

PVD 75 DC and RF SPUTTERING SYSTEM SOP

Revised April 2020

Purpose: To deposit a thin layers of solid materials. Available material can be found on the MNTC website: <https://louisville.edu/micronano/users>

System Start Up

1. The PVD75 and utilities should be on and the chamber should be under vacuum. After logging into FOM, simply touch the screen or mouse pad and the computer will wake up.
2. If the computer or entire system is off, make sure you are logged into FOM or contact the cleanroom staff.

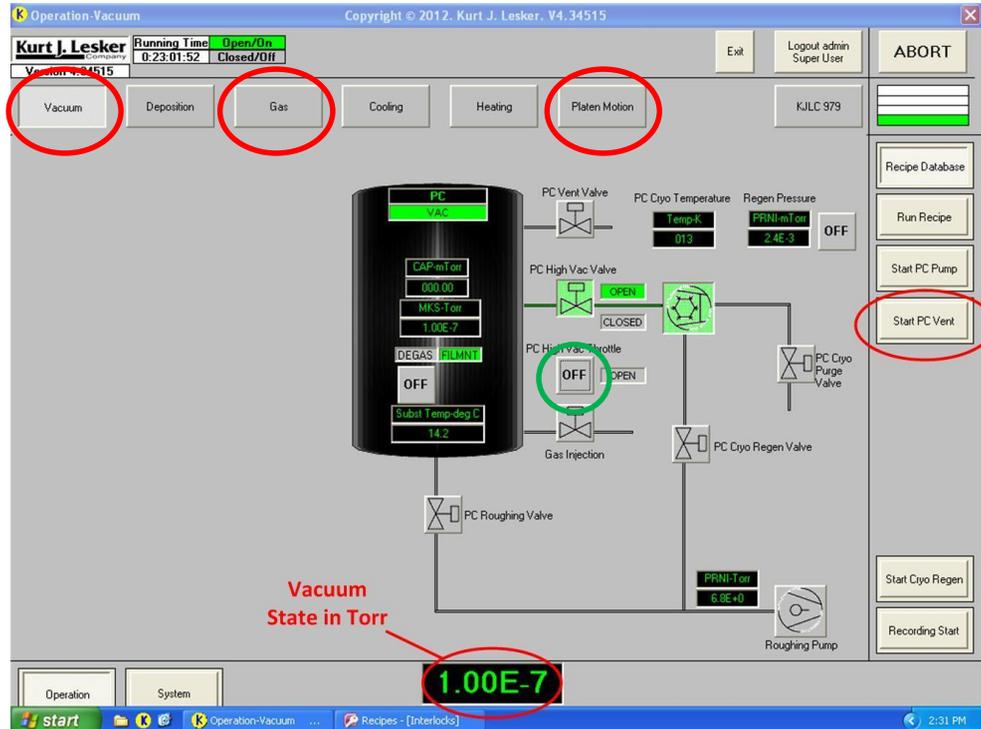


Figure 1. The vacuum page of the PVD 75.

Chamber Vent

3. Select the **Vacuum** tab at the top left of the screen, Figure 1. Take notice of the current vacuum level found at the bottom of the screen in Torr. If the vacuum is greater than 1×10^{-5} Torr there may be a problem and notify the MNTC staff.
4. To open the chamber press **Start PC Vent**.

Target & Substrate Loading

1. Once vented, select the **Deposition** tab in the upper left corner, Figure 2.
2. Press the **Source Shutter** button corresponding to the source you would like to use. Source 1 and 2 are for 3" sputter targets and source 3 is for 4" targets.
3. Change the material listed in the **Source Configuration** section, Figure 2, to the target material you are loading. Select the **Material** box that corresponds to your source number and enter the name of the target material you are loading.

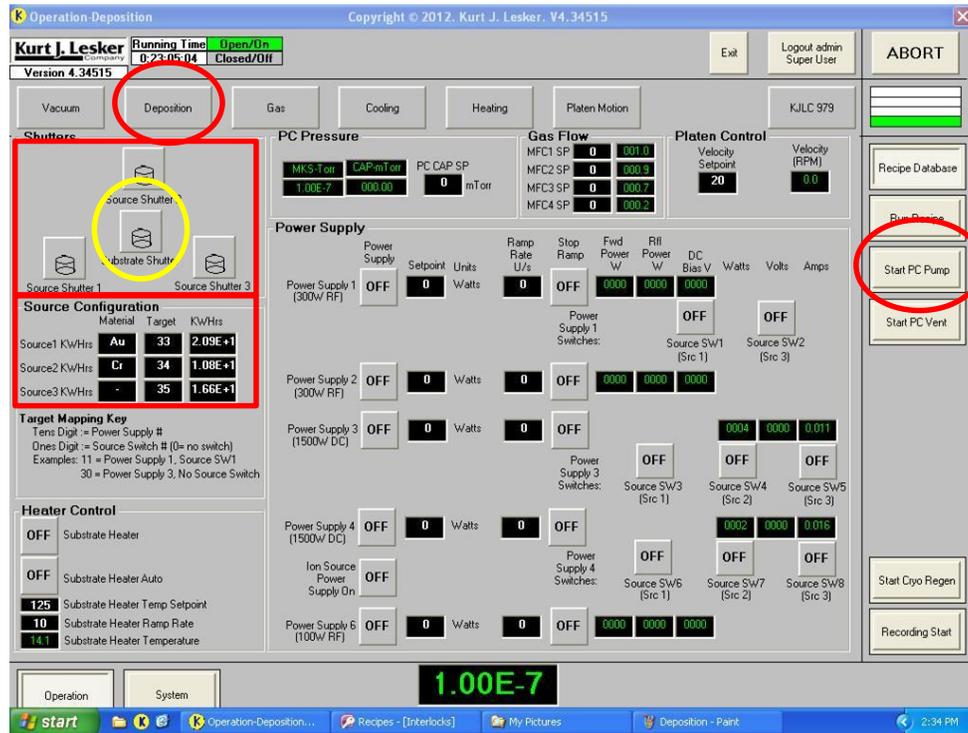


Figure 2. The deposition screen from the PVD 75.

4. From Figure 3, remove the gas inlet tube from the dark space shroud if connected. Note: it may be helpful to have the tube connected to the shroud when doing low pressure depositions less than 5 mTorr.
5. Remove the dark space shroud around the sputter head by loosening the 3 screws around the base of the sputter head, Figure 3.
6. Remove the 4 screws and the target rings holding the target in place.
7. Place the new target onto the selected sputter head and replace the target holder ring (3 screws). For 1/4" targets use (2) additional spacer rings. For 1/8" thick targets use (1) ring and the 1/16" thick target uses no rings.

CAUTION: The magnets in the sputter head, a.k.a. cathode, are strong and can snap magnetic targets (i.e. Nickel) to the head with substantial force. Watch your fingers when inserting new targets.

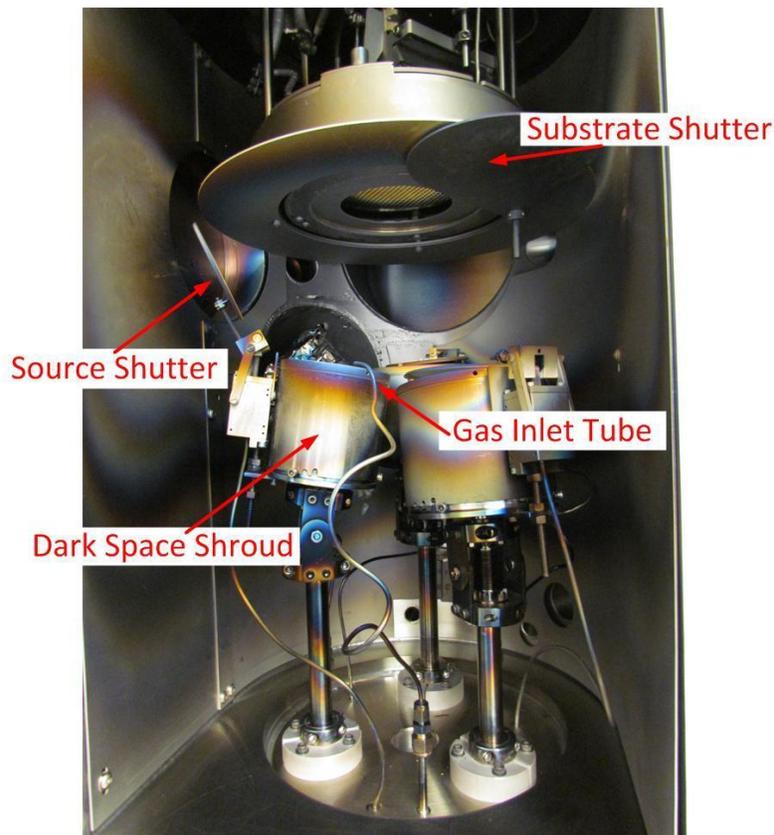


Figure 3. The interior of the vacuum chamber for loading targets and substrates.

8. Place the dark space shroud onto the sputter head into the shallow notches. Tighten all screws on the base of the shroud and reinsert the gas line.
9. Using the digital multi-meter check continuity between the target and shroud. They should be electrically isolated from one another. If there is continuity, then re-seat the dark space shroud or increase the height of the shroud by placing it on a shallower set of notches. For dielectric targets, it is impossible to perform the continuity check. Users are advised that it is common for a short to occur between the dark space shroud and the target holder rings therefore it is important to leave ample space between these electrodes. For RF dielectric depositions a short may not be discovered until one has failed to light the plasma.
10. Press the corresponding **Source Shutter** button, Figure 2, to close the shutter over the target.
11. Press the **Substrate Shutter** button (yellow circle), Figure 2, and remove the substrate access panel, Figure 3.
12. Remove the 4" substrate ring and place your substrate into the ring.
13. Load your substrate into the fixture and replace the substrate access panel.
14. Close the chamber door and press the **Start PC Pump** button, Figure 2.

DC and RF Deposition

1. Verify that the chamber is pumped down to at least 5×10^{-5} Torr. This usually take 25 to 30 minutes. For gold or precious metals pump down time needs to be approximately 45 to 60 minutes.
2. Select the **Vacuum** tab at the top left of the screen and press the **PC High Vac Throttle** (green circle on Figure 1 and not the PC High Vac Valve button). It will turn green when turned on.
3. Select the **Platen Motion** tab at the top right of the screen, Figure 1. Under the Drive Motor Continuous box press the **FWD** button to start rotating your substrate.
4. Select the **Gas** tab, Figure 5. Argon gas flow may be controlled via **constant pressure** or **constant flow rate**.

NOTE: For most applications constant pressure is the preferred method of gas flow.

To set the Argon flow for constant pressure

- a. Open the source valve for the sputtering head to be used, such as **Source 1 Gas** for head #1, Figure 5.
- b. Enter **4** in the mode window of MFC1, Figure 5.
- c. Enter a target pressure in mTorr (i.e. 5) in the window below **Capman Pressure SP**, Figure 5. Argon flow should begin and the pressure should approach the set point.

To set the Argon for constant flow

- a. Open the source valve for gas flow for the sputtering head to be used, such as **Source 1 Gas** for head #1.
 - b. Enter a target flow rate in the box below **Setpoint SCCM** for MFC 1 in the lower left of the screen.
5. Press the **Deposition** button at the top left of the screen. Typically, DC sputtering is used for conductive materials and RF is used dielectrics.

DC Deposition

1. Press the **Source Shutter #** associated with the sputter head to be used at the top left of the screen.
2. Select the source number corresponding to the desired target by pressing the button above the source number or **Source SW3 (SRC 1)** for Source 1.
3. Set the target power in Watts by entering the value (i.e. 300) adjacent to the Power Supply 3 **ON/OFF** button.
4. Press the **ON/OFF** button next to **Power Supply 3** label near the center of the screen. Verify that the plasma is lit by looking in the vacuum chamber window and note the voltage and current associated with the plasma in the displays at the center right of the screen. This current and voltage is an indicator of the plasma's impedance and is a useful diagnostic for the deposition.

5. Open the substrate shutter and begin timing the deposition.
6. Once the deposition is complete and turn off the plasma by pressing the Power Supply 3 **ON/OFF** button. Press the **Substrate Shutter** and the **Source Shutter** to close the shutters.

RF Deposition

Power Supply 1 is used to apply RF power and voltage bias to target/source 1 and target/source 3.

Power Supply 2 is used to apply RF power and voltage bias for target/source 2.

Power Supply 6 is used to apply a voltage bias on the substrate.

Using independent supplies allows the user to perform co-depositions of two materials at the same time. Co-depositions are not covered in this SOP. For purposes of this document it is assumed the user has loaded a target into either target/source 1 or 3.

1. In the row corresponding to **Power Supply 1**, Figure 4, press the **OFF** button above **Source SW1 (Src 1)** to turn it on.

Or

In the row corresponding to **Power Supply 1**, Figure 4, press the **OFF** button above **Source SW2 (Src 3)** to turn it on.

2. Ramp rate (purple rectangular box): Optional - Enter a ramp rate of 0.15 to 0.5 in the box below the label **Ramp Rate U/s**. Press the **OFF** button under **Stop Ramp** to turn on the ramp rate.
3. Set the power in Watts by pressing the **Setpoint** box in the red circle.
4. To start the RF Deposition Press the **OFF** button in the yellow circle.
5. Verify that the plasma is lit by looking in the vacuum chamber window. Note the reflected power, **Rfl Power W**, in the green rectangular box. If the reflected power is above 10% of the set point, stop the deposition for it can damage the power supply and there is likely a problem with the sputter cathode.

NOTE: If a ceramic or other dielectric target is used it is wise to start the plasma at some low power, e.g. 50 W, then slowly ramp the power up to avoid cracking the target due to thermal expansion.

After the power has reached the set point and plasma is lit, note the reflected power (green rectangle) and the DC bias (orange rectangle). If the reflected power is above 10% of the set point, there may be a problem. The DC bias is an indicator of the plasma's impedance or the energy of the arriving Argon ions and is a useful diagnostic for the deposition.

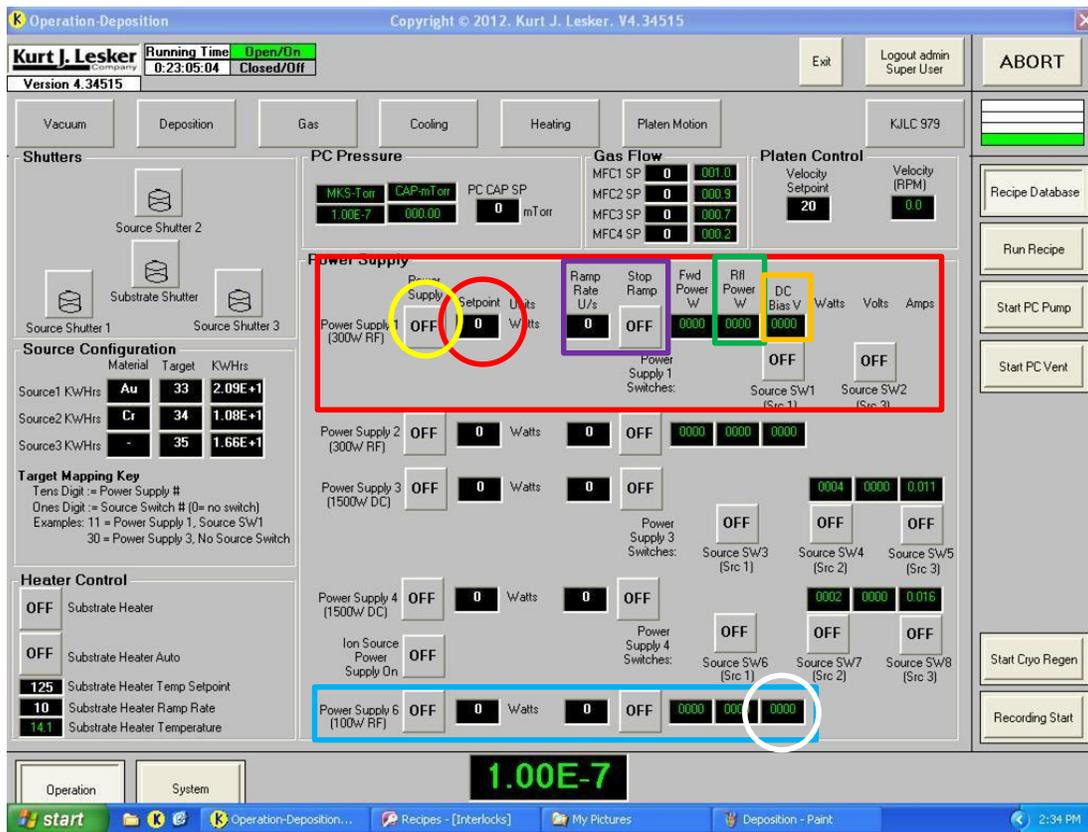


Figure 4. RF Deposition on the PVD 75.

Substrate Voltage Bias (Power Supply 6)

1. On the **Gas** tab, Figure 5, turn on the **Argon Etch** and **Gas Injection** and other regular gas selections to perform standard sputtering.
2. Turn on/strike the plasma for regular sputtering processes prior to turning on Power Supply 6 (light blue rectangle), Figure 4. Set the desired power in the box next to **Watts** and press the **OFF** button to turn on **Power Supply 6**. You should see a **DC Bias V** value appear in the white circle. Open the substrate shutter to begin sputtering. After a minute or so, open the viewing shutter and the plasma should look like a spreading mist.

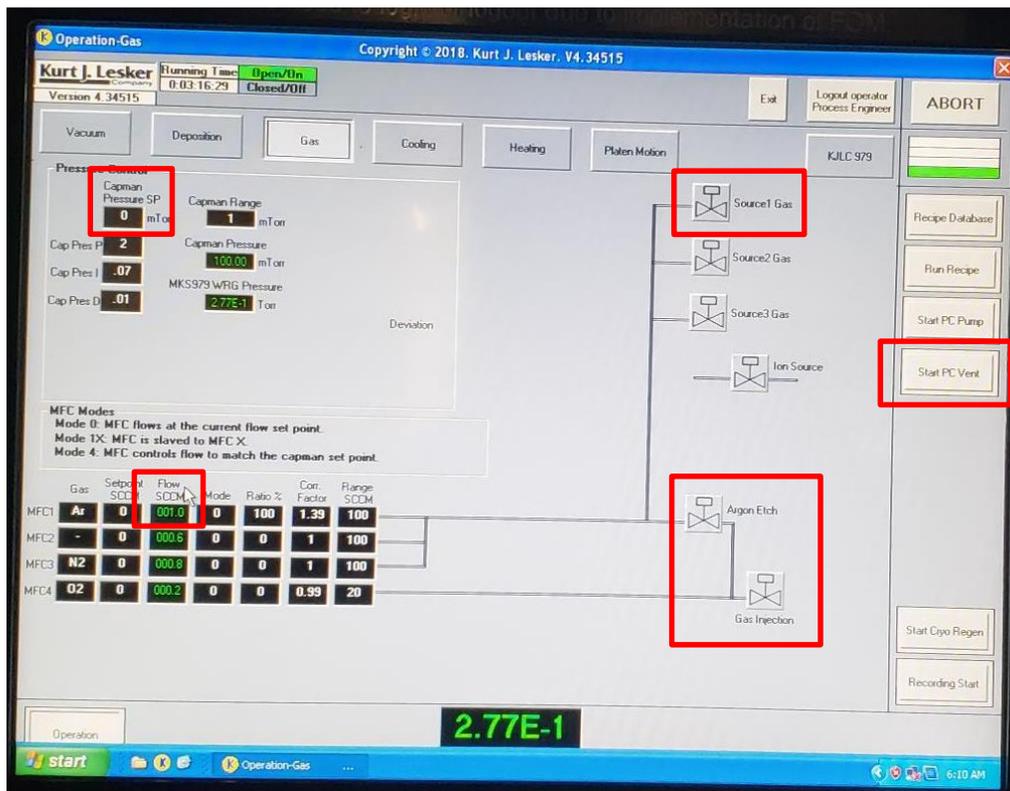


Figure 5. Additional gas lines to be turned on for Substrate Voltage Bias.

Removing your sample

1. After your depositions is complete turn off all **Power Supply #**, Figure 4.
2. Turn off all **Source # Gas** flows, return the **Capman Pressure SP** and the **Flow SCCM** to zero, Figure 5.
3. On the **Deposition** tab, press the **Substrate Shutter** followed by the **Source Shutter #** used during the deposition.
4. Press **Start PC Vent**, Figure 5. This will close all shutters, turn off the gas flow and switch off all power supplies before venting.
5. When prompted open the chamber door, remove your substrate and the target(s).
6. Press **Start PC Pump**, Figure 5, and leave the system under vacuum.
7. Logout from the tool in your FOM account.