ELECTRONIC VISIONS INC.

OPERATOR MANUAL

EV 420

Mask Aligner

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Note to the user

General:

1. Installation, adjustment, programming, and maintenance (except periodical maintenance as described in the manual) may only be done by qualified EV service engineers.

2. Please verify all equipment against the packing list(s) and notify Electronic Visions immediately if there is a discrepancy.

3. Please read the operating instructions thoroughly before operating the unit and follow the instructions closely.

4. The equipment may only be operated by personnel trained by EV service engineers.

5. No liability will be honored for personal injury or material damages in the event that these damages or injuries occur as a result of a failure to comply with the operating instructions; nor will any guarantees relating to repairs to or replacements of our products apply.

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Safety instructions

1. The equipment represents state-of-the-art technology with optimum reliability when used properly. The user may, however, be exposed to hazards if the equipment is used carelessly, improperly, or for reasons other than its intended and specified purpose!

2. If the equipment is used for any reason other than its intended and specified purpose, all liability and warranty claims are null and void!

3. All unauthorized modifications and alterations affecting the safety are prohibited!

4. The use of self made tools are not allowed in any case.

5. Any use by unauthorized personnel or careless handling may increase the risk for potential danger.

If the media support specified from EV are not fulfilled, the operational function of the equipment is not guaranteed.

Declaration of the Manufacturer

In accordance with EU machines guideline 89/392/EEC, Appendix II B and the directive on electromagnetic compatibility 89/336/EEC, Appendix 1 (2)

The Mask and bond aligner EV400 series and (B)AL6 series are in conformity with following standards, according to the provisions of the EEC directive mentioned above.
Any modification of the equipment without prior consultation of EV Co. will cancel the validity of that declaration.

Applied harmonized standards:

EN 292-1 : 1991, EN 292-2 : 1991, EN 294 : 1992,
EN 418 : 1992, EN 775 : 1992 (where applicable)
EN 60204-1 : 1992, EN 50081-1 : 1992, EN 50 081-2 : 1992,
EN 50 082-1 : 1992

Schärding, 19.12.1995

Erich Thallner, President

1. Preparing equipment for installation

1. 1. Installation

The mask aligner is protected against mechanical damage during transport.
Unpacking and removing the transport security locks shall only be done by an authorized service engineer.

The mask aligner has to be stored at a constant temperature of 20°C prior to installation.

1. 2. Safety instructions

Do not move in the tray before tray and cover are in highest position.
Finish the process regularly after fixing the locking pins of the anodic bond tool, otherwise the bond glass can break.
Regulator for "Chuck-Weight" may not be higher than position 500!!

Minimum nitrogen pressure 5 bar (70 psi), maximum 6 bar (90 psi). Minimum air pressure 5 bar (70 psi), maximum 6 bar (90 psi).

1. 3. Assembly instructions

for leveling the baseplate and the lamphouse module.

I) Transport of the EV420 with safety angles to the final assembly place.
II) Level the baseplate with the leveling bolts (check with water level)
III) Remove the safety angles between base plate and lamphouse module.

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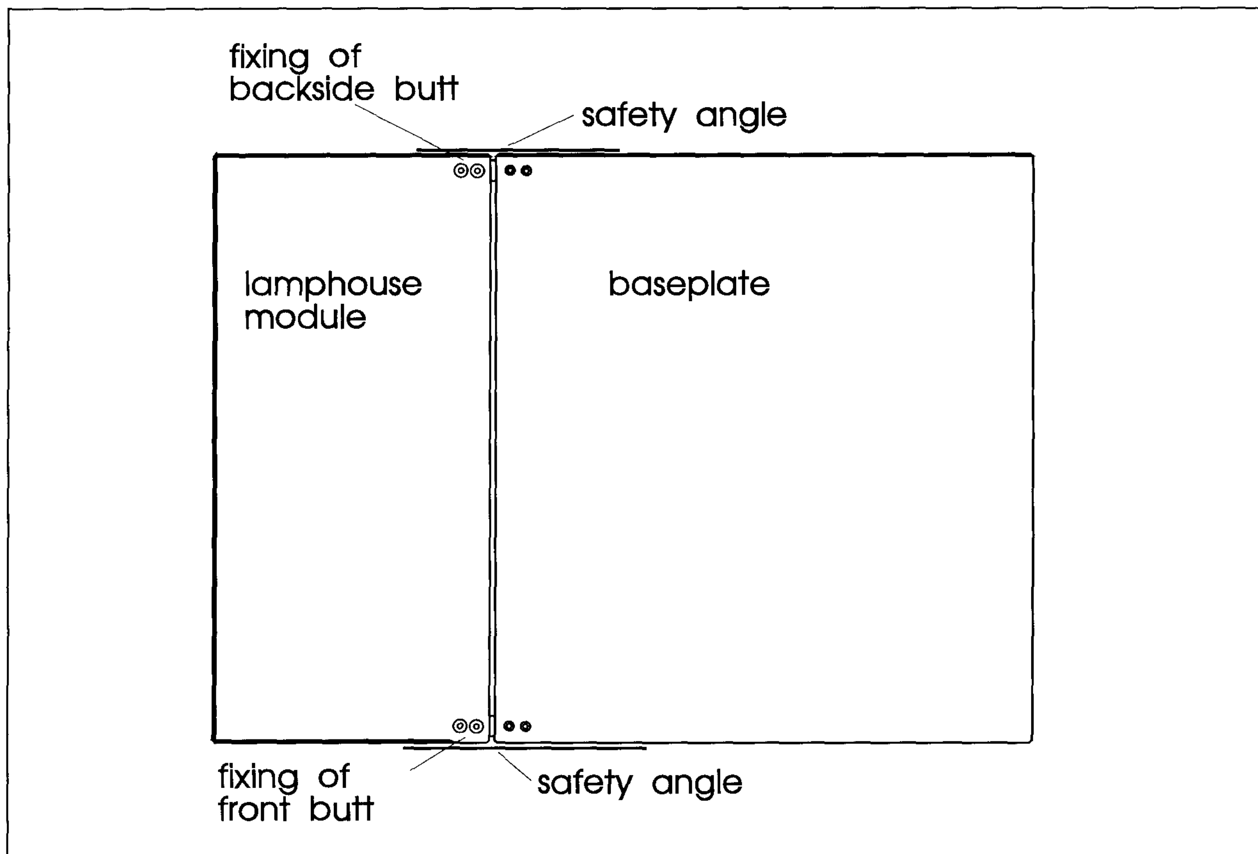
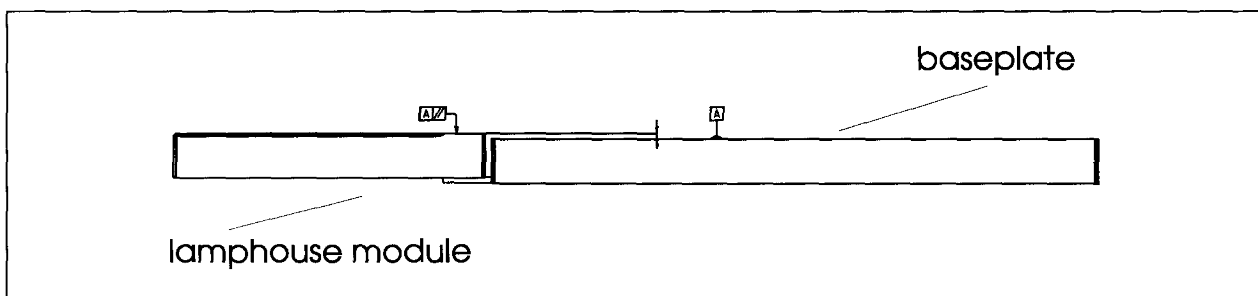


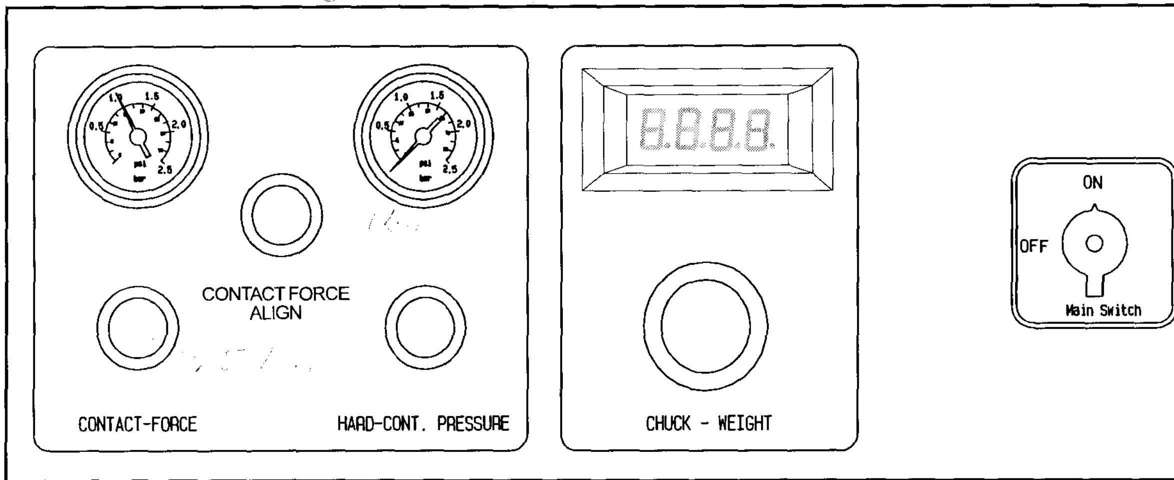
IV) Slightly loosen the butts at the lamphouse module (front- and backside).

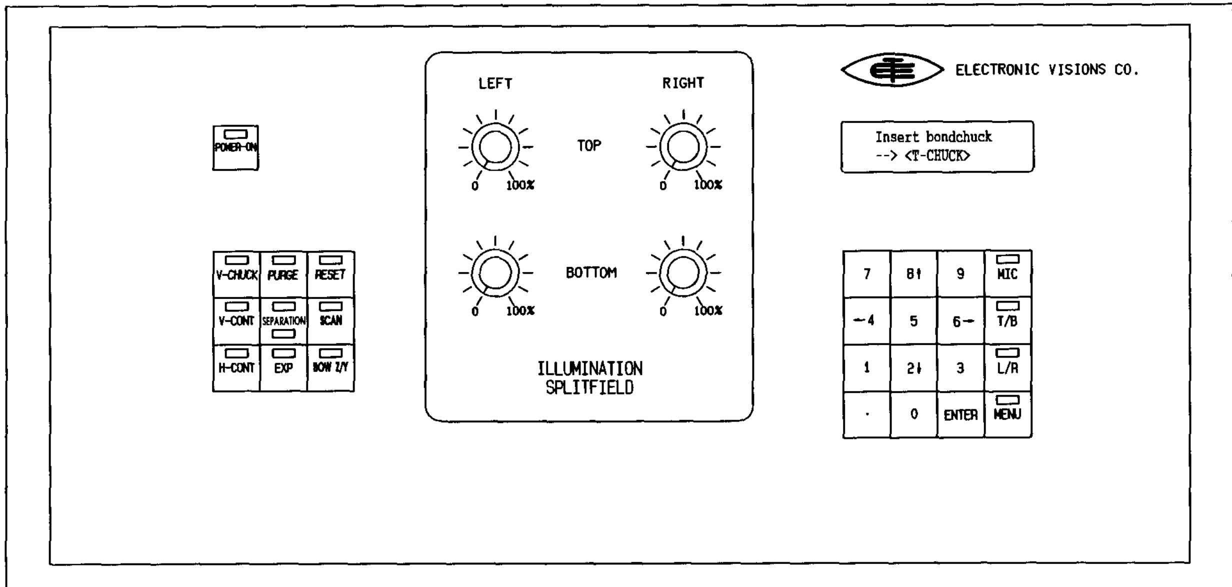
V) Level the lamphouse module approx. 0.3 to 0.4 mm higher, parallel to the baseplate.



2. Description of components

2. 1. Control panel





2.1.1. Switch for putting into operation

MAIN SWITCH:
Emergency stop.

POWER ON:
Power switch for control unit.

2.1.2. Keys for alignment and bond procedure

The actual condition is signaled by the lights on the keys.

V-CHUCK:
Vacuum to fix the wafer on the bottom chuck.

SEPARATION:
If the green LED and the red LED are on, the chuck (wafer) is in contact.
Make sure that the contact force is adjusted to 0.95 bar. This is necessary to ensure that the selected separation distance is equal to the movement of the Z-motor.
If the contact force is less the separation distance is less too.

V-CONT:
Evacuates the space between top and bottom wafer. Before loading the bottom wafer the sealing ring has to be set on the chuck. If you want to switch off the substrate vacuum (very thin and foil substrates) or reduce the vacuum, activate H-CONT and regulate the nitrogen pressure against zero. To activate vacuum contact, top and bottom wafer have to be in contact (separation LED is off).

H-CONT
Activates the pressure to press down the piston for bowing the upper wafer in silicon direct bonding.

PURGE
Activates the N2 pressure to flood the space between two wafers.

EXP
Activates the exposure process (starts illumination)

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SCAN:
Keyboard gets illuminated; lamphouse can be moved in Y-direction by hand to check the adjustment of wafer/mask with the top optic. After scanning press SCAN or ENTER until you get a message on the display. If you move the lamphouse back the keyboard illumination turns off and the process can be continued.

BOW Z/Y:
BOW is used to activate the pressure piston to bend the top wafer for SDB.
Z/Y is used to switch between Z and Y movement of the microscopes (optional).

RESET:
Pressing "RESET" cancels the actual process and unloads the last loaded wafer.
If the top wafer is already loaded, the following message is displayed for a short time:

```
   ** R E S E T **
UNLOAD TOP WAFER
```

i.e. top bond chuck moves up, V-Glass switches off, V-CHUCK switches off, Z-DC motor moves to its lowest position, and chuck stage moves.
Unload the top wafer and start the bond procedure again.

If both wafers are already loaded, "RESET" unloads the bottom wafer. After this you can continue the process or press " RESET " again to unload the top wafer as described.

2.1.3. Keyboard description

Numerical keyboard:
with add. functions (←↑→↓) for crosshair and optic motor movement on the monitor.

MIC:
Switch between optic motor movement and crosshair adjustment.

T/B
Switch between top and bottom camera. With T/B LED off the top camera picture is shown on the splitfield monitor. T/B LED on shows the bottom picture.

L/R:
Switch between both objectives and crosshair adjustment LEFT/RIGHT.

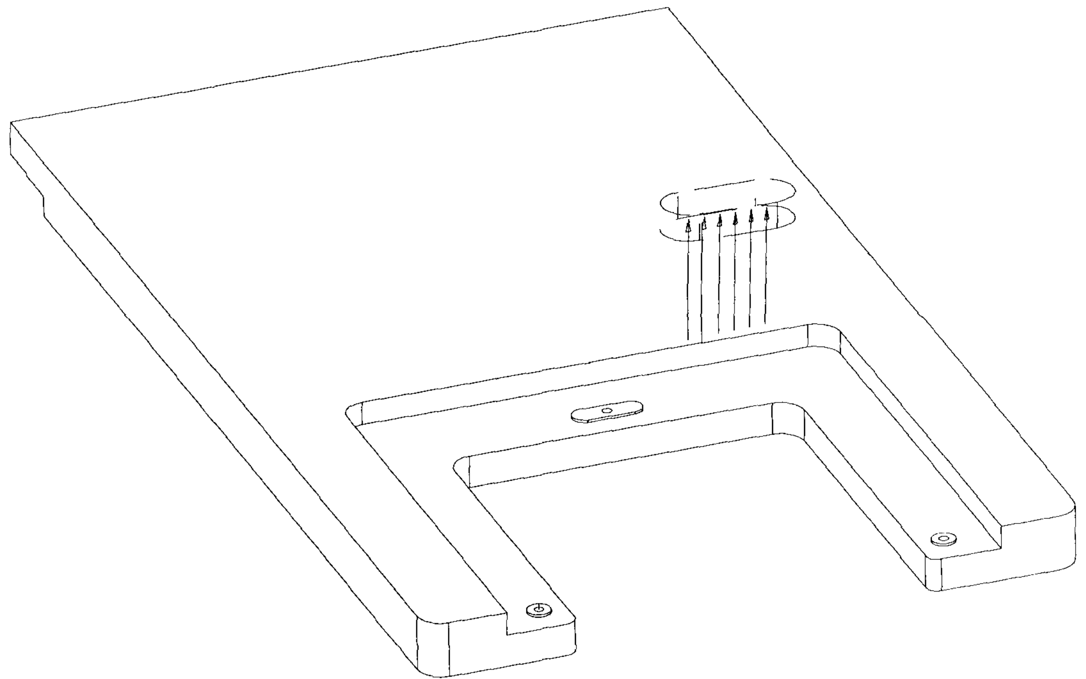
MENU:
Adjustment of process specific data (please refer to 2.5-set process data).

ENTER:
Confirms input data.

2.1.4. Regulators and displays on the control desk

ILLUMINATION SPLIT FIELD:
Regulators for the adjustment of the illumination intensity of the split field microscope. If the EV420 is equipped with a single field microscope, only the left regulator is active.

CONTACT FORCE:
To adjust the contact force during the planarization. The adjustment is achieved through pneumatic relief of the mask holder (increased pressure relieves the weight of the top bond chuck = reduced contact force).



The minimal contact force is theoretically 0 (suspended mask holder), reproducible values can be achieved starting from 1 N (about 100 g).

Please note, that the exactness of the planarization decreases with a small contact force, so we suggest to limit the contact force to 1 bar.

CONTACT FORCE ALIGN:
To adjust the contact force during alignment.

HARD-CONTACT PRESSURE:
To adjust the pressure pulling down the center piston on the top chuck.

CHUCK WEIGHT:
To adjust the air bearing system in the alignment unit (to lower the weight of the chuck) which is necessary to make a planarization.

2. 2. Bottom chuck stage

Includes the mechanical system for planarization and alignment. Rings in the sliding support allow adjusting of the height to different substrate-thicknesses.

The chuck stage enables the adjustment of the bonding substrates in X, Y and theta-direction.

2. 3. Switch ON the mask aligner

- Turn on POWER CONTROL: The electronic control is activated and after a few seconds the EV420 has completed the initialization procedure

2. 4. Initialization

After pressing the key POWER ON, the following message is displayed:

```
Initialization
move  tray  out
```

Follow all steps which are displayed.

2.5.1.1. SEPARATION:

Insert the separation distance in μm.

```
*  ->   separation    *
     Separat = 010
```

Make sure that the contact force is adjusted to 0.95 bar. Only with this value the inserted separation distance equals the movement of the Z-motor.
If the contact force is lower then the separation distance will be below the set value.

2.5.1.2. PROCESS

```
  *     -> process       *
   < BOND >       expo
```

Select PROCESS to adjust if you want to change parameters in a BOND PROCESS or for LITHOGRAPHY.

A) BOND

```
  *     -> process       *
 <NEW>   we-c   mic
```

NEW: Please refer to chapter 2.5.2.1
WE-C: Please refer to chapter 2.5.2.2
MIC: Please refer to chapter 2.5.2.3

B) EXPOSURE

```
  *     -> process       *
 <EXP>    we-c    mic
```

Depending on your selected view (top/bottom) you have two (top) or three (bottom) selections available in this menu. If you chose top, you are not able to select MIC.

EXP: Please refer to chapter 2.5.2.4
WE-C: Please refer to chapter 2.5.2.2
MIC: Please refer to chapter 2.5.2.3

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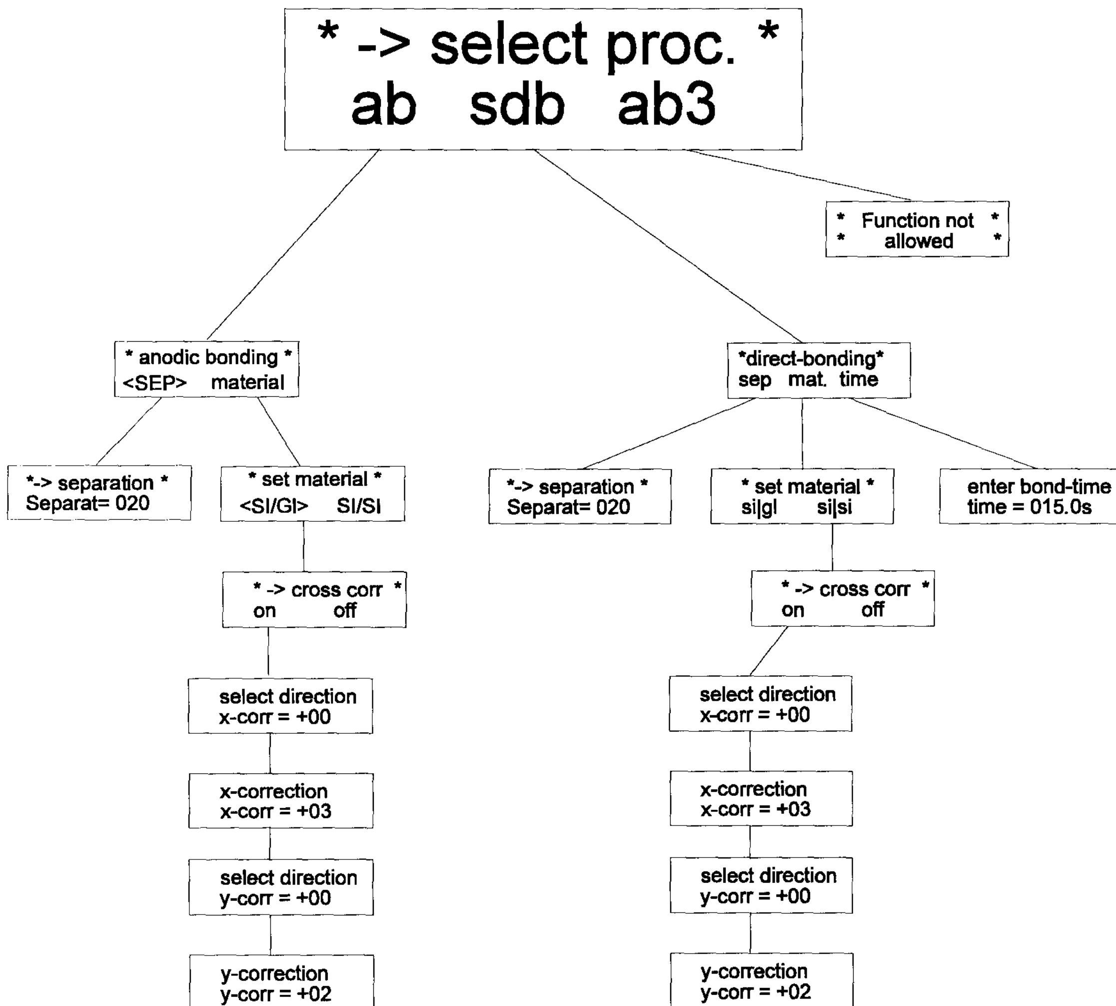
2.5.2. Lower Menus (NEW, WE-C, MIC, EXP)

2.5.2.1. Selection menu for bond-type *(OPTION)*

Flow diagram: Menu structure for selecting a process (NEW)



Explanation:

A) AB: Anodic bonding

```
*anodic bonding*
<SEP> material
```

- SEPARATION:

Insert the separation distance in μm.

```
* ->separation    *
  Separat = 010
```

Make sure that the contact force is adjusted to 0.95 bar. Only with this value will the inserted separation distance be equal to the movement of the Z-motor.
If the contact force does not match specified pressure (0,95 bar) it can occur that the separation distance does not match the defined value.

- MATERIAL:

Select the wafer material you are bonding with.

```
*   set material   *
  <SI|GL> si|si
```

SI|GL	top wafer SILICON bottom wafer GLASS	NO crosshair alignment
SI|SI	top wafer SILICON bottom wafer SILICON	crosshair alignment needed

If SI|SI is selected the display shows:

```
 * -> cross  corr *
    on     <OFF>
```

If you want to make an alignment without crosshair correction, press ENTER.

Otherwise select ON with the cursor keys and confirm with "ENTER" .

Cross correction is used when the alignment marks of the bottom wafer are offset to the top wafer in the range of micrometers. The cross for adjusting the second wafer is moved out of the middle position by the selected values in micrometers.

```
 select direction
    x-corr = +
```

Press key "5" to select between positive and negative crosshair correction values and press ENTER to confirm.

```
 x-correction
 x-corr = + _
```

Enter the value of the measured shift between top and bottom side [pixel]. Confirm with ENTER and follow the same procedure for Y-axis as proposed.

B) SDB: Silicon direct bonding

```
 *   direct-bonding      *
 <SEP>  cr-co   time
```

- SEPARATION

refer to anodic bonding

- Cross-correction
refer to anodic bonding

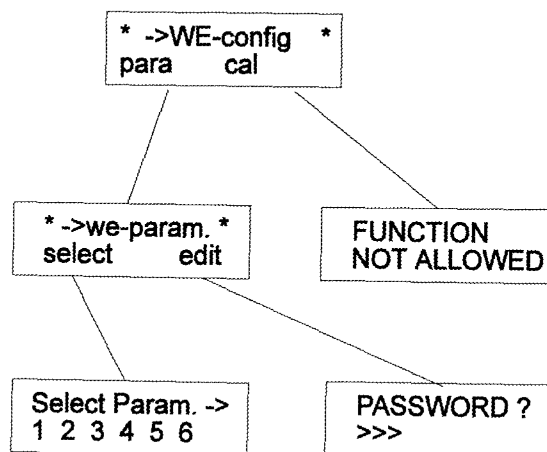
- TIME
Insert the bond time in seconds

enter bond-time
time = 005.0 s

Press ENTER to confirm.

2.5.2.2. Menu structure for we-configuration (WE-C)

Flow diagram: Menu structure for we-configuration (WE-C)

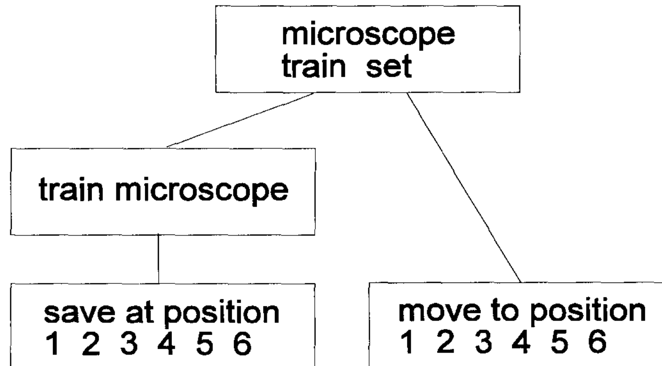


Explanation:

Within the WE-CONFIGURATION menu you are able to SELECT 1 of 6 preset timer s
the wedge error compensation procedure. These settings correspond to the different
(e.g. 4" wafer -> select nr. 4).
Editing these settings is prohibited by password and can be done by authorized m
staff only.

2.5.2.3. Menu structure for MICROSCOPE (MIC)

Flow diagram: Menu structure for microscope (MIC)



Explanation:

```
* ->Microscope *
<TRAIN>      set
```

A) TRAIN

Confirm with ENTER .
Move the bottom side objectives to a position you chose and confirm with ENTER.

```
save at position
<1> 2 3 4 5 6
```

Safe the actual mic position at a preset number you want. Select the desired number by moving the mark < > with the cursor-keys. Press ENTER to confirm and exit this procedure.

B) SET

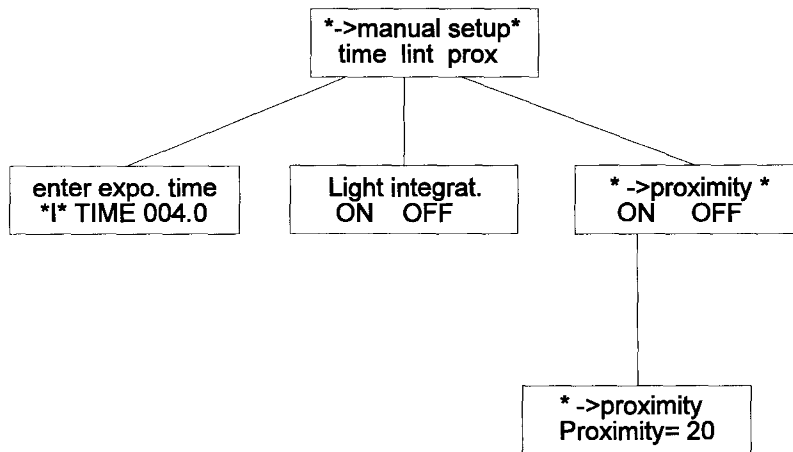
Moves the bottom optic to a saved position:

move to position
<1> 2 3 4 5 6

Select the preset number with the cursor-keys. After confirming with the ENTER-key, the bottom optic moves to the saved position and you exit this procedure.

2.5.2.4. Menu structure for EXPOSURE (EXP)

Flow diagram: Menu structure for exposure (EXP)



Explanation:

*   -> manual setup   *
<TIME> lint prox

TIME: Enter your selected EXPOSURE TIME.
LINT: Turn LIGHT INTEGRATION on or off.
PROX: Turn PROXIMITY on or off. If turned on you will be asked for the PROXIMITY value.

3. Anodic bonding *(OPTION)*

Before you start the anodic bond process, you have to install the appropriate tools.
These are: top load frame with top bond chuck and bottom chuck for anodic bonding.
The top bond chuck has to be fixed with the two handscrews inserted on both sides of the top cover. Make sure that the top bond chuck is positioned in the middle of the top cover.

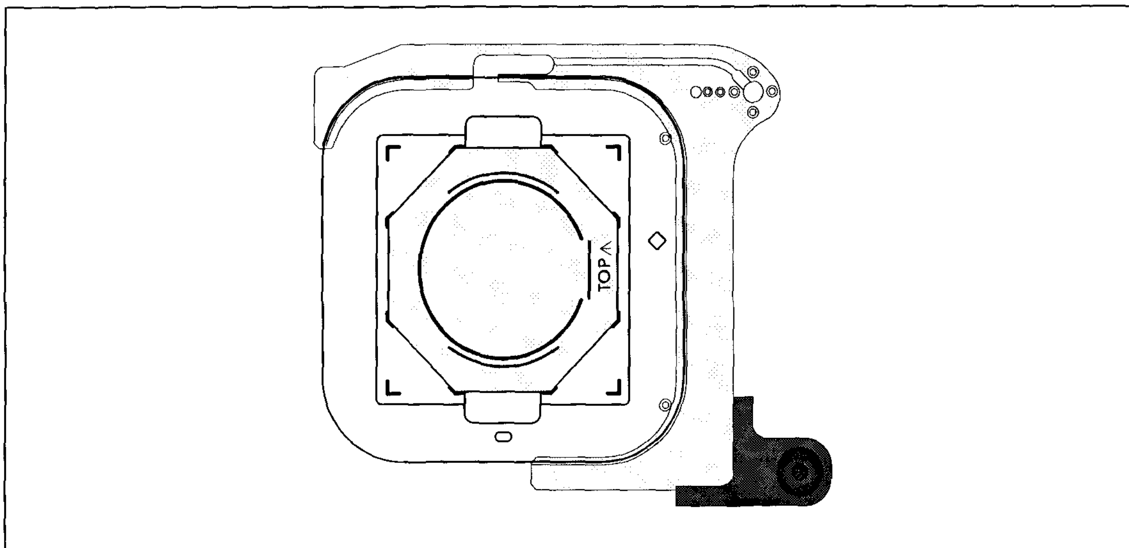
3. 1. Silicon / glass bonding

3.1.1. Loading the top wafer (SI)

Display:

load T - W + Glass
--> <V-CHUCK>

Position the bond glass on the chuck (see drawing):



Load the wafer on the chuck with the structured side down (use the ruler to preposition the bond glass and the wafer as shown in the drawing).

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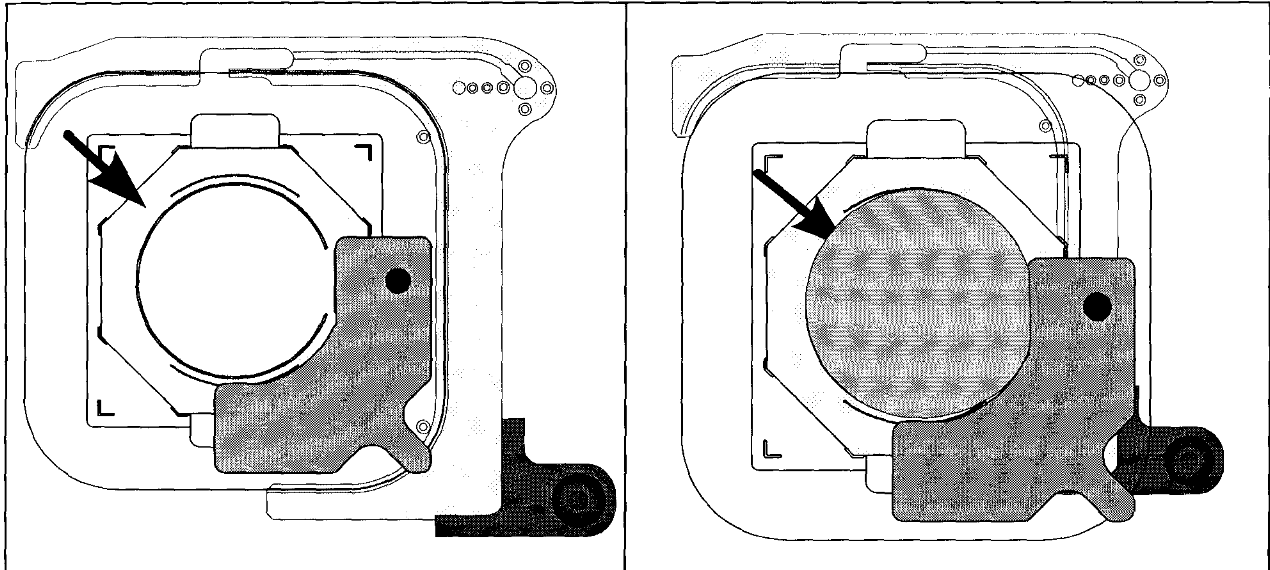
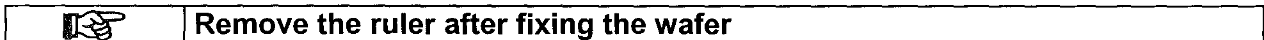


Move bond glass and wafer exactly to the edge of the ruler



Remove the ruler after fixing the wafer

Turn on V-CHUCK : The bond glass and the wafer must be fixed with vacuum on the bond chuck.

Display:

! remove ruler !
<ENTER> to cont.

Confirm this with ENTER
Display:

< CHECK FLAGS >
move tray in

When loading the first wafer, the separation flags have to be pulled out!
If the tray is in, it will be mechanically locked. Afterwards the planarization is released automatically .

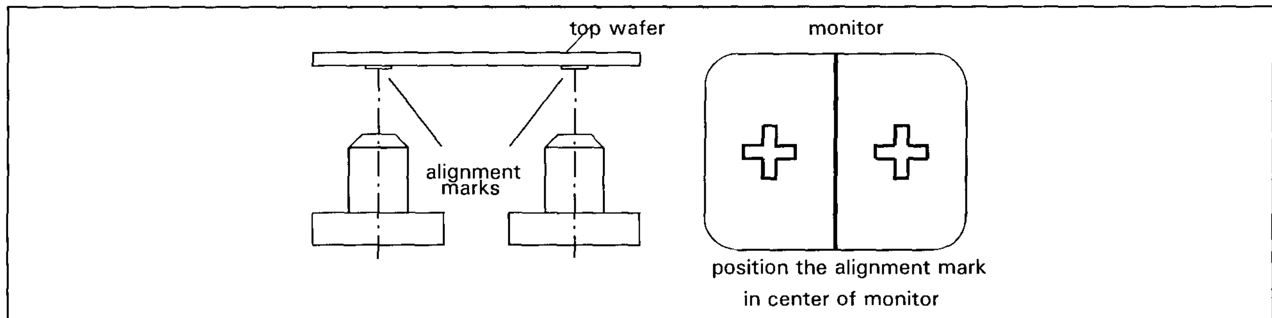
Display:

please wait W.E. comp

after w.e. comp you are in the alignment phase
Display:

adjust top - wafer < ENTER> to cont.

Adjust the top wafer with the spindles on the alignment stage in X-Y and Theta direction (the wafer is in separation to the top bond chuck).
To regulate the contact force during the alignment phase, turn regulator CONTACT FORCE ALIGN (see 2.1.4)



If the alignment mark is out of vision, move the microscopes by pressing ↔.
To adjust focus press ↑↓.

With key "5" it is possible to switch between slow and fast microscope movement .
When pressing the cursor keys the actual positions of the microscopes are displayed:

Display:

```
adjust mic
< MIC > to cont.
```

During pressing the cursor keys the positions of the microscopes are displayed.

Display:

```
Mic: -> 0536 -> 0670
[C]    0764->0834
```

Press < MIC >to fix the Wafer on the top-bond-chuck.

Display:

```
move tray out
```

3.1.2. Loading the bottom wafer (GL)

Now you are ready to load the bottom substrate:
Display:

```
Load  B -  W  +  Glass
 --> < V-CHUCK >
```

Load the bottom wafer (glass-wafer) on the chuck with the structured side to the top and press V-CHUCK (use the ruler to pre position the bond glass and the wafer as shown in the drawing 3.1).

Display:

```
! remove ruler !
<ENTER> to cont.
```

Confirm this with ENTER

```

move tray in
```

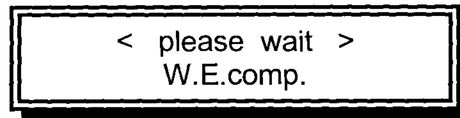
To obtain contact between the two wafers you have to insert the separation flags prior to the planarization.

Display:

```
Insert Sep. Flags
<ENTER>  to  cont.
```

3.1.3. Planarization

The planarization is released automatically.
Display:


< please wait >
W.E.comp.

Please check, whether regulator "CHUCK WEIGHT" is adjusted now (without adjustment of this regulator, the planarization can not be done correctly).
At the first PLANARIZATION you should make an optical check whether both substrates are in contact. Otherwise load the substrate again (press RESET) and
lower the contact force, until the top bond chuck moves against the bottom wafer.

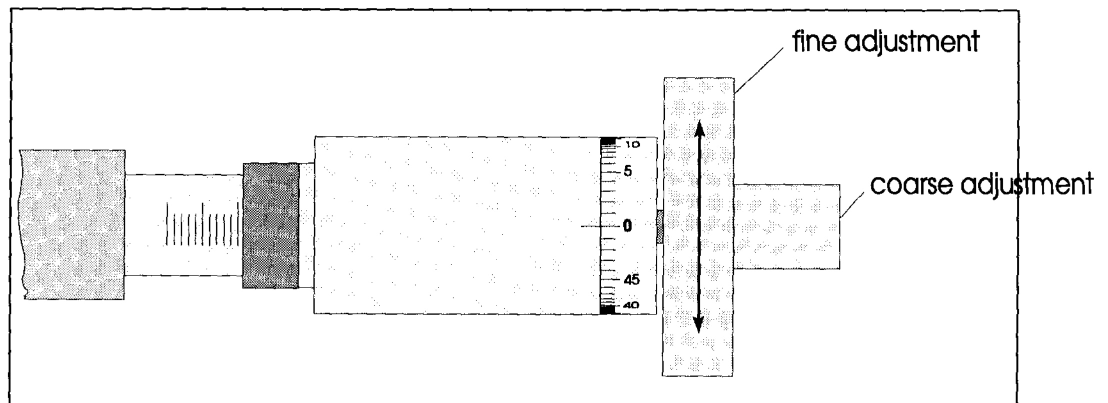
Now you are in the ALIGNMENT phase (see 3.1.5).

3.1.4. Adjust the separation distance

After the planarization both wafers are in separation (LEDs are ON). Pressing the SEPARATION-key, the top wafer moves into contact. How to adjust the separation distance refer to 2.5.2.1.A

3.1.5. Alignment

* Alignment of X - Y and Theta direction with micrometers (movement X and Y +/- 5mm, Theta +/-3,5°).
For fine adjustment a graduation on the adjustment knob of the micrometers is pressed.



During alignment you can change the contact force between both wafers with regulator "CONTACT FORCE ALIGN".

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Display:

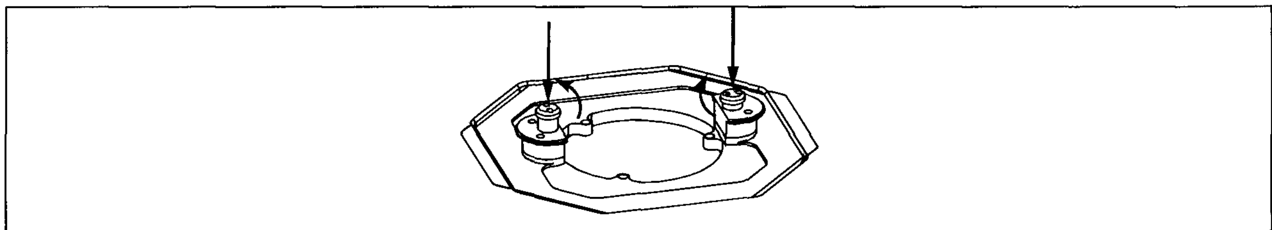
Align wafer
<SEP> to cont.

When the alignment is finished press separation-key to move into contact.

Display:

clamp wafer
< EXP > to bond

Insert the fixing bolts on the top bond chuck and press EXP to continue.



After pressing <EXP> the display shows: "bonding - remove bond chuck"

Display:

< BONDING >

Now the top bond chuck with the bonded wafers released can be removed.

Display:

remove bond chuck
<KEY> to cont

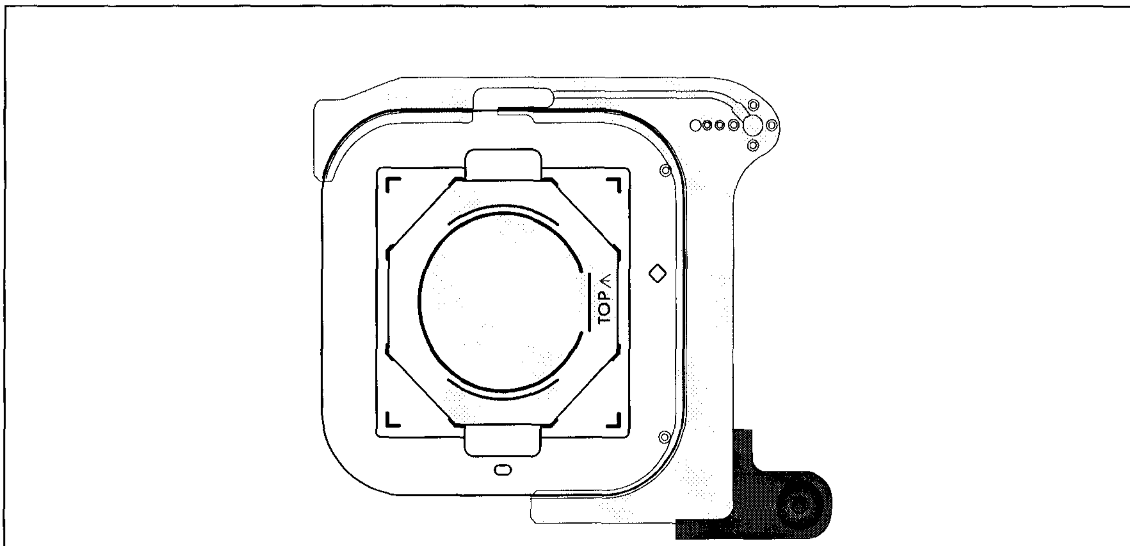
3. 2. Procedure for Silicon / Silicon bonding

3.2.1. Loading the top wafer (SI)

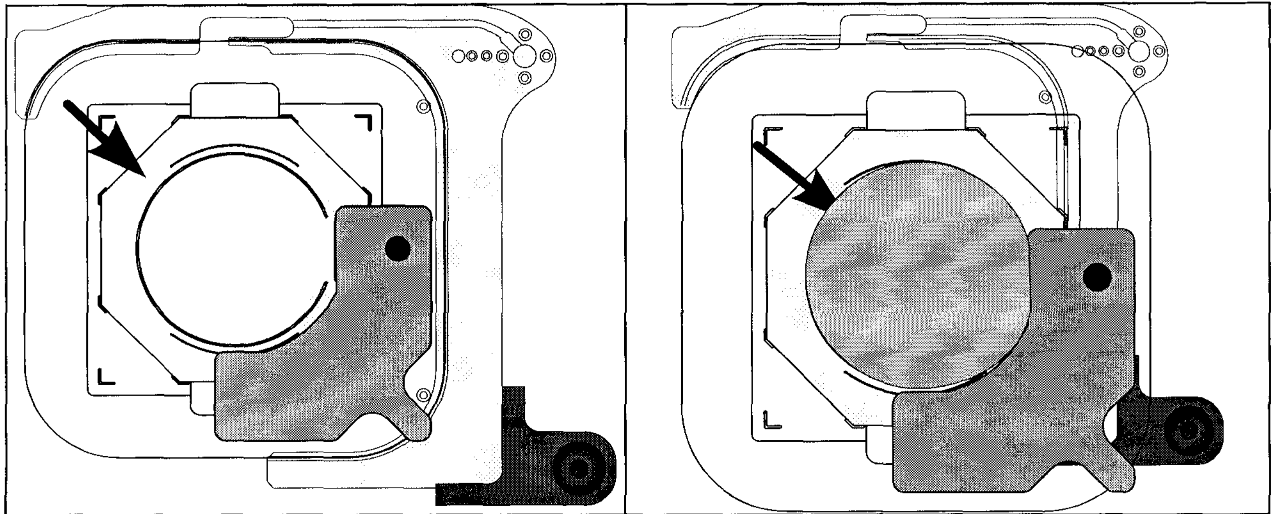
Display:

load T - W + Glass --> <V-CHUCK>

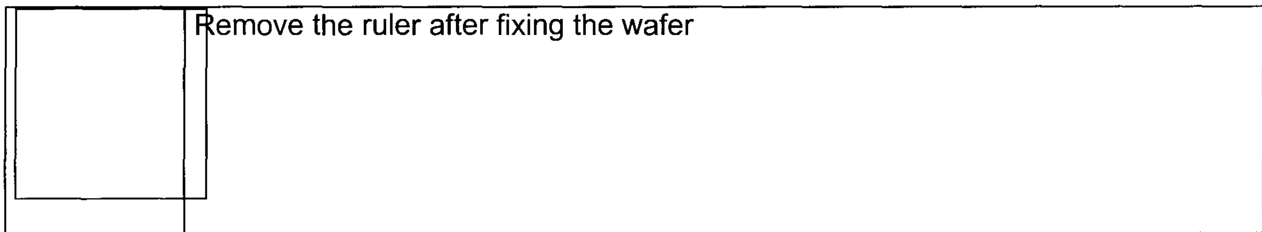
Position the bond glass on the chuck (see drawing):



Load the wafer on the chuck (use the ruler to pre position the bond glass and the wafer as shown in the drawing) with the structured side down.



Move bond glass and wafer exactly to the edge of the ruler



Remove the ruler after fixing the wafer

Turn on V-CHUCK : The bond glass and the wafer must be fixed with vacuum on the bond chuck.
Display:

! remove ruler !
<ENTER> to cont.

Confirm this with ENTER

Display:

< CHECK FLAGS >
move tray in

When loading the first wafer, the separation flags have to be pulled out!
If the tray is in, it will be mechanically locked. Afterwards the planarization is released automatically .

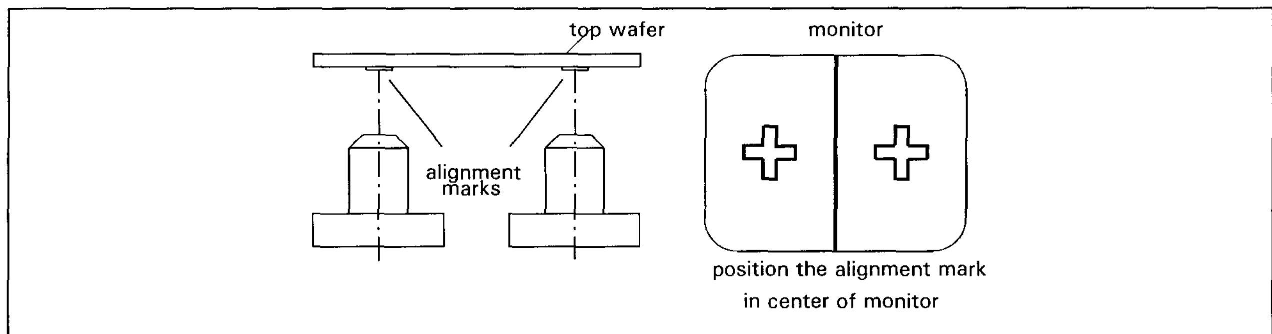
Display:

```
please    wait
 W.E. comp
```

After the planarization following message is displayed:

```
-->  align   wafer
< sep  >   to  cont.
```

Adjust the top wafer with the spindles on the alignment unit in X-Y and Theta direction (the wafer is in separation to the top bond chuck).
To regulate the contact force during the alignment phase turn regulator CONTACT FORCE ALIGN (see 2.1.4.).



If the alignment mark are out of vision, move the microscopes by pressing ↔.
To adjust focus press ↑↓.

With key "5" it is possible to switch between microscope movement slow and fast. During pressing the cursor keys the actual positions of the microscopes are displayed:

```
Mic:->0536->0670
 [C] 0764->0834
```

After alignment press MIC to fix the wafer on the top bond chuck and to align the crosshair to the alignment mark.

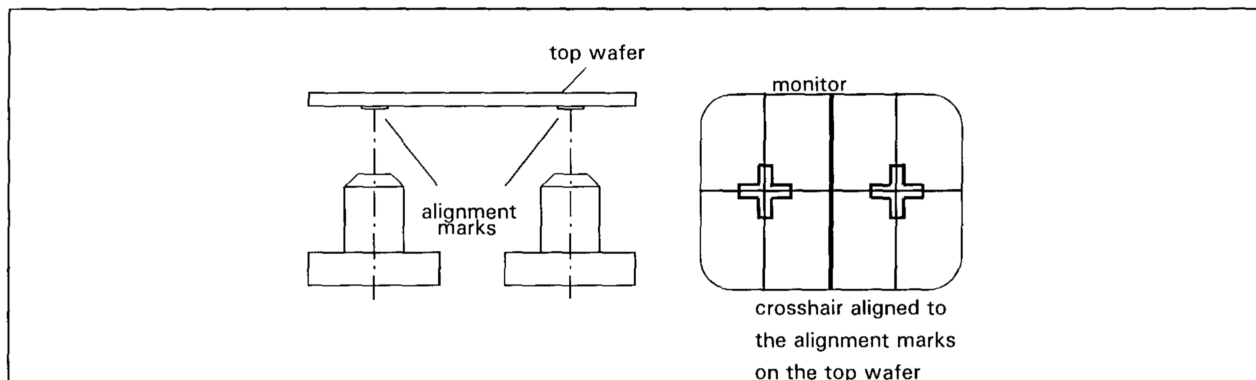
3.2.2. Align the crosshair

After pressing MIC, you have to align the crosshair to the alignment marks on the top wafer:

--> adjust hair
<ENTER> to cont.

Align the crosshair to the left and the right alignment mark on the loaded wafer by pressing the cursor keys "←↑→↓" .
With key L/R you can switch between crosshair adjustment on the left and on the right half of the monitor.
To change from fast movement to slow movement press key " 5 " .

Schematic description of CROSSHAIR ADJUSTMENT:



Please Note!	Touching the microscope after setting the crosshair will affect the accuracy between top and bottom side alignment.

If you want to refocus or align to an other alignment mark, press " MIC " -key:

--> adjust mic
< MIC > to cont

Now you are in the microscope adjustment menu again. Press " L/R " to switch between left and right bottom microscope or key " 5 " to switch between slow and fast microscope movement .

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If you want to exit, press " MIC "-key again to get back to the crosshair adjustment menu, or press ENTER.

After crosshair alignment press ENTER. The top wafer is fixed on the top bond chuck with vacuum and the following message is displayed:

move tray out

3.2.3. Loading the bottom wafer (SI)

Now you are ready to load the bottom substrate:

load B - W + Glass --> <V-CHUCK>

Load the bottom wafer (silicon-wafer) on the chuck (use the ruler to pre position the bond glass and the wafer as shown in the drawing 3.1) with the alignment marks to the bottom and press V-CHUCK.
Display:

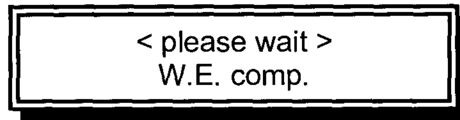
! remove ruler ! <ENTER> to cont.

Confirm this with ENTER

Display:

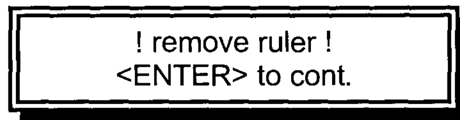
move tray in

Display:



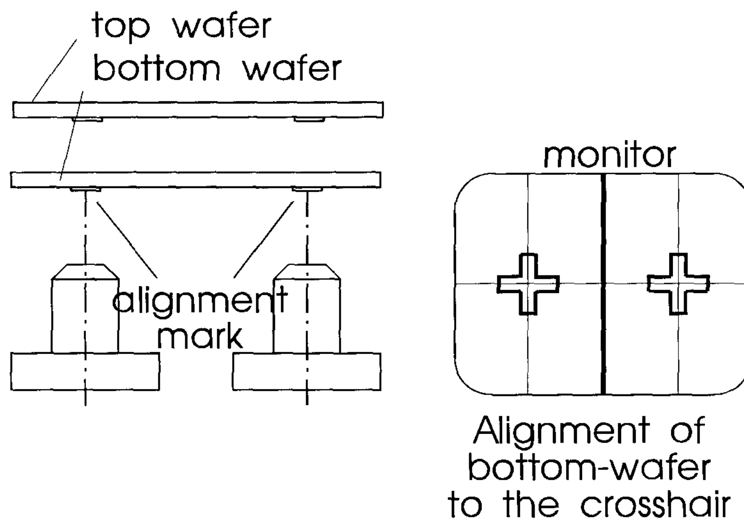
After planarization following massage is displayed

Display:



Confirm this with ENTER

Schematic description of CROSSHAIR ADJUSTMENT:

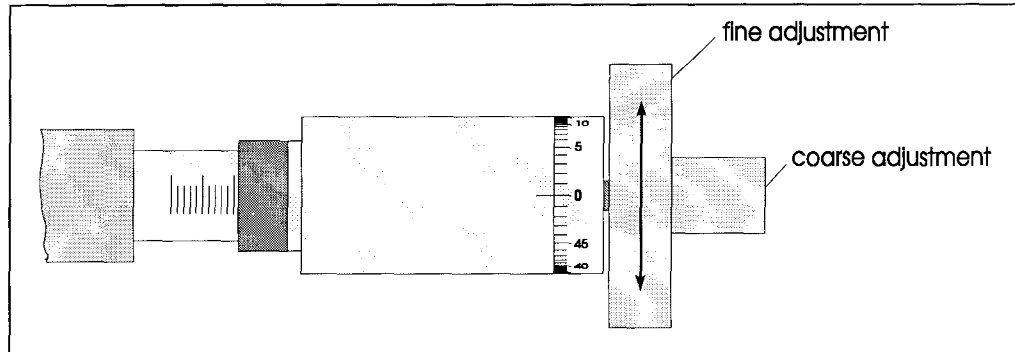


3.2.4. Adjust the separation distance

After the planarization both wafers are in separation (LEDs are ON). Pressing the SEPARATION-key, the top wafer moves into contact. How to adjust the separation distance refer to 2.5.2.1.A

3.2.5. Alignment of bottom-wafer to the crosshair

* Alignment of X - Y and Theta direction with micrometers (movement X and Y +/- 5mm, Theta +/-3,5°). For fine adjustment use the scale on the micrometers.

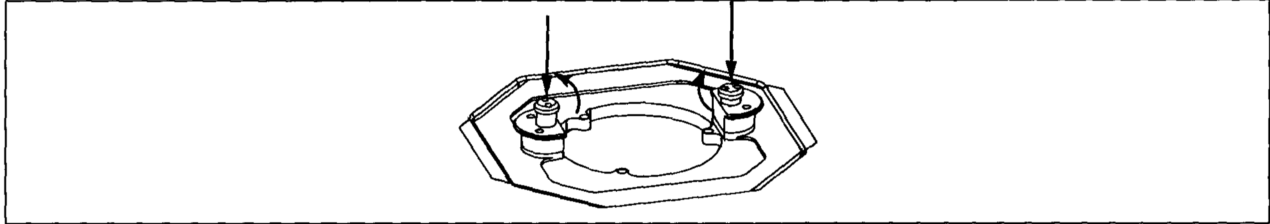


During alignment, you can change the contact force between both wafers with regulator "CONTACT FORCE ALIGN".
Display:

align wafer
<SEP> to cont.

When the alignment is finished press separation-key to move into contact. Insert the fixing bolts and press the EXP-button.

clamp wafer
< EXP > to bond



Now the display shows the countdown for the preselected bondtime. After this the top bond chuck with the bonded wafers is released and can be moved out.

On the display:

remove bond chuck
< KEY > to cont.

Now remove the top bond chuck with the aligned wafers, and pull out the tray to start a new bond process.

4. Silicon direct bonding *(OPTION)*

Before you start with the SILICON DIRECT BOND process, you have to install the appropriate bondtools on the aligner.
These are: Top load frame with top bond chuck for SDB and bottom chuck for SDB. Fix the top bond chuck with the handscrews on both sides of the cover.

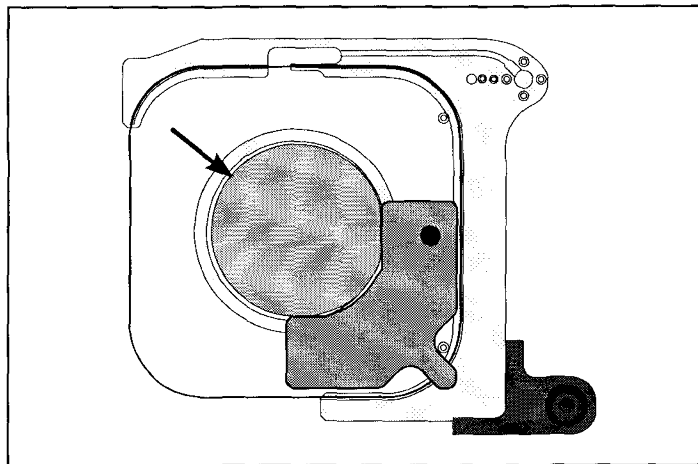
For SDB parametersettings refer to 2.5.2.1

4. 1. Loading the top wafer

After finishing the parameter selection for silicon direct bonding with MENU-key the following message is displayed:

```
load     top - wafer
-->  <V-CHUCK>
```

Load the wafer on the chuck (use the ruler to preposition the wafer as shown in the drawing) with the structured side down.



Move wafer exactly to the edge of the ruler

	Remove the ruler after fixing the wafer

Press V-CHUCK : The wafer must be fixed with vacuum on the bond chuck.
Display:

! remove ruler !
<ENTER> to cont.

Confirm this with ENTER

Display:

move tray in

If the tray is in, it will be mechanically locked. Afterwards the planarization is released automatically .

Display:

< please wait >
W.E.comp

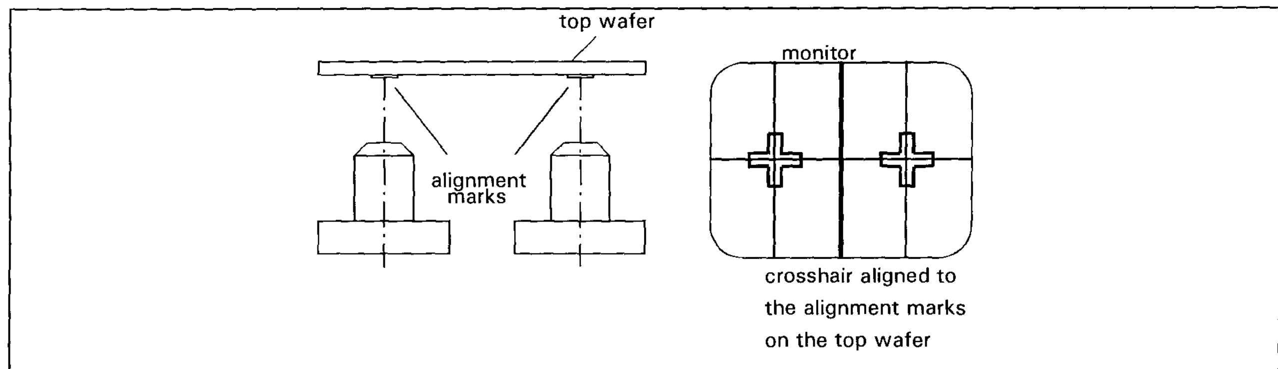
After planarization the following message is displayed:

adjust top- wafer
<ENTER> to cont

Adjust the top wafer with the spindles on the alignment stage in X-Y and Theta direction (the wafer is in separation to the top bond chuck); During the alignment phase purge is activated. Turn regulator CONTACT FORCE ALIGN (see 2.1.4) to regulate the contact force during the alignment phase.

After confirming with ENTER-key the following message is shown on the display:

```
--> adjust mic
< MIC > to cont.
```



If the alignment mark is out of vision, move the microscopes by pressing ←→.
To adjust focus press ↑↓.

With key "5" it is possible to switch between microscope movement slow and fast.
During pressing the cursor keys the actual positions of the microscopes are displayed:

```
Mic: -> 0536 -> 0670
 [C]  0764->0834
```

After alignment press MIC to fix the wafer on the top bond chuck and to align the crosshair to the alignment mark.

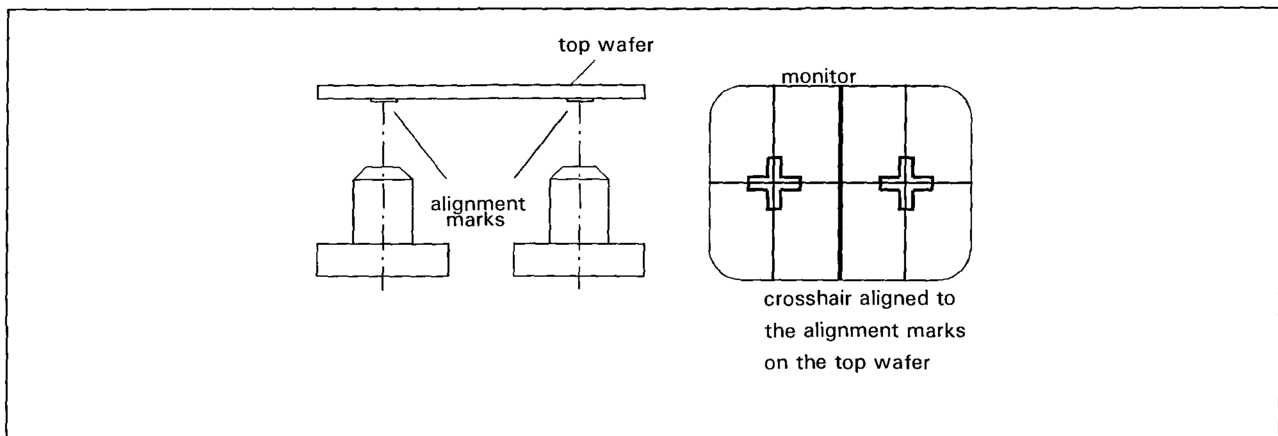
4. 2. Align the crosshair

After pressing ENTER, you have to align the crosshair to the alignment marks on the top wafer:

-> adjust hair <ENTER> to cont

Align the crosshair to the left and the right alignment mark on the loaded wafer by pressing the cursor keys " ←→↓↑" .
With key L/R you are changing between crosshair adjustment on the left and on the right half of the monitor.
To switch between fast movement and slow movement press key " 5 " .

Schematic description of CROSSHAIR ADJUSTMENT:



Please Note!	**Touching the microscope after setting the crosshair affects the accuracy between top and bottom side alignment!**

If you want to refocus or align to an other alignment mark, press " MIC "-key:

```
--> adjust mic
< MIC > to cont.
```

Press MIC to return to the crosshair alignment.

After crosshair alignment press ENTER. Now PURGE is activated, the top substrate is fixed with vacuum to the top chuck and the following message is displayed:

```
move tray out
```

4. 3. Loading the bottom wafer (SI)

Now you are ready to load the bottom substrate.
Display:

```
load Bottom Sub.
--> < V-CHUCK >
```

Load the bottom wafer on the chuck (use the ruler to pre position the wafer as shown in the drawing 3.1) with the alignment marks to the bottom and press V-CHUCK.
Display:

```
! remove ruler !
<ENTER> to cont.
```

Confirm this with ENTER

Display:

move tray in

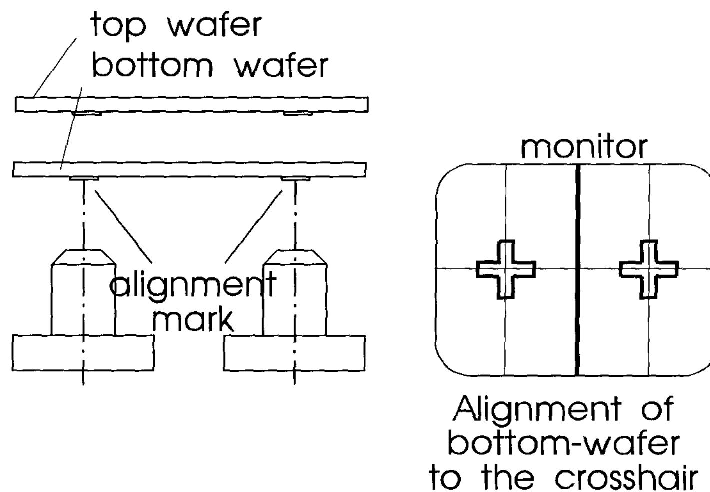
Follow the instructions.

4. 4. Alignment of bottom-wafer to the crosshair

Display:

align wafer <H-CONT> act. bow

Schematic description of CROSSHAIR ADJUSTMENT:

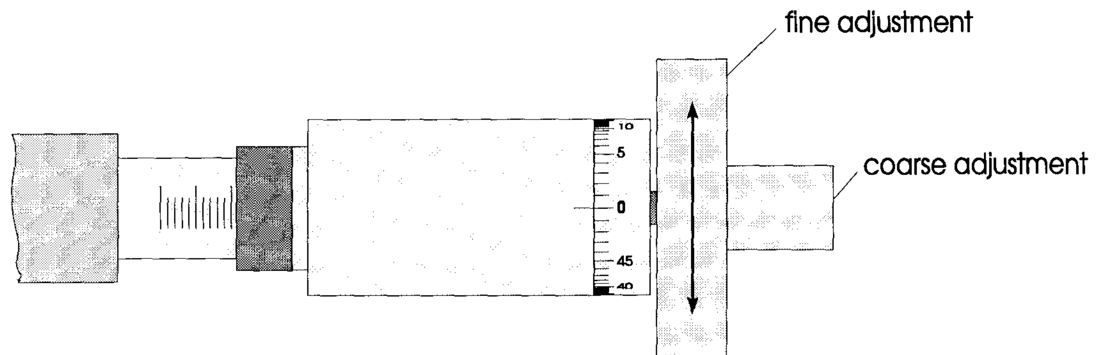


Alignment of bottom-wafer to the crosshair

Please Note!	Do not change the crosshair positions when adjusting the bottom wafer to the crosshair! Otherwise the alignment between the two wafers is incorrect!

* Alignment of X - Y and Theta direction with micrometers (movement X and Y +/- 5mm, Theta +/-3,5°).

For fine adjustment use the scale on the micrometers.
During alignment the cover stays in the upper position (Separation).

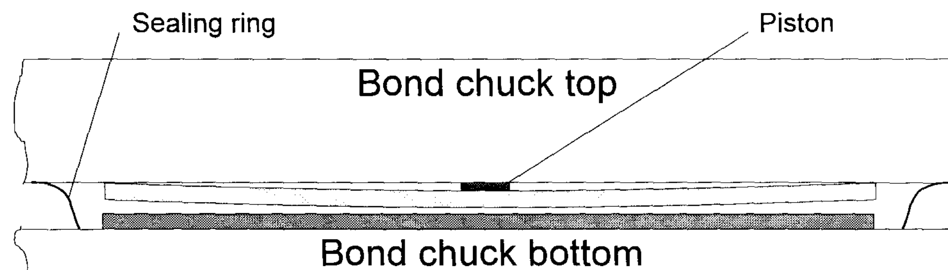


When the alignment is finished, you have several possibilities to proceed:

A) *Bond the wafers without vacuum and without H-CONT* (top wafer is not bent in the center). For this selection press <EXP> to bond.

B) *Bond the wafers without vacuum and with H-CONT* (top wafer is bent in the center). Press <H-CONT> and adjust the hard contact regulator to bend the top wafer in the center. Now you will be asked for V-CONT to evacuate. If you want to bond without vacuum, press <EXP> to bond.

C) *Bond with vacuum and H-CONT*. Follow the instructions shown on the display. Don't forget to maintain the sealing ring for vacuum on the bottom chuck!



Display:

press v-cont
<V-CONT> to cont.

Press **V-CONT** if you want to evacuate the gap between top and bottom chuck.

Display:

press exp.
< EXP > to cont.

Afterwards press **EXP**-key to release the bond procedure.
When both wafers are in contact the count down for the bondtime starts and the following message is displayed:

< BONDING >
Bond - Time = 20.0

After bonding move out the tray and unload the bonded wafers.

Display:

move tray out

5. EXPOSURE

Before you start with the exposure procedure you have to install the glass vacuum chuck.

5. 1. Top side alignment and EXPOSURE

Set process parameters -> refer to chapter 2.5
Before you start with the alignment for EXPOSURE you have to install the appropriate chucks for this process.

5.1.1. Preparation

Preadjustment of regulator "CHUCK WEIGHT" see 2.1.4

5.1.2. Lamp Ignition

* Turn on MAIN SWITCH of the mask aligner and power switch of the lamp power supply.

* Start lamp: press START key on the external lamp power supply. The measurement tools on the power supply have to show now constant values. If not - press start key again. Continue until the measurement tools show constant values. Now the lamp is ignited.

* Turn on POWER ON: The electronic control is activated and after a few seconds the EV420 has completed the initialization procedure.

CAUTION: After pressing the POWER ON-key the lamp house moves to the rear position for a short time. AREA IN FRONT OF THE LAMP HOUSE SHOULD BE KEPT CLEAR!

5.1.3. Initialization

After pressing the key POWER ON:

```
    Initialization
 move   tray   out
```

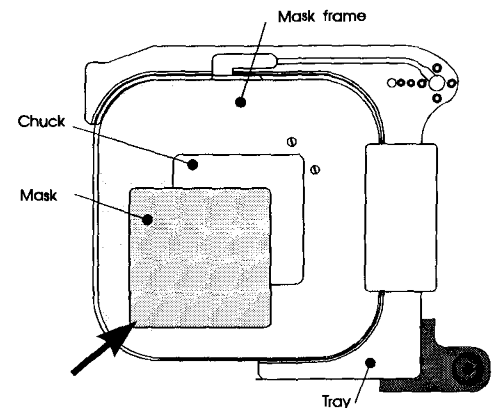
Follow all steps which are displayed.

5.1.4. Load mask

Display:

```
   --> load mask
    move tray in
```

* Load the maskframe on the chuck (refer to the position on the drawing) and load the mask (coated surface to the bottom) and pre position it with the prealignment pins.



* Move tray in. The planarization between mask and top chuck will be done automatically.

```
 <  please wait  >
    W.  E.  comp.
```

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After the end of the planarization you see:

```
--> align mask
< ENTER > to cont
```

Align the mask positioned on the tray by using the micrometers and position the top microscopes to the alignment marks on the mask. During this procedure the chuck is in separation to the mask. The contact force during the alignment procedure is adjustable with regulator "CONTACT FORCE ALIGN" .

After alignment confirm with ENTER.

Display:

```
move tray out
```

When the tray is out, following message is displayed.

Display:

```
remove loadframe
<ENTER> to cont.
```

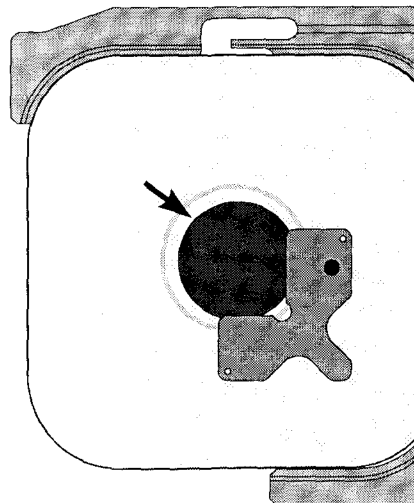
After confirm with <ENTER> you are in the substrate loading procedure.

5.1.5. Topside alignment and exposure

5.1.6. Load substrate

After loading the mask and pulling out the tray the following message is displayed:

-> load substrate <V-Chuck>to cont.



* Remove the Maskframe and load the wafer on the chuck (use the ruler to pre position the wafer as shown in the drawing 3.1) with the structured side down.

- Press V-CHUCK : Now the wafer is fixed with vacuum on the chuck. ***After fixing the wafer remove the ruler!***

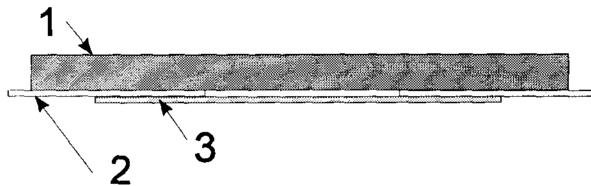
Display:

! remove ruler ! <ENTER> to cont.

Display:

move tray in

If proximity exposurement is set, the proximity flags move in after loading the substrate.
The planarization will be done with inserted flags afterwards the flags move out and the Z-motor moves to the proximity distance set.



1 .....mask
2 .....proximity flags
3 .....substrate

5.1.7. Planarization

When the tray is moved in the planarization is released automatically.

Display:

< please wait >
W. E. comp

Please check whether regulator "CHUCK WEIGHT" is already adjusted (without adjustment of this regulator the planarization can not be done correctly). At the first PLANARIZATION you should make an optical check whether both substrates are in contact. Otherwise load the substrate again (press RESET) and lower the contact force till the top bond chuck moves against the bottom wafer. Now you are in the align phase (see 5.1.9.)

Display:

--> align wafer
<SEP> to cont.

5.1.8. Adjustment of the top side microscope

*Adjustment of the depth of focus.

*X-adjustment for left and right objective: the Y-axis of the alignment marks are adjusted in the field of vision.

5.1.9. Adjustment of the separation distance

After planarization mask and wafer are in separation.

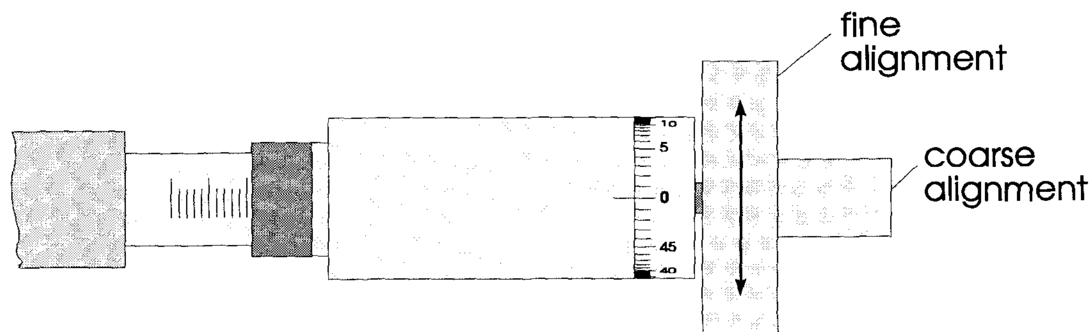
Press " SEPARATION "-key, to bring mask and wafer in contact.

5.1.10. Alignment

Display:

--> align wafer <SEP> to cont

* Alignment of X - Y and Theta direction with micrometers (movement X and Y +/-5mm, Theta +/-3,5°). For coarse-adjustment a graduation on the adjustment knobs of the micrometers are placed.



During alignment you can change the contact force between mask and wafer with regulator "CONTACT FORCE ALIGN".

5.1.11. Selection of the exposure procedure

PROXIMITY
The mask moves into the proximity distance set.

CONTACT
Press the separation-key (LED goes off). Now the mask is on the wafer with the adjusted contact force (same contact force as during alignment).

Display:

<H-Cont> <V-Cont>
<EXP> to cont

VACUUM CONTACT
Establish the contact with the separation key.
Turn VACUUM-CONTACT on: The space between wafer and mask is evacuated and the sealing ring is fixed to the mask. To turn off the wafer vacuum (V-CHUCK), you can simultaneously turn on H-CONT with an adjusted nitrogen pressure of 0 bar.

HARD-CONTACT
Establish the contact with the separation key.
When you set H-Cont following massage is displayed
Display

adjust chamber
vacuum <ENTER>

refer to par. 2.1.2.

Turn on H-CONT and adjust the desired N_2-pressure on the regulator. In case of higher nitrogen pressure, vibrations of the mask holder could appear, if there is a nitrogen cushion under the wafer. In this case vacuum contact (in combination with HARD-CONTACT, i. e. with nitrogen pressure) should be used.

5.1.12. Exposure

Press key EXP:

	The area in front of the lamp house should be kept CLEAR!

The wafer is exposed according to the set time. After exposure the space between mask and wafer is purged with N2 and the mask is elevated.

```
*  exposure   *
move  lamphouse
```

The lamp house moves to exposure position and exposes for the preselected time. Then the lamp house moves back again to alignment position.

After exposure you have to wait until the tray is up. Afterwards bring the tray in loading position and take the wafer from the chuck. Now the EV420 is ready for loading the next substrate.

Display:

```
  unload   wafer
move    tray    out
```

You can unload the exposed wafer and load the next wafer (refer to 5.1.5 load substrate).
If you don't want to expose another wafer, continue with chapter 5.1.12 to unload the mask.

5.1.13. Unload the mask

Instead of loading the substrate press RESET.

On the display:

```
unload  mask
no           < YES>
```

Press ENTER to unload the mask.

```
unload  mask
move   tray   in
```

Move in the tray with the loaded mask frame. Now the mask holder moves down and loads the mask onto the chuck. When the mask holder elevates from the chuck you can see on the display:

```
unload  mask
move   tray  out
```

Move out the tray and unload the mask.

5. 2. Bottomside alignment and exposure

Set process parameters -> refer to chapter 2.5
Before you start with the alignment for EXPOSURE you have to install the appropriate chucks for this process.

5.2.1 Preparations

Preadjustment of regulator "CHUCK WEIGHT" see 2.1.4

5.2.2. Switching on and starting the lamp

*Turn on MAIN SWITCH of the mask aligner and power switch of the lamp power supply.

*Start lamp: press START key on the external lamp power supply. The measurement tools on the power supply have to show now constant values. If not - press start key again. Continue until the measurement tools show constant values. Now the lamp is ignited.

*Turn on POWER ON: The electronic control is activated and after a few seconds the EV420 has completed the initialization procedure.

CAUTION: After pressing the POWER ON-key the lamp house moves to the rear position for a short time. AREA IN FRONT OF THE LAMP HOUSE SHOULD BE KEPT CLEAR!

After pressing the key POWER ON:

Initialization move tray out

Follow all steps which are displayed.

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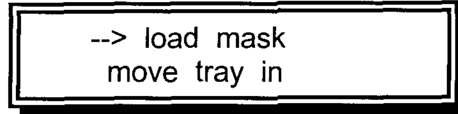
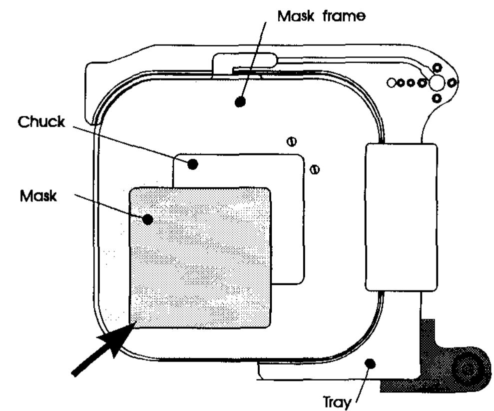
5.2.3. Mask loading

Display:



* Load the mask frame on the chuck (refer to the position on the drawing) and load the mask (coated surface to the bottom) and pre position it with the prealignment pins.



Move tray in.

5.2.4. Set process data

refer to 5.1.10

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5.2.5. Adjustment of bottomside alignment

After mask loading on the display:

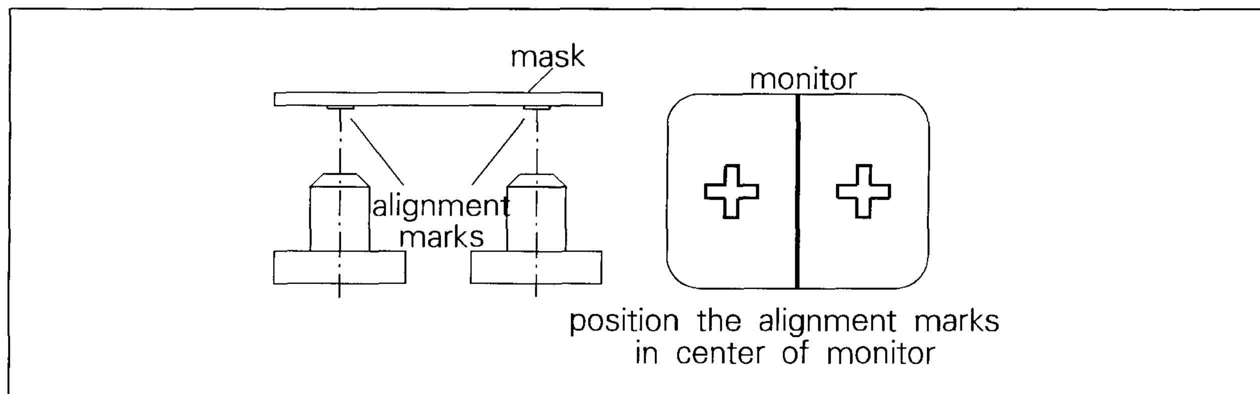
```
-> load substrate
<V-Cont> to cont.
```

By pressing key ** **T/B** ** bottomside alignment is selected.

```
sub-load ### bot    adj
-> <V-SU>###-><ENTER>
```

5.2.6. Microscope adjustment

Schematic description:



If the alignment mark is out of view, press MIC to activate microscope alignment modus.

Shown on the display:

```
--> adjust  mic.
 < MIC > to cont.
```

Move the microscopes by pressing ←.→ . To adjust focus press ↑↓.
With key 5 it is possible to switch between slow and fast microscope movement .
During pressing the cursor keys the actual positions of the microscopes are displayed:

```
Mic: ->  0536  ->0670
[C]       0764   ->0834
```

	PLEASE NOTE! *On touching the microscope after setting the crosshair, the accuracy between top and bottom side is not guaranteed.*

Pressing MIC-key you return to crosshair adjustment modus.

5.2.7. Crosshair adjustment

By Pressing ENTER, BOT ADJ is selected and following message is displayed:

```
--> adjust  mask
   move tray  in
```

	Load the tray ***WITHOUT A SUBSTRATE****.*

Display:

```
< please   wait >
--> W. E.  comp
```

The planarization between mask and chuck is carried out automatically. For the first time you should make an optical check if mask and wafer are in contact. If not, the pressure for the maskholder relief (CONTACT FORCE) is too high. After reducing the pressure, you should load the substrate again (press RESET).

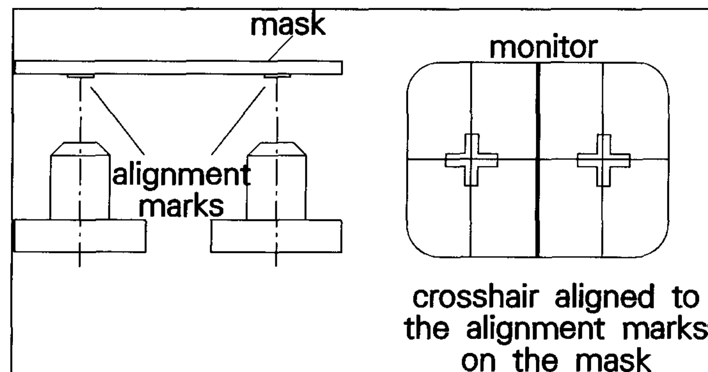
After planarization following message is displayed:

```
 --> adjust  cross
< ENTER >  to  cont.
```

By pressing the cursor keys you can align the crosshair to the alignment marks on the mask (see schematic description: CROSSHAIR ALIGNMENT). With key L/R you are changing between crosshair adjustment on the left and on the right half of monitor.
During pressing the cursor keys the actual positions of the microscopes are displayed:

```
CROSS :->536  ->670
[C]          764  ->834
```

Schematic description of CROSSHAIR ADJUSTMENT



With key 5 it is possible to switch between crosshair movement slow and fast.
Pressing ENTER leaves the align modus.

5.2.8. Load the substrate

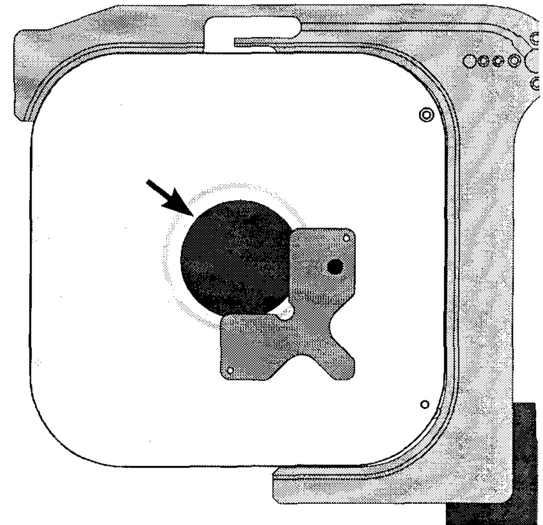
After crosshair alignment following message is displayed:

move tray out

The maskholder has already moved up. Now you can pull out the tray to load the substrate. When the tray is out the display shows:

sub - load | bot adj -><V-SUB> | - <ENTER>

Load the substrate (use the ruler to pre position the wafer as shown in the drawing 3.1) with the structured surface to the bottom side. Press V-CHUCK to fix the wafer on the chuck.



- Press V-CHUCK : Now the wafer is fixed with vacuum on the chuck.

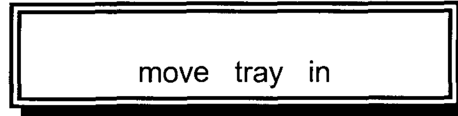
	After fixing the wafer remove the ruler.

Display:

! remove ruler ! <ENTER> to cont.

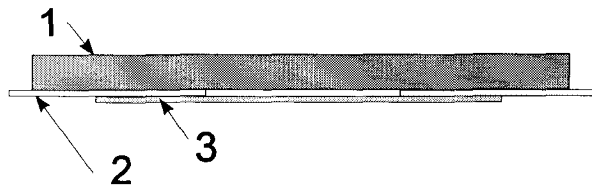
Confirm with ENTER

Display:



If proximity exposure is set , the proximity flags move in after loading the substrate.

The planarization will be done with inserted flags. Then the flags move out and the Z-motor moves to the entered proximity distance.

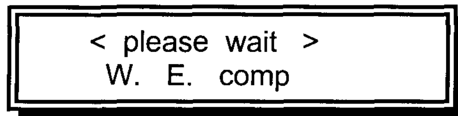


1.....mask
2 .....proximity flags
3 .....substrate

5.2.9. Planarization

If the tray is in (end switch is active) the planarization is released automatically.

Display:



Please check whether regulator "CHUCK WEIGHT" is already adjusted (without adjustment of this regulator the planarization can not be done correctly). During the first PLANARIZATION you should make an optical check whether both substrates are

in contact. Otherwise load the substrate again (press RESET) and lower the contact force till the top bondchuck moves against the bottom wafer.

Now you are in the align phase.

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Display:

--> align wafer
<SEP> to cont.

5.2.10. Adjustment of the separation distance

After planarization mask and wafer are in separation.

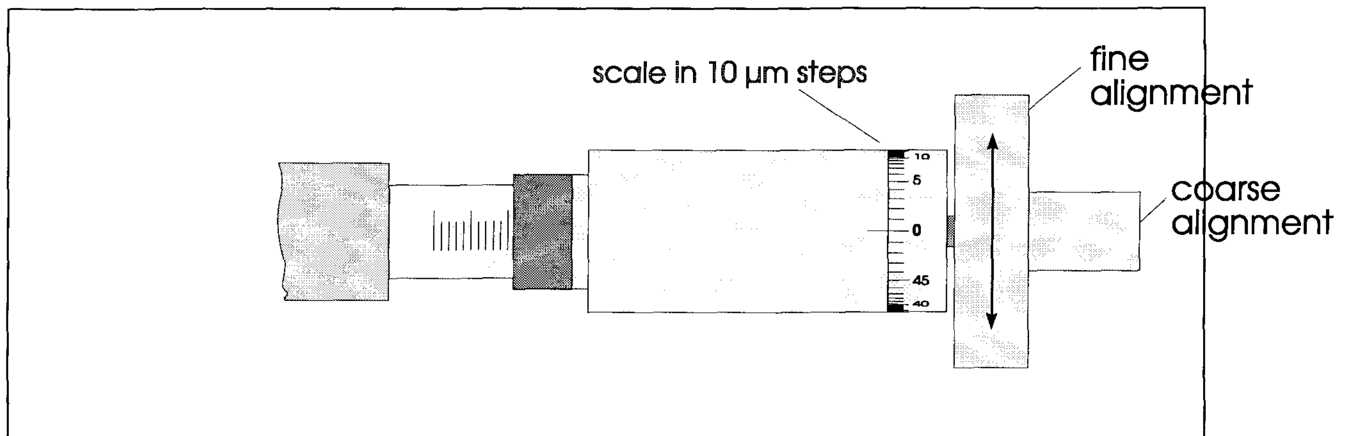
Press " SEPARATION "-key, to bring mask and wafer in contact. How to adjust the separation distance refer to 2.5.

5.2.11. Alignment of wafer to the crosshair

Display:

--> align wafer
<SEP> to cont.

* Alignment of X - Y and Theta direction with micrometers (movement X and Y +/-5 mm, Theta +/-3,5°)
For fine adjustment a graduation on the adjustment knob of the micrometers is placed.



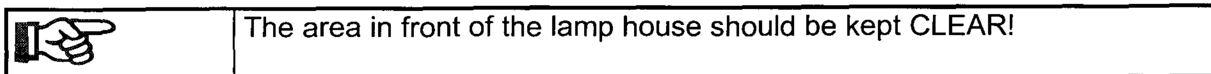
During alignment you can change the contact force between mask and wafer with regulator "CONTACT FORCE ALIGN".

5.2.12. Selection of the exposure procedure

refer to par. 2.5.

5.2.13. Exposure

Press EXP:

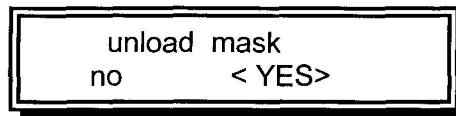


The wafer is exposed according to the time set. After exposure the space between mask and wafer is purged with N_2 and the mask is lifted up.
After exposure you have to wait until the tray is up. Then bring the tray in loading position and take the wafer from the chuck. Now the EV420 is ready for loading the next substrate (refer to 5.2.8.).
If you don’t want to load another wafer continue with chapter 5.2.14 to unload the mask.

5.2.14. Unload the mask

Instead of loading the substrate press RESET

On the display:



Press ENTER to unload the mask.

Move in the tray with the loaded maskframe. Now the maskholder moves down and loads the mask onto the chuck. When the maskholder elevates from the chuck you can see on the display:

Move out the tray and unload the mask.

Appendix A

Technical data

Substrate parameters:	max. 6" wafer 4" x 4" squared	
Mask parameters max.	7"	
Mask thickness	< 4mm	
Alignment: X,Y:	+/- 5mm	
Rotation:	+/- 3.5°	All movements are manual
Alignment accuracy:	better than 1µm	
Separation/proximity:	stepless adjustable	

Contact pressure mask-substrate: stepless adjustable starting from 1N

Possibilities of exposure:		softcontact hardcontact vacuumcontact proximity
Microscope top:		splitfield with triple revolving nose piece (standard)
Objective distance:		34-100mm (X)
Adjustment area:	Y:	+/-3mm
	Z:	+/-1.5mm
Microscope bottom:		splitfield (standard)
Adjustment area:	X:	30-100mm
	Z:	+/- 5mm
Monitor (option):		BW-CCD-camera and monitor with high resolution
Lamp house: type	A:	240-290nm 200/350/500/1000W
	B:	280-350nm 200/350/500/1000W
	C:	350-450nm 200/350/500/1000W
Illumination surface:		4", uniformity: better than +/- 3% 6", uniformity: better than +/- 5%

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Utility requirements:

Supply voltage:	110V/50Hz
Power requirement:	0.5 - 1.3 kW (depends on lamp power)
Compressed air:	5 bar (72 psi) (alternative N2)
Vacuum:	150 mbar (absolute) (112 Torr)
Nitrogen N2:	6 bar (87 psi)
Dimensions EV420 (WxDxH):	1000 x 720 x 800
Minimum distance to back wall:	200mm
Dimensions power supply:	620 x 250 x 410mm

Weight:	Mask aligner:	155 kg (337 lbs)
	Power supply:	46 kg (100 lbs)

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Appendix B Warranty

Electronic Visions warrants the EV 420 for one year against defects in workmanship and materials exclusive of consumable parts such as lamps, bulbs, mirrors, heating elements and rubber or polymer parts such as gaskets, seals, o'rings, etc.

This warranty is limited to replacement of any parts which upon examination by Electronic Visions are determined to be originally defective, not damaged through negligence or abuse. Any parts returned for determination of defect should be returned to Electronic Visions prepaid.

Use of not EV manufactured or certified parts on the mask aligner EV 420 and its components will result in a loss of warranty.
Several components are sealed to limit the access to EV authorized service engineers. A broken seal will exclude any warranty claims.

Appendix C Maintenance

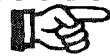
Lamp house

Changing the lamp

	Do not touch the glass of the lamp with bare hand. Impurities could burn into the quartz glass. Avoid direct eye-contact when the lamp is on.

a. Turn off MAIN SWITCH

b. The lamp must cool down for about 20 minutes.

	***During operation the lamp is under high pressure.***

c. Remove the lamp house cover (4 knurled screws on the front side of the lamp house).

d. Replace the faulty lamp. In the standard version (type A, B, C; 200, 350, 500 1000 W) the lamp is screwed to the socket with the anode (+).

	Do not touch the dielectrical filter to avoid contaminations. The screws on the lamp socket have to be closed carefully, otherwise ignition properties could be reduced.

e. Fix the ground wire on the socket (cathode) with the knurled screw delivered with the new lamp.

f. Close the lamp house in reverse order.

After changing the lamp check uniformity of the illumination.

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Adjusting the lamp

a. Putting into operation: MAIN SWITCH on, IGNITION (lamp started)

b. About 5 minutes after ignition the lamp has reached its intensity.

c. Remove the objectives and the maskholder and insert the measure plate instead of the maskholder.

d. Turn POWER ON (electronic is activated). Insert the tray and press ***EXP*** (V-MASK and V-CHUCK must be switched off): The lamphouse moves to exposure position and opens the shutter.

e. The UV-sensor (optional equipment from Electronic Visions Co.) is moved under the front-lens. Groves in the measure plate help positioning 4" and 6" lenses.

f. Position the sensor in the center of the exposure surface. Adjust the lamp with the control knob "Z" until the maximum intensity is displayed on the UV-powermeter. Turn the Z-knob counter-clockwise until the optical integrator is completely illuminated from the lamp.

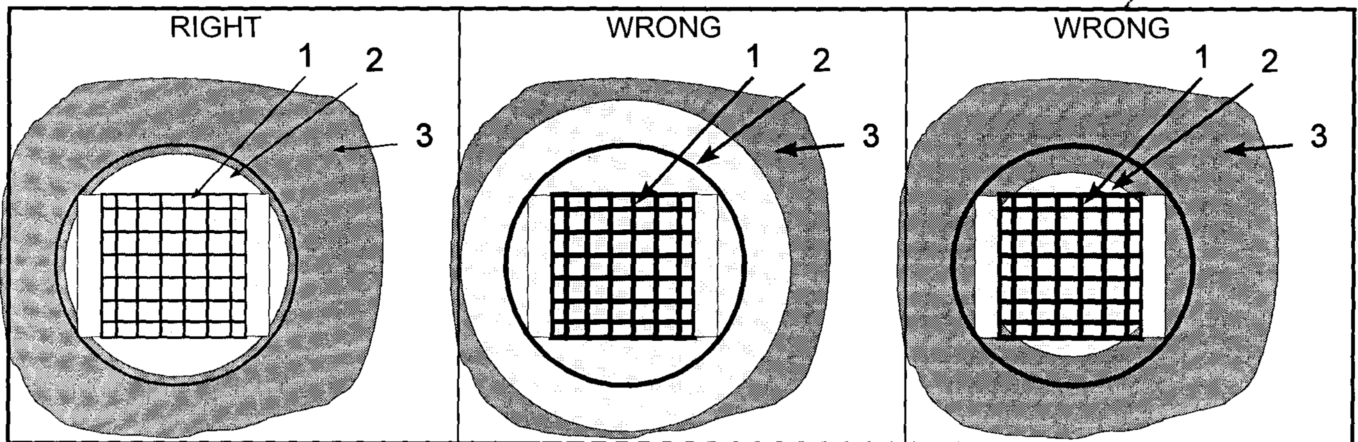
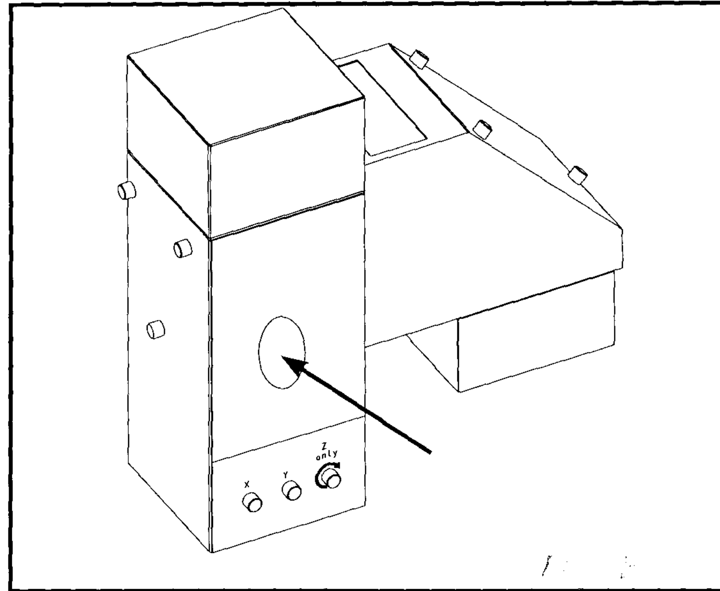


Fig. A

Check of the illumination can be done through the window at the lamphouse.



g. Adjust uniformity in Y-direction. Measure the intensity value on the front- and rear edge of the illumination surface. Adjust the lamp with the "Y" screw until you get the same values for front and rear edge.

h. Adjustment of the uniformity in X-direction. Position the sensor on the left and right side and adjust with the "X" screw to get the same values for the left and right side.

i. All 5 measuring points have to be checked and if necessary a fine adjustment has to be done.

j. With the maximum and minimum value of the 5 measuring points, you get the illumination uniformity as follows:

$$\frac{MAX-MIN}{MAX+MIN} * \frac{100}{2} = +/- \ \% \text{ uniformity}$$

For the illumination surface of 4", the uniformity should be < +/- 3 %.

To quit this process press EXP again.

Changing the lamp power setting

The EV420 can be equipped with 2 different power supply units:

200/350/500 W	type A, B, C
500/1000 W	type A, B, C

This should only be done by an authorized service engineer.

Changing the wavelength

The resetting to a different wavelength is possible between lamp house type A (240 - 290 nm), B (280 - 350 nm) and C (350 - 450 nm). Exchange kits with the following components are necessary:

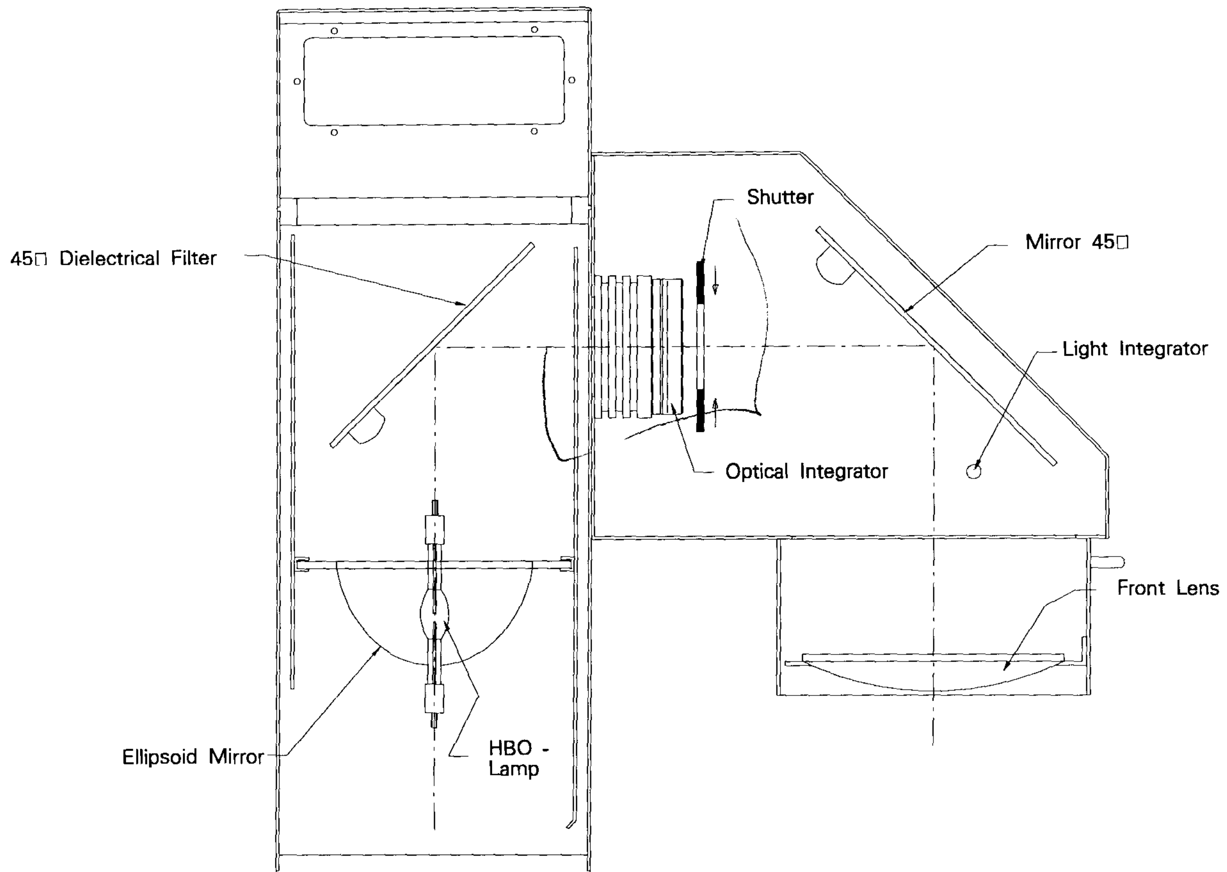
* Ellipsoid mirror

* Honey-comb condensor

* Dielectrical filter

* Turning mirror

* Front lens including lens box



Operating steps

a. Turn off MAIN SWITCH

b. Before you start working on the lamp house, the lamp should cool down for about 20 minutes.

c. Remove the covers (lamp house tower and mirror housing).

d. Remove the dielectric filter (move the grip upwards until the filter can be slid out from the support).

e. Remove the lamp (screw off cathode and lamp from the socket).

f. Open the ellipsoid mirror support (4 screws) and take the ellipsoid mirror out.

g. Remove the turning mirror (same fixing system as the dielectric mirror).

h. Pull off the shutter (the shutter is placed on the honey comb condensor with the cooling fins).

i. Replace the honey comb condensor.

j. After removing the monitor you can take out the front lens by pulling out the lens box.

k. The new components can be mounted.

- ellipsoid mirror
- lamp (the same)
- dielectrical filter
- honey-comb condensor + shutter
- turning mirror
- lens box

l. Close the lamp house

m. After changing the optical sets, you should check the illumination uniformity (with a UV-sensor in the range of the new wavelength) and adjust the lamp if necessary.

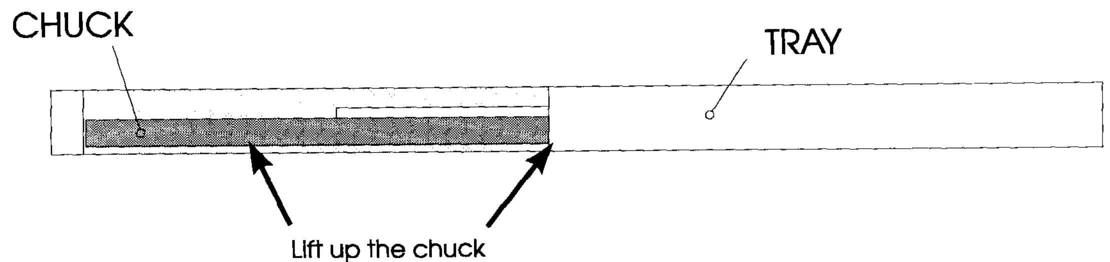
Changing the mask holder

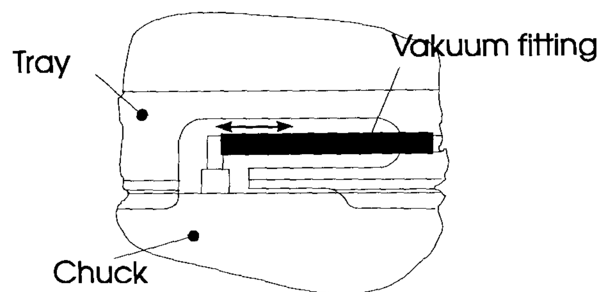
Remove the objective and switch off the aligner (POWER OFF; maskholder moves down). Loosen the fixing screws in front of the maskholder and move the maskholder carefully to the front.

Changing the chuck

Requirements:
Tray in loading position

Lift up the chuck from the tray and disconnect the vacuum hose from the chuck. Connect the vacuum hose to the new tray and put it in.





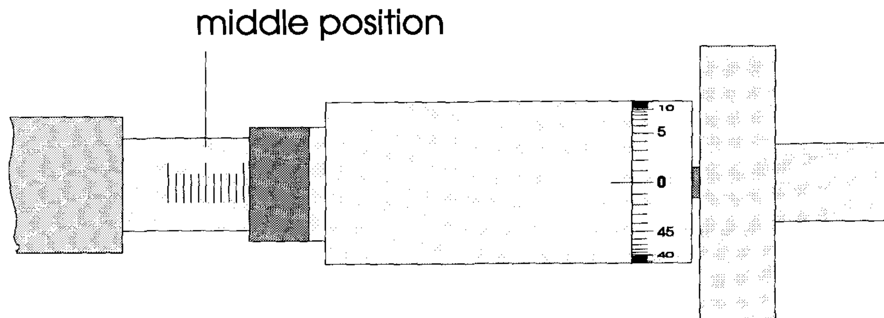
	***Caution**: Do not damage the glass insertion.*

Changing to different substrate size

Switch off the aligner (POWER OFF);
Remove the maskholder (refer to: Changing the maskholder) and insert the new one.
Change the chuck (refer to: Changing the chuck).

Adjusting the wafer thickness

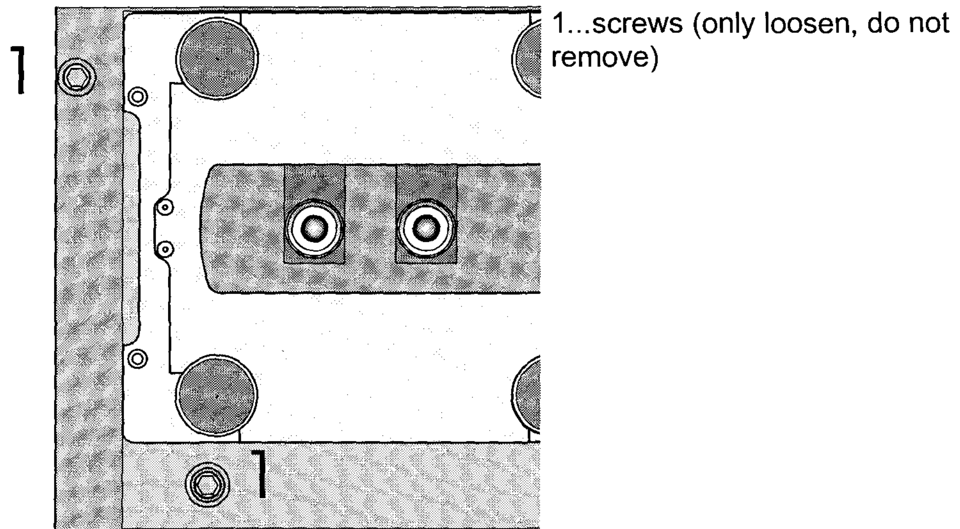
The height of the chuck stage has to be adjusted to the wafer thickness. The requested wafer thickness is factory-set. Substrate thickness deviations of +/- 250 µm can be neglected. If you want to change to other substrate sizes, remove or add distance slices under the alignment stage.
Before changing the height you have to bring each level (X-, Y-, and theta) into middle position (refer to scale on the spindles and mark on the Theta level).



a. Switch off the aligner. (MAIN SWITCH off)

b. Remove the plastic cover in front of the alignment stage.

c. Loosen (do not completely remove the screws) the 3 screws on the alignment stage. Now the unit lifts up due to integrated springs under the stage and you can add or remove distance slices.



1...screws (only loosen, do not remove)

d. After adding or removing distance slices push all slices to the block and fix the unit with the 3 screws again.

e. Take back the plastic cover and start the aligner again.

Microscope

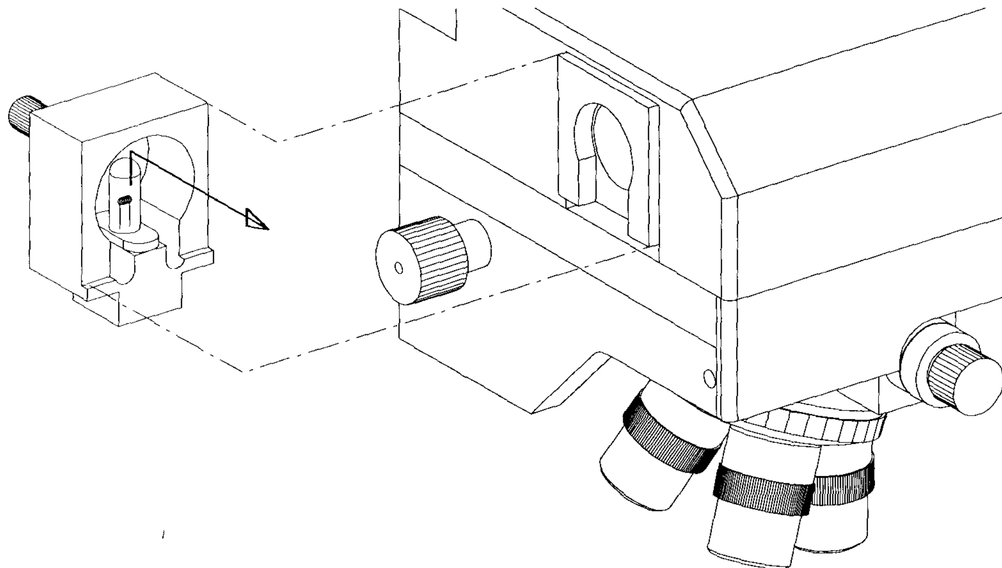
Changing the magnifications (objective, oculars)

Change the objectives if this is necessary

Switch off the aligner (MAIN SWITCH off) and move the lamphouse with the top microscope into alignment position. Now change the objectives (turn counter-clockwise).

Changing of microscope-lamps

The lamps of the splitfield microscope are in both lamphouses left and right on the microscope housing. Unscrew diagonally the knurled screws on the corresponding lamp house.



The lamps are in a plug-in socket holder. After changing the lamp, the lamp house has to be positioned again. A picture with a low magnification (if an objective revolving nose-piece is available) has to be focused by shifting the microscope lamp house until the illumination is uniform.

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