

GENERAL PROCESS AND OPERATION SPECIFICATION

Lesker PVD 75 E-beam Evaporator

I. SCOPE

- a. The purpose of this document is to describe requirements and basic operating instructions for the Lesker PVD 75 Electron-Beam Evaporator. This tool is intended for thin film deposition by e-beam evaporation. Use of this tool is limited to only thin films and substrates that are approved.

II. SAFETY

- a. Be sure that you are trained and signed off to use this equipment.
- b. Be sure to keep all doors and protective shields in place before operating this equipment.
- c. Use care when operating around high voltage or high current.
- d. After power has been disconnected, wait for at least 3 minutes before starting work on the power supply to allow the capacitors to discharge themselves. Use the grounding rod to discharge the capacitors and high voltage feed thru before coming in contact with them. Touch the grounding rod to contacts around the e-gun before performing any work to change crucibles or clean the e-gun surfaces.
- e. Use the provided goggles to view inside the chamber during deposition.
- f. If you are unsure about any procedure or indication while operating this equipment be sure to contact a staff member or trainer for assistance.

III. APPLICABLE DOCUMENTS, MATERIALS AND REQUIREMENTS

- a. For more information about the detailed operation of this tool refer to the Lesker factory manual – “PVD 75 Thin Film Deposition System Operation Manual.” File name: PVD 75 Manual.pdf.
- b. Appendix A: Table of Recipes, Gun Positions, and Materials
- c. Appendix B: Changing the Crystal Monitor
- d. Appendix C: How to manage changing the thermal conductivity of the system
- e. This tool is intended to be used with a restricted selection of substrate and evaporation materials.
- f. Approved evaporation materials. Materials provided by AggieFab as part of normal lab fees are: Al, Cr, Cu, Ti, Ni. For a complete list of other approved materials refer to Appendix A in this document.
- g. Approved substrate materials: Glass, Si, PVDF (with no substrate heating).
- h. Other substrate and evaporation materials must be pre-approved by the Materials Review Board before running in this tool.

IV. OPERATION

- a. Log in by clicking the button on the top right of screen.
- b. Click “PC Vent” on the right of screen.
 - i. Ensure the HV power supply switch is turned off by opening the right door and turning OFF the green switch near the floor.
 - ii. Click “Yes” when this is done.

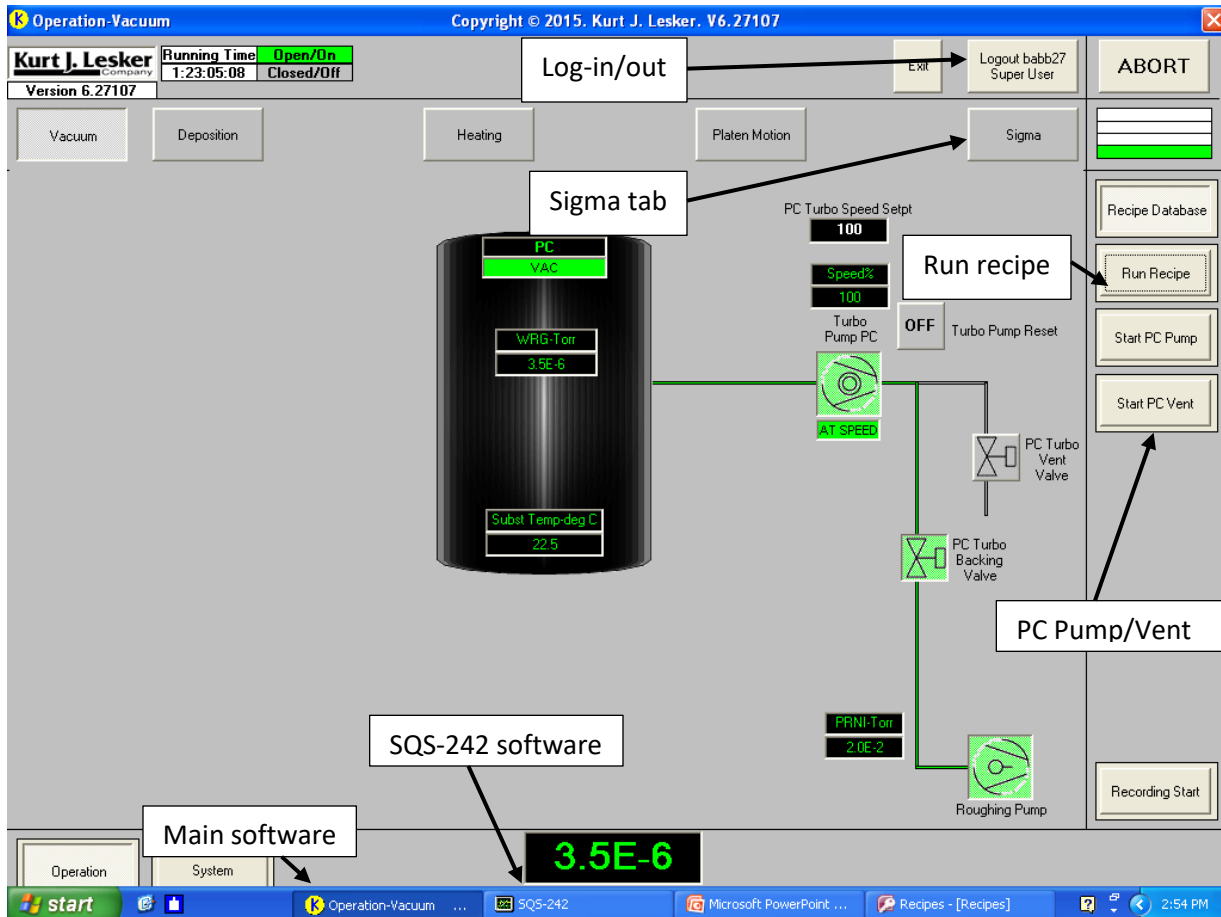


Fig. 1: Main software (CWare) homescreen with major functions labeled

- c. Before opening the process chamber (PC) door, hold the grounding wand (left side of tool) in your hand to ensure you remember to use it.
- d. Open the door and discharge five places:
 - i. Two wires underneath the main platform.
 - ii. Three plates of the main platform.
 - iii. Other places as wanted (side shields, door shield, etc).
- e. Remove the substrate holder and mount your sample:
 - i. Kapton tape or clips can be used to adhere the sample to the holder.
 - ii. After adhering the sample, turn the holder upside-down with your hand underneath and shake it gently to ensure the samples will remain there.
- f. Place the substrate holder back.
- g. Prepare target crucible:
 - i. Open the right side door to get to the EB gun controller.

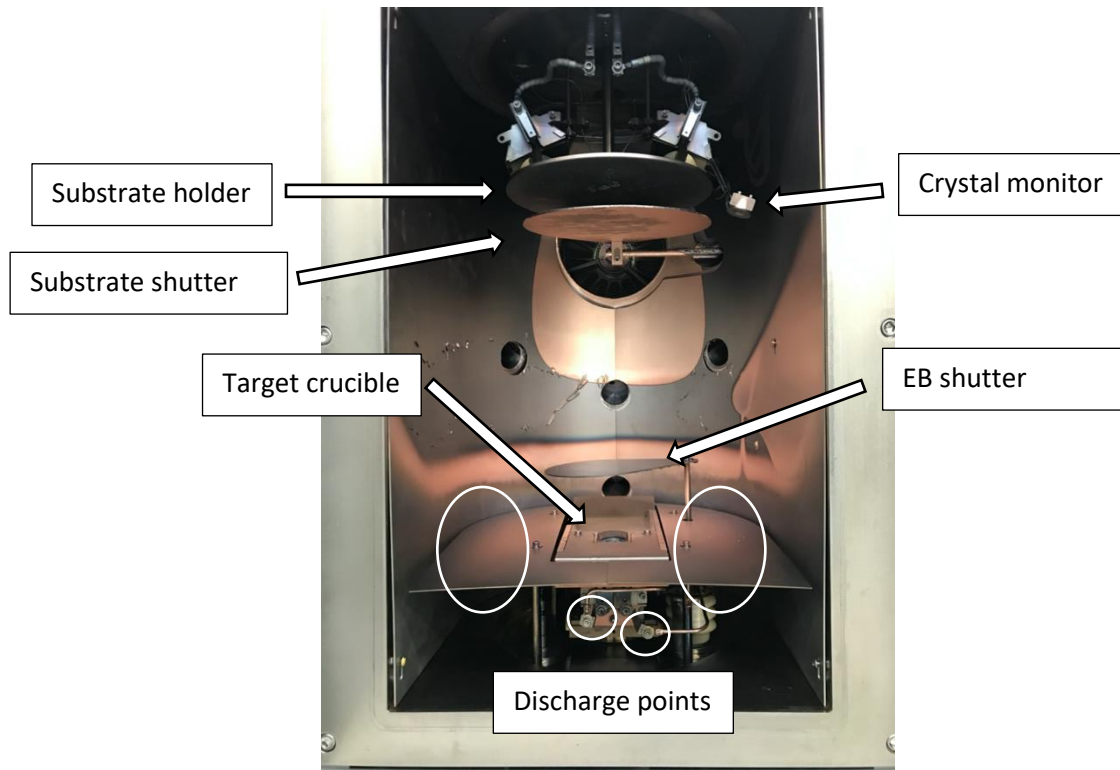


Fig. 2: Process chamber with major functions labeled

- ii. Use the left joystick to go to “Auto/Manual”, then use the right joystick to change to “Manual Operation”.
- iii. Use the left joystick to go to “Set Pocket”, then use the right joystick to go to the pocket(s) the materials will be depositing from.
- iv. Hold the right joystick to the right while the correct pocket is highlighted. The material name will now say “-Search-“ and the crucible indexer will be moving. Hold until “-Search-“ is no longer there.



Fig. 2: EB gun controller screen. Left joystick controls “Set Pocket” and “Auto/Manual” (left side) and right joystick controls the Pocket/Material/Data (right side).

- v. Remove the current crucible using tweezers, then wet a cotton swab with IPA and swab the copper part of the pocket. Vacuum the pocket as needed.
- vi. Check crucible for cracks and add target material (if needed). **The maximum crucible fill rate is 75%.**

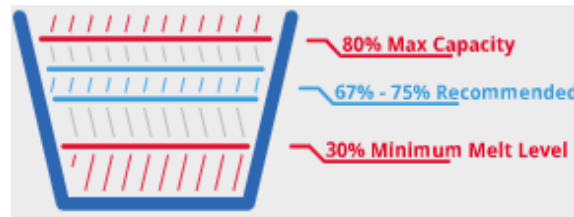


Fig. 3: Fill rate levels

- vii. Place the desired crucible back in. This can be a new material or the crucible that was just removed.
- viii. Repeat as needed for other pockets.
- ix. Go back to Pocket 1.
- x. Use the left joystick to go to “Auto/Manual”, then use the right joystick to change to “Automatic Operation”.
- h. Check crystal monitor life:
 - i. Select the “Sigma” tab near the top of the screen, then look for “Xtal Qual %”. If this is under 70%, change the crystal monitor.
- i. Check the window film:
 - i. Open the window shutter and check if the film is transparent. If it is not, replace with a transparent one.
- j. Select “Yes” to the “Are you finished loading” recipe step.
- k. Click “PC Pump” on the right side of screen.
 - i. Push on the PC door to ensure it seals properly.
- l. Set up material parameters:
 - i. Click on the “SQS-242” application on the bottom of screen.
 - ii. Click “Edit” on top left, then “Process”.
 - iii. Use the dropdown menu to select which material you will be depositing.
 - 1. Note: Chromel is Cr-Ni alloy, not Cr. Alumel is Al-Ni alloy, not Al.
 - iv. On the “Layer” tab, set the deposition rate and total thickness by entering a number in the “SetPt” and “Final Thick” boxes, respectively.
 - v. On the “Deposit” tab, change the shutter “Accuracy” and “Hold” times as wanted:
 - 1. “Accuracy” is the range of values the deposition rate can be within to be considered stable. Ex: If the dep. rate setpoint is 1.0 A/s and the shutter accuracy is 20%, the dep. rate can be between 0.8-1.2 A/s to be considered stable. 15-30% is recommended.
 - 2. “Hold” is the time the dep. rate needs to be within the accuracy range to move on to the actual deposition step. 5-10 sec is recommended.
 - 3. Either decreasing accuracy, increasing the hold time, or both will improve dep. rate stability.
 - vi. After all parameters have been set, click the red X at the top. Select “Yes” if it asks you if you want to set “[MATERIAL] Process” as operating process.

- m. Go back to the CWare software and wait for the “PC Pump” recipe to complete, i.e. the chamber pressure reaches 5.00E-6 Torr.
- n. When “PC Pump” completes, open the right door and turn on the green HV power supply switch near the floor.
- o. Click “Run Recipe” on the right of screen.
- p. Choose the recipe you would like to run and click the green area: P[x] [material] [rotation option].
 - i. P[x] indicates the pocket the material will be deposited from.
 - ii. [Material] is the material that will be deposited.
 - iii. If “no rotation” is included in the recipe name, the substrate will not rotate. Else, the substrate will rotate at 20 rpm.
- q. Click “Yes” to both questions asking if the HV power supply switch is on and if SQS-242 is launched.
- r. Open SQS-242 and watch the following phases. Fill out the logbook while this is occurring.
 - i. Power ramping. The material will go through four phases of power ramping as specified in the “Condition” tab of “Edit Process”:
 - 1. Ramp 1: Power increases to [Ramp 1 Pwr]% in [Ramp 1 Time] sec.
 - 2. Soak 1: Power remains constant at [Ramp 1 Pwr]% for [Soak 1 Time] sec.
 - 3. Ramp 2: Power increases to [Ramp 2 Pwr]% from [Ramp 1 Pwr]% in [Ramp 2 time] sec.
 - 4. Soak 2: Power remains constant at [Ramp 2 Pwr] for [Soak 2 Time] sec.
 - ii. Deposition rate stabilization. The bottom shutter (E-beam shutter) opens to allow the crystal monitor to measure deposition rates. If the deposition rate is too low, the software will automatically increase power to increase deposition rate. Once the deposition rate is considered stable (based on the “Accuracy” and “Hold” parameters in the “Deposit” tab), it will begin deposition onto the substrate.
 - iii. Deposition. Both shutters (EB and substrate) are now open and there is a clear path between the target material and substrate.
 - 1. In the logbook’s column “Power %”, note down the power the material is depositing at.
 - iv. Post-deposition power ramping (turning off). The power will slowly decrease back to 0.0% and hold there to ensure proper cooling.
- s. When the “P[x] [material]” recipe is complete, there are two options:
 - i. To vent the chamber and retrieve your substrate, click “PC Vent” and continue to the next step.
 - ii. To deposit another material, edit that material’s process (as detailed above) and run the respective “P[x] [material]” recipe.
- t. Turn off the HV power supply switch and click “Yes” to the question asking if it is turned off.
- u. The PC vent process will take about 20 min to complete.
- v. Hold the grounding wand in your hand and open the door to discharge the five places as before.
- w. Remove substrate holder and sample(s).
- x. Remove personal crucible if needed. Go back to Pocket 1 when finished.
- y. Place empty substrate holder back.

- z. Click “Yes” to the load/unload question.
- aa. Click “Run Recipe”, then choose “Post Process Roughing”.
- bb. Log out of the tool by clicking username in the top right of screen, then “Log out”.

V. SIGNATURES AND REVISION HISTORY

- a. Original author of this document: Larry Rehn
- b. Original author Title or Role: AggieFab technical manager
- c. Date of original: 11 September 2015
- d. Revision B notes: Complete rewrite. Changed verbiage to be more succinct. Updated words/steps to reflect GERB protocols. Deleted unnecessary information.
- e. Revision C notes: Added Appendix C

Approvals:

Technical Manager Signature: _____

Date: _____

Revision History:

Revision	Author	Date
Original Issue	L. Rehn	
Rev A	L. Rehn	11 September 2015
Rev B	Ethan Morse	20 January 2019
Rev C	Sandra Malhotra	17 March 2021

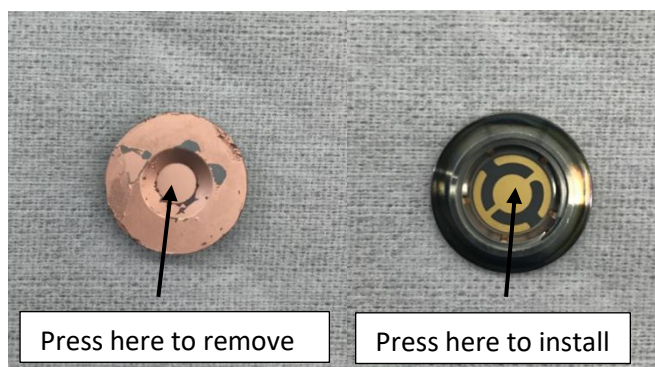
Appendix A: Recipes, Gun Positions, and Materials

Material	Gun Pocket	Gun Profile	Ramp 1 Power/Soak/Time	Ramp 2 Power/Soak/Time
Ag	3	ALP310KV	6/30/60	12/60/180
Al (existing crucible/melt)	3	ALP310KV	10/60/60	15-20/60/60
Al (new crucible)	3	ALP310KV	5/60/60	10/60/60
Au	4	P4_M10KV	10/60/90	15/60/90
Cr	1	P1_M10KV	1/30/30	1.5/45/45
Cu	2	META10KV	5/90/90	12/90/90
Fe	4	META10KV	2/30/30	4/60/180
Ge	3	META10KV	5/150/150	10/120/120
Mo	4	META10KV	8/30/30	12/30/30
Ni	2	META10KV	5/60/60	10/60/60
Pt	4	META10KV	15/30/90	25/60/90
Si	4	META10KV	2/60/30	4/60/30
SiO2	4	SIO2_6KV	3/30/60	4/30/60
Ta	4	META10KV	20/60/30	25/60/90
Ti	2	META10KV	5/30/30	8/30/60
TiO2	4	OXIDE6KV	9/30/60	13/30/60

Appendix B: Changing the Crystal Monitor

The EBE uses a 6 MHz crystal monitor (CM) to measure deposition rate and total thickness. As material builds, the monitor's frequency decreases, causing the accuracy to be worse. Monitors with less than 70% life remaining should be replaced with a new monitor.

1. Check the CM life by going to the "Sigma" tab, then looking for "Xtal Qual %". If this is less than 70%, change the CM.
2. Open the chamber door and locate the CM housing near the top of the chamber (right side on EBE1, back side of EBE2).
3. Pull out the circular piece (housing) that holds the CM.
4. Pop the CM out by pressing your thumb on the small circle (the side that was facing down before you pulled it off).
5. Dispose of the old CM in the trash.
6. Place a new CM into the housing and gently seat it using your thumb. The patterned side should be facing up and the all-gold side facing down.
 - a. New CM are located in drawer near EBE1. They are in a circular case with the brand name Inficon.
7. Place the housing back into the frame.
8. Check the CM life to verify it is new (>95%).



Appendix C: When changing the thermal conductivity of the system

When you change the thermal conductivity of the system (material, crucible liner, hearth pocket) you must redefine the Ramp2/Soak2 power setpoint. Thermal conductivity of this system determines at what power you get a given rate. When you place a spacer under the crucible, for example, you intentionally limit the thermal conductivity (by adding another thermal interface). As a result, you cannot use the same recipe with the same ramp/soak levels because now it will take less power to make rate. Any time you make changes like adding or removing a spacer you must redefine the ramp/soak power levels.

This is done by running the material up in power until you get the desired rate (1 A/sec) and noting that power. That power then becomes the new Ramp2/Soak2 power level. This way when you are going from the manual power ramp/soaks into the Shutter Delay phase where the PID loop kicks in to control rate using the quartz crystal monitor you will not overshoot or undershoot the rate by too much and you will not waste material.

Any time there is a change to the thermal conductivity of the e-gun pocket system (like adding a spacer or removing a spacer or changing the high voltage) the Ramp2/Soak2 power needs to be manually determined and fed back into the recipe.