Standard Operating Procedure

MJB3 Mask Aligner Operation

1. General Perspective

This document describes the operations, parts, and materials required to perform UV contact lithography using the Carl Suss MJB3 mask aligner.

1. 1.1 General Safety Precautions
   1.1.1 Do not perform any work that you are not specifically trained to do.
   1.1.2 Never look directly at the UV light.
   1.1.3 Never turn off the machine power, which shuts off the required cooling nitrogen supply to the lamp and thus can result in tool damage.
   1.1.4 The UV lamp contains mercury which is a health hazard if the bulb breaks or explodes.
2. 1.2 Process Failure
   If a problem that is not covered in the Operating Procedure occurs: 1.2.1 Hold all work affected by the problem.
   1.2.2 Leave a note on the tool explaining the problem for other users
   1.2.3 Report the problem to NANO FAB Staff.**)**

2. System Description

The MJB3 mask aligner is a simple, broadband UV exposure tool that accommodates wafers up to 3" (and 4" wafers with limited range for alignment) and masks up to 4". The system has 3 exposure modes (Soft, Hard, and Vacuum contact). There is a single-field alignment microscope. Alignment resolution of a few micrometers and micrometer-sized features are reliably achievable with this tool.

2.1 Mask Holder Selection

4" mask holder, with 3" diameter opening, shared with the MJB4 **4" mask holder,** with 2" square opening, shared with the MJB4

3" mask holder, with 2" diameter opening, shared with the MJB4

2. 2.2 Sample Chuck Selection
   1", 2", and 3" diameter chucks
3. 2.3 Lamp Power Selection
   CI-1: constant intensity mode, measured at 365 nm (i-line) – Set at 12 mW/cm2 but not routinely measured nor calibrated.
   CI-2: constant intensity mode, measured at 405 nm (h-line) – Set at 25 mW/cm2 but can drift from this setpoint. This is the standard operating mode. The intensity at both 365 nm and 405 nm is measured weekly and posted in the photolithography bay.
   CP: 255 W constant power mode.

3. Operating Procedure

Figure 1: Critical controls for MJB3 mask aligner.

3.1 Pre-Operation Check

3.1.1 Ensure UV lamp is lit. If it is not, follow these steps:

3.1.1.1 Make sure the mask aligner power is on

3.1.1.2 Press the "ON" key on the lamp power controller located under the aligner table.
3.1.1.3 Press the key for the desired power mode (CP, CI1, CI2)
3.1.1.4 Press the "start" key. The lamp will take 5-10 minutes to warm and stabilize.
3.1.2 Check that the gas and vacuum gauges are indicating acceptable values: vacuum > 2 bar, parallelity 2 bar, and pressure/wafer 1 bar.

2. 3.2 Mask Loading
   3.2.1 Select the proper mask holder.
   3.2.2 If necessary, remove the mask holder from the tool by loosening the knurled screws on the mask holder frame, then place the mask holder upside-down on the aligner table.
   3.2.3 If a different mask holder than the one connected is needed, carefully disconnect the plastic tube from the installed mask holder, and connect it to the desired mask holder.
   3.2.4 Place the mask onto the mask holder, with the chrome side facing up.
   3.2.5 Press the "mask vacuum" button to turn on the mask vacuum. Nudge the mask to ensure that the vacuum is on.
   3.2.6 With the chrome side of the mask facing down, push the mask holder into the tool, and finger-tighten the knurled screws on the mask holder frame.
   3.2.7 Be careful not to accidentally press the "mask vacuum" switch during the rest of the tool operation, as this will cause the mask to drop from the frame, possibly damaging the mask or the tool.
3. 3.3 Sample Loading
   3.3.1 Unlock the z-height adjustment knob by rotating the black locking switch on knob to the up-position.
   3.3.2 Lower the sample stage by turning the z-adjustment knob clockwise. One revolution is 150 micrometers. Lower by at least the thickness of your substrate.
   3.3.3 Make sure that the "contact" lever on the left-hand side of the machine is at the "release" position.
   3.3.4 Gently slide the chuck transport to the right until it stops. If it does not move, do not force it, but ensure that the contact lever is completely in the "release" position.
   3.3.5 Check that the stage adjustment calipers for x, y and theta are roughly centered.
   3.3.6 Select a sample chuck. If the vacuum contact mode is to be used, a chuck fitted with a rubber gasket must be used. Load the chuck onto the transporter.

3.3.7 Place sample substrate on the chuck, ensuring that all of the vacuum holes are covered. Do not use tape to cover any of the vacuum holes

3.3.8 Carefully slide the chuck transport to the left until it stops.

3.3.9 Bring the substrate into contact with the mask by rotating the "contact" lever to the "contact" position, with the lever pointing away from the operator. The "contact" indicator will illuminate. If strong resistance is encountered while moving the lever, return to the "release" position, and lower the z-adjustment knob several rotations, then repeat 3.3.9.

3.3.10 While holding the "separation" lever in the "contact" position, turn the z-adjustment knob counter-clockwise until it is finger-tight.

3.3.11 Move the "contact" lever to "release".

3.3.12 Turn the z-adjustment knob one-half turn counter-clockwise.

3.3.13 Move the "contact" lever to "contact". This has corrected any wedge error between the substrate and the mask.

3.4 Alignment and Exposure

3.4.1 Select the contact mode

3.4.1.1 For soft contact, press the "soft cont" button

3.4.1.2 For hard contact, make sure that none of the exposure mode buttons (HP/ST, soft cont, vacuum chamber) are selected.

3.4.1.3 For vacuum contact, press the "vacuum chamber" and "HP/ST" buttons

3.4.2 **First Level Exposure**

3.4.2.1 No sample alignment is necessary for the first level exposure.

3.4.2.2 Set the exposure time using the dial timer on the front of the tool. The inner dial sets the scale (seconds, 10 seconds, etc) for the outer dial.

3.4.2.3. Press the "expose" button, and move clear of the microscope.

3.4.2.4. The microscope and shutter housing will move forwards, and the exposure will take place automatically.

3.4.3 **Alignment and Exposure**

3.4.3.1 Turn on the microscope lamp power.

3.4.3.2 Focus the microscope onto the mask, and adjust the microscope lamp power if necessary.

3.4.3.3 Locate the mask alignment mark, using the microscope motion control rod to position the microscope. The two buttons on the bottom of the rod release the microscope to travel left-right and front-back.

3.4.3.4 Place the substrate in separation by moving the "separation" lever to the "separation" position (toward the operator). The "contact" indicator will turn off, and the "separation" indicator will turn on.

3.4.3.5 Align the substrate to the mask by using the x, y, and theta micrometer control knobs.

3.4.3.6 If the alignment mark is out of the range of travel of the control knobs, unload the substrate, reposition either the substrate or the mask, and start again from 3.2.

3.4.3.7 Check that the alignment is correct by moving the "separation" bar to the "contact" position. If necessary, adjust the substrate position, making sure to place the tool in "separation" before moving the substrate.
3.4.3.8 Set the exposure time using the dial timer on the front of the tool. The inner dial sets the scale (seconds, 10 seconds, etc) for the outer dial.
3.4.3.9 Press the "expose" button, and move clear of the microscope.
3.4.3.10 The microscope and shutter housing will move forwards, and the exposure will take place automatically.
3.5 Sample Unloading
3.5.1 After exposure, wait until the shutter housing has moved back to the home position.
3.5.2 Move the "contact" lever to the "release" position.
3.5.3 Turn the z-adjustment knob two turns clockwise.
3.5.4 Slide the chuck transport to the right and remove substrate.

5. 3.5 Mask Unloading
   3.5.1 Loosen the two knurled screws on the mask holder frame.
   3.5.2 Slide the mask holder out of the frame, and place upside-down on the aligner table.
   3.5.3 Press "mask vacuum" to turn off the mask vacuum.
6. 3.6 Final Steps
   3.6.1 Turn off the microscope lamp power