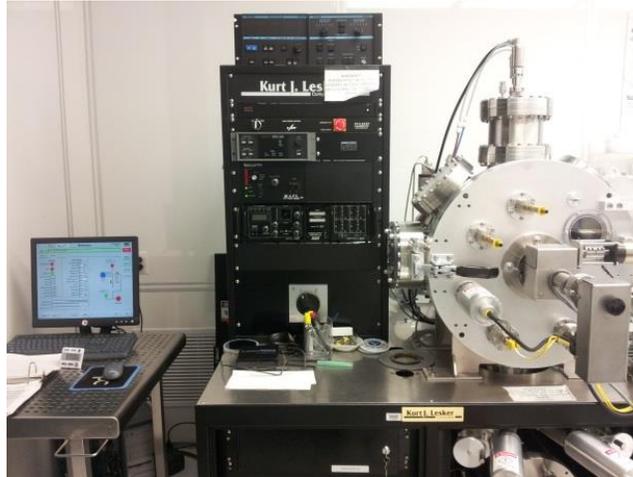


## E-BEAM EVAPORATOR SOP

KURT J. LESKER

Revised April 2020



**NOTE:** Don't forget to login into your FOM account and login to the tool.

### Loading Metals and Samples

1. Check the system to make sure there are no depositions in process:
  - Click on the **DEPOSITION** tab and make sure everything is **OFF (RED)**.
  - Click on the **MOTION** tab and rotate the platen to 90 degrees by entering this value into the **POSITION SETPOINT** window under **PLATEN POSITION**. Using the flashlight look through the window to the right side of the chamber and make sure there are no samples on the platen.

**NOTE:** If there is any sample inside the chamber or the e-beam is running, please contact a MNTC Staff member to figure out whose sample this is and if they can unload it for you.

2. Select the **VACUUM** tab and click on **START PC VENT** button on the right side of the operation screen.

**NOTE:** PLATEN MUST BE AT 180 DEGREE BEFORE OPENING OR CLOSING THE CHAMBER DOOR.

3. Once the **ATM** indicator becomes **GREEN**, open the chamber and load your sample. Make sure you hold your sample by using the clamps or temperature resistant tape.
4. Close the chamber and open the crucible holder drawer, load your crucible (make sure the crucible is centered and you put enough metal inside the crucible).

5. If you are loading more than one metal load the second crucible and remember by how many degrees you would have to turn the knob in order to center the second metal. Load you first metal last and leave it centered.
6. Close the crucible holder drawer.

### Pumping Down

1. Click on **START PC PUMPDOWN** and wait 380 sec. At this point the **PC HIVAC** valve should turn on (GREEN). You will see the count down time at the **PROCESS RECIPE STEP** window. If **PC HIVAC** does not turn itself on, then you need to do a manual pump down:
  - Click on the **ROUGH PUMP**, then click on **PC ROUGH**
  - Wait 380 sec, and **PC HIVAC** will turn on (GREEN) (Pressure should reach  $2.0 \times 10^{-1}$  Torr before **PC HIVAC** turns on)
2. At this point the pump down process begins. The wait time to reach the recommended deposition pressure ( $5 \times 10^{-7}$  -  $1 \times 10^{-6}$  Torr) is approximately 45 min.

### Setting Up the Sigma Software

1. Check chamber pressure has reached  $5 \times 10^{-7}$  –  $1 \times 10^{-6}$  Torr.
2. Go to the **SIGMA** tab or click on the **SIGMA SQS-242** button to open the **SIGMA** program. This software communicates with the equipment and calculates the amount of metal deposited on your substrate.
3. On the **SIGMA SQS-242** window go to **FILE** -> **PROCESS** to choose the metal you are depositing, or to create a new one.
4. Go to **VIEW** -> **SENSOR READINGS**. A window pops up displaying the readings from the sensors located in the process chamber. (These sensors will help calculate the amount of metal deposited on to your substrate).
5. Go to **EDIT** -> **PROCESS** and click on the **SOURCE/SENSOR** tab. Make sure the material name is the same as the process name and that **TOOLING** is set to **150**. Then close the edit window.
6. Click on **START PROCESS** in the upper left corner. Wait for the “Thick (kA)” for **Sensor 1** to reset to 0 and then click on then on **ABORT PROCESS**. (This resets the sensor readings).
7. This loads the metal data without running the auto-deposition program.
8. Click on **AUTO->MANU** (This activates the manual operation mode).
9. Return to the operation screen.
10. If you would like to heat your substrate:
11. If you would like to heat your substrate, go to **HEATING** tab.

- Click on **HEATER ENABLE** and **AUTO MODE**. Enter the desired values for temperature set point and ramp rate. Max ramp rate allowed is 10 degrees per minute. You may start at 0 and ramp it manually by gradually increasing the temperature set point.

### Starting Deposition

- Click on the **MOTION** tab.
- Turn on **PLANET SPEED**.
- Under **PLATEN POSITION** change the Position Setpoint to **225** degrees and hit **GO** to bring the mirror into position. (The mirror can be seen from the window on the left side of the chamber, and it will serve to help adjust the beam.)
- Turn **ON** the breaker to e-beam power supply.

**NOTE:** The subsequent operation can be done in either auto mode or manual mode.

### Manual mode (recommended)

- Wait 2 minutes for the electronics to warm up before turning on the e-beam. Press the Voltage/Emission **ON** button on TT-3/6 control unit. See photo shown on the right.
- Wait 2 minutes and that verify all interlocks are **GREEN**; top row of LEDs on the TT-3/6 controller.
- Go to the **DEPOSITION** tab in the software and click **SUB SHTR** to open the substrate shutter so the beam and crucible can be seen.
- Gradually increase the power: slowly rotate **EMISSION CURRENT ADJ** knob until the emission current changes from a negative number to zero. You should see the image of electron beam through view port now.
- Increases emission current 10 mA per minute until you see the beam on and starting to heat the material.
- By turning the **FREQ** and **AMP** knobs visually adjust the e-beam in a way that would melt the material evenly throughout the crucible (wear protection goggles). If your beam is not spread, then it might melt all the way down to the crucible.
- Once the e-beam is well positioned, raise the emission current gradually by 10 mA per minute. Regularly check the position of the beam as the space charge from increasing current will cause it to move.
- Once you have reached the desired current and **Sensor 2** is reading an acceptable deposition rate, close the **SUB SHTR (RED)** and rotate the substrate (**MOTION** tab) to 0 degrees and click **GO** (substrate now faces down). Open the shutter to begin deposition



Figure 1 TT-3/6 E-beam power supply controller panel

by clicking **SUB SHTR (GREEN)** (**Sensor 1** will start to read a deposition rate once the shutter is open).

If the deposition rate on **Sensor 1** is not high enough, you can increase the power output of the e-beam during deposition (repeat step 11).

**NOTE:** If you need to deposit a second material close the shutter and decrease the emission current by 10 mA per 30 sec down to 0 before turning off the e-beam.

Power off the e-beam by pressing the **OFF** button and rotate the knob on the materials chamber to change the position to the second material crucible. Then repeat Steps 1 through 9 above.

### Auto mode

1. Wait 2 minutes before turning on the e-beam. Press the Voltage/Emission **ON** button on TT-3/6 control unit. See photo above.
2. Wait 2 minutes and that all interlocks are **GREEN**.
3. Go to the **DEPOSITION** tab and click **SUB SHTR** to open the substrate shutter so the beam and crucible can be seen.
4. Gradually increase the power:
  - Enter **0.2** for ramp and then **2%** for power. (**Wait until it resets back to 0**).
  - Enter **0.2** for ramp again and **2%** for power.
5. You should now see the beam on starting to melt the material.
6. By turning the **FREQ** and **AMP** knobs visually adjust the e-beam in a way that would melt the material evenly throughout the crucible (wear protection goggles). If your beam is not spread, then it might melt all the way down to the crucible.
7. Once the e-beam is well positioned, raise your power gradually by **0.2** (ramp) and **2%** (power) increments. (Wait for 1 minute in between each increment).

### Recommendations:

Gold=>13%-17%	Nickel=>14.5%-16%	Iron=>10%-21%
Silicon=> 5%-10%	Titanium=>14%	

**NOTE:** 100%=6000Watts, 1 kA=100 nm

8. Once you have reached the desired power and **Sensor 2** is reading an acceptable deposition rate, close the **SUB SHTR (RED)** and rotate the substrate (**MOTION** tab) to 0 degrees and click **GO** (substrate now faces down). Open the shutter to begin deposition by clicking **SUB SHTR (GREEN)** (**Sensor 1** will start to read a deposition rate once the shutter is open).

If the deposition rate on **Sensor 1** is not high enough, you can increase the power output of the e-beam during deposition (repeat step 11).

**NOTE:** If you need to deposit a second material close the shutter and decrease the power gradually down to 0% before turning off the e-beam.

Power off the off the e-beam by pressing the **OFF** button and rotate the crucible knob on the materials chamber to center your second material. Then repeat Steps 1 through 9 above.

### Stopping Deposition and Unloading

1. Close the **SUB SHTR (RED)**.
2. In manual mode, decrease emission current by 10 mA per 30s until the current go back to zero. (recommended)  
  
Alternatively, in auto mode, ramp down using **0.2** ramp rate decreasing **2%** at a time until the e-beam power goes back to **0%**. Remember to wait for the values to reset each time. (You may also check the current monitor to go back to 0 Amps).
3. Wait 2 minutes and then turn off e-beam by pressing the **OFF** button in manual mode (recommended) or turn off the **EB (RED)** in auto mode.
4. Turn the heater **OFF** if you had it on.
5. Go to the **MOTION** tab, turn off platen speed if you had it on and rotate the platen position back to 180 degrees.
6. Wait 2 minutes before turning off the breaker to e-beam power supply. This time is enough for the crucibles to cool down.
7. Click **START PC VENT**.
8. Wait for **ATM** indicator in the software to turn **GREEN** before opening the chamber. (To assure the chamber has reached atmospheric pressure).
9. Open the chamber to take out your samples and crucibles.
10. Close the chamber and start **PC PUMP DOWN**. (Wait until **HIVAC** turns **GREEN**, if it fails please contact a staff member).
11. Logout from the tool in your FOM account.