Evaporator

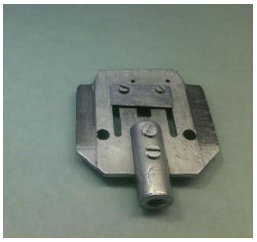
Loading

Checking the Evaporator

1. Check that there are no notices on the evaporator stating it is not working, check the log book for any notices
2. Ensure turbo is off and it is safe to add nitrogen into the load-lock
3. Make sure gauge C is off
4. Stage tilt is at 24 in mm scale and stage has not been rotated
5. Gate between load-lock and main chamber is closed

Preparing the Sample

1. Clean the sample holder in IPA and avoid touching it, any source of grease in a UHV environment may contaminate your sample
2. Attach your sample to the sample holder using colloidal silver or carbon tape or metal clamp. Make sure the sample is absolutely flat and is the correct way up:



3. Use the green pliers to grab the sample holder. It has to be inserted with the specimen facing downwards and the screw thread on the right hand side
4. Use nitrogen to blow off any contaminations

Loading the Sample

1. Close the valve to the scroll pump. Vent the chamber by opening the N_2 valve, opening the needle valve and opening the final turbo valve. Undo the latch on the load-lock door
2. Open the load-lock door. Put your sample inside and attach it to the transfer rod using the pliers
3. Close door and evacuate load-lock by opening the valve to the backing pump, the N_2 valve should be closed but the needle and turbo valves can be left open
4. When pressure in loadlock is below 100 milliTorr with the Varian 801 analog gauge ($1 * 10^{-1}$ mbar with gauge B), turn on the turbo pump. Turn on the turbo pressure gauge (gauge C) after a while.
5. If you are using the ion-beam milling then you can skip these next steps;
6. Turn on the e-beam power source using the breakers on the power supply – it needs to warm up for at least 10 minutes

7. When the pressure is below $5 * 10^{-6}$ mBar open the gate to the UHV chamber. Do not open it above this pressure regardless of the hurry you are in. It generally takes between 5-15 minutes to pump down depending on your sample.
8. Transfer your sample inside to the sample stage. The stage tilt should be 24.2 on the mm scale
9. Retract the transfer rod and close the UHV - load-lock gate
10. If you wish to use liquid nitrogen then add it to the trap now

Loading Source

There are five crucibles inside the evaporator. Choose the source by adjusting the crucible position, using the black screwing handle behind the evaporating chamber.

Evaporating

Setting the thickness meter parameters

1. Turn on the JTC-200 deposition rate controller.
2. Press 'Menu', select '2'.
3. Enter the crucible number (film number).
4. Press 'Start' two times, and press 'Stop'.

Turning on the e-beam evaporator

The main power switch should be turned on for at least ten minutes before the following processes.

1. Ensure the pressure in the main chamber is below $1 * 10^{-7}$ mbar
2. Switch on the deflection coil power supply on the top of the rack, typical values can be found from the log-book, adjust only the current and not the voltage
3. Turn on the e-beam controller (TT-3/6 Control Telemark). If the fuse trips switch off the e-beam power supply and switch the fuse marked R1 at the wall, switch the e-beam power supply back on and try again
4. Slowly increase the emission current.
5. Make sure the emission current is increased slowly as increasing it too quickly leads to poor evaporation in the best case and broken crucibles in the worst. Around 5 mA/min should be the maximum, do not exceed 400 mA.
6. Make sure to monitor the chamber pressure, parts may offgas and the system will shut down to protect itself if the pressure gets too high.
7. Wait at 20mA for 5 minutes in order for the crucible to heat evenly
8. Monitor the deposition rate, displayed on the TTC-200 deposition rate controller.
9. Adjust the e-beam spot using the deflection coil power supply if it is not in the middle of the cup
10. Keep increasing the emission current until the deposition rate is sufficient.

Starting the deposition

1. Set the thickness meter to zero by press ‘zero’ on TTC-200 deposition rate controller, and simultaneously opening the shutter between the sample holder and the material crucible. (The shutter is controlled by the rotating knob on top of the evaporating chamber.)
2. Monitor the thickness and the deposition rate.
3. Close the shutter when at the required thickness
4. Slowly decrease the emission current to zero, if you go too fast you may break the crucible
5. Switch off the e-beam controller (TT-3/6 Control Telemark)
6. If you are immediately evaporating another film you may skip these steps and change crucible
7. Switch off the TTC-200 deposition rate controller and deflection coil power supply
8. Wait 10 minutes and then switch off the e-beam power supply, this is a good opportunity to let the sample cool down

Oxidizing

There are two available oxidation schemes. The first is a static scheme where no pumps are running and the oxidation gas will remain static in the chamber. The second is a flow scheme in which the pumps are running and there is a flow of oxygen. Both schemes are constant pressure.

Make sure you familiarise yourself with this guide before you start the oxidation.

Static

- Final oxidation pressure can be calculated using

$$P_f = 0.1237 \cdot P_0$$

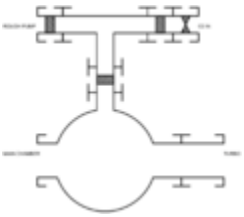
Where P_0 is the pressure measured in the oxygen chamber.

If you are using very low oxidation pressures (<0.1 mbar final) then for accuracy you may want to calculate using

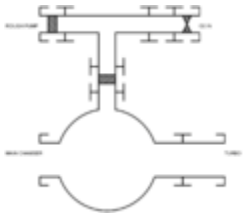
$$P_f = 0.1237 \cdot P_0^{0.95}$$

1. Check the gauge on the oxygen chamber before you move your sample into the load-lock. It should read 0 and it is good practise to evacuate this chamber whilst you are evaporating.
2. Close the oxidation valve between the load-lock and oxygen chamber.
3. Open the valve next to the needle valve, if the pressure rises then pump it away as appropriate.
4. Start filling the oxygen chamber to your desired pressure using the needle valve to regulate the flow until the pressure has been reached. If you overfill use the rough pump to remove the extra gas but be careful to not shock the turbo backing. Close the valve adjacent to the needle valve.
5. You may now move your sample into the load-lock.
6. Isolate the turbo from the load-lock using the gate valve and switch off gauge C.

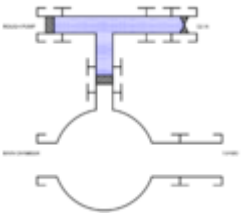
7. Open the oxidation valve between the load-lock and oxygen chamber, this will cause the oxygen to quickly rush into the load-lock chamber and start oxidising the sample.
8. If the final pressure is below 2 mbar the turbo gate valve can be opened directly to start pumping and therefore stop the oxidation. If it is higher than 2 mbar the chamber will need to be roughed first and the following steps should be taken.
    1. Close the turbo backing valve.
    2. Open the roughing valve.
    3. When pressure is below 0.1 mbar the turbo backing valve can be reopened.
    4. Close the roughing valve.
    5. Open turbo gate valve.
9. When pressure is below $5 * 10^{-6}$ mbar the sample can be returned to the main chamber.



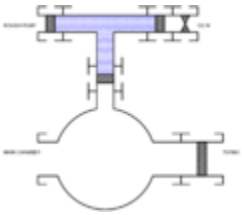
1. The condition of the load-lock prior to oxidation.



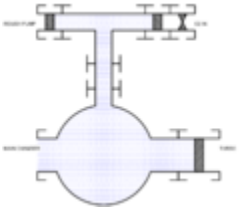
2. Open the valve adjacent to the needle valve.



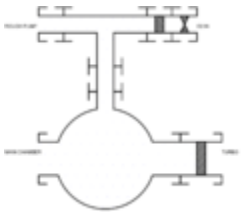
3. Fill the oxygen chamber with gas to desired pressure.



4. Isolate turbo just before oxidation.



5. Open the valve between load-lock and oxygen chamber to begin oxidation.



6. Use rough pump or turbo to pump gas away.

Flow

For the flow regime you should do a dry run to find the correct settings.

1. Switch off gauge C and open the oxidation valve and needle valve assembly.
2. Start the gas flow and adjust needle valve to desired setting for the pressure you want. **If the pressure is below 0.1 mbar (100 mTorr) you may use the turbo to pump. If it is higher than this the roughing pump must be used.**
3. Close the needle valve to stop gas flow and pump the chamber to below $5 * 10^{-6}$ mbar.
4. Move sample to load-lock and start the oxidation.
5. When the oxidation has finished close the needle valve and allow the oxygen to be pumped away. Once the pressure has dropped to below $5 * 10^{-6}$ mbar the sample can be returned to the main chamber and all valves can be returned to their original position.

Unloading

1. Remove sample from UHV chamber and return to the load-lock (load-lock pressure must be below $5 * 10^{-6}$ mbar)
2. Turn off turbo and close backing valve. Turn off gauge C. It takes approx. 20 minutes for the turbo to spool down
3. Once the turbo has stopped open the N_2 valve and let nitrogen into the load-lock, at the same time undo the latch on the door
4. If you wish to monitor the pressure you may connect the digital pressure gauge to gauge B
5. When the load-lock is at atmospheric pressure open the door and remove the sample holder using the pliers. Close the door, close the N_2 valve and open the backing valve
6. Remove your sample from the sample holder

IonMilling

If you wish to use ion milling it is recommended you read the entire page first.

Approximate etch rates are;

Material	Etch rate (nm/mA/s)
Al	0.03
Cu	0.073
PMMA 950K	0.12

Preparation

1. The ion milling power comes from a 3-phase plug near the wall sockets, to use the device the e-beam power supply must be unplugged from R1 (ensure the power supply is off first) and the ion milling socket plugged in. Because of this you cannot warm up or turn on the e-beam power supply at the same time as ion milling.
2. When loading the sample you must remove the metal guard at the bottom of the load lock

Loading and Initial Operation

1. Load the sample normally and attach to the transfer rod
2. Turn the transfer rod so that the sample faces up rather than down
3. Close the load-lock door and start pumping to below $5 * 10^{-6}$ mbar
4. Here the procedure is the same as oxidation. You should open all gas valves and the needle valve fully and pump to $5 * 10^{-6}$ mbar. Once you've reached base pressure you should open the Ar bottle valves (do *NOT* use oxygen), gas valve 2 and gas valve 1, make sure the needle

valve is closed before you do this. Once the gas is on and valves you open you should slowly adjust the needle valve to your desired pressure.

5. Turn the MPS-3000 FC ion miller on, it should beep and display P
6. Initial settings should display as such;

Cathode Filament Current	**Discharge Current**	**Beam Current**	**Acceleration Current**	**Neutraliser Filament Current**
3.7 A				
	Discharge Voltage	**Beam Voltage**	**Acceleration Voltage**	**Filament Current**
	40 V	1000 V	80 V	2.5 A

1. Push button 'Source' on, the discharge voltage is set to 150 V initially but will fall to 40 V. If it does not fall to 40 V then increase the pressure.
2. Push button 'Beam' on, the parameters will change to be similar to the following;

Cathode Filament Current	**Discharge Current**	**Beam Current**	**Acceleration Current**	**Neutraliser Filament Current**
3.7 A	1.05 A	40 mA	6 mA	13 mA
	Discharge Voltage	**Beam Voltage**	**Acceleration Voltage**	**Filament Current**
	40 V	1000 V	80 V	2.5 A

1. If they do not change or an alarm sounds then the plasma has not formed and the flow rate/pressure should be changed
2. If they show then the plasma is flowing and the sample holder should be turned upside down to expose the sample to the ion beam
3. Please note that the ion miller and gas flowing through it heat up extremely quickly and may damage your sample, it is better to expose the sample in short bursts of 10-20 seconds and then stop the beam to keep temperature low.
4. Once finished, press button 'Beam' off
5. Press 'Source' off
6. Switch off the MPS-3000 FC
7. Close the Ar gas bottle and open the needle valve fully to allow the turbo to pump all Ar from the line. Failure to do this will severely inhibit pumping time for the next user
8. Once the line has been pumped (at least below $5 * 10^{-6}$ mbar) then close the gas valves fully
9. Remove the sample, replace the protective cover and plug the e-beam power supply back in