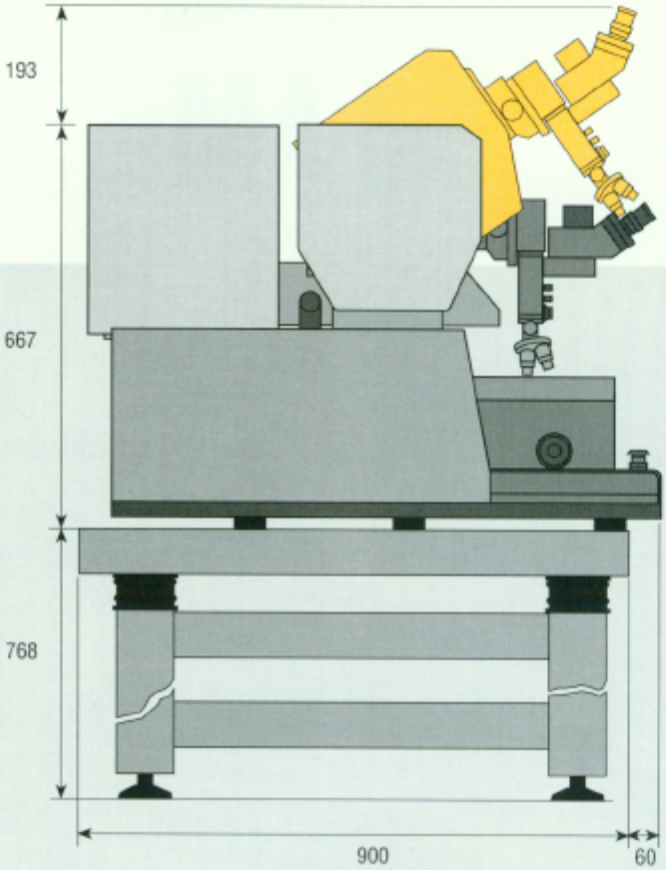
Optional antivibration table

CUSTOMER SPECIFIC CHUCKS

The MA6 can expose wafers or substrates up to 6 mm thick without a special chuck. In addition to chuck designs for standard shapes, SUSS has a wide range of chucks to meet requirements for individual customer applications, such as chucks for rectangular substrates and special chucks for fragile substrates (GaAs)

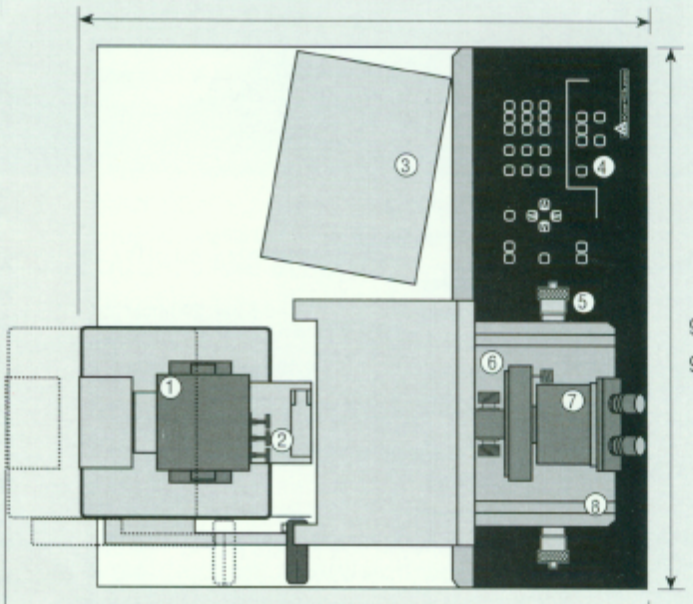


Customer specific chuck



SUSS MA6
MASK ALIGNER

1 Lamp house
2 UV exposure system
3 Monitor
4 Control panel, keyboard
5 Micrometer screw
6 Microscope focus
7 Top side microscope
8 Alignment stage



TECHNICAL DATA: SUSS MA6 MASK ALIGNER

Wafer Size	2"–150 mm
Substrate Size	2"x2"–6"x6", pieces
Mask Size	up to 7"x7" standard

Exposure System

Modes	Large gap, contact and proximity
Exposure gap	1–100 µm
Gap adjustment resolution	1 µm
Contact pressure, adjustable	0.02–1.0 N/cm²
Vacuum contact, adjustable	to 200 mbar abs

Exposure Optics

Resolution (see page 8)	down to 0.5 µm

Wavelength	Range	Exposure Source
UV400	350–450 nm	350 W or 1000 W Hg
UV300	280–350 nm	350 W or 1000 W Hg
UV250	240–260 nm	500 W HgXe
UV248	248 nm	KrF Excimer Laser
UV193	193 nm	ArF Excimer Laser

Intensity uniformity	better ±5%

Alignment

Methods		Top side alignment TSA Bottomside alignment BSA Infrared alignment IR
Dual focus alignment system AL300		
Principle		Image storage
Accuracy	TSA	down to 0.5 µm
	BSA	down to 1 µm
Alignment gap		1–300 µm

Alignment Stage

Alignment range in X	±10 mm
Alignment range in Y	±5 mm
Alignment range in θ	±5 deg
Mechanical resolution in XYθ	0.1 µm

TSA Microscope Stage

Fullfield microscope	
M400	X: ±50 mm Y: +25/–75 mm
Splitfield microscope	
M204/M234	X: ±50 mm Y: +25/–75 mm θ: ±5°
M206/M236	X: ±25 mm Y: +15/–75 mm θ: ±3°
DVM6	X: ±25 mm Y: +15/–75 mm θ: ±3°
Pneumatic microscope lift	

Topside Microscope TSA

Microscope Type	Objective separation mm	Magnification
Fullfield M400	–	up to 400x
Splitfield M204	24–95	up to 375x
Splitfield M234	31–95	up to 375x
Splitfield M206	45–135	up to 375x
Splitf. Video DVM6	40–140	up to 750x
DVM6 Option	28–190	on 12" monitor
Objective magnification		5 x–32 x

Bottomside Splitfield Microscope BSA

Objective separation	25–100 mm
Objective separation Option	15–95 mm
Movement range in Y	+50/–20 mm
Overall magnification	up to 300 x/12" monitor
Field of view	0.6 x 0.8 mm²
Objective magnification	8 x

Programming

Exposure modes	Large gap, proximity, soft contact, hard contact, adjustable vacuum contact, vacuum contact
Exposure time	0–999 sec, 0.1 sec steps
Alignment gap	1–300 µm, 1 µm steps
Exposure gap	1–100 µm, 1 µm steps
Resist type	Positive, negative
Alignment side	Top/Bottom
Program storage	100 different programs

Utilities

Vacuum	<–0.8 bar, 200 mbar abs
Compressed air	5 bar (75 psi)
Nitrogen	≥1 bar (15 psi)
with 350/1000 W lamp	0.4 m³/h / 0.6 m³/h

Power Requirements

Voltage	AC 230 V
Frequency	50–60 Hz
Consumption with 350/500/1000 W lamp	1500/2000/2600 W
Weight	360–396 kg

Data can often depend on machine configurations and process conditions and may be not valid at the same time

KARL SUSS WORLDWIDE

GERMANY
KARL SÜSS KG · GmbH & Co.
Schleissheimer Strasse 90
D-85748 Garching bei München
Germany
Tel (+49) [0]89/3 20 07-0
Fax (+49) [0]89/3 20 07-162

FRANCE
KARL SUSS France SARL
KARL SUSS Technique S.A.
Avenue des Colombières
F-74490 Saint Jeoire · France
Tel (+33)-[0]45 03 58-3 92
Faxl (+33)-[0]45 03 58-8 01

GREAT BRITAIN
KARL SUSS Great Britain Ltd.
23 Ivanhoe Road
Hogwood Industrial Estate
Finchampstead · Wokingham · Berkshire
GB-RG40 4QQ · England
Tel (+44)-[0]1189-732144
Fax (+44)-[0]1189-734395

JAPAN
KARL SUSS Japan K.K. · Yokohama
カール・ズース・ジャパン株式会社
〒226-0006 神奈川県横浜市緑区白山 1-18-2
ジャーマン・インダストリー・センター
Tel (+81)-[0]45-931-5600, Fax -5601

ASIA
KARL SUSS Asia Co., Ltd.
212/2 Soi Ladprao 10
Ladprao Road, Ladyao · Jatujak
Bangkok 10900 · Thailand
Tel (+66) - 2 938 44 -26, -27
Fax (+66) - 2 512 5569

NORTH AMERICA
KARL SUSS America Inc.
P.O. Box 157, Suss Drive
Waterbury Center · VT 05677 · USA
Tel (+1) 802-244-5181, Fax -5103

INTERNET / WWW
http:// www.suss.com

Representatives in over 30 countries.
Please visit our web site for our address list.

TD.MA6.US.0296 · KSM.BTM.P.M.2000 · Printed in Germany on chlorine-free bleached paper · Subject to change without prior notice

SUSS. WHERE SOLUTIONS SET STANDARDS

KSM Karl Suss