

BOC Edwards Auto 306 E-beam Evaporator

Operating Instructions

This machine is to be used by authorized personnel only. For training & consultation contact:

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1. Contact a Staff Member immediately if you observe anything unusual such as the controller and the thickness monitor being off, chamber not under vacuum, or strange and unusual noises from the vacuum pump compartment below.
DO NOT ATTEMPT TO OPERATE THE EVAPORATOR if you have any doubts!
2. Place the "Ebeam Reserved" sign on the evaporator.
3. ENABLE Ebeam using iLabs

Loading Substrates & Pumpdown

4. Press the **VENT** button to vent the chamber to atmosphere. Wait until the pressure display reads (>5.0 +2 TR)
5. Gently attempt to open the chamber door. If the door resists opening, wait an additional time. **NOTE: DO NOT FORCE THE DOOR OPEN UNDER ANY CIRCUMSTANCES**
6. Once the door is open, press **SEAL** button to terminate the chamber vent.
7. Locate the acrylic crucible holders. Refer to [Figure 1](#). Remove the desired crucible from the holder.
8. If needed, add the desired authorized material to be evaporated into the correct crucible liner (See [Table 1](#)).
 - Do not over fill the crucible liner.
 - Too much material in the crucible may cause a thermal short, contaminate the material in the adjacent pockets or not allow rotation of the hearth.
 - Contact Lab Manager to obtain permission to evaporate any materials that are not listed. No un-authorized evaporations are allowed!
9. Clean the hearth pockets with an IPA-soaked cleanroom wipe to remove the accumulated dust and particles.
 - Locate and use cleanroom vacuum if necessary.
 - Ask for assistance as needed to prevent damage to components.

10. Place crucible inside the hearth pocket.
 - If more than one film is to be deposited, rotate hearth **CLOCKWISE ONLY** using external knob to access other hearth locations.
 - Arrange the liners in the 4-pocket hearth according to the desired evaporation sequence.
11. Attach substrates onto the appropriate substrate holder.
 - There are separate work plates for different size wafers.
 - There is also an extension piece for evaporation at lower working distance/power levels.
 - Cover the substrate holders with aluminum foil prior to mounting the samples.
12. Ensure Quartz Crystal Monitor USAGE is < 500.
 - If not, please contact staff for crystal replacement, or the thickness monitor could stop indicating the deposited thickness during the deposition run.
 - The Crystal has expired when the Xtal 1 LED on the thickness monitor panel is flashing and no other values are displayed.
13. Close and latch the chamber door then press **CYCLE**.
 - This will start the chamber pumpdown process.

NOTE: Liquid N₂ may be used to accelerate pumpdown to base pressure when the chamber has reached the 10⁻⁵ Torr region. Pour Liquid N₂ into the metallic funnel located on the outside and on the left side of the evaporator chamber (Refer to [Figure 2](#)). Use only one Dewar container of liquid N₂.

Evaporation

14. For best vacuum, load samples late in the evening of the day before your scheduled deposition and allow overnight pumpdown of the chamber to achieve a pressure in the 10⁻⁶ Torr range.
15. When the chamber pressure reaches the mid 10⁻⁶ Torr (5.0 -6 TR) range you can press the **SEAL** key followed by the **PROCESS** key on the Auto 306 Controller panel.
 - The vacuum interlock LED on the EB3 source panel should light up.
16. On the FTM7 Film Thickness Monitor, select the appropriate layer for the metal you wish to deposit (see [Table 1](#)).
 - Set the desired thickness by repeatedly pressing the **DATA** button until the TERMINATE light is illuminated.
 - Press the green **UP** or **DOWN** arrow keys to set the desired thickness
17. Continue pressing the **DATA** button on the FTM7 to verify the density and z-value settings for the source materials of interest using [Table 1](#).

- Values can be adjusted higher or lower pressing the **UP** or **DOWN** arrow keys.
18. Turn on the **Sweep Control**
 19. On the EB3 Source Control panel, ensure that the **CURRENT** knob is set to the minimum counter clock-wise position.
 - Press in the **ON/OFF** button.
 - Press in the **GUN** button
 - Make sure the high voltage and ebeam current displays turn on.
 - After 15 seconds the high voltage display should read a value of about 5.00 kV.
 20. Verify that the **REMOTE** and the **SS1** buttons are both pressed in on the shutter control panel.
 21. Make sure that substrate holder is turning by pressing **START** button on the ROTARY WORKHOLDER panel.
 22. On the EB3 Source Control panel, increase the current slowly by rotating the **CURRENT** knob clockwise to 10-15mA if practical based on Table 2 data.
 - Let the metal and crucible stay (soak) at this setting for a few minutes or more.
 - The material inside the liner should start glowing.
 - Typically, the chamber pressure will initially rise due to outgassing from the liner and its contents but then the pressure will drop back to a baseline.
 23. Use the X-Axis and Y-Axis control knobs on the sweep control box to ensure the beam is centered inside the liner.
 - X-Axis is forward and backwards from the operator and the Y-axis runs to left and right of the operator.
 - You can sweep or oscillate the beam inside the liner for a more uniform melt, especially for materials that sublime.
 24. As necessary and with lots of care, slowly and slightly rotate the hearth to make sure the crucible is lined up with the beam and the opening of top shield on the hearth.

NOTE: Materials such as Bismuth (Bi), Tellurium (Te), Quartz (SiO₂) start evaporating below 10mA.

25. Increase the current in increments of 4-5mA and soak periods of 4-5 minutes until a desired deposition rate appears on the FTM7 monitor. Use Table 2 as a guide.
26. Press the **RUN** button on the FTM7 panel to open the shutter.
 - This begins the measurement of the deposited film thickness.
 - Make sure that the green LED under SS1 on the SHUTTER CONTROL panel is lit.

- Shutter will close when desired thickness is reached.
- Operator MUST REMAIN in the cleanroom until the deposition is complete or risk evaporating all the source material and damaging hearth and crucible.

NOTE: Although the shutter will close automatically at the set point, the evaporation will not stop until the operator lowers and turns off the current.

27. Slowly reduce the current by turning the **CURRENT** knob counter- clockwise around 5-10mA per minute, back to zero.
28. Ensure the **CURRENT** knob is at the minimum setting.
29. Allow the crucible to cool until it is no longer giving off a glow as you look through the viewport.
30. Using the turn knob clockwise, change to a different liner position clockwise and repeat the above process steps starting at step 16.
31. If you are done with evaporation, then first depress the **GUN** and then the **HIGH VOLTAGE ON/OFF** buttons, in that order, to turn power supply OFF.
29. Turn off **Sweep Control**.
30. On the Main Controller panel press the **SEAL** button to isolate the high vacuum pump.
31. Press the **VENT** button to bring the chamber to atmosphere. Wait until the pressure display reads (>5.0 +2 TR). Gently attempt to open the door. If the door resists opening, give the chamber a few minutes to vent and the door will not offer resistance. Never force the chamber door open
32. Press **SEAL** to stop the vent N2 once the chamber door opens.
33. Depress **START** button on ROTARY WORKHOLDER panel to stop sample holder rotation.
34. Remove sample holder.
35. Remove the crucible liners and place them back in the acrylic liner holder seen in [Figure 1](#).
36. Use a vacuum cleaner to remove any metal flakes and debris from the bottom of the chamber.
 - Very carefully and taking care not to damage any chamber components vacuum.
37. Remove the four coated glass slides protecting the viewport and replace with clean ones.
38. Close the evaporator door and press the **CYCLE** button to pump down the system for the next user.

Table 1 – Allowable/Authorized Evaporation Material & Relevant Properties

Metal	Liner Material	Layer	Density (g.cm⁻³)	z-value	Tooling
Aluminum (Al)	(Contact Staff)	1	2.70	8.17	
Titanium (Ti)	Intermetallic	2	4.50	14.05	
Copper (Cu)	Graphite	3	8.93	20.20	
Chromium (Cr)	Graphite	4	7.20	28.94	
Gold (Au)	Graphite	5	19.3	23.17	0.3
Platinum (Pt)	Graphite	6	21.4	36.06	
Bismuth (Bi) **	Graphite	7	9.80	8.1	
Nickel (Ni)	Intermetallic	8	8.91	26.66	
Tellurium (Te) **	Intermetallic	9	6.25	9.3	
Silver (Ag)	Graphite	10	10.5	16.68	
Germanium (Ge)	Graphite	(11)	5.35	17.1	
Quartz (SiO ₂)	Graphite	(11)	2.2	8.3	
Al-Zn-O	Graphite	(11)	5.58	15.99	
Palladium		(11)			

** Both Bismuth & Tellurium require extensive preparation. Only MNFC staff are allowed to evaporate these metals. Handling of Tellurium requires respiratory protection equipment. You must contact the Staff Engineer to deposit any material not listed.

Table 2 – Typical Evaporation Behavior in the MNFC Auto 306 E-beam Evaporation System.

Deposition rates vary depending on volume of material, beam conditions, etc.

Metal	Current (mA)	Source-to-Substrate Distance (cm)	Deposition Rate nm/sec
Bismuth (Bi)	9	28.6	0.2
Chromium (Cr)	30	28.6	0.08
Copper (Cu)	50	28.6	0.4
Germanium (Ge)	53	28.6	0.07
Gold (Au)	55	13.3 (extension)	0.07
Gold (Au)	75	28.6	0.1
Nickel (Ni)	30	28.6	0.03
Nickel (Ni)	42	13.3 (extension)	0.09
Platinum (Pt)	290	28.6	0.05
Platinum (Pt)	165	13.3 (extension)	0.04
Silver (Ag)	85	13.3 (extension)	0.04
Tellurium (Te)	2	28.6	0.2
Titanium (Ti)	30	28.6	0.04
Quartz (SiO ₂)	<10mA	13.3	0.1
Palladium		28.6	

Figure 1 – Acrylic Crucible Liner Holder for Common Metals

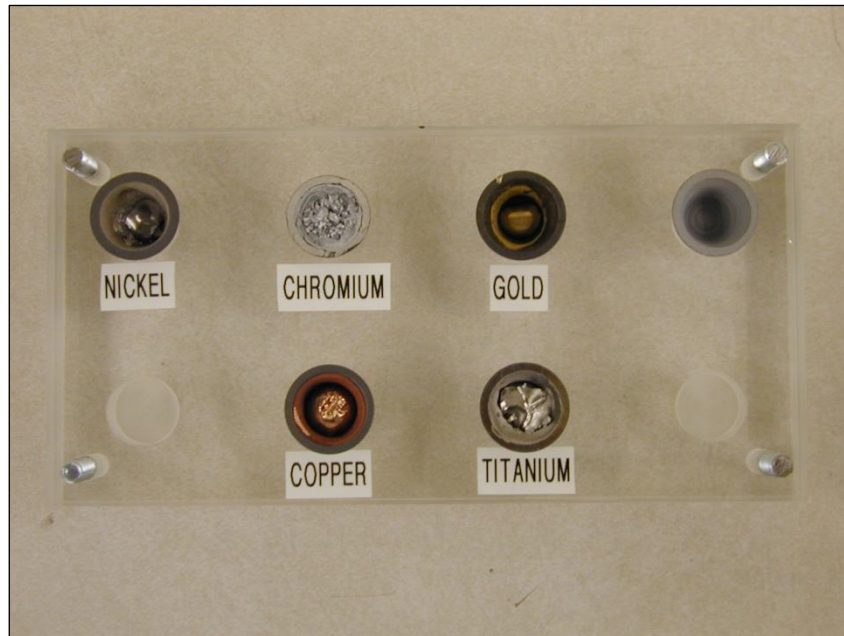
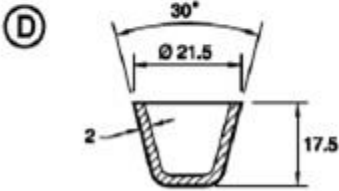
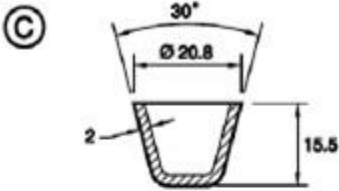


Figure 2 – Liquid Nitrogen fill funnel on the side of the chamber



2cc Crucible Liner Dimensions



- C Graphite/molybdenum hearth liner for four hearth crucible
- D Intermetallic hearth liner for four hearth crucible

Reference Position for the Quartz Crystal Monitor (Adjustment by STAFF ONLY)

Z =(vertical distance from detector head to z-plane of the hearth) = 4"

r = (horizontal distance from the center of pocket z-axis of the detector head) = 4"

Process Consumables

- Liners (Graphite, Intermetallic): 2cc, Super Conductor Materials Inc.
- Copper: Kurt J. Lesker, Pellets 1/8"x1/8", 99.99%, EVMCU40EXEB or CERAC Inc., 3mmx3mm pellets, 99.99%, C-2073
- Gold: Kurt J. Lesker, <4mm pieces, 99.99% EVMAU40SHOT
- Bismuth: Kurt J. Lesker, 2-4mm pieces, 99.999%, EVMBI2-4MMB
- Chromium: Kurt J. Lesker, 0.8-6.0mm, 99.95%, EVMCR35D
- Titanium: CERAC Inc., 3mmx3mm pellets, 99.8%, T-2069
- Germanium: Alfa Aesar, 2mm & down, 99.999%, stock#43986