

SPUTTER DEPOSITION: STANDARD OPERATING PROCEDURE (SOP)

Materials

- High-Ultra Purity Argon (Ar) Gas
- Water Chiller
- Kapton Tape
- Timer
- Cleanroom Wipes
- High-Ultra Purity Nitrogen (N₂) Gas
- Tweezers
- Wafer Specimen
- Notebook
- Isopropyl Alcohol

[The Desk Top Pro should be powered **ON** with both pumps running under normal conditions. If the machine is powered **OFF**, this procedure will detail how to restore it to its operational mode. Refer to page 47 in the 'Desk Top Pro Coating System Operational Manual' for more detailed instructions.]

Start-Up Procedure (Machine is Powered OFF)

1. Go outside to the outdoor closet and turn on the:
 - a. **Water chiller** - Check the water level so that it sits at the halfway mark of the PVC pipe.
 - b. **Argon tank** - the pressure should be between **5 - 10 psi**. Adjust if necessary.
 - c. **Nitrogen tank** - the pressure should be between **5 - 10 psi**. Adjust if necessary.
2. Return inside and check the pressure of the compressed air, located on the wall between the fume hood and the yellow chemical storage container. The pressure should read **90 psi**.
3. To the left of the machine, turn the water valves (black handles) so that the arrows are pointing to the right. (**OPEN** position)
4. Behind the machine, turn the **TOP** two gas valves (labeled Ar and N₂) so that they are horizontal (parallel) to their lines. (**OPEN** position)
 - a. The compressed air valve is already in the **OPEN** position. **NEVER CLOSE** this valve.
 - b. Let the flow stabilize for 1 – 2 minutes before turning on the machine.
5. On the front of the machine, make sure the emergency shutdown nob (left red nob) is fully pulled out so that the yellow sticker lining underneath is visible to eyes sight.
6. On the front of the machine, turn the switch (right red switch) to the vertical position to supply power. (**ON** position)
7. On the front of the machine, press the power button (green button) to power on the machine.
 - a. Let the machine stabilize for 5 minutes.
 - b. Once stabilized, the machine is ready for experimental use.

Note: The machine can be left powered on when not in operational use assuming that the chamber has been pumped down.

8. On the main screen, press "**Auto Vent**" to vent the chamber. The lid will open after 5 minutes.
 - a. Once the lid is open, use isopropyl alcohol and cleanroom wipes to clean the inner walls and bottom surface of the chamber. **!!!DO NOT!!!** let any debris, particles, or liquid to enter the exposed turbo-vac hole at the bottom of the chamber. This will destroy the machine.
9. Prep your sample by placing a small amount of Kapton tape on the non-polished side of the wafer to hold it down.
10. Using tweezers, grab the wafer by the flat edge and carefully place it on the sample stage inside the chamber.
 - a. Make sure the wafer is positioned with the flat edge pointing toward the right. This makes it easier to place and retrieve the wafer.
11. Clean the entire O-ring including its mating surface of the lid using isopropyl alcohol and cleanroom wipes. This rids of any debris that might prevent a successful vacuum seal.
12. Close the lid and latch the handle by rotating it so that the handlebar is parallel with the lid.
13. On the main screen, press "**Auto Pump**". The chamber will begin to pump down.
 - a. The pressure should reach 5E-6 Torr or below after approximately 35 minutes.
 - i. If the pump down takes more than 45 min – 1 hour, press "**Auto Vent**" to open the lid.
 - ii. Clean around the O-ring and its mating surface again and assure that nothing is out of place or is blocking the lid from closing correctly.
 - iii. Repeat steps 12 and 13.

Note: The machine can be left at this pressure (**5E-6 Torr**) when the machine is powered on and not in operational use.

Start-Up Procedure (Machine is Powered ON)

1. Go outside to the outdoor closet and turn on:
 - a. **Water chiller** - Check the water level so that it sits at the halfway mark of the PVC pipe.
 - b. **Argon tank** - the pressure should be between **5 - 10 psi**. Adjust if necessary.
 - c. **Nitrogen tank** - the pressure should be between **5 - 10 psi**. Adjust if necessary.
2. Return inside and check the pressure of the compressed air, located on the wall between the fume hood and the yellow chemical storage container. The pressure should read **90 psi**.
3. To the left of the machine, turn the water valves (black handles) so that the arrows are pointing to the right. (**OPEN** position)
4. Behind the machine, turn the **TOP** two gas valves (labeled Ar and N₂) so that they are horizontal (parallel) to their lines. (**OPEN** position)
 - a. The compressed air valve is already in the **OPEN** position. **NEVER CLOSE** this valve.
 - b. Let the flow stabilize for 1 – 2 minutes before operating the display screen.

Note: The machine should already be powered on and pumped down to a low pressure (approximately **5E-6 Torr**)

5. On the main screen, press "Auto Vent" to vent the chamber.
 - a. The lid will open after 5 minutes.
 - b. Once the lid is open, use isopropyl alcohol and cleanroom wipes to clean the inner walls and bottom surface of the chamber. **!!!DO NOT!!!** let any debris, particles, or liquid to enter the exposed turbo-vac hole at the bottom of the chamber. This will destroy the machine.
7. Prep your sample by placing a small amount of kapton tape on the non-polished side of the wafer to hold it down.
8. Using tweezers, grab the wafer by the flat edge and carefully place it on the sample stage inside the chamber.
 - a. Make sure the wafer is positioned with the flat edge pointing toward the right. This makes it easier to place and retrieve the wafer.
9. Clean the entire O-ring including its mating surface of the lid using isopropyl alcohol and cleanroom wipes. This rids of any debris that might prevent a successful vacuum seal.
10. Close the lid and latch the handle by rotating it so that the handlebar is parallel with the lid.
11. On the main screen, press "Auto Pump". The chamber will begin to pump down.
 - a. The pressure should reach 5E-6 Torr after approximately 35 minutes.
 - i. If the pump down takes more than 45 min – 1 hour, press "Auto Vent" to open the lid.
 - ii. Clean around the O-ring and its mating surface again and assure that nothing is out of place or is blocking the lid from closing correctly.
 - iii. Then repeat steps 10 and 11.

General Deposition Process

1. The deposition process can begin when the machine reaches **5E-6 Torr or less**
2. Turn on the DC power supply located to the right of the chamber. The power should read zero once powered on. (Turn on at least 30 min prior to deposition)
3. From the main screen, press "Screens" in the lower left corner.
4. Press "DC Sputter" in the top-middle area of the screen.
5. Press the number under "Setpoint". Enter the desired current and press "Enter".
6. Verify that the shutter is closed on the screen.
7. Press "On" under Gas.
 - a) Let the gas stabilize for 1 – 2 minutes.
 - b) Adjust the needle valve above the screen until the desired gas pressure is achieved. **GO SLOW!!**
 - c) Let the pressure stabilize for 1 – 2 minutes.
8. On the screen, press "Ignition". The DC power supply will ramp to the setpoint entered in step 5. The cathode will ignite, producing a purple glow that can be observed through the window located in front of the chamber.
 - a) Let the cathode stabilize for 1 – 2 minutes.
 - b) If the cathode does not stay lit, the "Current" light on the DC power supply will turn off, and the power level will start dropping or fall to zero.

- (i) If the power is dropping, set the “Setpoint” to a lower wattage to keep the cathode on. You can start bumping up the power as needed from here.
 - (ii) If the power falls to zero, the cathode must be re-lit using the “Ignition” button. Proceed to step 8.
- c) If the cathode stabilizes at the desired Setpoint proceed to step 9.
- 9. To start depositing material onto the substrate, press “open” on the screen to open the shutter. Use a timer to measure the deposition rate once open.
- 10. When the deposition is finished, press “close” to close the shutter.
- 11. Turn off the “Power” and “Gas” on the screen.
- 12. Turn off the DC power supply.
- 13. Wait 5 minutes to let the cathode cool down, then press "Auto Vent". The lid will open after another 5 minutes.
- 14. Remove the sample. Use tweezers to pick up the sample from the flat side and place the sample in a sample holder. Label the sample accordingly.
- 15. Close the lid and latch the handle by rotating it so that the handlebar is parallel to the lid.
- 16. On the main screen, press "Auto Pump". The chamber will begin to pump down.
 - a) The pressure should reach **5E-6 Torr** or below after approximately 35 minutes.
 - (i) If the pump down takes more than 45 min – 1 hour, press “Auto Vent” to open the lid.
 - (ii) Clean around the O-ring and its mating surface again and assure that nothing is out of place or is blocking the lid from closing correctly.
 - (iii) Repeat steps 15 and 16.
 - b) The machine can be left at this pressure when not in operational use.
- 17. To the left of the machine, turn the water valves (black handles) so that the arrows are perpendicular to their lines. (**CLOSED** position)
 - a. Behind the machine, turn the **TOP** two gas valves (labeled Ar and N₂) so that they are vertical (perpendicular) to their lines. (**CLOSED** position)
 - b. The compressed air valve can be left **OPEN**. **NEVER CLOSE** this valve.
- 18. Go outside to the outdoor closet and turn off the:
 - a. **Water chiller**
 - b. **Argon tank**
 - c. **Nitrogen tank**

Deposition Procedure for Aluminum Metal

1. Make sure the chamber pressure is at or below **5E-6 Torr** then the DC powers supply is turned on.
 - a. Let the power supply stabilize for 1 – 2 minutes.
2. From the main screen, press "Screens" in the lower left corner.
3. Press "DC Sputter" in the top-middle area of the screen.
4. Press the number under "Setpoint". Enter **60 Watts** as the desired current and press "Enter".
5. Verify that the shutter is closed on the screen.
6. Press "On" under Gas.

- a. Let the gas stabilize for 1 – 2 minutes.
 - b. Adjust the needle valve to **8E-3 Torr**.
 - c. Let the pressure stabilize for 1 – 2 minutes.
7. On the screen, press “**Ignition**”. The DC power supply will ramp to the setpoint entered in step 4. The cathode will ignite, producing a purple glow that can be observed through the window located in front of the chamber.
 - a. Once the cathode lights, start a timer and increase the power by **10 Watts** every minute until **250 Watts** is achieved.
 - b. Let the power stabilize for 1 – 2 minutes at **250 Watts**.
8. Decrease the power by **20 Watts** every **10 seconds** until **70 Watts** is achieved.
9. Drop the power to **60 Watts** and let sit for **20 seconds**.
10. Decrease the gas pressure by **1 millitorr** every **20 seconds** until **2 millitorr** is achieved using the needle valve. **GO SLOW!!**
11. Start a new timer and open the shutter to begin the deposition.
 - a. The machine can be left at this pressure when not in operational use.
12. To the left of the machine, turn the water valves (black handles) so that the arrows are perpendicular to their lines. (**CLOSED** position)
 - a. Behind the machine, turn the **TOP** two gas valves (labeled Ar and N₂) so that they are vertical (perpendicular) to their lines. (**CLOSED** position)
 - b. The compressed air valve can be left **OPEN**. **NEVER CLOSE** this valve.
13. Go outside to the outdoor closet and turn off the:
 - a. **Water chiller**
 - b. **Argon tank**
 - c. **Nitrogen tank**

Deposition Procedure for Chromium Metal

1. Make sure the chamber pressure is at or below **5E-6 Torr** and the DC power supply is turned on.
 - a. Let the power supply stabilize for 1 – 2 minutes.
2. From the main screen, press “**Screens**” in the lower left corner.
3. Press “**DC Sputter**” in the top-middle area of the screen.
4. Press the number under “**Setpoint**”. Enter **60 Watts** as the desired current and press “Enter”.
5. Verify that the shutter is closed on the screen.
6. Press “On” under Gas.
 - a. Let the gas stabilize for 1 – 2 minutes.
 - b. Adjust the needle valve to **6E-3 Torr**.
 - c. Let the pressure stabilize for 1 – 2 minutes.
7. On the screen, press “**Ignition**”. The DC power supply will ramp to the setpoint entered in step 4. The cathode will ignite, producing a purple glow that can be observed through the window located in front of the chamber.
 - a. Once the cathode lights, start a timer and increase the power by **10 Watts** every minute until **100 Watts** is achieved.

- b.** Let the power stabilize for 1 – 2 minutes at **100 Watts**.
- 8. Start a new timer and open the shutter to begin the deposition.
- 9. When the deposition is finished, press “close” to close the shutter.
- 10. Turn off the “Power” and “Gas” on the screen.
- 11. Turn off the DC power supply.
- 12. Wait 20 minutes to let the cathode cool down, then press "Auto Vent". The lid will open after another 5 minutes.
- 13. Remove the sample. Use tweezers to pick up the sample from the flat side and place the sample in a sample holder. Label the sample accordingly.
- 14. Close the lid and latch the handle by rotating it so that the handlebar is parallel to the lid.
- 15. On the main screen, press "Auto Pump". The chamber will begin to pump down to 5E-6 Torr.
 - a. The machine can be left at this pressure when not in operational use.
- 16. To the left of the machine, turn the water valves (black handles) so that the arrows are perpendicular to their lines. (**CLOSED** position)
 - a. Behind the machine, turn the TOP two gas valves (labeled Ar and N2) so that they are vertical (perpendicular) to their lines. (**CLOSED** position)
 - b. The compressed air valve can be left **OPEN**. **NEVER CLOSE** this valve.
- 17. Go outside to the outdoor closet and turn off the:
 - a. Water chiller**
 - b. Argon tank**
 - c. Nitrogen tank**

Troubleshooting

1. Cathode Won't Stay Lit

- a. Chromium
 - i. Chromium can build up on the target or shutter after a deposition. This can cause an arc, shorting the supplied current, which keeps the cathode from lighting or staying lit. To avoid this:
 - 1. Disassemble the shutter and the target casing and thoroughly clean them using the sandblaster.
 - 2. Make sure the lid is closed for 10 minutes after a deposition. The cathode needs time to cool before being exposed to ambient air.
 - 3. The cathode may also need to be conditioned if too much alumina builds up on the surface.
- b. Aluminum
 - i. Alumina can build up on the target or shutter after a deposition. This sometimes keeps the cathode from lighting or staying lit. To avoid this, make sure the lid is closed for 10 minutes after a deposition. The cathode needs time to cool before being exposed to ambient air. The cathode may also need to be conditioned if too much alumina builds up on the surface.

2. Blue Sheen on Sample After Deposition

- a. The blue sheen is alumina. This means that the alumina was not removed from the cathode before the deposition.
- b. With the shutter closed, run the DC power at a high wattage for an extended period to fully remove the alumina.

3. Lid Won't Open After Venting

- a. Check the N₂ line. Make sure the valves behind the machine are on (horizontal) and check the N₂ tank in the outside closet.