

Standard Operating Procedures

E-Beam Evaporation system

System Main Figure-1

Front View of the System



1. Chamber View Ports
2. Manual Source Shutter Knob
3. Gas Inlet Needle Valve
4. Electron Beam Gun Power Supply
5. High Vacuum Valve
6. Electrical Control Console
7. Air Admittance Valve
8. Turret Indexer Controller
9. Combination Valve

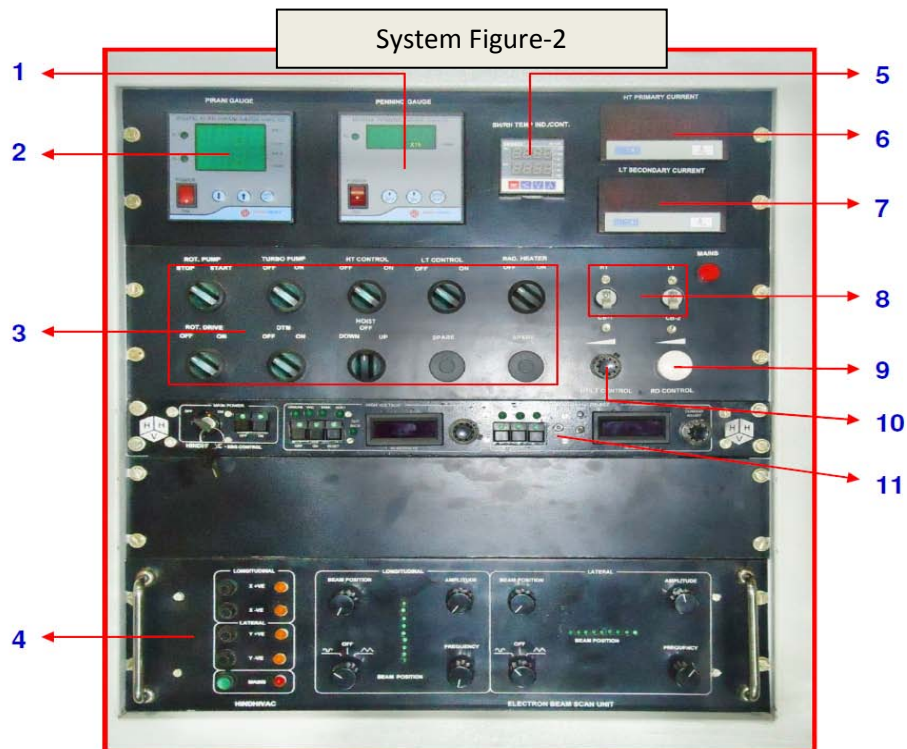
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Pre-checks before starting the tool:

1. Ensure that one facility person is around/in the lab for your process duration.
2. Switch ON chillier (Maintain chillier water temperature at 18-20 °C) and open the inlet valve of water supply to E-Beam evaporator.
3. Switch ON Gas PN₂ (~2mbar) from Facility Area.

Switch on process:

4. Switch on E-beam evaporator system mains.
5. Check Gas inlet valve (see system main figure-1 SN-3) closed or not (If it is open, close the valve).
6. Switch on rotary pump by rotating the rotary switch on the control panel (See system figure-2).



1. Digital Penning Gauge
2. Digital Pirani Gauge
3. Control Switches
4. Electron Beam Scan Unit
5. Temperature Indicator / Controller
6. HT Primary Current Meter
7. LT Secondary Current Meter
8. HT/LT Circuit Breaker
9. Rotary Drive Controller Pot
10. HT/LT Control Pot
11. Electron Beam Gun Power Supply Controller

7. Put combination valve into backing position (see system main figure-1, SN-9).
8. Switch on Pirani gauge (see system figure-2, SN-2).
9. Wait until the Pirani gauge (PR-1) reading is better than 0.05 mbar (<0.05 mbar).
10. Switch on Turbo pump by rotating the Turbo switch on the control panel (see system figure-2). The turbo pump will take few minutes (15 -20 min) to reach operating speed (820 Hz).
11. Once turbo pump reached the operating speed, open chamber air admittance valve (see system main figure-1, SN-7).
12. Select the Hoist-up switch and raise the chamber (while raising chamber, close air admittance valve (see system main figure-1, SN-7 for admittance valve)).

Load the Substrates:

13. Select require crucible by changing the crucible using turret indexer (see system main figure-1, SN-8 for turret indexer) and fill the targets with material required if material in crucible is less.
14. Load your samples on the substrate holder as desired position and sample holding clamp.
15. Clean chamber with IPA
16. Clean O-ring sealing portion with IPA and see no foreign material is left on the base plate where chamber "O" ring sits.
17. Lower the chamber by selecting Hoist Down switch and set it properly so that no misalignment occur at base in Hoist and "O" ring.

Roughing process:

18. Since by this time, Turbo pump is ready. Now close backing valve and open roughing valve slowly using combination valve (see system main figure-1, SN-9).
19. Wait until PR-2 shows vacuum 3×10^{-2} mbar
20. Close Roughing valve and open backing valve again using combination valve.

High Vacuum Step:

21. Slowly open the high vacuum valve so that high vacuum is created in the process chamber.

22. Switch on Penning gauge to read high vacuum in chamber (see system figure-2, SN-1). (Note: Sometimes it shows F.L, in such case switch ON and OFF and again ON the Penning gauge).
23. Wait until penning shows vacuum 3.0×10^{-6} mbar (It takes around 25-30 min).
24. Switch on DTM program (Figure -2, SN-3) (for adjusting settings see APENDIX - A).
 - i. Press “Program” button
 - ii. Using the dial on the film controls, select the film number that corresponds to the deposition material in the table in Appendix A.
 - iii. Press the “next” button. This will load the material parameters into memory. Ensure that the material parameters match those listed in Appendix A.
 - iv. Press the “program” button again to save the selection.

Now For e-beam evaporation process follow from step 25.

HV Power supply operation for e-beam:

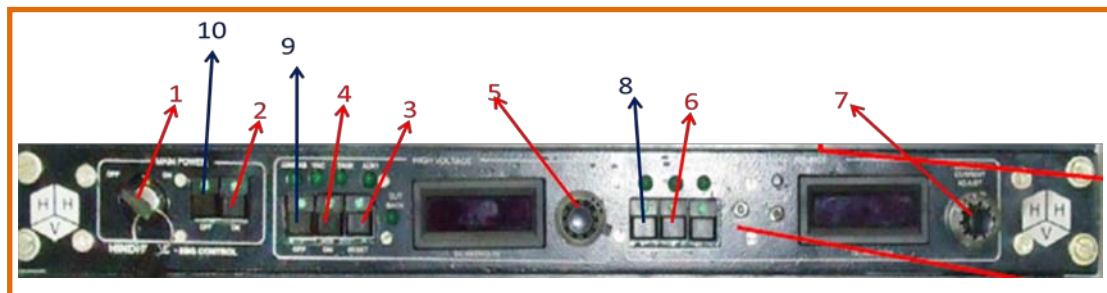


Figure -3: Electron beam gun power supply controller

25. Switch on 3-Phase of power supply (see system main figure-1, SN-4).
26. Turn on controller **KEYLOCK** (Figure 3 & Switch 1).
27. Switch on main power (Figure 3 & Switch 2).
28. Wait for 1 minute.
29. Check voltage adjustment potentiometer & emission current adjustment potentiometer is at zero/minimum position or not (Figure 3 & switches 5, 7). If not then make it minimum (zero) position.
30. Press the controller **RESET** button to reset interlocks (Figure 3 & Switch 3). Wait for 1 minute for the HV/Power Cabinet fans to reach normal speed.

NOTE: Observe the interlock lights. All should be ON.

31. Turn on high voltage by pressing the HV ON PUSH button (Figure 3 & Switch 4).
32. Wait **3-5 mints** for Warm-up before tuning HV ON. [Waiting is compulsory. Negligence may damage the tool. Have patience and be cautious after this step].
33. High voltage will now be applied to the electron beam source and HV level will be indicated by the HIGH VOLTAGE meter.
34. Increase the VOLTAGE ADJUST potentiometer very slowly until the meter reads the operating voltage 7.99KV. (Figure 3 & Switch 5).
35. Turn on Beam position scan unit (see system figure-2, SN-4).
36. Switch on current source in power supply controller (Figure 3 & Switch 6).
37. Adjust emission current part 0.005 A - 0.007A (Figure 3 & Switch 7).
38. Adjust the beam position exactly at centre of crucible by varying longitudinal and lateral beam position variable part.
39. Adjust beam-scanning level by varying amplitude and frequency. Try to keep beam scan level slow so that it remains within crucible area.
40. After making sure that beam is at centre of crucible, then only slowly increase the emission current up to material melting point. Watch if the material is melting inside crucible. Make sure the beam is not hitting outside the crucible.
41. At this point make sure that chamber view ports are closed (see system main figure-1, SN-1).
42. Press zero in DTM thickness monitor for resetting value.
43. Open source shutter to allow the evaporated material to be deposited on substrate.
44. Wait for deposition until desired thickness.
45. Make sure that you have entered all the values in the logbook available with the tool.

Note: While deposition observe CUTBACK LED, if it glowing and voltage reading shows zero, then immediately minimise emission current and voltage by current and voltage adjust potentiometers (Figure 3 & Switches 7 and 5), and then Switch off source & voltage button (Figure 3 & Switches 8 and 9) and then switch OFF the controller **KEYLOCK** (Figure 3 & Switch 1). Again after some time (5 minutes) Restart switches again as discussed from step -26.

Turning off the HV Power supply:

46. Close source shutter
47. Reduce current by EMISSION CURRENT ADJUST potentiometer to minimum (zero) level.
48. Turn off the current source in power supply controller by pressing the SOURCE OFF push button (Figure 3 & Switch 8).
49. Reduce voltage to minimum position i.e. ZERO level (Figure 3 & Switch 5).
50. Turn off high voltage by pressing the HV OFF push button (Figure 3 & Switch 9).
51. Wait **3-5 minutes** for cooling down otherwise the power supply may get damaged.
52. Turn of main power and Key switch (Figure 3 & Switches 10 and 1).
53. Switch off 3-phase power supply (see system main figure-1, SN-4).
54. Switch off beam scanning unit (see system figure-2, SN-4) and DTM sensor (Figure -2, SN-3).

Unload the sample:

55. Wait for 5-10 minutes for cooling the chamber up to 40 °C.
56. Switch off penning gauge (see system figure-2, SN-1) and then Close High vacuum valve by rotating in clockwise direction (see system main figure-1, SN-5).
57. Open air admittance valve (see system main figure-1, SN-7 for admittance valve) and wait until PR-2 reading shows 1×10^3 mbar.
58. Switch on Hoist up switch, and then immediately close air admittance valve.
59. Unload you deposited samples.
60. Load the samples for next deposition, and follow from step 13 – step 59 again. otherwise, follow system shut down process from step-61.

Shutdown process of the evaporation system:

61. After step-60, if your process is completed, then, lower the chamber by selecting Hoist Down switch and set it properly so that no misalignment occur at base in Hoist and “O” ring.
62. Now close backing valve and open roughing valve slowly using combination valve (see system main figure-1, SN-9).
63. Wait until PR-2 shows vacuum 3×10^{-2} mbar.
64. Close Roughing valve and open backing valve again using combination valve.

65. Switch OFF Turbo pump by rotating the Turbo switch on the control panel (see system figure-2).
66. Wait for around 30 minutes for turbo pump to reach speed to reach 200 Hz.
67. Close backing valve.
68. Switch off rotary pump (see system figure-2, SN-3).
69. Switch off main supply for e-beam evaporator located at back side of the system.
70. Switch off chillier and Gas and inform the facility person.

Important NOTE:

1. Don't apply force while pushing switches or any valve.
2. Any accidental damage must be reported immediately.
3. Do not touch any HV sources unless it is properly grounded with safety probe. It may cause injury if HV charge is held.
4. While depositing observe the Crucible, because may chance to tilt or broken.
5. Don't go to anywhere and don't talk phone while Power supply on.
6. Don't look on the e-beam directly because it may damage your eye.
7. While deposition observe CUTBACK LED, if it glowing and voltage reading shows zero, then immediately minimise emission current and voltage by current and voltage adjust potentiometers (Figure 3 & Switches 7 and 5), and then Switch off source & voltage button (Figure 3 & Switches 8 and 9) and then switch OFF the controller **KEYLOCK** (Figure 3 & Switch 1).
8. Restart switches again as discussed from step -26.
9. If you observe moisture around the chamber, clean with lint free cloth. And Chamber should be in vacuum only don't open it.

Emergency Power supply failure in the lab:

1. Whenever you observe that the power is gone in the lab, immediately you should close the Hi vacuum valve (Figure 1, SN -5).
2. Close the backing valve using combination valve (Figure 1, SN – 9).
3. Switch off all the power supplies and switches to its default value.
4. Once power supply comes, start from beginning.

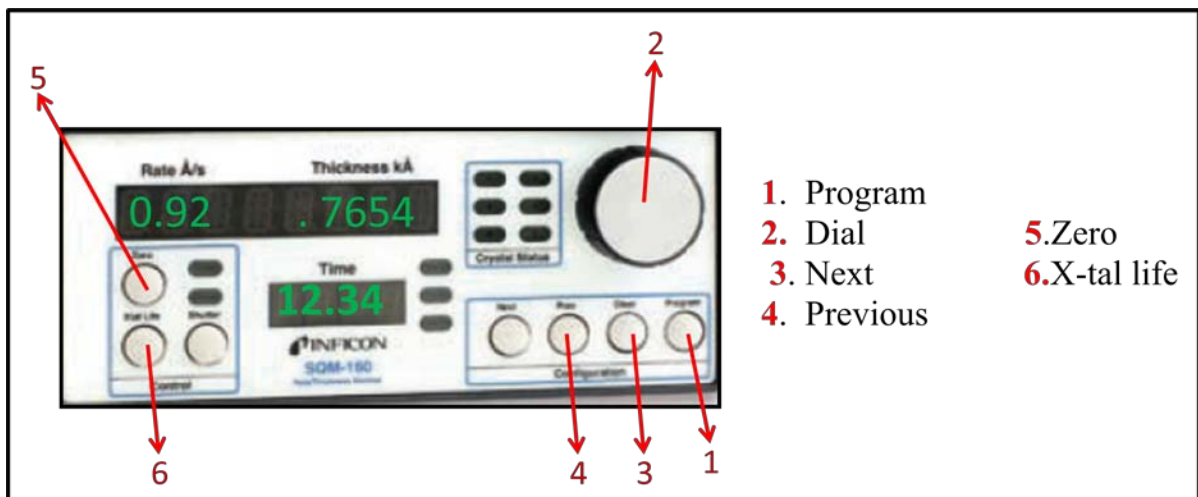
Appendix A: Film selection

This table is used in step 24 to determine which film to select.

Film Number	Deposition Material	Density	Z-ratio	Acoustic impedance
FILM 1	TITANIUM	4.5	0.628	14.06
FILM 2	SILVER	10.5	0.529	16.69
FILM 3	ALUMINUM	2.70	1.08	8.18
FILM 4	PELLADIUM	12.038	0.357	24.73
FILM 5				

Using film 5 to set your own deposition material:

DTM operating process



- 1) Use only film 5 for custom settings. Never change the settings for films 1-4.
- 2) When setting the film number as per step 24 in the operating procedure, turn the dial on the film.
- 3) Controls until “Film 5” is displayed.
- 4) Press the “next” button.
- 5) Rotate the dial to set the density to the appropriate value.
- 6) Use the “next” and “previous” buttons to cycle through **density**, **tooling factor**, **z-ratio**, and desired Final thickness. If you make a mistake, press the “clear” button.
- 7) Press the “program” button when done to save your settings. Proceed to step 25 of the operating procedure.