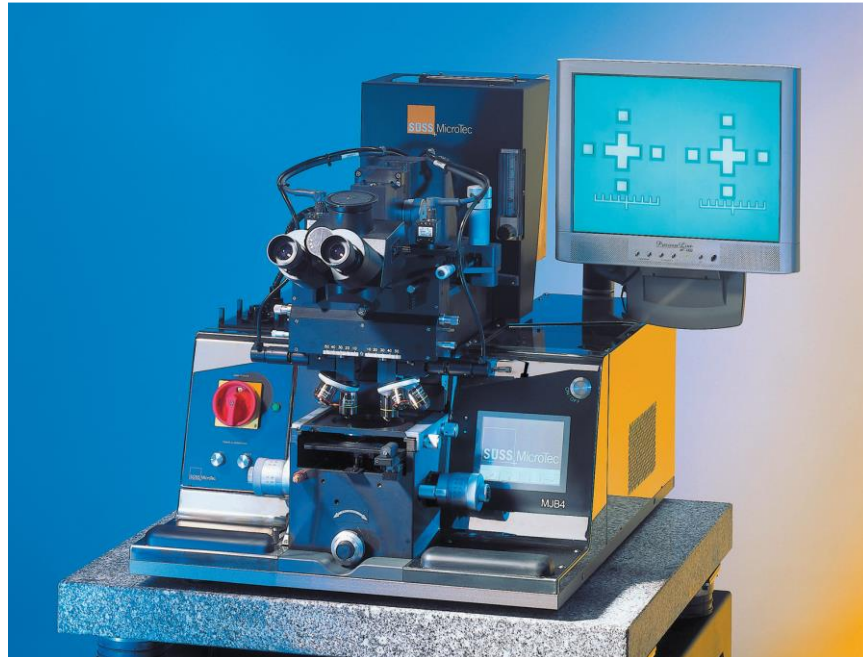


SUSS MJB4 Contact Mask Aligner

Equipment Operation Manual



University of Notre Dame

Department of Electrical Engineering

The MJB4 offers both front and back side illumination for contact lithography (top/bottom wafer sides alignment is doable). The aligner is equipped with a UV-LED light engine providing several spectral lines (corresponding to spectral lines of a HG-lamp): i-Line (365 nm), h-Line (405 nm) and g-Line (435 nm). Single line or broadband wavelengths in any combination can be selected.

Regarding the light intensity of each line and uniformity, please refer to the shared Google drive (COE-EE-Cleanroom).

CAUTION:

During Exposure – DO NOT STARE DIRECTLY AT THE UV LIGHT.

Prolonged exposure to UV light may damage your eyes.

Safety glasses are to be worn during exposure.

In Case of Emergency, Please Contact Notre Dame Security at

911

Contacts

Only trained users may use the equipment – for training please contact Fei Cheng (fcheng2@nd.edu). For problems, clarification of procedures, or general information pertaining to this machine please contact lab staff at staff-ndnf-list@nd.edu.

Standby Conditions check list:

1. Stage X and Y motion micrometers in MIDRANGE Position (reading ~10 mm, travel path is ± 5 mm) and stage rotation is zeroed.
2. Contact lever rotated to the **FRONT** of the machine
3. Separation knurled knob towards the **BACK** of the machine
4. Alignment gap setting (with knurled knob) at the **FRONT** of the machine
5. Z-Micrometer **unlocked** (top left position)
6. LCD screen should be on by pen touch
7. **Green** Status indicator of LED power supply (under table) light is on.
8. Mask holder with blank/training mask loaded and vacuum turned ON
9. MAIN POWER switch (left circular red) is ALWAYS ON
10. Microscope Light turned OFF (2 knurled knobs left fully CC)
11. VACUUM CHAMBER and WEC PRESSURE (LED displays on the right side) set at ~ 0
12. 4" chuck table with Teflon gasket is set on the chuck table slide.

Preparation:

- Spin/bake photoresist as per the resist manufactures specifications
- Ensure the backside of the sample does not contain resist
- Ensure chuck that will be used is clean. Note: DO NOT scratch the chuck – this can result in vacuum failure and broken wafers.
- Mask Clean (as needed)
 - Acetone, Methanol, IPA rinse in solvent bench
 - N₂ Dry
 - Drytec O₂ clean as needed to remove resist
- Enable System in iLab

Calculating the Exposure Time:

$$\text{Exposure Time (sec)} = \frac{\text{Photoresist Specific Required Dose } \left(\frac{\text{mJ}}{\text{cm}^2}\right)}{\text{UV Light Intensity } \left(\frac{\text{mW}}{\text{cm}^2}\right)}$$

LED light selection and intensity:

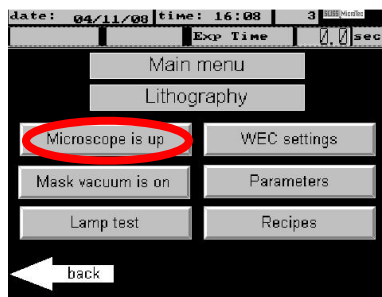


The corresponding intensity (unit: mW/cm²) at each wavelength:

- i-Line (365 nm): 25.5
- h-Line (405 nm): 16.4
- g-Line (435 nm): 16.9
- Broadband h-Line (405 nm): 59.4, intensity uniformity: $\pm 1.5\%$ across 4" wafer area measured by UV-Optometer (SUSS UV1000 intensity meter, Nov. 2023)

Loading a Mask:

CAUTION: Before changing masks, verify the microscope is at the UP position by checking (not clicking) under the Main menu: “Microscope is up” is displayed:



If it is in the down position, move the microscope to the upper position by pressing the “Microscope is down” button.

1. Remove the mask holder by loosening both knurled screws on the mask holder frame, flip it over and put it on a flat surface.
 - a. Be careful not hit into anything
 - b. Be careful don't stretch the vacuum hose
 - c. Don't touch the chrome side of the mask by finger
2. Press the “Mask vacuum is on” button for 2 seconds to switch off the mask vacuum.
3. “Mask vacuum is off” is shown and remove the training or blank mask.
4. Place the desired mask (Chrome side facing up) on the mask holder against the 3 stop pins.
5. Press on the “Mask vacuum is off” button to switch on the mask vacuum.
6. CAREFULLY check to ensure the mask is held in place by the vacuum before flipping it over. Failure to do this can result in broken masks.
7. Pick up the mask holder, turn it over, and insert it into the stage. NOTE:
DO IT SLOWLY AND NOT HIT INTO ANYTHING!

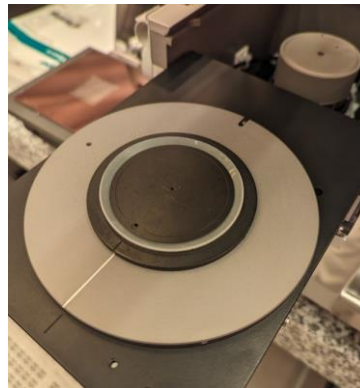
8. Clamp the mask holder in place by gently tightening the two knurled knobs. NOTE: **DO NOT OVERTIGHTEN!**

Microscope Setup (For alignment purpose):

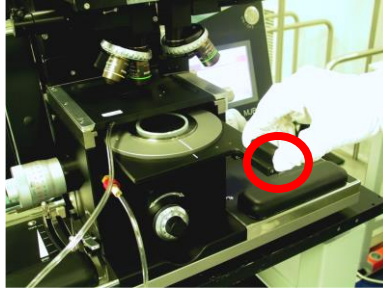
1. Verify or change objective lens (left and right) to the lowest magnification (x5). As needed, change it to x20 after focusing on x5 is done.
2. Focus the microscope on mask / substrates on the monitor or through eyepieces. Refer to Appendix part 1 on adjusting the top side alignment (TSA) Microscope for details.

Loading a Sample:

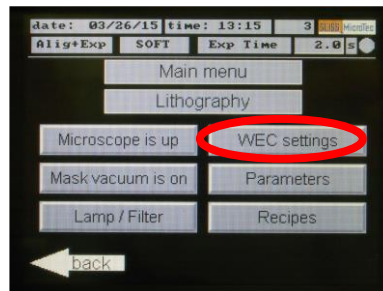
- 1 Pull out the transport slide to the outside limit.
- 2 If you need to replace the 4" chuck with a different one, make sure it sits correctly into the chuck adapter. We have one dedicated for small pieces (up to 10x10mm, left image blow) and some chucks from MJB3 can be used too (right image blow).



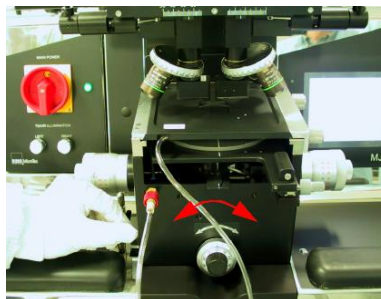
- 3 Place sample on the chuck (verify the backside is clean w/o PR).
- 4 While thumb holding the transport-vacuum-hand-valve (front right side of the transport slide, image below), carefully and slowly insert the transport slide until it reaches the end stop.



- 5 In the main menu, select WEC (Wedge Error Compensation) settings. At the touch screen appears: “Close contact lever”.



- 6 Move the substrate towards the mask by pushing **SLOWLY** the contact lever to the backside of machine.
- 7 Adjust the stage height with the Z-micrometer:
 - a. Verify the Z micrometer is **NOT** locked: the black lever in top left position;
 - b. If it reads “Mask + wafer too thick! Adjust WEC to the right <down>”, turn the Z micrometer **slowly clockwise** to lower the stage, until “Adjust WEC to the left <up>” appears and reverse slowly until “WEC setting OK, Open contact lever” appears.



- c. If it reads “Adjust WEC to the left <up>”, raise the contact height by turning the Z micrometer counter-clockwise, until “Adjust WEC to the right <down> until ok” and reverse slowly until “WEC setting OK, open contact lever” appears;
 - d. Note that if you turn the Z micrometer too fast, you may need to adjust it back and forth several times. Please be patient and adjust slowly, and don't force it if it was locked.
- 8 Fully open the contact lever **SLOWLY**. You can see the Main menu.

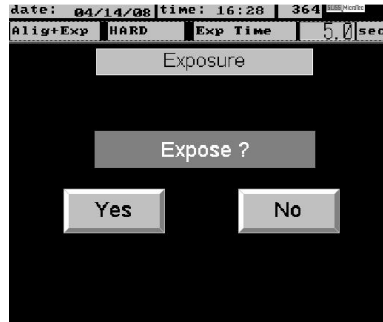
Alignment & Exposure:

1. From the Main menu, press the “parameters” button.
2. From the Parameters list, you usually can see the following screen:

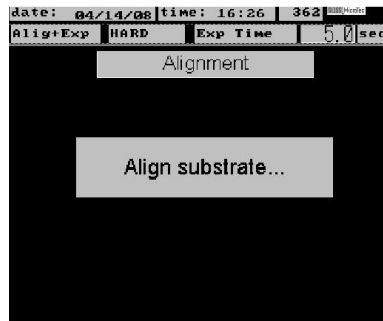


- Left side
 1. Align + Exp. (Do not change)
 2. Exp. Modes: choose 1 from the drop list. Vacuum contact gives the best resolution. Refer to Appendix part 2 for explanation of different modes.
 3. Splitfield (Do not change)
 4. Reflected light should be selected unless the top/bottom wafer side alignment is needed, which requires a separate training by the lab staff.
- Right side: only change the exp. Time as needed; keep the Pre vac. time (5s.) / Full vac. time (5s.) / Exposure cycles: 1.

3. **SLOWLY** engage the contact lever. The microscope is lowered and the screen shows Exposure menu.
4. If you need just first layer print, press on the **Exposure** button to start it and then **Yes** button to confirm the action.



- Mirror house will move over the mask
 - When the mirror housing reaches position – the LED light source turns on and exposure takes place for the amount of time set in the para page
 - When the exposure is completed, the LED is off and mirror house moves back.
5. Following step 3, if you need alignment done, bring the separation knurled knob from “contact” position to front “gap” position, and screen shows “Align substrate...”



- Turn on illumination both left and right.
- Find the feature or marker at both sides of the mask / wafer. Refer to Appendix part 1 for microscope focus.
- Do rotation correction (near X translation knob on the right) **firstly** and then translation (x-trans. on the right and y-trans. on the left).

- As the alignment check is done, the separation lever must be moved into contact position. The Exposure menu appears on the touch screen again.
- Click on the Exposure button and wait for the exp. is done.
- **Note: Never move around the substrate if the mask and substrate are in contact! Doing so will damage the mask and substrate.**

Unloading a Sample and Completing the Process:

- 1- Once the exp. is done, rotate “Contact” lever toward the front of the machine
 - Note that if your sample is a 4” wafer, rotate the contact lever **SLOWLY** because it has a large surface area to release the vacuum and doing it fast can cause vibration of the wafer or even cause damage to thin wafers.
- 2- Pull the chuck (transporter slide) out of the system (while holding the transport-vacuum-hand-valve)
 - a. Remove exposed sample
 - b. Load new sample(s) as needed
- 3- Loosen the mask plate holder knobs and remove the mask plate with mask
- 4- Place the mask holder on the table and press/hold the “Mask vacuum is on” button until vacuum is off
- 5- Remove mask and place training or blank mask on holder
- 6- Turn on mask vacuum and check to make sure mask is held in place
- 7- Place mask holder back onto the system – no need to tighten knobs
- 8- Clean up work area
- 9- Log out of iLab

Appendix:

Part 1:

Adjusting the top side alignment (TSA) Microscope

1. The **SPLITFIELD** switch must be set to the middle position.
2. Microscope Illumination: The illumination must be **Reflected light** which has to be set in the Parameters. Set the brightness using the left/right potentiometers (silver knurled knob) on the left front plate. The illumination on left and right can be adjusted separately.
3. Coarse focusing is possible using the TSA Z-motion located behind the TSA microscope.
4. Fine focusing is set separately on the microscope. To do this, use the OBJECTIVE FOCUS FINE MANUAL knob on the microscope.



Part 2:

Exposure modes explanations. (Pages: 13-14, refer to “exp modes.pdf” in the shared drive folder Litho - MJB4)

Part 3:

Wafer top/bottom sides alignment using IR illumination. (Pages: 15-21, refer to “Trans alignment.pdf” in the shared drive folder Litho - MJB4)