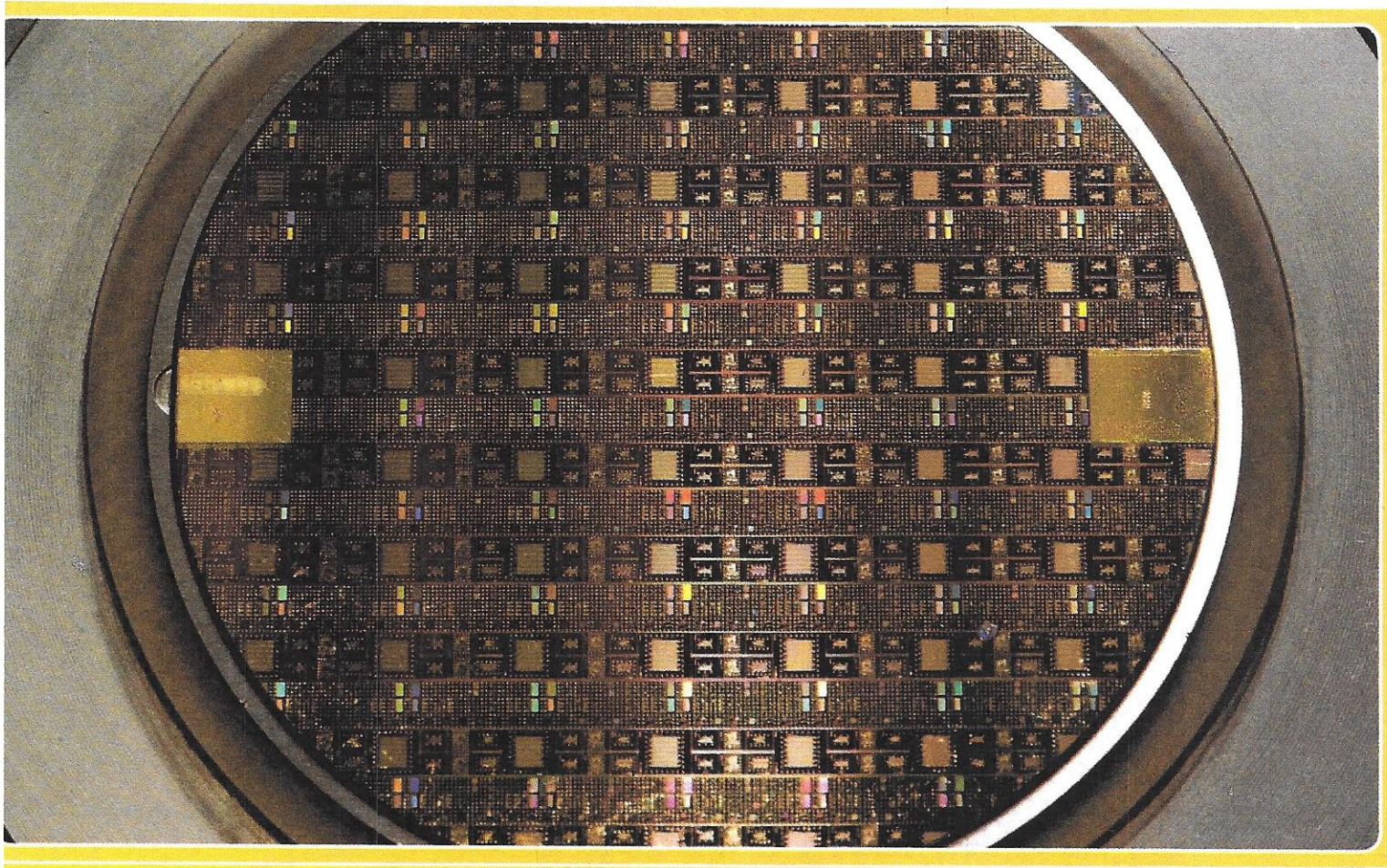


The Range of Application

The powerful SUSS MJB 3 model range finds application in

- Research and development.
- Laboratories.
- Small series and pilot production.

The SUSS MJB 3 is designed for

- Outstanding resolution far into the submicron region.
- Correspondingly extreme demands on the alignment accuracy.
- All contact exposure processes with practically oriented and simple operation.

Due to the versatile accessory and adaption equipment features can be easily replicated on

- Wafers up to 3" Ø, substrates up to 3" x 3".
- Partial wafers or substrates.
- Highly sensitive and fragile materials such as GaAs, InP, InSb.
- Thick substrates.
- Hybrids (high-frequency components into the gigahertz bands).

The Concept of the SUSS MJB 3 Model Range

The SUSS MJB 3 Model Range integrates:

- Simple basic assembly, compact, versatile.
- Solidly constructed and durable mechanics, high precision alignment stage.
- Special high performance alignment microscopes of various designs, positionable in X-Y by manipulator.
- Specific exposure ranges from 450 nm down to 193 nm.
- Different corresponding exposure systems optimized for high pressure lamps and excimer lasers.
- Very reliable electronic and pneumatic controls and partially automated program sequencing.
- Easy adaption to different processes.
- Adaption to different wafer, substrate and mask sizes in seconds, without tools.

From these features result machines which may be specified with various equipment, beginning with

- cost-effective and economical units with performance equal to or better than competitive aligners,

extending to

- high performance units with outstanding resolution reaching far into the submicron region, a result otherwise matched only by electron- or ion-beam and X-ray lithography systems.

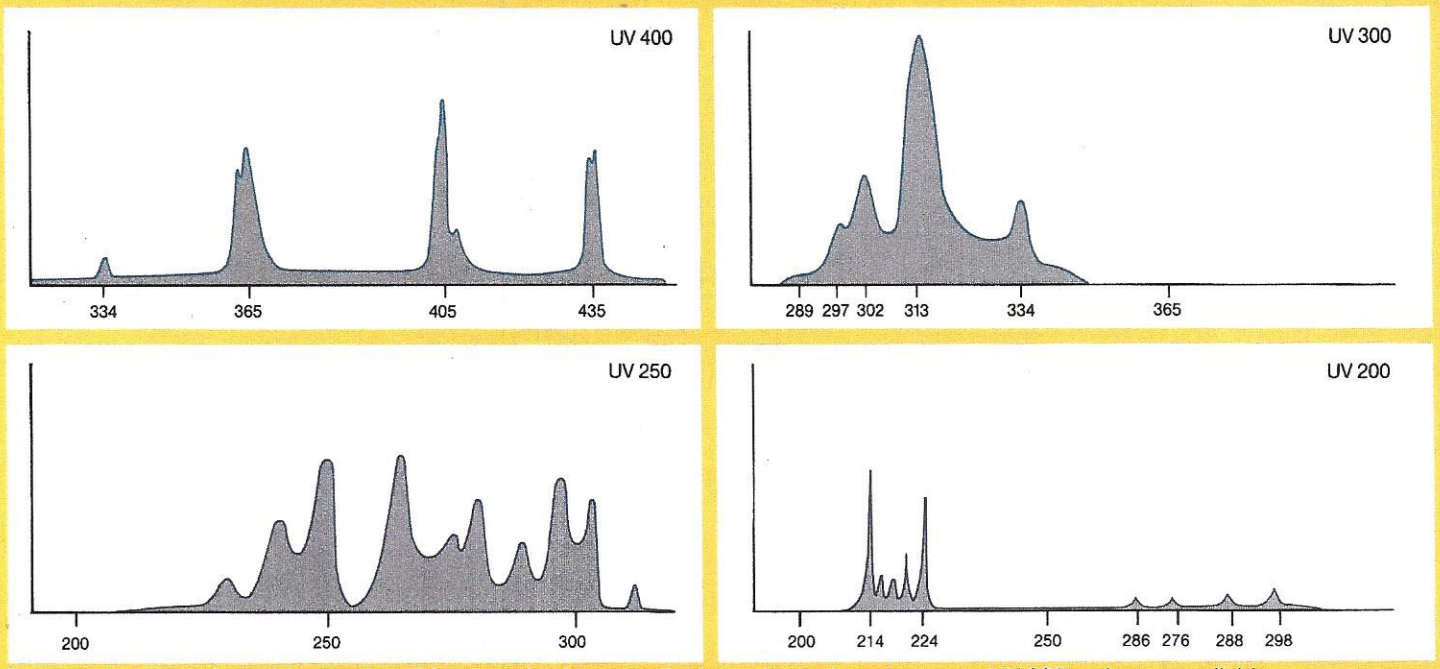
For the operator every machine offers:

- Interlocked operational sequencing.
- Simple operational controls.
- Easy accessibility to all parts of the mask aligner.
- Optimum laminar flow conditions in the work area.
- Minimum of operator training.
- Maximum of ergonomic efficiency.

And

- Service-friendliness.

Intensity distribution in the various spectral regions.



The wavelength scale is the same for all four graphs, however the intensity scale varies. The intensities in the different spectral regions may not therefore be directly compared.

UV 200 no longer available

Resolution

In contact lithography processes the achievable resolution in an appropriate photoresist of the exposed features is primarily influenced by

- The spectral range employed.
- The gap between the mask and wafer during exposure.
  This gap is a function of wafer topography, cleanliness and exposure mode.

In the exposure modes soft contact (slight mechanical pressure alone to produce contact) and hard contact (mechanical and pneumatic pressure) a resolution of 1-2 µm is obtained under good conditions.

The SUSS MJB 3 Standard as the simplest version of the model range achieves this performance with the unfiltered spectrum of a 200 W high pressure mercury arc lamp and its associated exposure system (parallel light path). For many purposes this equipment is an excellent instrument.

The SUSS MJB 3 UV 400/UV 300/ UV 250 submicron models
offer considerably higher resolution. This is achieved by

- Reduction of the remaining gap between mask and wafer.
- Use of shorter wavelength regions.
- Application of more sophisticated exposure optics.

Some comments:

All SUSS MJB 3 submicron mask aligners can perform vacuum contact processes. Vacuum contact yields considerably higher resolution than hard or soft contact, because the gap between mask and wafer is further reduced. The vacuum between mask and wafer can be regulated according to requirements. To obtain the highest resolution the photoresist thickness also has to be optimized.

Even under the best conditions it is only possible to achieve linewidths of the same order as the wavelength of the exposure illumination. Therefore it is useful to apply only the shorter (filtered) wavelength regions of various high pressure lamps. An excimer laser may also be employed.

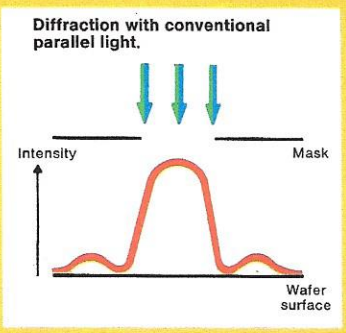
Diffraction effects from the exposure illumination at the feature edges limit the achievable resolution. They are proportional to the square root of the wavelength. Therefore shorter wavelengths provide less diffraction. However diffraction effects may be further reduced by employing diffraction reducing exposure systems. SUSS was the first to develop such diffraction reducing exposure systems of different designs for the various spectral ranges. They are a significant factor in the improvement of resolution and yield optimum resist sidewall profiles.

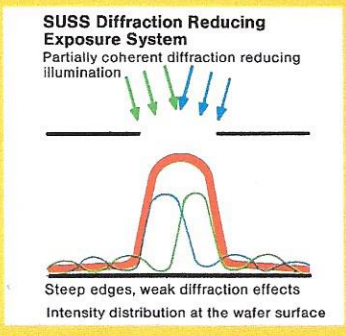
The following resolutions are achieved in vacuum contact by the SUSS MJB 3 submicron models with the individual spectral ranges:

Near-UV	UV 400 (350-450 nm, 350 W Hg lamp)	0.6 µm
Mid-UV	UV 300 (280-350 nm, 350 W Hg lamp)	0.4 µm
Deep UV (polychromatic)	UV 250 (240-260 nm, 500 W Hg-Xe lamp)	0.3 µm (PMMA)
Deep UV (monochromatic)	UV 248 (248 nm, KrF excimer laser)	0.3 µm
	UV 193 (193 nm, ArF excimer laser)	0.2 µm

Often shorter exposure wavelengths are desirable, not necessarily to achieve higher resolution, but instead to obtain wide process latitude. In this respect, UV 300 is particularly attractive. It can be used with conventional resists and glass or quartz masks. A process developed for example using near-UV (UV 400) can be easily adapted to or refined by UV 300. The interchange of UV 400 and UV 300 exposure optics and vice-versa can be accomplished without extinguishing the lamp.

There is also an important development in exposure technology. A lamp with its associated optical system may be installed as light source in a SUSS MJB 3 with an excimer laser. This provides the ability to alternately apply either source.





The Choice of Equipment

The choice of the most suitable equipment and associated accessories for a given application is defined by several factors:

1. Desired resolution and/or desired process latitude.
2. Desired alignment accuracy.
3. Requirement for back side alignment. If so, will the equipment be dedicated to this process or also used for conventional alignment?
4. Requirement for highest possible throughput.
   A splitfield microscope yields shorter alignment times, however the maximum usable magnification, and therefore the achievable alignment accuracy, is less than that of a normalfield microscope.

Resolution is listed on page 4. The following table shows the different standard equipment of the particular models and the exposure modes which may be employed.

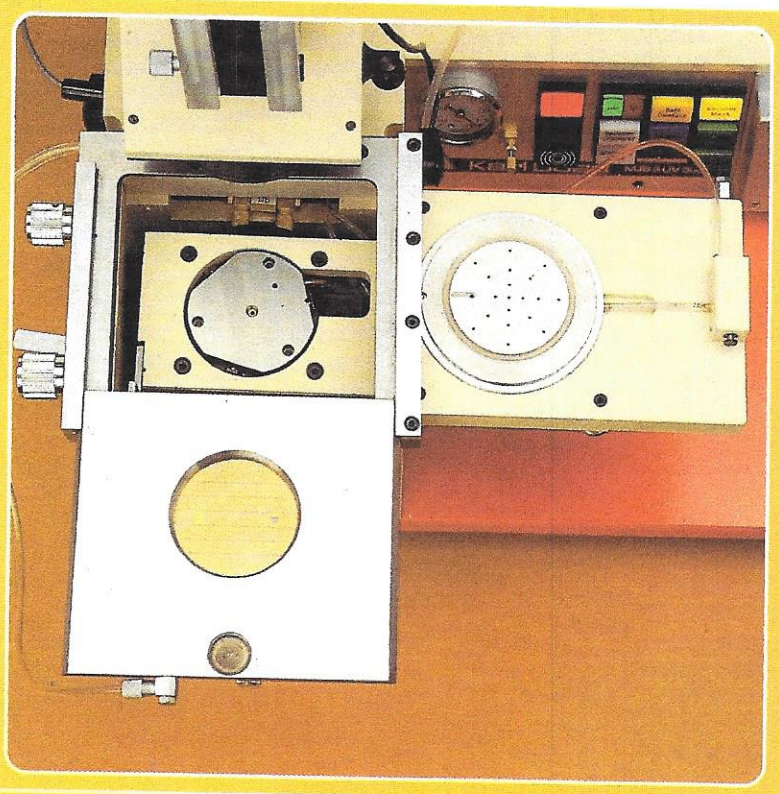
The desired alignment accuracy determines the choice of the alignment microscope and its magnification. However depth of focus and the design of suitable alignment keys also play an important role.

Equipment Summary

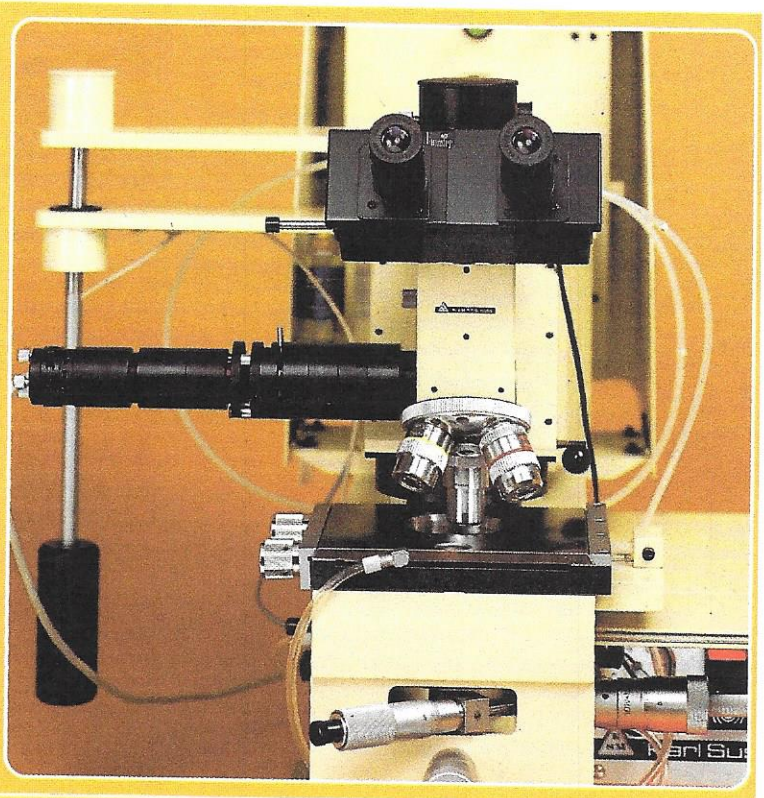
SUSS MJB 3 Mask Aligner

	Standard	UV 400	UV 300	UV 250	Excimer Laser
XYΘ Alignment Stage					
Standard design	●				
Submicron design		●	●	●	●
Light Sources					
200 W Hg lamp	●				
350 W Hg lamp		●	●	○	○
350 W Cd-Xe lamp		○	○	●	○
Excimer laser		○	○	○	●
SUSS Exposure Systems					
Parallel light	●				
Diffraction reducing System for					
UV 400		●	○	○	○
UV 300		○	●	○	○
UV 250		○	○	●	○
UV 248, for KrF excimer laser		○	○	○	○
UV 193, for ArF excimer laser		○	○	○	●
Exposure Modes					
Soft contact	●	●	●	●	●
Hard contact	●	●	●	●	●
Vacuum contact		●	●	●	●
Alignment Microscopes					
SUSS Splitfield Microscopes:					
M 204	●	○	○	○	○
M 234 Revolver	○	○	○	○	○
SUSS Normal Field Microscopes:					
M 400	○	●	●	●	●
M 400 IR		○	○	○	○

● = Standard component of the respective SUSS MJB 3 model.
○ = Optional equipment.



Alignment stage with mask holder and transport slide for the wafer.



SUSS M 400 Normal Field Microscope

SUSS MJB 3 Submicron Mask Aligners

SUSS MJB 3 UV 400
SUSS MJB 3 UV 300
SUSS MJB 3 UV 250
SUSS MJB 3 Excimer Laser.

These high precision mask aligners are designed for the highest demands on resolution and alignment accuracy. They incorporate highest SUSS quality in mechanics (alignment stage) and exposure optics. Separation/contact shift is undetectable by optical means. The high alignment accuracy is obtained through the use of special, high resolution microscope objectives. The objectives are optically compensated, where necessary, for observation through the mask.

A special advantage lies in the possibility to check the alignment condition in vacuum contact, before exposure. The succeeding initiation of exposure or return to separation position is a simple one-step operation.

Each SUSS MJB 3 submicron model incorporates the diffraction reducing SUSS optical system, individually optimized for the particular spectral region and the corresponding desired resolution.

The exposure systems of the SUSS MJB 3 UV 400 and UV 300 submicron mask aligners are manufactured from herasil and are suitable for processes using near UV (UV 400) or mid-UV (UV 300). Filter elements provide the different spectral ranges with the same lamp.

The exposure system of the SUSS MJB 3 UV 250 submicron mask aligner, on the other hand, incorporates quartz lenses, which are used in the deep UV (UV 250), with corresponding lamps as light sources. The quartz lens system can also be applied with the 350 W Hg lamp and associated filter elements for processes in the UV 400 or UV 300 regions. The lamphouse is equipped with an exhaust system for cooling, which simultaneously removes the resulting ozone.

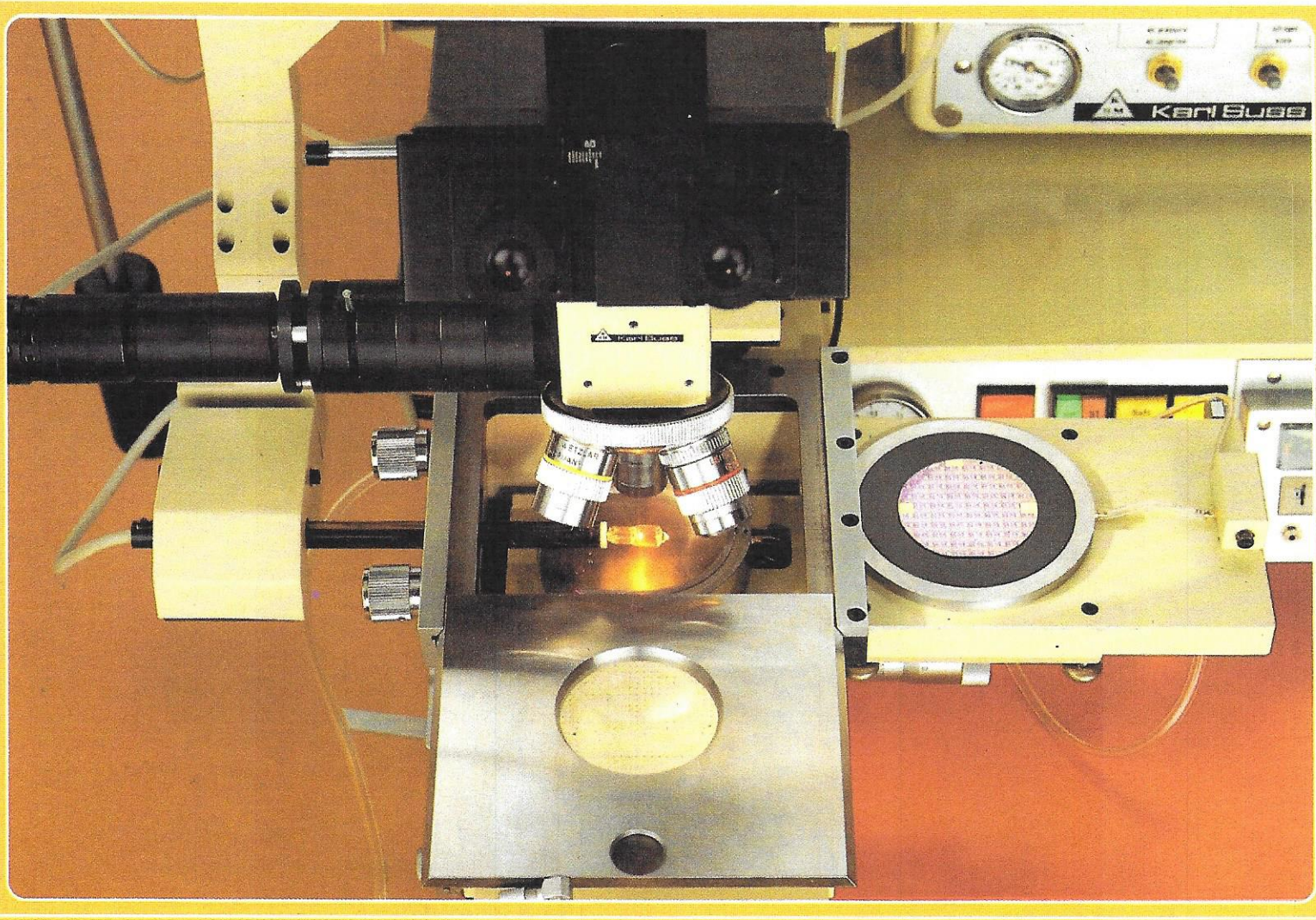
For process techniques in the UV 250 spectral region a suitable photoresist, such as PMMA for example, must be used. This resist is sensitive only below 260 nm. It is not possible to filter out all the intensity at longer wavelengths and to simultaneously preserve reasonable intensity in the deep UV (exposure times of a few minutes).

If an excimer laser is employed as light source, the photoresist can be selected on the basis of etch resistance or process latitude factors, since the radiation is monochromatic. Its high intensity provides shorter exposure times in the deep UV.

The SUSS MJB 3 with excimer laser possesses a special quartz diffraction reducing exposure system. Either 193 nm (ArF) or 248 nm (KrF) may be used as exposure wavelengths.

The throughput of the submicron mask aligners is up to 60 wafers or substrates per hour, depending on process conditions.

K SM Karl Suss



View of the infrared illumination which is moved using the manipulator simultaneously with the microscope.

SUSS IR Transmission Systems

The SUSS MJB 3 UV 400, UV 300, UV 250 and Excimer Laser models can be equipped for back side alignment by employing infrared light.

SUSS IR Transmission Alignment Systems are applicable to materials transparent to wavelengths in the range from 400 to 2000 nm, where a mask should be aligned to features on one side of the wafer (front-side) but exposed on the other (back-side). Examples are vias for III-V compound microwave circuits, opto-electronic detectors and solid state lasers. Infrared alignment can also be used to align to buried diffusions.

The SUSS IR Transmission Alignment System includes:

- Modified alignment stage.
- Infrared light source under the chuck, positioned by motor.
- Special glass chucks, transparent to infrared but opaque to UV and visible light.
- Video camera and tube in two versions with different sensitivity ranges.
- Video monitor.
- Control electronics for illumination and light source positioning motor.

The infrared light source under the chuck is always situated directly below the microscope objective during alignment. The microscope and light source move synchronously.

This design has two advantages compared to systems with fixed light sources: every point of the wafer within the scan field of the microscope can be observed with the same infrared intensity, and misalignment as a result of parallax errors is avoided.

Two camera tubes with different sensitivity ranges are available:

- Silicon vidicon tube with a response from 400-1100 nm, suitable for materials such as silicon, GaAs and InP.
- Lead sulfide tube with a response from 400-2000 nm, applicable with materials such as InAs and InSb. This tube should only be used for materials which exhibit no transparency below 1000 nm.

Machines with a SUSS IR Transmission Alignment System may be easily converted to conventional processes. Two appropriate adapters, which can be installed in a few minutes, allow the use of conventional chucks for soft, hard or vacuum contact. With the infrared alignment method only soft and hard contact exposure modes are possible.

The achievable alignment accuracy is the key with infrared applications. It depends upon the quality of the infrared image and is influenced by: