Standard Operating Procedure (SOP)
Lesker PVD75 E-beam Evaporator
(PVD-04)

In case of fire or injury please call 911 (511 from campus phones)

If there is an error on the system/tool please report it in IRIS, the staff will take care of it
Please DO NOT run diagnosis without a staff member’s approval

Common Errors and What To Do If You See Them:

1) “Rate below setpoint” error and recipe aborts: Do not try running the recipe again. Unload your sample to the loadlock, and report the issue in IRIS. If it’s during regular business hours, call staff from one of the lab phones to help come and adjust the recipe.
2) Crystal quality is below 30%: if the crystal quality is below 30% before your run, please stop your run, and report this as a problem through IRIS. If the crystal quality is above 30%, but drops below 30% during the run, you may complete your run, but please report this as a problem through IRIS afterwards.
3) If you think the crucible doesn’t look right, please report it as a problem to staff.
PVD-04 Training Video, QR Code:

In YouTube, search: “qnf pvd-04”

Link: https://www.youtube.com/watch?v=OxkmP7Lr9Lo&t=0s

QR code (below):
Lesker PVD75 E-beam Evaporator

- Primary tool owner: David J. Jones
- For processing questions, contact David Jones at: davijon@seas.upenn.edu
  Problems with the tool MUST be reported on IRIS. Do not contact primary tool owner with tool issues directly.

Tool Policy:

- If a deposition recipe is running, you must be in the lab, at the tool while that deposition recipe is running (unless there’s an emergency, i.e. a fire alarm or toxic gas alarm).
- Look at the metal in the chamber periodically during the deposition, and check to make sure it’s not getting too low.
- You must pump down the loadlock when you’re done using the tool.
- The tool is stocked with Ti, Au, Pd, and Cr.
  - If you’d like to deposit another materials than these, please request training for one of these tools, depending on your need:
    - Evaporators:
      - KJLC PVD75 E-beam/Thermal Evaporator (PVD-02)
      - KJLC Nano-36 Thermal Evaporator (PVD-01)
    - Sputterers:
Tool Overview:

The Kurt J. Lesker PVD75 E-beam Evaporator is an electron-beam (e-beam) evaporation tool. The tool is used for depositing Ti, Cr, Au, and/or Pd via e-beam evaporation.

In e-beam evaporation, an electron beam is used to heat up the source metal to the point where it will evaporate. As Figure 1 shows, a voltage is applied to a filament, which allows the filament to emit electrons. A magnetic field is then used to steer the electron beam and raster it across the source metal and, subsequently, heat up the source metal.

Figure 1 – Schematic of an electron beam evaporation process.
Additionally, the system operates under high vacuum (< $5 \times 10^{-6}$ Torr), which allows the system to operate with relatively high mean free path (average distance between particles) within the chamber. With high mean free path, the electrons are able to sweep over the source metal with minimal interaction with gas particles, and the source metal is able to evaporate.

The tool will warm up the metal during the “ramp and soak” phases of the process. The tool will ramp up the power, and then let the beam run over the sample to warm it up during the “soak” phase. Next, it will repeat this process for the “ramp and soak 2” phases. Then, it will open up the shutters, measure the deposition rate, adjust the power to dial in the deposition rate to $2 \text{Å/s}$, and start keeping track of what thickness of material has been deposited. Once the target thickness has been deposited, the tool will close the shutters and ramp down the power to complete the deposition process.
Full procedure:

Log into the tool via IRIS.

Check the crystal quality under the “Deposition” tab. If the crystal quality is under 30%, please stop your run and report it as a problem in IRIS.

**Attention:** not doing this is tool misuse.
1. **Mount the sample to the platen**

1.1. If your sample is smaller than 6” in diameter, find the ring and sample platen (disc) on the table next to the tool.

1.2. If your sample is a 6” wafer it may be placed in the ring directly.

1.3. Secure your sample to the platen. You may do this by using the screws and clips in the tray next to the tool, or you can use kapton tape.
2. **Vent the loadlock:**

   2.1. Click the “LL Vent” button to vent the loadlock to atmospheric pressure

3. **Load sample(s) into the loadlock:**

   3.1. Place your sample face-down into the ring.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.2.</strong> Open the panel that the computer is on (it’s a door), and open the loadlock.</td>
<td><img src="image1.jpg" alt="Image" /></td>
</tr>
<tr>
<td><strong>3.3.</strong> Place the ring with the sample into the loadlock. Remember to make sure that the sample is face-down.</td>
<td><img src="image2.jpg" alt="Image" /></td>
</tr>
</tbody>
</table>
3.4. Close the loadlock lid, and close the door.

4. Pump the loadlock, and load sample into chamber
   4.1. Click “LL Pump and Load Sample” to pump down the loadlock and load the sample into the chamber.

   4.2. The recipe will prompt you to enter a sample ID. The Recipe Monitor will show you this →
4.3. Click the “Motion” tab, and type in something in the LL Substrate ID (i.e. “sample” or “[your PennID]”), and press Enter on the keyboard.

4.3.1. Note that pressing “Enter” on the keyboard is required. If you don’t press “Enter” after typing in the LL Substrate ID, the tool’s software won’t register the sample ID, and won’t run the recipe.

4.4. Click the “Resume” button on the Recipe Monitor.

4.5. Allow the recipe to run and finish before proceeding.
5. **Run deposition recipe(s)**

5.1. Run a deposition recipe. To do this: click Run Recipe, select the deposition recipe that you’d like to run, and “Run Recipe.”

5.2. The tool is programmed to work with deposition thicknesses in units of kiloangstroms (kA), and not nanometers (nm). To convert your thickness target from nm to kA, divide your thickness target in nm by 100 (e.g. 100 nm = 1 kA, 50 nm = 0.5 kA, 10 nm = 0.1 kA, etc.).

5.3. Enter your thickness target in kA, then hit “Enter” on the keyboard. Then, click Continue Load to start the process.

5.4. Throughout the deposition process, we should keep an eye on the deposition rate and the power being used by the tool. We can do this by keeping an eye on the chart.

5.5. If you see this icon on the bottom bar in Windows, click it to open the chart.
5.6. If you don’t see the icon from 5.5 on the bottom bar in Windows, click “Chart”, Settings, Files, Import saved settings, and open “master ebeam chart.ini”.

5.7. We recommend to set the time scale on the chart to 5 minutes. To do that, open up the chart and click Settings, Parameters, set the Range to 00:05:00, and click “Apply”.
5.8. Take a look at the metal periodically to make sure that the e-beam is rastering over the metal and isn’t drilling into the crucible itself. To do so, hold open the shutter next to the tool. Be sure to use an eyepiece to protect your eyes – some of the metals (especially Ti) will glow very brightly, which could damage your eyes.

5.9. Wait for the deposition recipe to finish. If you’d like to deposit another metal (i.e. Au after depositing Ti), you may do so.

6. **Unload the sample to the loadlock, and vent the loadlock**

   6.1. Run the SampleUnload to LL recipe to unload your sample to the loadlock. Wait for the recipe to finish.
   6.2. Run the LL Vent to vent the loadlock. Wait for the recipe to finish.

7. **Unload the sample from the loadlock**
   7.1. Take out your sample, and close the loadlock.

8. **Pump down loadlock**
| 8.1. Run the LL Pump Only recipe to pump down the loadlock. Please wait for the LL Pump Only recipe to finish before logging out and leaving the tool. |
| Log out of the tool via IRIS once the pumping is done. Remember, if the quality is below 30%, please report that to staff! |

Feel free to contact the staff members with any questions about your process and the tool.