Karl Suss MJB4 Mask Aligner Standard Operating Procedure

General Safety Precautions:

- Do not perform any work that you are not specifically trained to do.
- Never look directly at the UV light, which is harmful to the eyes.

System Description and Specification

The MJB4 Mask Aligner can perform contact UV exposures for a variety of sample and mask sizes. Sample sizes that can be accommodated range from small pieces to 4” wafers. It can be used with masks of up to 5” by 5”. The maximum combined thickness of the substrate and mask is 9 mm. The achievable position alignment accuracy is ~1 µm. The MJB4 allows 1 µm resolution in vacuum contact mode. The tool has 5 different contact modes (proximity, soft, hard, low vacuum, and vacuum), and three different exposure modes (flood, first, and align and expose).

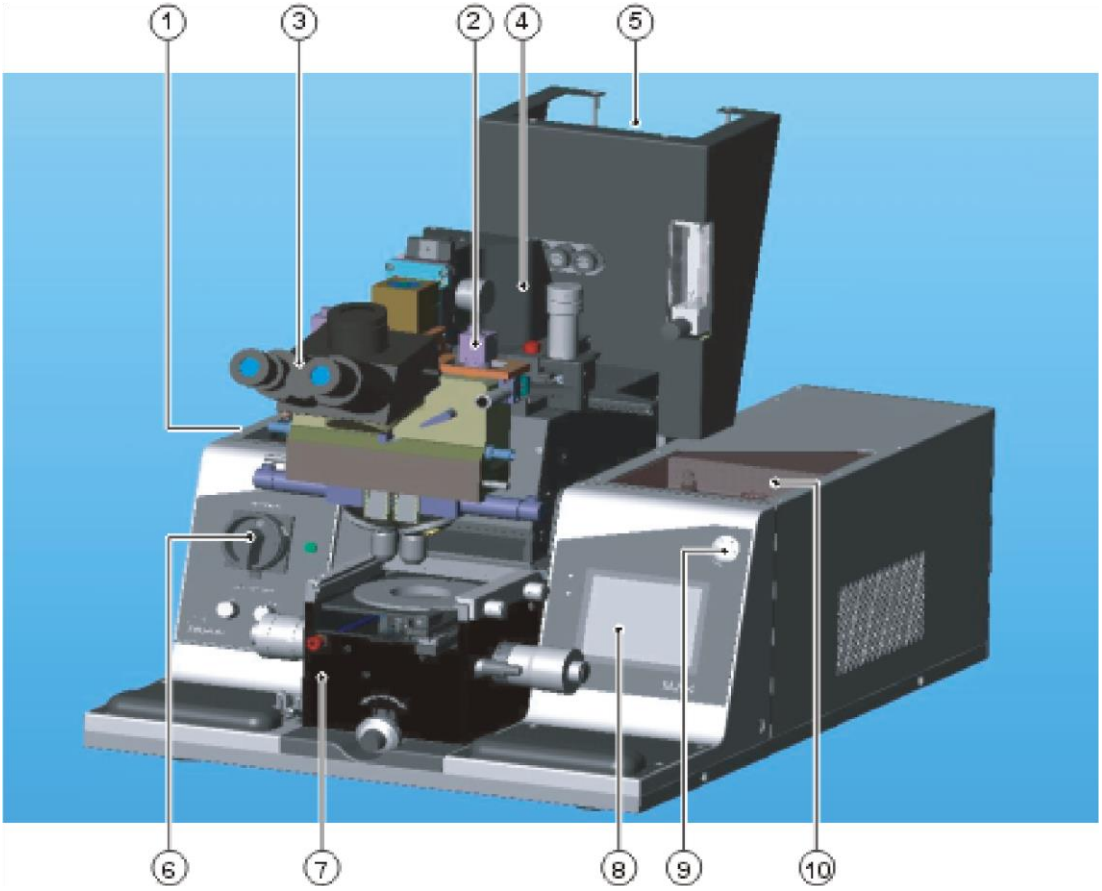


Fig. 1 Suss MJB4 Mask Aligner

1 TSA/IR lighting

2 Microscope focus setting

3 TSA microscope

4 TSA microscope manipulator

5 Lamp housing

6 Main switch with emergency off function

7 Adjusting table

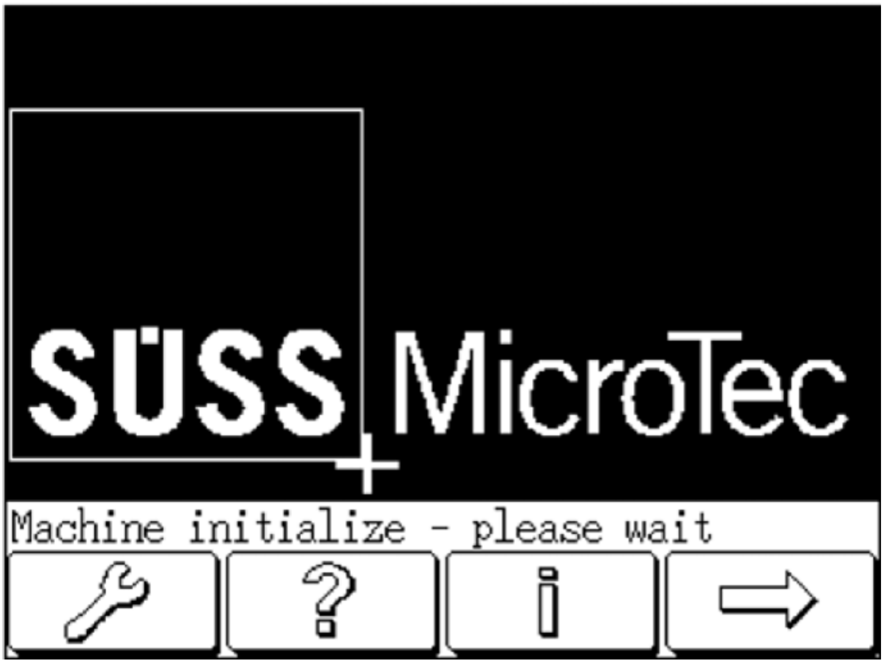
8 Display/touch screen

9 Electronics ON/OFF key

10 Pneumatic settings

Start up Procedure

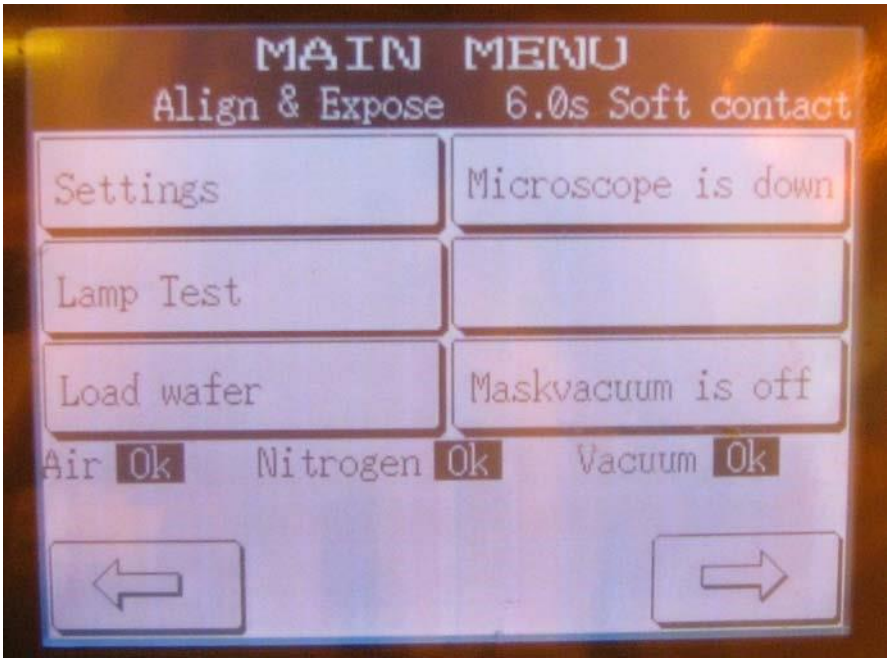
1. Switch the red isolation switch to on (red, on the front plate, left - No 6, Fig. 1).
2. Press the 'ON/OFF' button by the touchscreen (front plate, right - No 9, Fig. 1). The start page appears in the display, as shown in Fig. 2.



Machine initialize - please wait

Fig. 2 Start Page

3. After the machine is initialized (~ 5 seconds) and the message "**MJB4 PRECISION MASK ALIGNER** – **ready"** appears, press the right arrow button to return to the MAIN MENU (Fig. 3).
4.



MAIN MENU

Align & Expose 6.0s Soft contact

Air Ok Nitrogen Ok Vacuum Ok

Fig. 3 Main Menu

5. Check if the lamp power supply is ON (the green and yellow light should be on) at the back of the Mask Aligner
6.

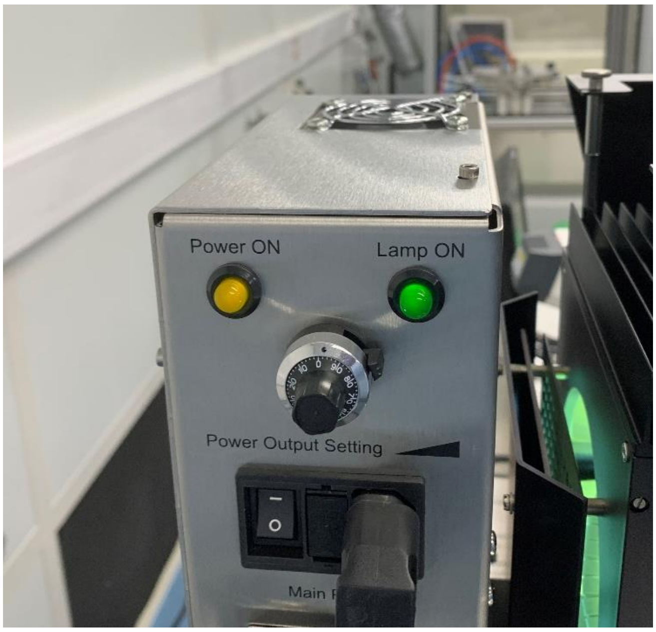
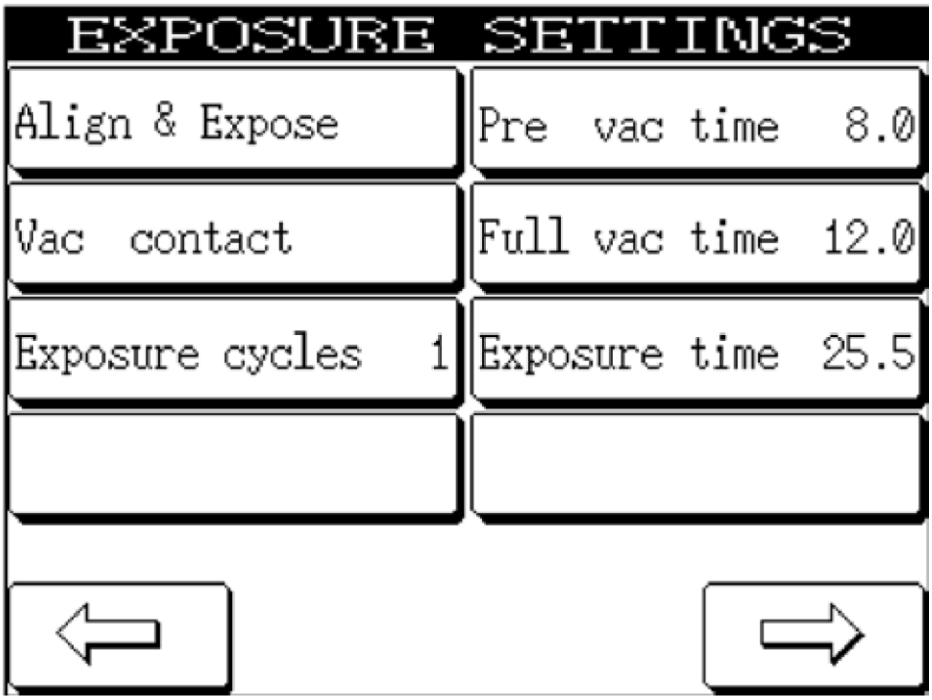


Fig. 4 Lamp power supply

7. Allow 20 minutes for the lamp to warm up before use if starting from cold.

Setting Exposure Values

1. To set the exposure values, from the main menu, press SETTINGS and then EXPOSURE SETTINGS. You can set the desired program and exposure parameters in the EXPOSURE SETTINGS menu, as shown in Fig. 5. The appearance of the EXPOSURE SETTINGS menu will depend on the options selected in that menu.



EXPOSURE SETTINGS

Align & Expose
Pre vac time 8.0
Vac contact
Full vac time 12.0
Exposure cycles 1
Exposure time 25.5

Fig. 5 Exposure Settings

2. Exposure Mode.
   The MJB4 has three different exposure modes:
   a. **First exposure** - choose this function if substrate alignment is not required
   b. **Align & Expose** - choose this process if you need to align the mask to features on the substrate.
   c. **Flood exposure** - this function is used to expose the substrate without a chrome mask, either to do a flood UV exposure, or when using a flexible/Mylar mask.
3. Contact Type
   An important parameter for exposure is the type of contact between the mask and substrate. Generally speaking, the greater the force pressing the mask and substrate together during contact, the higher the resolution that will be achievable, but also the higher the likelihood of the resist being damaged or sticking to the mask.
   a. **Distance Contact Mode (Proximity mode):**
      The wafer is not in contact with the mask during exposure. The space between the wafer and mask (up to 50 um) can be adjusted by the separation lever. The substrate is held on the chuck by vacuum during exposure.
   b. **Soft Contact Mode:**
      The substrate and the mask are brought into contact, then vacuum is applied through the small holes on the chuck during exposure, drawing the substrate down onto the chuck. This might move the wafer away from the mask, thus reducing the pressure applied between the two during exposure.
   c. **Hard Contact Mode:**
      Nitrogen pressure, supplied through the small holes in the chuck, pushes the wafer up into contact with the mask during exposure. At the time this SOP was written, the hard contact pressure was set to 1.6 bar.
   d. **Low Vacuum Contact mode:**
      To use this mode, a flexible vacuum ring must be placed around the rim of the chuck. Partial vacuum, which is adjustable, is applied through the large hole in the chuck, creating a vacuum chamber between the chuck and the mask. The effect is that the chuck and substrate are pushed into the mask with partial atmospheric pressure.
   e. **Vacuum Contact mode:**
      To use this mode, a flexible vacuum ring must be placed around the rim of the chuck. Vacuum is applied through the large hole in the chuck, creating a vacuum chamber between the chuck and the mask. The effect is that the chuck and substrate are pushed into the mask at atmospheric pressure. The vacuum applied is about -0.8 bar, which is the maximum vacuum that the machine can provide. This mode provides the highest achievable resolution on this tool.
4. Exposure Cycles
   If more than one exposure cycle is entered, the pause time between the individual cycles can be changed. Press PAUSE TIME on the display to do so.
5. Exposure Time
   Pressing this button opens the EXPOSURE TIME menu which allows you to enter the desired exposure time. Confirm your entry with the ENTER button. The display automatically switches back to the EXPOSURE VALUES menu and adds the value that you just set.
6. Hard Contact Time
   This is the amount of time that the system waits, after applying nitrogen pressure for the “hard contact” mode, before starting the exposure. The purpose of this waiting period is to

allow any motion of the substrate, induced by the application of the nitrogen pressure, to dampen before the exposure starts.

7. Pre-Vacuum Time and Main Vacuum time
   This is the amount of time that the system waits, after applying vacuum for the “low vacuum or vacuum contact” mode, before starting the exposure. The purpose of this waiting period is to allow any motion of the substrate, induced by the application of vacuum, to dampen before the exposure starts.

Load Mask

Caution!

Before loading or unloading a mask, the microscope must be moved to the “up” position. This is accomplished by pressing the MICROSCOPE IS DOWN button on the computer screen. The tool will beep, the display will change to MICROSCOPE IS UP and the microscope will move to the “up” position.

1. Remove the mask holder by loosening both knurled screws on the mask holder frame, and then place the mask holder upside down on the left armrest of the tool.
2. Unload any masks if necessary. To remove the mask, the mask vacuum should be switched off by pressing the MASK VACUUM ON button for 3 seconds (then the button switches to MASK VACUUM OFF).
3. Place the mask on the mask holder, with the chrome side facing up. Press the MASK VACUUM IS OFF button to turn on the mask vacuum.
4. Check your mask is firmly held in place, then invert the holder and gently insert it back into the slot on the aligner until it reaches the back of the frame.
5. Tighten the locking screws to fix the mask holder in place. Finger tight is quite sufficient!

Never release the mask vacuum when the mask holder is inserted. The mask will fall out and damage the sample holder as well as your very expensive mask!

Load Substrate and Wedge Error Correction

Always ensure that the stage has been reset by previous user to the centre and the WEC dial to 5-6. Never force the dials, this can cause damage to the equipment.

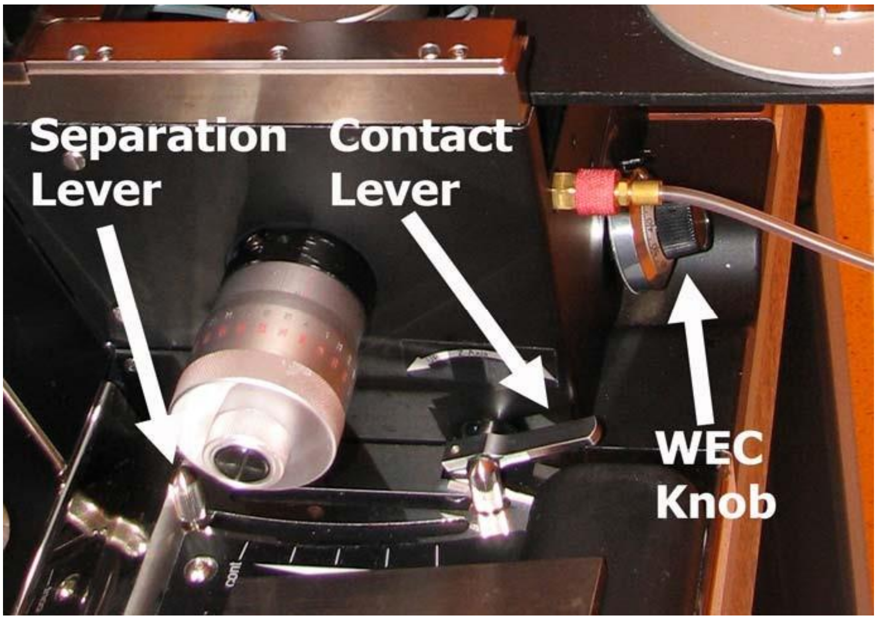
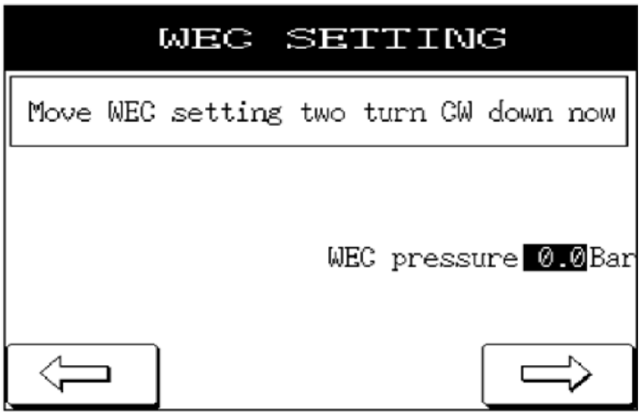


Fig. 6 Alignment Stage Left Side

1. Lower the stage using the WEC dial located at the front of the aligner
2. Gently pull out the sample stage and place your substrate on the chuck. Hold the vacuum button and gently push the holder back into the aligner.
3. Adjusting for substrate thickness and wedge error correction
    a. From the main menu, select SETTINGS, then WEC SETTINGS
    b. Move the substrate towards the mask by pushing the CONTACT LEVER forward (Fig. 7a).
    c. Turn WEC knob (on the front of the tool, directly below the mask frame) counterclockwise (moving the substrate up towards the mask) until the message MOVE WEC SETTING TWO TURN CW DOWN NOW (Fig. 7b) appears in the top left of the display.
    d. Turn the WEC knob clockwise (moving the substrate down) until the message WEC SETTING OK (figure 6b) is displayed.
    e. Pull the CONTACT LEVER back, to the lowered position, then use the RIGHT ARROW BUTTON to return to the main menu.



Move WEC setting two turn CW down now

WEC pressure 0.0Bar

Fig. 7a Set WEC

WEC setting ok

WEC pressure 0.0Bar

Fig. 7b Set WEC

Substrate Alignment and Exposure

The MJB4 mask aligner only has Top-Side Alignment (TSA), but with two exposure process modes: First exposure and Align and Expose.

1. First Exposure
    a. No sample alignment is necessary for the first level exposure of the substrate.
    b. For soft, hard, low vacuum and vacuum contact modes, the exposure process will start once the substrate is brought into contact with the mask using the CONTACT LEVER (Fig. 6).
    c. If “proximity mode” is used, the SEPARATION LEVER must be pulled back before the exposure will start.
    d. After the exposure has finished, wait until the computer display reads UNLOAD SUBSTRATE, then lower the substrate using the CONTACT LEVER.
    Before sliding out the transfer slide, turn the WEC knob several turns clockwise (down) to ensure that the slide will clear the Zpiston.

Caution: The exposure unit will move out by ~ 150 mm in the direction of the operator at the start of the exposure process.

2. Align and Expose mode

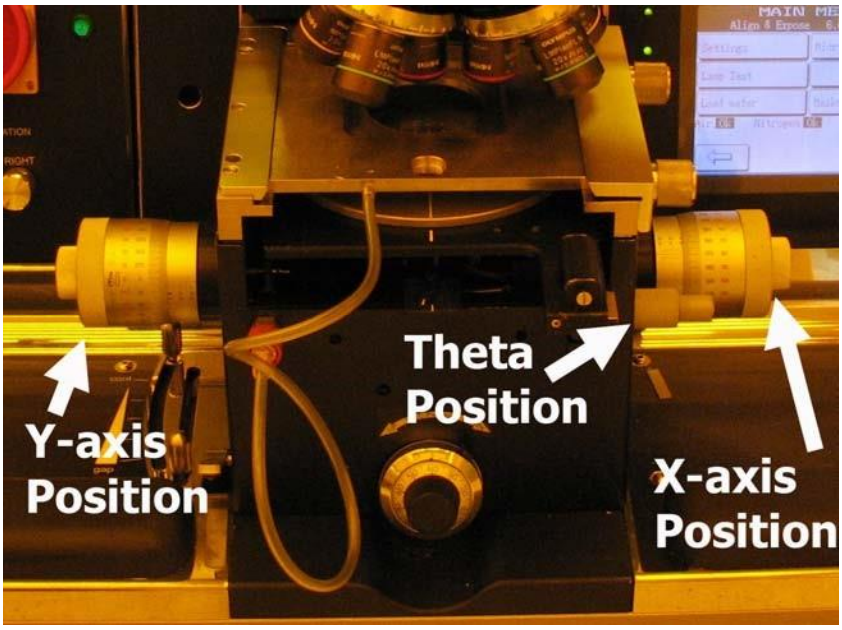


Fig. 8 Adjusting Table

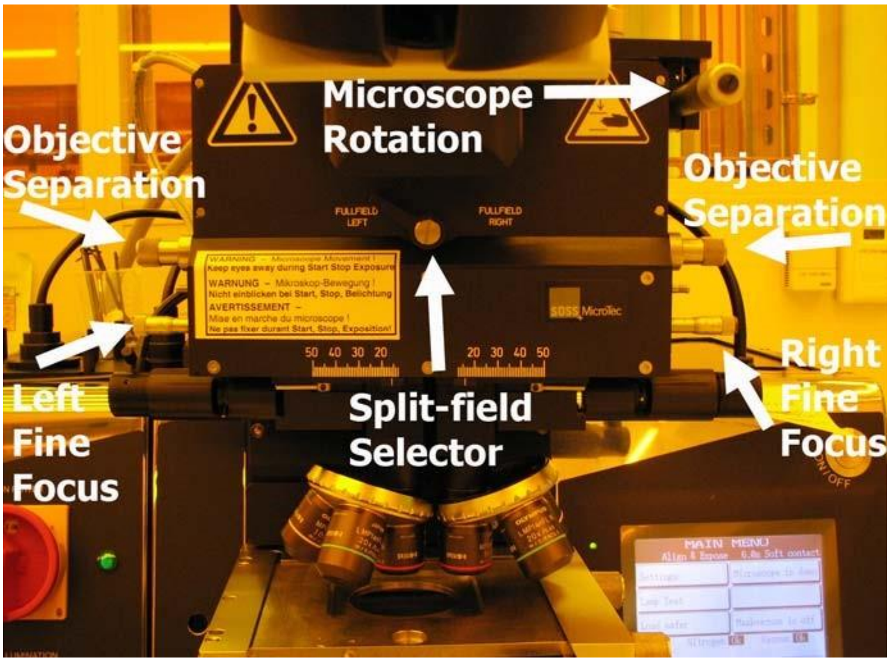


Fig. 9 Alignment Microscope

a. Align the TSA Microscope with mask.

- The left, right, or both microscope objectives can be viewed in the eyepieces by using the SPLIT-FIELD SELECTOR directly under the microscope eyepieces.
- Set the lamp brightness using the LEFT and RIGHT MICROSCOPE ILLUMINATION controls on the left front plate. There are yellow filters on the lights, so that it does not expose the photoresist.
- Focus on the mask using the COARSE FOCUS KNOB, located behind the TSA microscope.
- Fine focusing is set separately for each objective on the microscope. To do this, use the OBJECTIVE FINE FOCUS knobs for each objective.

- ➢ Move the microscope using the POSITION ADJUSTMENT knobs so that one of the mask alignment marks is in view. If necessary, change the SPLIT-FIELD SELECTOR to “both”, and then adjust the OBJECTIVE SEPARATION so that the second mask alignment mark is in view. If necessary, adjust the microscope rotation with the MICROSCOPE ROTATION micrometer.

b. Substrate alignment

- ➢ Move the Separation Lever to the GAP Position (Alignment position).

Caution: Never move the substrate if the mask and substrate are in contact! Doing so can damage the mask and substrate.

- ➢ Use the X, Y and theta micrometer screws on the stage to align the substrate with the mask. The maximum travel in X and Y is one centimeter – between the 5 and 15 marks on the red scale on the micrometer barrels. Moving the micrometers beyond this range can cause damage to the system.
- ➢ Confirm the alignment by moving the SEPARATION LEVER back to the CONTACT position.
- ➢ (Optional) Check that applying the selected contact mode does not cause sample misalignment by pressing the ALIGNMENT CHECK button.
- ➢ If, after steps above, further adjustment to the substrate position is needed, make sure to move the separation lever to the GAP position before adjusting the substrate position.

c. Exposure

- ➢ Once the substrate is aligned to the mask and brought to the CONTACT position using the SEPARATION LEVER, press the EXPOSE button to perform the exposure.
- ➢ You must press YES again on the display to confirm the exposure. If you press NO, or move the CONTACT or SEPARATION levers, the exposure sequence is initiated with the shutter closed.

Caution: The microscope head will move up and the exposure unit will move out by ~ 150 mm in the direction of the operator at the start of the exposure process.

Unload Wafer

After the exposure process is complete, the message UNLOAD WAFER will appear on the computer display.

1. Lower the substrate using the CONTACT lever.
2. Before sliding out the transfer slide, turn the WEC knob several turns clockwise (down) to ensure that the slide will clear the Z-piston.
3. Move out the transfer slide and unload the substrate.

Unload the Mask

1. To release the mask holder, loosen the knurled screws on the right side of the mask holder frame.
2. Take out the mask holder and place it on a tray upside down.
3. Switch off the mask vacuum by pressing the MASKVACUUM IS ON button for at least 3 seconds.
4. The mask can now be removed.

Shut Down Procedure

1. Remove the mask holder from the aligner. Turn the mask holder over and hold ‘mask vacuum off’ on the touchscreen. After approximately five seconds, the vacuum will be released, and your mask can be safely removed.
2. If you have changed the mask holder. Please remove the holder you have been using and replace the original.
3. If another user is waiting, please leave the equipment on. If nobody is waiting to use the equipment then...
4. Press the ‘On/Off’ button above the touchscreen. The message ‘MJB4 SHUTTING DOWN’ will appear, along with a countdown timer. Once the countdown timer is complete, the touch screen and services will automatically switch off.
5. After the equipment has switched off, turn the red isolation switch to off.