

OAI Model 204IR Mask Aligner

Standard Operating Procedure

Faculty Supervisor: Prof. Robert White, Mechanical Engineering (x72210)

Safety Office: Peter Nowak x73246 (Just dial this directly on any campus phone.)
(617)627-3246 (From off-campus or from a cell phone)

Tufts Emergency Medical Services are at x66911.

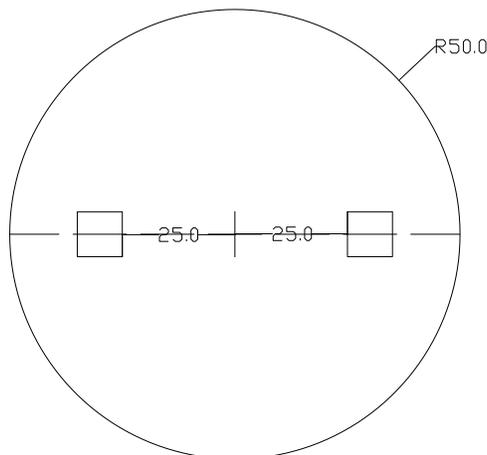
Revised: January 8, 2018

Warnings:

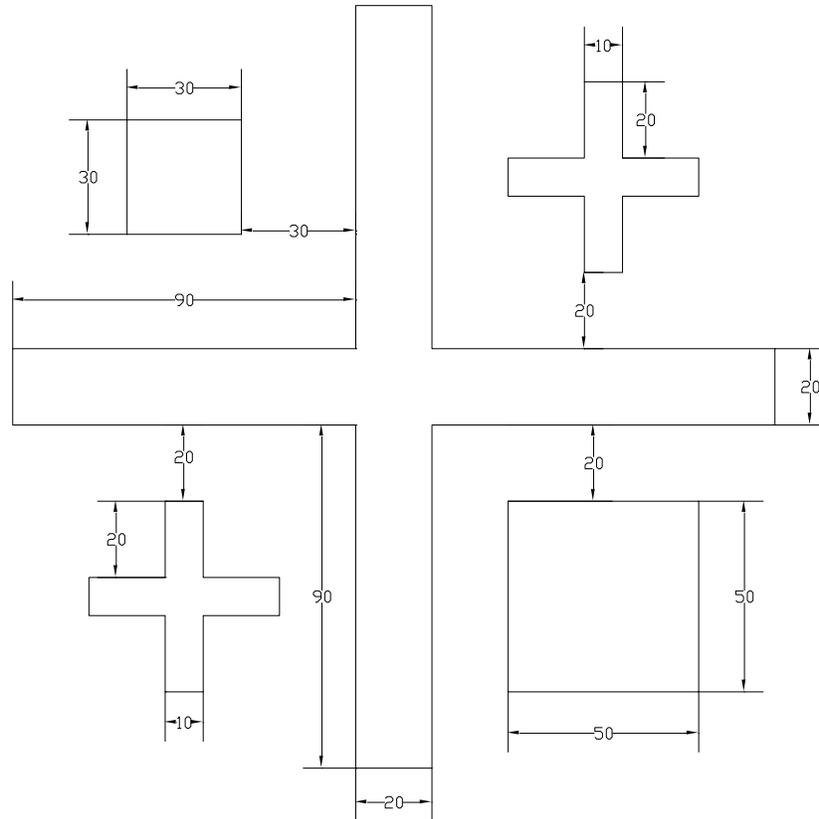
1. Whenever the shutter is open you may be exposed to UV radiation. Never look directly at the lamp. Do not put your hands under the lamp while the shutter is open.
2. The lamp contains mercury. If the lamp explodes immediately exit the cleanroom (take your suit off in the hall outside). Call the safety office (number is at the top of this page) and Prof. White.

Notes:

1. The lamp is calibrated to $15\text{mW}/\text{cm}^2$ intensity at 365 nm (I-line), approximately $45\text{mW}/\text{cm}^2$ broadband exposure
2. The microscope objectives can not move closer together than 48 mm. The field of view of the microscope at maximum magnification is approximately $350\ \mu\text{m} \times 450\ \mu\text{m}$. You should size and place your alignment marks appropriately. Here is a suggestion:



Try placing alignment marks along the wafer centerline, between 25 mm and 35 mm from the center. Make them symmetrically positioned about the wafer center!



Try using this alignment mark. Dimensions are in microns. If you make the crosses and squares transparent on your mask, make the crosses and squares slightly smaller (18 and 8 microns wide crosses, something like 48 and 28 micron square squares, but positioned at the same centerpoints!!) on the substrate. If you make the crosses and squares opaque on the mask, then do the reverse. I'm sure this isn't optimal. It's just a suggestion.

1.0 Material Requirements:

- 1.1 Equipment: A 5" by 5" by 0.09" mask plate (usually we use Chrome on Soda Lime glass)
- 1.2 Personal Protective Equipment: Nitrile gloves and safety glasses (standard cleanroom gear)

2.0 Procedure:

Startup:

1. Open the valves for compressed dry air (CDA) and vacuum to the left of the instrument.
2. Turn on the main power switch to the aligner on the front panel.
3. Move the optics module all the way back by using the horizontal black handle to the back right of the tool. Push in the small button to release, and push the optics module all the way back (it will hit a solid hard stop at the back of the machine.)
4. Push "Cycle". The main module will move to the right, if it is not there already.

Turning on the Lamp:

The Lamp is typically left on (it idles at a lower power standby state, you should see a glow at the back of the lamp housing. it is not subtle. If the lamp is off notify management and try the following startup -

If the lamp is off:

1. Plug in the blower module (on the floor to the back right of the aligner). It should start blowing out air.
2. Check the settings on the lamp controller. The controller is on the shelf under the aligner. Channel: "A" Mode: "C/I" (this means constant intensity mode) Intensity-Power: Power
3. Turn on the power switch on the lamp controller. The power switch is the throw switch on the right hand side.
4. To ignite the lamp, press the "Start" switch on the lamp controller in for about a second, then release. The lamp should ignite; the power level should start to rise, and you should see a purple glow if you look behind the aligner.
5. Wait at least 5 minutes for the lamp to warm up. The power should stabilize around 300(?) Watts.

Loading the Mask:

1. Inspect your mask under the microscope and make sure it is clean. You can clean your mask with solvents (acetone then IPA) in the hood and cleanroom swabs. If the mask is really dirty, a Piranha clean may be used.
2. Move the optics module all the way back by using the horizontal black handle to the back right of the tool. Push in the small button to release, and push the optics module all the way back (it will hit a solid hard stop at the back of the machine.)
3. Push "Cycle". The main module will move to the right, if it is not there already.
4. Toggle the mask vacuum button to "off" (if it is not already off).
5. Loosen the thumb screws on either side of the mask frame, and lift the mask holder out and flip it over. (Keep the vacuum hose attached.)
6. Remove two of the four thumbscrews and swing the mask clamps out of the way.
7. Put the mask into the holder, using the alignment pins to position the mask. Be careful not to scratch or smudge your mask. Make sure you put the mask in the right way up, so that the chrome side will end up being in contact with the wafer.
8. Turn on the mask vacuum toggle. The mask should now be stuck to the frame.
9. Replace the mask clamps and the two thumbscrews. Tighten finger tight.
10. Flip the mask frame back over, put it into the mask holder, align the scribe marks (this gets your mask mostly square to the wafer) and tighten the two side set screws.

Loading the substrate:

Note: You need to get the microscope out of the way in order to raise the mask frame

1. Toggle the mask frame to "open". The mask should lift away from the wafer.
2. Place your wafer on the chuck. Try to align the wafer so the major flat is towards you and mostly square to the machine. Try to get the wafer more or less centered on the chuck.
3. Turn on the sub. vac. (substrated vacuum) switch. The wafer should be stuck down.
4. Confirm that the substrate chuck is the "down" position by turning the black Z adjust knob CCW until you start to feel it tighten slightly
5. Toggle the mask frame to "close". The mask should settle back to horizontal.

Alignment

1. Move the microscopes back over the mask by pressing in on the button on the main supporting arm and sliding the stage toward you. Finer positioning of the microscope can be accomplished by use the two buttons on the back of the positioning handle just to the right of the microscope. Pressing the top button permits 'Y' positioning and the bottom button permits 'X' positioning.
2. Turn on the fiber optic illuminator to about 10-20% power. The light level on the illuminators is important... if you can't see anything, try adjusting this.
3. Turn on the two TV monitors.

Note: You will want to use low magnification for set-up and for locating any alignment features because the low magnification provides the greatest depth of field and field of view. This next step is the hardest part. Be patient.

4. Focus the microscope on the mask structure. There are fine focus rubber rings just above the microscope objectives (you should see the objectives move up and down a little). You can adjust the objective relative spacing by loosening the thumb screws behind them and sliding them left and right. You can adjust the X and Y position of the objectives using the large, black handle to the top back right of the optics unit with the two buttons, one for X and one for Y. You can adjust the rotation of the mask by loosening the mask frame thumbscrews and rotating the whole frame. There are also zoom adjustments for each objective, going from 1x to 4x.
5. Next you will raise the substrate toward the sample. The goal is to make the mask and wafer parallel. Be sure that the "Ball Vac." toggle is in the "Unlock" position. This allows the wafer chuck to swivel freely in its ball-and-socket coupling.
6. On the front panel there is a D.C. ammeter and black knob that are collectively referred to as the "Chuck 'Z' Adjust". The current controlled here feeds an electronic clutch that engages a belt on the 'Z' adjust knob (the big black one on the front of the alignment module). Turn the black knob clockwise until the reading on the ammeter is about 15-20 mA. The clutch is now engaged.
7. Slowly turn the knob on the front of the alignment module to raise the substrate into contact with the mask. When contact is made, you should feel a significant resistance to turning the knob, and the belt will stop moving. The wafer and mask are now in contact, and hence parallel. The clutch is slipping. Switch the "Ball Vac." toggle to the "Lock" position. This locks the ball-and-socket joint so the substrate will stay parallel to the mask.
8. Lower the substrate a little (approximately 20 units on the black knob) and align the features. It will be easier if the microscope is properly adjusted for your eyes. Adjust the illumination, focus, and zoom as needed.

Note: During alignment, especially with a small gap, it may help to turn on the N₂ purge to blow some air between the mask and wafer. Especially if you are having sticking problems or trying to align with a very small gap.

For frontside alignment: Turn the IR module enable-disable switch to "disable".

For backside alignment: Turn the IR module enable-disable switch to "enable". Push the cycle button. The IR lamps will move under the wafer. Turn up the Olympus controller to get the desired backside illumination. You should be able to see through silicon using IR light.

9. The wafer position is controlled with the three micrometers. The one in the middle is back-forward. The one on the right is left-right. The one on the left is theta (rotation).
10. When you are satisfied with the alignment, raise the substrate into contact with the mask using the black knob.
11. You are now in "soft contact". For higher resolution toggle hard contact "on". More pressure will be exerted between the mask and substrate. This can cause sticky resists to stick to the mask but will give finer resolution. For 2-5 micron features, hard contact should be sufficient.
12. For even smaller features, turn on "Vac Contact", which will pull a vacuum between the mask and substrate. This can be used in addition to "hard contact" if desired. The vacuum level can be adjusted by the vacuum level knob on the right.

Exposure

1. Check or set the desired exposure time (in seconds) on the left of the front panel of the aligner. Set to either "100 second" or "1000 second" mode, and then adjust the thumbwheel switches to set exposure time. Note that the controller is configured for 15 mW/cm² exposure intensity.

2. Make sure everything is all set to go. Press the cycle button. The main module will move under the lamp, the shutter will open and expose for the specified time, and the module will move back.

Removing your substrate

1. Toggle the “Contact Vac.” Switch, and the hard contact switch to the “Off” position.
2. Switch on the “Nitrogen purge” toggle and open the “Nitrogen purge flow valve” to blow some air between wafer and mask. Adjust the flow rate to somewhere mid-range (around “5”) on the N₂ flow meter.
3. Lower the substrate out of contact with the mask using the black knob.
4. Move the optics all the way to the right using the two-button handle. If you do not do this, the IR module will crash into the wafer stage when you try to move the optics back!!!
5. Slide the alignment optics to the back of the tool as done earlier.
6. Open the mask frame and turn off the substrate vacuum (sub. vac.). You can now remove the substrate.
7. Close the mask frame.
8. Turn off the N₂ purge.

Removing your mask:

1. Loosen the thumb screws on either side of the mask frame, and lift the mask holder out and flip it over. (Keep the vacuum hose attached.)
2. Remove two of the four thumbscrews and swing the mask clamps out of the way.
3. Turn off the mask vacuum toggle, and remove the mask.
4. Replace the mask clamps and the two thumbscrews. Tighten finger tight.
5. Flip the mask frame back over, put it into the mask holder, align the scribe marks (this gets your mask mostly square to the wafer) and tighten the two side set screws.

Shutting down the system:

1. Turn off the fiber optic illuminators and the TV monitors.
2. Turn off the main power to the unit on the front left.
3. Close the CDA and vacuum valves to the left of the instrument

Shutting off the lamp: (Typically the lamp remains on at standby power, this section is included fyi)

1. Turn off the power on the front panel of the lamp intensity controller. The lamp should shut off.
2. After allowing the lamp to cool for a few minutes, unplug the exhaust blower.

If at any time you feel a situation is dangerous, do not hesitate to call the safety office (x73246, Peter Nowak) the faculty supervisor/lab manager (x72210, Robert White), or Tufts Emergency Services (Police/Fire/Ambulance at x66911).

Report all accidents (injuries, major spills, fires) to the safety office at x73246 (Peter Nowak) and Prof. White at x72210. For emergencies, call Tufts Emergency Services at x66911.