



Center for Functional Nanomaterials
Brookhaven National Laboratory

Lesker e-beam evaporator standard operating procedure (SOP)

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PAGE
1 OF 6

This SOP does not replace the detailed training sessions you should receive before being allowed to use the machine independently

Lesker e-beam evaporator standard operating procedure (SOP)

1) Ground rules (very important!)

- Keep evaporator workbench and tools clean and in order. If do not find things right, tell a staff member.
- You can only evaporate by yourself those materials that have been previously evaporated in the presence of a staff member. If you want to try a new material, first make an appointment with a staff member to perform that first run with him.
- When running alone, you should use similar current and film thickness values as those used during the first run with a staff member. If you need to change parameters by more than 25%, contact a staff member before reserving tool time.
- Your evaporation run should follow closely a previous run for the same material and similar run parameters. You should know the expected run parameters. It is your responsibility to record and use these parameters. If during a run anything is significantly off these values (e.g, by more than 25%), stop work immediately and find a staff member to assist you. When in doubt, ask!
- After each deposition, it is mandatory to fill all fields of the Excel log file.
- This SOP involves MANUAL mode deposition. DO NOT use AUTOMATIC mode deposition.
- Only Users authorized by a staff member can change or refill crucibles.
- It is very important that you can see into the chamber during your process: make sure the mylar window liner is transparent enough. If you have any doubt about it, replace with a new one!
- Staff members that will assist you are Don Elliott (x6072), Aaron Stein (x3527), or Fernando Camino (x7606).
- Failure to follow these rules and this SOP will result in prohibition from using the evaporator.

2) Loading sample

- If you ever need to start the software, the user name and password are both “user”.
- You should find the machine under vacuum. Hit “Start PC Vent” to vent the machine (“PC” stands for “process chamber”). It will take ~10+ minutes to vent.
- To remove the sample platen, first open the sample shutter. You can do this on the “deposition” tab on the software display. Then, rotate the sample platen into the unload position by hitting "home stage" (60 degrees position) in the "platen motion" tab. To remove the platen, first lift it about 1/2" (so it is above centering pins) and then slide the platen out towards your left.
- Samples can be mounted anywhere on the holder with clips. Feel free to move the clips as necessary. An Allen key that works with these screws is in a box on the evaporator table. Return the wrench to its box when you are finished.
- Only if you are authorized, change or refill the materials you want to evaporate. Otherwise, have a staff member (Aaron, Don, or Fernando) do it for you. There is a material list posted on the evaporator, which shows the current materials in each crucible position. Make sure there is enough quantity of material (more than half of the crucible filled). Again, feel free to consult with a staff member. Crucible position is selected on the “deposition” tab of the software.
- If a new mylar window liner is needed, change it. They are located in a plastic pocket on the workbench. You have to see inside the chamber when evaporating. Old mylar sheets are stored in the respective plastic pocket on the workbench
- Check the sample shutter for correct operation. Leave it closed.
- Inspect sealing surface and chamber door O-ring for pieces or lint, thread, etc. Call a staff member if you see any problem. Sealing surface should only be cleaned by staff members. A scratch in the metal surface is very damaging to the system.
- Inspect thickness monitor for cleanliness. If too many flakes are around crystal, please inform a staff member. Crystal replacement dates are posted on the evaporator. A crystal is changed when its life is ~ below 80%.
- Once you have loaded your sample and your deposition materials are present, close the door and hit “Start PC Pump”. The entire pumping process is automated. If after ~15 min the chamber is not in the 10^{-4} Torr range or better, there might be a problem. Please inform a staff member. It will take less than an hour to get into the mid 10^{-6} Torr range and will get into the 10^{-7} Torr range after a couple of hours. Overnight pumpdowns should be well into the low 10^{-7} range.

3) Evaporating

- Once adequate vacuum is achieved (low 10^{-6} Torr or better), it is time to evaporate.
- Using a flashlight to see through window, verify that the sample shutter is closed.
- Select desired crucible from the "deposition" tab in the software. Visually confirm that crucible is in place. At this point, the "Active" light above the corresponding source position in the software should be green.
- Launch the thickness monitor program. Click "START" on the desktop screen, and open "SQM242 Monitor" program. Input the density and Z-factor for your material, see materials parameter list on evaporator workbench. **IMPORTANT:** after loading a different material file, or updating existing parameters, you need to do the following for the program to recognize the new parameters: 1) Hit View, then hit Select, and then hit OK. Now you should see the right parameters on the program. 2) Push STOP, and then PUSH START.
- Verify that the crystal life percentage is above 80%; otherwise, ask a staff member to have the crystal replaced.
- Open the evaporator door (the one on which the screen is placed) to have access to e-beam controls. **ONLY TOUCH THE CONTROLS DESCRIBED IN THIS OPERATING PROCEDURE!**
- Make sure the MANUAL/AUTOMATIC switch in the bottom box (power supply) is in the MANUAL (upward) position. If not, flip this switch upward.
- Turn on power supply. First, rotate "e-beam disconnect" circular switch into "ON" position. Then flip upward the main power supply switch. Wait 2-3 minutes for the power supply to warm up.
- Verify that the interlock lights (ZERO, WATER, DOORS, VAC, READY) on the upper left side of the "sweep and control" box (second from the top) are all green. If not, please call a staff member.
- Check that "emission current" potentiometer is zero (turned all the way counterclockwise). If not, set it to zero.
- Turn on high voltage by depressing the controller's ON push-button.
- You should read about 7.8 kV and zero current on the voltage/current display. If voltage reading is different by $> 10\%$ or if current reading is not zero, turn off high voltage, and call a staff member.

- Make sure that the "sweep control" has sweep set to "spiral" (switch located below joystick), that the sweep potentiometers are all in the vicinity of 1.0, and that the center sweep switch is set to "control".
- **REMEMBER: At any stage of the evaporation, the chamber pressure should not go above mid 10^{-5} Torr range.**
- Slowly increase the emission current to ~ 0.005 A, wait ~ 1 min while checking chamber pressure. If pressure keeps rising, wait until it starts to drop again. Check deposition rate in thickness monitor. Repeatedly verify that the beam is always inside the crucible, if not, bring down emission current to zero, turn off the high voltage, and call a staff member. **CAUTION: WHEN VIEWING A BRIGHT SOURCE, USE TINTED WINDOW FROM WELDING GOGGLES (on workbench) TO AVOID DAMAGING YOUR SIGHT.**
- Keep increasing emission current in ~ 0.005 A increments as described in the previous step. Once you detect a deposition rate (material starts evaporating), pressure will generally increase as the rate increases, unless you deposit a "getter" material (e.g., Ti or Cr), in which case the pressure will actually drop.
- Slowly increase emission current at the rate of ~ 0.005 A/min until you reach the desired deposition rate. Usually, we use rates between 0.1-0.2 nm/s. At most use 0.3 nm/s. Normal deposition rate vs. current values are posted on the evaporator. Your material should be there. In addition, you know the expected values for this run. If the current is larger by $> 25\%$ of the expected value, DO NOT PROCEED. Bring down the emission current, turn off the high voltage, and call a staff member.
- Once you have reached the desired rate, let it stabilize, and start the actual deposition on your sample. For this purpose, open the sample shutter and "zero" the thickness monitor.
- Once the desired film thickness has been deposited, close the source shutter, bring down the emission current, and turn off the high voltage.
- If depositing several layers, wait for source to cool down (2-4 min), select another source, and evaporate as explained above. Don't forget to load the right material file into "SQM242 Monitor" program and to update it as explained above.

4) Unloading sample

- When you are done with all your films. Check that high voltage is off and that emission current potentiometer is at zero. Wait about 2-3 min for the system to cool down. Turn off main power (bottom box) and rotate "e-beam disconnect" circular switch into "OFF" position.
- To vent the system, simply hit "PC Vent" in the software. This will vent the chamber and make sure the system is in a proper state. There is nothing more to do but to wait ~15 min.
- After venting, remove the platen and your sample. Put the platen back into the chamber when you are done and pump the chamber back down.
- Be sure to fill all fields in the Excel log file.
- Make sure you are leaving the workbench clean and all tools clean and in order.