



Angstrom Engineering - EvoVac

Safety

- This tool contains high voltage sources and there are trip hazards behind the tool. Do not go behind the tool, attempt to open covers, or work inside the tool.
- Use caution when using the step ladder to load your wafers.
- Do not pinch your fingers in the chamber door or with the load lock lid.
- Do not bump your head when the door is open.
- The inside of the tool can get very hot, particularly the ion source and the crucibles.
- Shutters in the tool can snap shut.
- Do not abrasively scrub the sample holder. It is made of molybdenum.
- If you open the chamber and it is flaking badly (i.e. small aerosols, not big flakes), close the door, leave and inform staff.

Allowed Materials and Processes

- Aluminum, aluminum oxide, silicon dioxide, titanium, titanium nitride, and titanium oxide.
- To add new materials to this list, please email andrew.lingley@montana.edu.

Restricted Materials and Processes

- Do not attempt to make your own recipes without extensive training and explicit permission from the lab manager.
- Never change the sample stage.

Important Equipment Notes

- **Do not run “Transfer from Dep” when the substrate holder is in the load lock or “Transfer to Dep” when the substrate holder is in the deposition chamber. Either of these operations will damage to the tool.**
- Always hit “Load Recipe” after selecting a recipe from the dropdown or browse menus and verify that the recipe loaded correctly by looking at the “Recipe” cell on the upper left of the “Process” screen.
- Do not bump or run into the plumbing to the left of the tool.
- Do not bump or turn the black knobs on the Angstrom EVA power supplies.
- Except for the Chamber Light, do not operate the overrides in the System menu. Do not operate the servos manually.

Operating Procedures

1. Check reservations and make one: https://www.montana.edu/cpa/apps/mmf_tools/.
2. Check tool status, visit: <http://www.mmf.montana.edu/equipment-status.html>.
3. Check the lab status.
 - a. Check N₂ bottle pressure. If it is below 500 PSI, inform staff, but continue operation as normal. If it is below 200 PSI, inform staff and wait for staff to change the N₂ bottle.
 - b. Check that the N₂ is on for lab.
4. Check the equipment status.



- a. Click the “System” button and then click the “Vacuum System” tab on the left. Then click on “Dep Chamber.”
 - b. Check Dep Pressure in the upper right of the screen. If it is above $8e-7$ Torr, inform staff and leave a note on the tool marking it as inoperable.
 - c. Check that the cryo temperature is below 18 K.
 - d. Check that the chiller pressure is 50 ± 10 PSI by pressing the down arrow on the chiller once. If it is not, report to staff and leave a note on the tool that it is inoperable.
 - e. Check the load lock pressure. If it is at atmospheric pressure, inform staff but continue as normal.
5. Check the tool configuration
- a. Click “Main” and then click “Load Materials”. Check if the materials that you need to deposit are loaded.
 - b. Verify that the gas you need for the ion source is selected with the two-way valve on the wall to the left of the tool. If you need the other gas, work with staff.
 - c. Click System, Pressure Control, and verify that the Current Gas in MFC 2 Ion Source is the correct gas for your process. If you need a different gas, work with staff.
6. Load materials (Optional)
- a. Click System, Vacuum, and Dep Chamber. Verify that at least 5 minutes have passed since the last deposition and that the substrate has cooled below 50 C. Press Vent and Start. Wait about five minutes for the chamber to vent and open the chamber door. When you open the door, all the sources will turn off and the air pressure to the shutters will bleed off. The tool will also throw a fault that cannot be cleared while the door is open.
 - b. Click Main and Load Materials to see what materials are currently in the pockets. Navigate to the pocket you want to change or refill by clicking on the pocket number and then hit “Move to Pocket”.
 - c. Physically rotate the source shutter forward and out of the way. Take out the material using tweezers and be very careful that the crucible is not still hot. Do not ding the hearth with the tweezers.
 - d. Vacuum out the tool and hearth carefully to make sure there are not any pieces of material that will prevent the crucible liner from fitting snugly. Also vacuum out below the hearth to make sure there aren't any flakes that will short the filament.
 - e. Refill or change the material and reload the crucible into the hearth. Do not overfill the crucible; except for SiO₂, crucibles should never be more than $\frac{3}{4}$ full. Make sure the crucible is entirely in the pocket and sitting flat.
 - f. Update the Load Materials section. If you are not changing the material type, reset the Accumulated Power. If you are changing materials, you will be prompted to reset the Accumulated Power after you select a new material.



- g. Wipe the sealing surfaces with a dry wipe and close the door. Click Main and Process, and then select Deactivate next to Bias Mode Activation. This will clear the fault.
 - h. Pump down the Dep Chamber. Click System, Vacuum System, Dep Chamber, Pump Down, and Start. Wait for the system to reach base pressure. This takes about 2 hours.
- 7. Load samples
 - a. Prepare samples. Load your sample onto the substrate holder. You can affix your samples using screws, clips, or with vacuum-rated Kapton tape.
 - b. Click System, Vacuum System, and Load Lock. Click Vent and then Start.
 - c. **Open the load lock lid and load the sample holder into the load lock. Make sure the open end of the “C” is facing into the chamber and that the notch on the holder is properly aligned.**
 - d. Close the load lock lid.
 - e. From the “Load Lock” screen, select Pump Down and then Start. Wait for the load lock to reach base pressure, $2e-5$ Torr. This should take about 15 minutes.
 - f. **Click Main” and then Process. On the lower right of the screen, select from the dropdown menu “Transfer to Dep” and then Load Recipe. Verify in the upper left next to Recipe that “Transfer to Dep” is listed. During a Transfer to Dep process, the VAD stage should tilt counterclockwise immediately. If it does not, stop the process.**
 - g. Click Start. Watch the wafer as it is loaded into the deposition chamber and be ready to hit the big red Stop button if something does not look right.
- 8. Deposit
 - a. From the “Load” dropdown menu, select “Browse...”, navigate to the desired folder, and select your recipe. Click “Load Recipe.” Verify that the recipe loaded.
 - b. **Verify that your wafer loaded properly. Depositing without the sample holder in place can get on the substrate heaters.**
 - c. Check recipe. Edit the “Thickness (A)” and “Timeout (s)” in the recipe after it has loaded if you need a different thickness than the saved value. Verify that the recipe loaded correctly and that the process steps have not been edited. A good practice is to have a hard copy of the recipe parameters saved for your process.
 - d. Press “Start” and monitor the deposition. Always watch the ion beam start up and look for abnormalities, such as the plasma not striking, flickering, or going out. Watch the e-beam while the power ramps up, make sure the beam is centered, and verify that the correct material is in place. Periodically check the tool during long depositions to make sure that there have not been any faults and that the output power is stable. Verify that the stage rotation and tilt are as expected for your recipe.



9. Remove samples
 - a. Make sure the “Substrate Temperature” in the upper right of the Process window reads below 50 C.
 - b. In the “Process” window, select “Transfer from Dep” from the dropdown menu and then click “Load Recipe.” Verify that “Transfer from Dep” is listed beside “Recipe” in the upper left side of the screen.**
 - c. Press “Start.” Watch the sample unload and be prepared to hit “Stop” if anything seems awry.
 - d. Under “System,” “Vacuum System,” and “Load Lock,” verify that “Sources OK to Vent” is green, and then click “Vent” and “Start.”
 - e. Unload the sample holder, close the lid, and pump the load lock.

Troubleshooting

- Chamber will not vent.
 - Ensure lab N2 is on.
 - Ensure lab N2 bottle has enough pressure.
- Recipe error.
 - Clear the error by hitting acknowledge, then run the recipe again.
- Pump down will start.
 - Make sure to select.
- Failed to reach final thickness error.
 - Make sure to update “Timeout (s)” if you edit the final thickness.
- Light will not turn on
 - Click System, Overrides, and Dep Chamber. Verify that the Chamber Light is set to Auto.