

# Standard Operating Procedure for the Lesker AXXIS DC Magnetron Sputtering System

## Version: 18 April 2013

### 1. Utility Requirements

- a. System power is supplied through the large switch box on the wall, to the right of the sputterer. When doing maintenance to electrical components, disconnect power by moving the switch handle to the lower position.
- b. The sputterer currently uses three compressed gasses to operate: Argon, Nitrogen and Compressed Breathable Air.
  - Argon, the process gas, is supplied by a (UHP/Plus grade; 99.9993% pure) T-sized tank located in the gas room. The pressure is regulated to 25 psig at the tank and 7 psig at the instrument.
  - Nitrogen, the purge gas, is house-supplied (99.9999% pure; ~90 psig). This gas is internally regulated to 15 psig. Only open the Nitrogen valve when venting the chamber.
  - Compressed Air, which is house-supplied (fluctuates 65-90 psig), is used to open the various valves and shutters. The gas is supplied via a gate valve on the wall in the Photolithography room; it is left on whenever the system is on.
- c. Cooling water is house-supplied from lines directly behind the sputterer. This water is filtered internally by a 5 micron sediment filter.

### 2. General Precautions

- a. In an emergency, press the **EMERGENCY STOP** button—located at the bottom right of the control panel—to stop all processes.
- b. Avoid turning the **Ion Gauge (IG1 on the IGC100 touch screen)** on and off manually, as this could allow for operation of the gauge at higher pressures ( $>5 \times 10^{-3}$  Torr), which could damage or destroy it. The **IG Auto** setting should be used exclusively to activate the ion gauge. The gauge should last one to two years under constant use.
- c. It is desirable to leave the system under vacuum when not in use. This helps to prevent moisture accumulation and will help to desorb contaminants from the inside walls of the chamber.

### 3. Putting a Substrate in the Chamber for Deposition

- a. Power up the system by turning the **OFF-ON-START** switch—located at the bottom left of the control panel—to **START**, then quickly releasing the switch to the **ON** position.
- b. Start the **IGC100** vacuum gauge controller, located at the top right of the control panel, by pressing the red **Power** button. Press the **IG Auto** button to allow the ion gauge (IG1 on the touch screen) to become active when ready. See **Section 2c**.
- c. Open the **Rough Valve** switch, located on the left, on the second pane from the top of the control panel. **If the chamber is not under vacuum, open the HI-Vac Valve switch as well, and skip to step “j”.**
- d. Press the **Start/Stop** button (LED indicates on or off) on the **BOC Edwards** panel, located at the top left of the control panel, to start the roughing and turbo pumps. (**NOTE:** The roughing pump starts loud but quickly calms down. The turbo pump will become audible as it accelerates; orange and green LED's on the **BOC Edwards** panel indicate the turbo pump's relative speed.)

- e. Once all of the green LED's are illuminated, open the **HI-Vac Valve** switch, located on the left, on the second pane from the top of the control panel.
- f. Press the blue **Start/Stop** button (LED indicates on or off) on the **BOC Edwards** turbo pump controller, located at the top left of the control panel, to stop the vacuum pumps.
- g. **After the GREEN turbo pump speed indicator LED's (located on the BOC Edwards panel) have gone out**, open the **Nitrogen Purge** valve and the **Vent Valve** to begin venting the system.
- h. When the **Pirani Gauge (PG1)** on the **IGC100** touch screen) indicates a chamber pressure near atmospheric pressure (~600 Torr), crack the handle to the chamber door. The door can be opened at ~700 Torr.
- i. Close the **Nitrogen Purge** valve and **Vent Valve**.
- j. Place the substrate(s) on the stage and secure it with the steel clamps around the perimeter. Use a 3/32 allen wrench to tighten the clamp screws. (**NOTE:** To ensure good film adhesion, the substrate(s) should be clean and dry prior to putting them in the chamber. One is highly encouraged to plasma clean substrates for one minute, immediately prior to this step.)
- k. If desired, replace the acetate (transparency sheets for high temperature copiers) cover on the inside of the viewing glass in the chamber door. Use the old piece as a template for the new one. Hold the new piece in place with two small pieces of Scotch Magic Tape.
- l. Close the chamber door and secure the handle.
- m. Press the **Start/Stop** button on the **BOC Edwards** panel to start the roughing and turbo pumps. (**NOTE:** The roughing pump starts loud but quickly calms down. The turbo pump will become audible as it accelerates; orange and green LED's on the **BOC Edwards** panel indicate the turbo pump's relative speed.)
- n. Allow the chamber to reach a base pressure of **5 x 10<sup>-7</sup> Torr** at maximum before sputtering. (**NOTE:** Pumping to this pressure takes about 18 hours.) See **Section 2c**.
- o. **Enter the appropriate information on the chamber status card on the BOC Edwards controller panel. If you have changed any of the targets, make sure that the corresponding gun labels have been changed as well.**

#### 4. Deposition of Metal Films

- a. Ensure that the base chamber pressure is less than **5 x 10<sup>-7</sup> Torr**, as indicated by the **Ion Gauge (IG1)** on the **IGC100** touch screen. See **Section 2c**.
- b. **Enter the appropriate information in the LOG BOOK as you proceed.**
- c. Ensure that the **Cooling Water** is being supplied to the instrument. The valves, located behind the chamber, are open when the handles are parallel with the water lines and closed when they are perpendicular. (**NOTE:** 3 red lights will be visible through the front glass door below the chamber if there is sufficient water flow. These safety interlocks will not allow metal deposition to occur if the water flow rate is too low.)
- d. Ensure that the pressure of the tank of **Argon** process gas is regulated at 25 psig. If the tank pressure is less than 700 psig, notify the cleanroom supervisor. **Do not proceed if the tank pressure is less than 300 psig.**
- e. Open both **Process Gas** (Ar) valves. (**NOTE:** switch the **Black** valve --next to the Gun Shutter 1 valve-- to **ON** and turn the left **Green** valve --below the IGC100-- so that it is vertical.)
- f. Turn the **Hi-Vac Throttle** switch to the **ON** position. The ion gauge will go off-line and the **Capacitance Manometer (CM1)** on the **IGC100** touch screen) will come on-line. Allow the **CM1** readout to stabilize. It should read between 1 x 10<sup>-3</sup> and 4 x 10<sup>-3</sup> Torr.

- g. Select the proper gun setting using the **REM** rotary switch on the lower front panel (waist level). Gun 1 is the left gun, which is reserved for adhesion metals, such as Titanium (Ti), Nichrome (80:20 Nickel-Chromium) or Chromium (Cr). Guns 2 and 3 are used to deposit the subsequent layers. (**Note: use only Pd, Pt, and Au targets in gun 3.**)
- h. Start the gun **Output Power** on the **MDX 500** panel, located at the middle-left of the control panel, by pressing the **Start** button. Increase the power to **100 watts**. The plasma should be struck at this point, as indicated by solid illumination of the **Plasma** and **Setpoint** LEDs. If not, temporarily open the appropriate gun shutter to assist a plasma strike. If this does not help, increase the process gas flow rate by **slowly** turning the needle valve next to the green ON/OFF valve. Small degrees of turning the needle valve have a great affect on the chamber pressure, as indicated by the CM1 readout. The pressure may need to be raised to the 5-to-10 mTorr range to strike the plasma.
- i. Increase the **Output Power** depending on the metal being sputtered:

Metal	Power (W)	Metal	Power (W)	Metal	Power (W)
Ti	220	Cu	250	Pd	250
NiCr	250	Ag	200	Pt	200
Cr	250	Al	250	Au	250
Ni	250	Fe	250		

Consult the **log book** to determine the deposition time for the desired film thickness.

- j. Adjust the **Deposition Pressure** to  $2.4 \pm 0.05 \times 10^{-3}$  Torr by turning the aforementioned needle valve accordingly: counter-clockwise to increase pressure and clockwise to decrease pressure. (**NOTE:** Deposition rates have been determined at this pressure. Deviating too far from it will result in inaccurate rates and imprecise film thicknesses.)
- k. Turn on **Stage Rotation** by flipping the toggle switch on the black box on right side of chamber door. Avoid adjusting the speed of rotation.
- l. Adjust the **Stage Orientation** so that the substrate surface is facing the gun in use. To do this, loosen the setscrew for the collar sticking out of the center of the chamber door. Rotate the collar until the red lines match up; tighten the setscrew.
- m. **De-scum the target** surface by letting the system sit idle, at full power with the shutter closed, for at least 2 minutes (**5 minutes for Ti**).
- n. Open the appropriate **Gun Shutter** to start metal deposition. Monitor the time for the desired film thickness. (**NOTE:** Check to make sure that the shutter opened. You may have to help the shutter open by slightly turning the collar at the end of the off-center metal rod next to the appropriate gun.)
- o. When deposition is complete, stop the gun **Output Power** on the **MDX 500** panel by pressing the **Stop** button. Decrease the power to **0 watts**.
- p. Close the appropriate **Gun Shutter**.
- q. To deposit **Additional Film Layers**, repeat **steps g through p** detailed above.
- r. After metal deposition is complete, turn the **Process Gas** valves to the **OFF** position. (**NOTE:** Both the **Black** valve (next to Gun Shutter 1) and the left **Green** valve (below the IGC100) must to be off.)
- s. Turn the **Hi-Vac Throttle** to the **OFF** position. The CM1 gauge will go off-line and the Ion Gauge will come on-line. See **Section 2c**.
- t. Stop the **stage rotation**.
- u. Loosen the setscrew for the **stage orientation** and return it to center. Re-tighten the setscrew.
- v. Set the **REM switch** to **OFF**.

## 5. Venting the Chamber after Deposition

- a. Press the blue **Start/Stop** button (LED indicates on or off) on the **BOC Edwards** turbo pump controller, located at the top left of the control panel, to stop the vacuum pumps.
- b. **After the GREEN turbo pump speed indicator LED's (located on the BOC Edwards panel) have gone out**, open the **Nitrogen Purge** valve and the **Vent Valve** to begin venting the system.
- c. When the Pirani Gauge (**PG1** on the **IGC100** touch screen) indicates a chamber pressure near atmospheric pressure ( $\sim 600$  Torr), crack the handle to the chamber door. The door can be opened at  $\sim 700$  Torr.
- d. Close the **Nitrogen Purge** valve and **Vent Valve**.
- e. Remove the substrate(s) from the substrate holder using the 3/32 allen wrench.
- f. Shut the chamber door and secure the handle.

## 6. Shutting Down the System with the Chamber Under Vacuum

- a. Press the **Start/Stop** button on the **BOC Edwards** panel to **start** the roughing and turbo pumps.
- b. When the chamber has reached a pressure of  $\sim 5 \times 10^{-3}$  Torr, close the **Hi-Vac Valve**. This will close the gate valve between the chamber and the turbo pump, thereby isolating the chamber.
- c. Press the **Start/Stop** button on the **BOC Edwards** panel to **stop** the roughing and turbo pumps.
- d. **After the GREEN turbo pump speed indicator LED's (located on the BOC Edwards panel) have gone out**, open the **Nitrogen Purge** valve and the **Vent Valve** to begin venting the system components now isolated from the chamber. It is extremely important to vent these components. If they are left under vacuum, oil from the roughing pump will be drawn up through the tubing and into the system. Since the chamber is still under vacuum, the PG1 gauge will not read atmospheric pressure when vented. Continue to vent until a slight gurgle is heard coming from the mechanical pump. This sound is OK since the pressurized nitrogen is passing through the components in the rear of the system and through the oil in the roughing pump.
- e. Close the **Nitrogen Purge** valve and the **Vent Valve** once the aforementioned gurgling is heard.
- f. Close the **Rough Valve**.
- g. Turn off the system by turning the **OFF-ON-START** switch—located at the bottom left of the control panel—to the **Off** position.