# Denton Discovery 18 SOP

## Purpose and Scope

This document provides job breakdowns and references for the Denton Discovery 18 sputtering operations.

## Table of Contents

Denton Discovery 18 SOP ....................1
Purpose and Scope ....................1
Table of Contents ....................1
Reference Documents ....................1
Acronyms, Abbreviations and Definitions ....................2
Equipment and Supplies ....................2
Safety ....................2
Forms ....................3
JB1 – Enable/Disable the Denton 18 (1 of 1) ....................4
JB2 – Venting the Main Chamber (1 of 1) ....................5
JB3 – Removing and/or Installing Targets (1 of 3) ....................6
JB4 – Loading Samples (1 of 1) ....................9
JB5 – Pumping Down Main Chamber (1 of 1) ....................10
JB6 – DC Sputtering Procedures (1 of 5) ....................11
JB7 – RF Sputtering Procedures (1 of 3) ....................16
JB8 – Unloading Samples (1 of 1) ....................19
JR1 – HSC Data Collection (1 of 3) ....................20
Appendix ....................23
Revision History ....................24

## Reference Documents

| Reference Documents | Specification No. |
|---|---|
| NanoFab User Guide | HTTPS://WWW.NANOFAB.UTAH.EDU/DOCUMENTS/2016/02/SMBB-USER-GUIDE.PDF/ |

## Acronyms, Abbreviations and Definitions

| Term | Description |
|---|---|
| SOP | Standard Operating Procedure |
| JB | Job Breakdown |
| JR | Job Reference |

## Equipment and Supplies

| Description | |
|---|---|
| Denton 18 Sputter System | |
| Wafer/Sample | |
| Target | |
| Allen Wrench | |
| Liquid Nitrogen Dewar | |
| | |

## Safety

## Safety alert symbol

The Safety Alert Symbol is used in conjunction with signal words to convey a personal injury hazard is present.

## Signal words

| | |
|---|---|
| **DANGER** | Indicates an <u>imminently</u> hazardous situation, which if not avoided, will result in death or serious injury. The Safety Alert Symbol should always be used. |
| **WARNING** | Indicates a <u>potentially</u> hazardous situation, which if not avoided, may result in death or serious injury. If the safety alert symbol is NOT used in conjunction with this signal word, then the hazard conveyed is severe equipment or material damage. |
| **CAUTION** | Indicates a <u>potentially</u> hazardous situation, which if not avoided, may result in minor or moderate injury. If the safety alert symbol is NOT used in conjunction with this signal word, then the hazard conveyed is minor equipment or material damage. |

# Forms

## Training Form

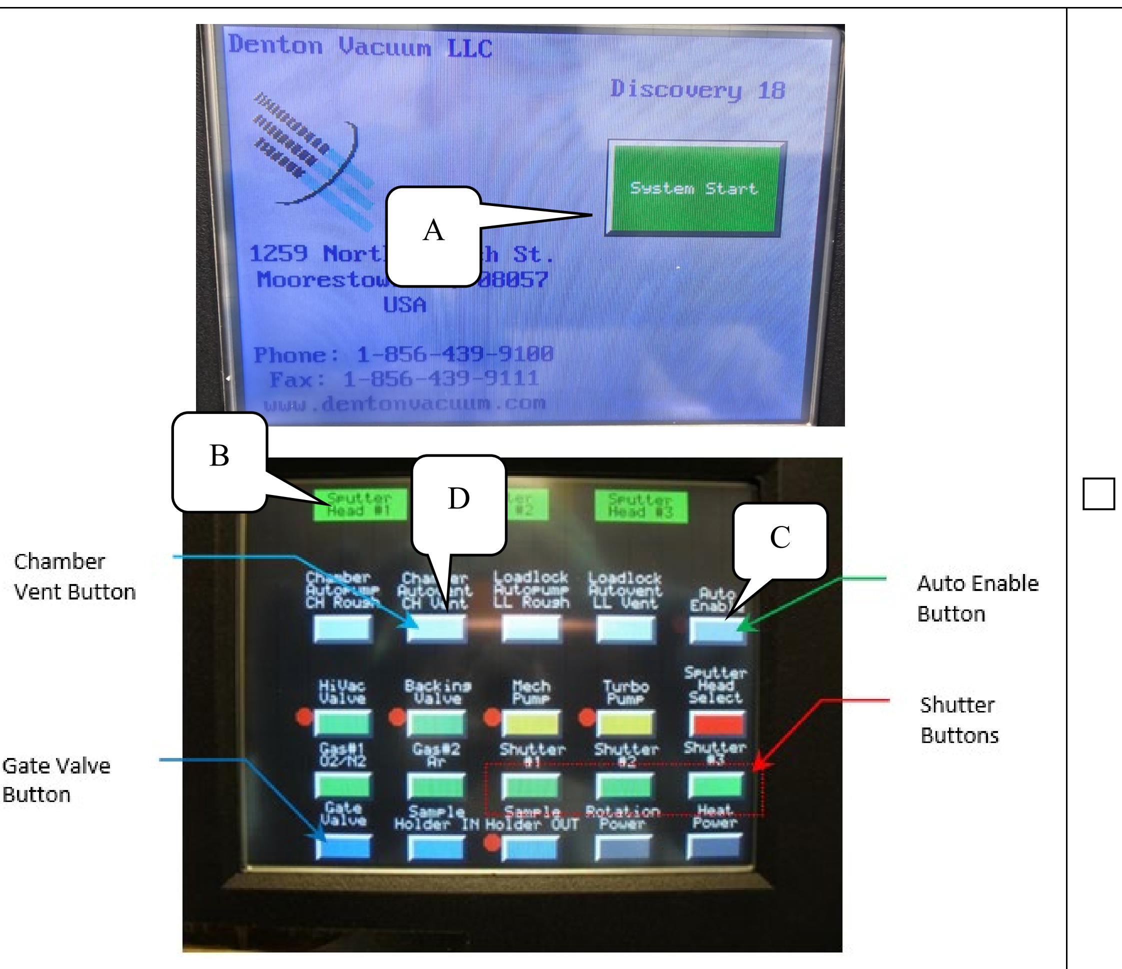
| Trainee: | | | |
|---|---|---|---|
| Area: | | | |
| This person has been declared qualified to train others ☐ *(check if "Yes")* | | | |
| Item # | Task | Date Training Completed | Trainer |
| 1 | Know the safety hazards of the tool | | |
| 2 | Enable & Disable tool using HSC | | |
| 3 | Know and agree to use HSC data collections, generate measurement samples. | | |
| 4 | Demonstrate venting and pumping main chamber. | | |
| 5 | Correctly remove and install targets, know the different types and details associated with installation/deinstallation. | | |
| 6 | Use the correct tools, tray, resistance check, adjustment tools, etc. | | |
| 7 | Know the conditions of the auto enable button, on vs. off. | | |
| 8 | Demonstrate gas flow set up | | |
| 9 | Demonstrate power set up | | |
| 10 | Demonstrate plasma ignition, pre sputter and deposition. | | |
| 11 | Demonstrate post deposition activities including locking and measuring samples. | | |

| Training Notes (Optional) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Run completion dates: | 1) | | 2) | | 3) | | 4) | | 5) | |

# JB1 – Enable/Disable the Denton 18 (1 of 1)

| | | | |
|---|---|---|---|
| **1.** | A. Log into HSC and navigate to the NanoFab Deposition dropdown. | | ☐ |
| **2.** | **A.** Select the Denton 18 Sputter.<br><br>**B.** Select the desired block of time. | | ☐ |
| **3.** | **A.** Send "Unlock" to the tool for starting.<br><br>**B.** Send "Lock" command for stopping. | | ☐ |

# JB2 – Venting the Main Chamber (1 of 1)

| | | | |
|---|---|---|---|
| **1.** | Put on a brand new pair of clean gloves. Do not touch the inside of the chamber or the targets or the samples with bare hands or dirty gloves.<br><br>A. Press the green System Start button on the touchscreen.<br><br>B. Make sure sputter power supplies are off and none of the sputter heads are selected. Sputter heads are green when off and red when on.<br><br>C. Make sure the AUTO ENABLE button is flashing on the control panel. If not, press it.<br><br>D. Press CHAMBER AUTOVENT button.<br><br>E. The lid will automatically rise when it is vented, carefully hold the lid so it does not rise too fast. |  | ☐ |

# JB3 – Removing and/or Installing Targets (1 of 3)

**1.**

*Note: If your sputtering target of choice is already installed. The target doesn't need to be removed or installed. Follow the appropriate Remove or Install steps for your conditions.*

**Remove Old Target:**

⚠ *The seal can be damaged by twisting or rocking the sputter head aggressively. Be careful to gently remove the dark shield with enough force to remove, but not damage the feedthrough seal. Be careful of pinch points and sharp objects.*

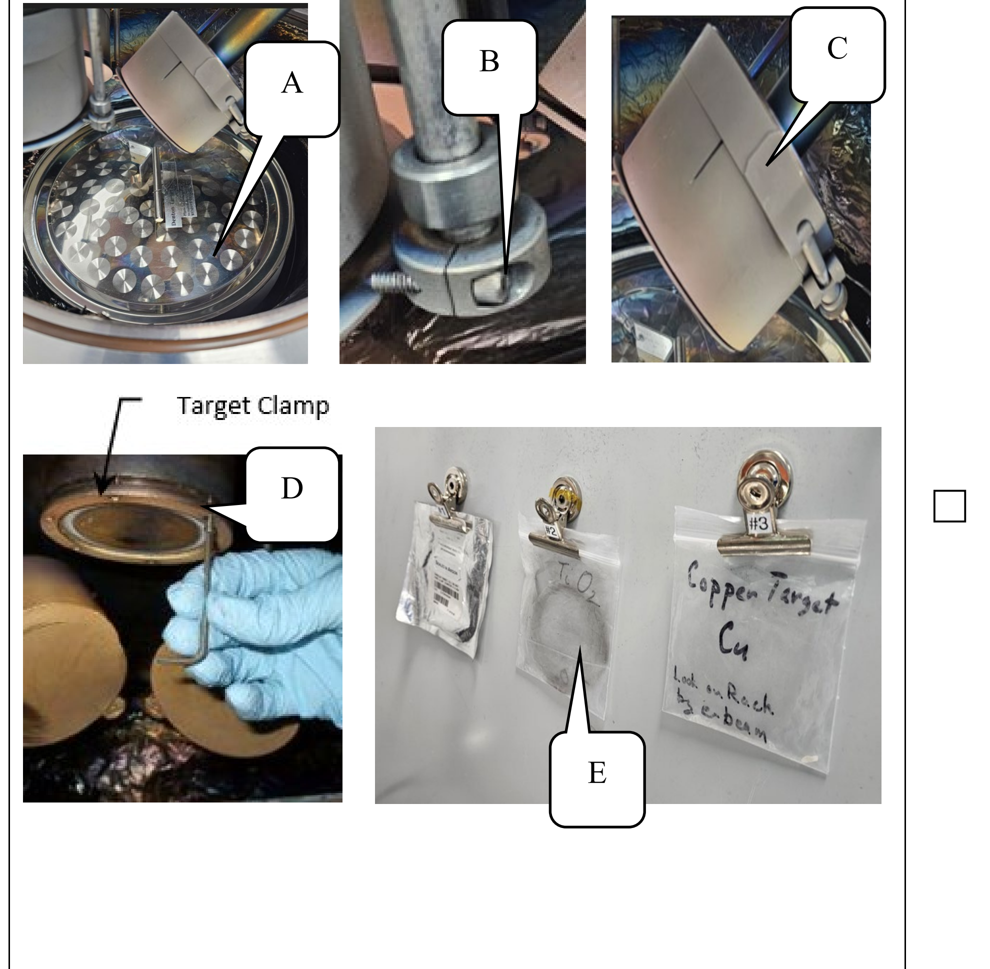
A. Place the catch tray into the bottom of the sputter.

B. Use an Allen wrench to loosen screws a couple of turns on both sides of the clamp. Place the shutter and all vacuum components on a clean sheet of aluminum foil.

C. Use the wing nut to carefully loosen and remove the dark shield.

D. Use an Allen wrench to remove the screws from the target clamp and remove the old target.

E. Place the old target in its corresponding bag and put it on the sputtering target shelf. The target bags for the tool are displayed on the side of the tool with respect to the appropriate cathode.




☐

# JB3 – Removing and/or Installing Targets (2 of 3)

**2.**

*Note: If your sputtering target of choice is already installed, the target doesn't need to be installed.*

**<u>Install New Target:</u>**

F. Insert new target into desired cathode for DC or RF sputtering. Only cathodes 1 and 2 have RF power supplied. All cathodes have DC power supplied.

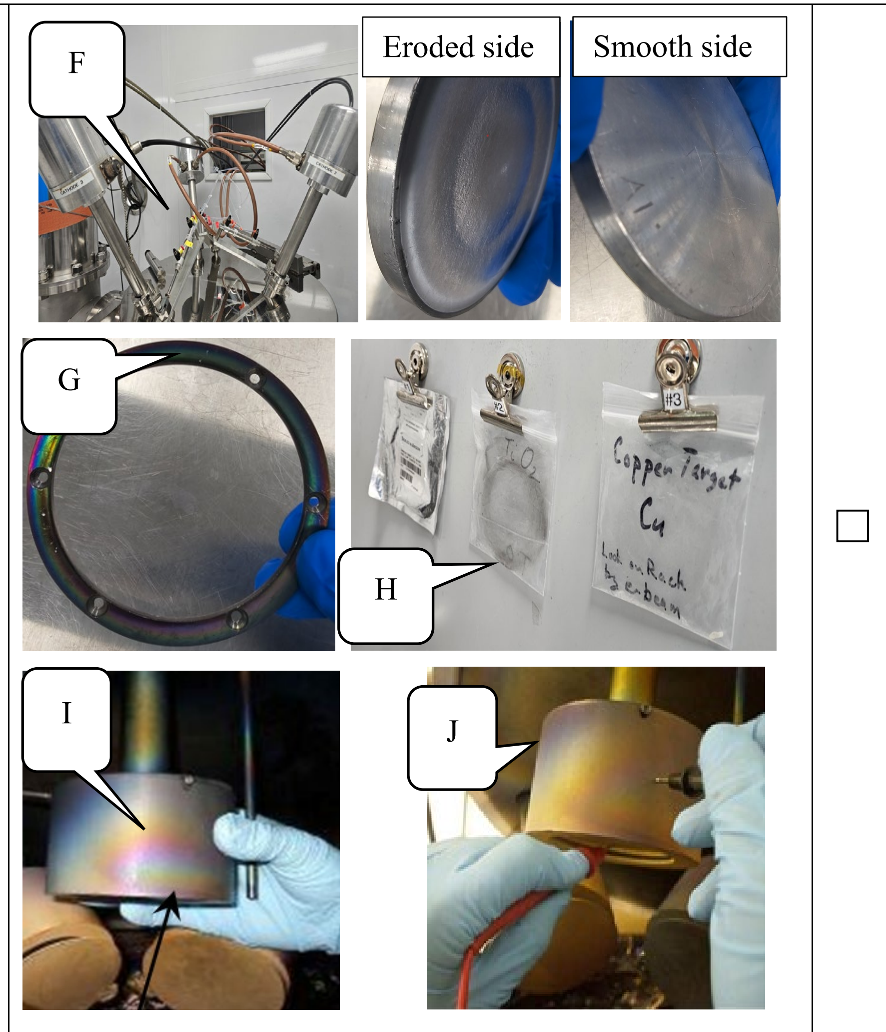
*Note: Make sure the smooth, flat side of the target is facing toward the sputter head so good heat conduction occurs. The eroded (used) circular pattern should be facing out.*

G. Put the target clamp over the new target in the sputter head and replace the screws and tighten them using the Allen wrench.

H. Put the new target's bag in the corresponding pouch on the side of the rack. The sputter head's number is located outside the chamber where the water and electrical contacts are made.

I. Replace the dark shield and tighten the three screws being careful not to over-tighten.

J. Do a resistance test by placing one of the leads on the dark shield and placing the other lead on the target clamp ring. The resistance should read around 1 MegaOhm. If it is less than 100 kOhm, the target and the dark shield may be shorted. You should remove and then reinstall the dark shield with a larger gap between it and the target until the resistance is around 1 MegaOhm.




☐

# JB3 – Removing and/or Installing Targets Continued (3 of 3)

**3.**

K. Replace the shutter and open and close it a few times (SHUTTER button on the control panel) to ensure it completely covers the target when the shutter is closed.

L. To test the shutter, make sure the AUTO ENABLE light is not blinking.

M. Press the SHUTTER button corresponding to the cathode number to open/close it.

N. Test the open and close shutter buttons making sure there is no drag between the shutter and the dark shield. The gap between the shutter and dark shield should be no larger than a ¼ inch.

O. When testing is complete, close the shutter.

P. Repeat JB3 for any other new targets you want to install.

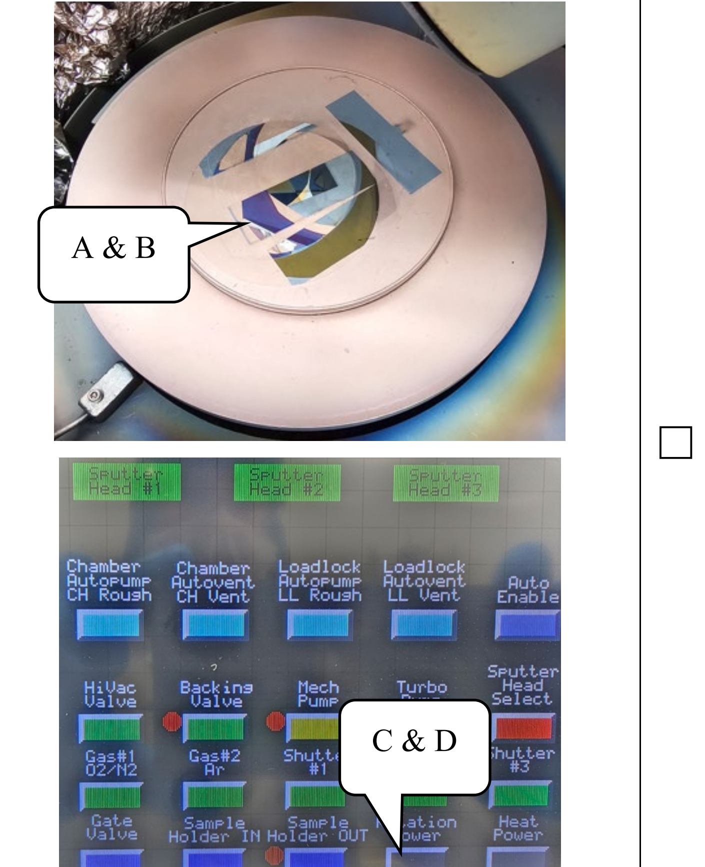
Q. Remove the catch tray when target installations are completed

R. If the inside of the machine is dirty, vacuum it.

S. Clean around the machine to remove dust that could harm your work.

☐

# JB4 – Loading Samples (1 of 1)

| Step | Instructions | Images | Check |
|---|---|---|---|
| **1.** | A. Place the 6” sample holder in the round groove in the center of the main chamber.<br><br>B. Place your clean, dry samples on the 6” sample holder.<br><br>C. Test the sample rotation by pressing the ROTATION POWER button (AUTO ENABLE light must be off).<br><br>D. Turn off the ROTATION POWER after testing it. |  | ☐ |

# JB5 – Pumping Down Main Chamber (1 of 1)

**1.**

A. Check the Cryopump monitor. If it is greater than 20 degrees Kelvin do not continue, contact staff.

B. Ensure the turbo controller is on and the light is green, if not, contacts staff.

C. Close the lid to the main chamber and latch it in place.

⚠ *Be careful of pinch points when closing the lid. The latch will open once under vacuum. Do not close it under vacuum.*

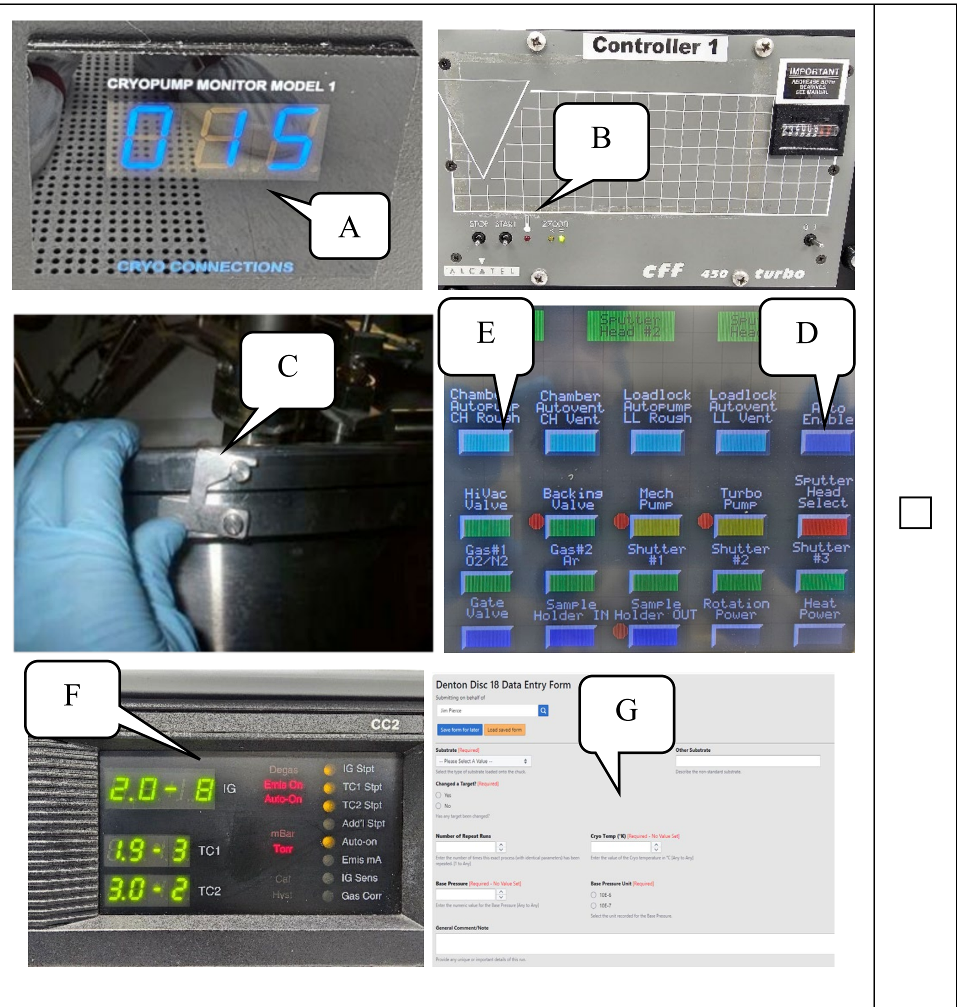
D. Make sure the AUTO ENABLE light is blinking. If not, press the AUTO ENABLE button.

E. Press the CHAMBER AUTOPUMP button. The system will automatically rough down the chamber and open the Hi-Vac valve and Gate Valve. The ion gauge will come on automatically once conditions are met.

F. Ensure the TC and IG pressures are displaying before leaving the tool. This process can take up to 15 minutes, but will take longer to achieve the desired base pressure.

G. Prepare to gather required HSC data collections.

H. Choose the desired sputtering method (DC or RF) and proceed to the appropriate JB6 6 for DC and JB7 for RF.




☐

# JB6 – DC Sputtering Procedures (1 of 5)

**1.**

*Note:*

- *For best results wait until the base pressure (ion gauge green pressure readout) reads at less than 2 x 10 ^-6 Torr before sputtering. Higher pressures may oxidize metallic films.*
- *The base pressure and the pump down time to be recorded in HSC at disable.*
- *The red pressure readout meter should be zeroed once the process pressure is reached. To zero the readout hold the 'zero' button down for 3 seconds.*

**Start Argon Flow**

A. Turn off the AUTO ENABLE button, so it is not blinking.

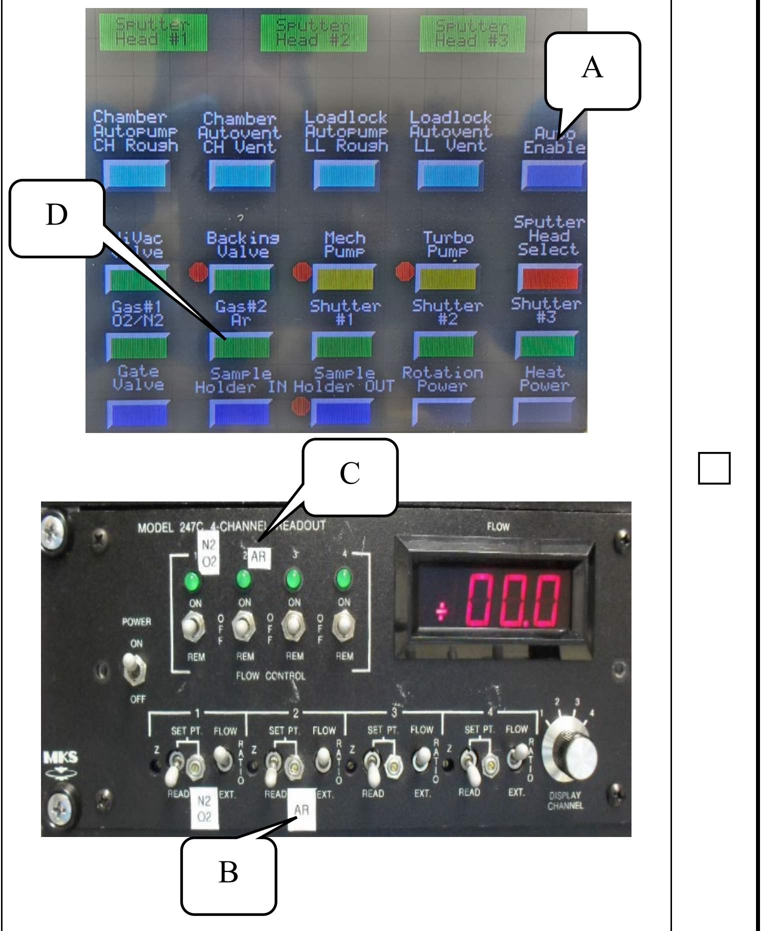
B. Set argon gas flow rate to 40% by holding the #3 toggle switch in the SET PT. position and turning the adjustment screw to the right of the toggle switch..

*NOTE: The MFC is rated at 200 SCCM so a set point of 40% would be a flow rate of 80 SCCM.*

C. Turn on the Argon FLOW CONTROL toggle switch on the flow control panel.

D. Press the GAS 2 button on the touchscreen to start the argon flow.

*NOTE: The pressure readout on the red pressure readout meter and the green ion gauge should go up.*




☐

# JB6 – DC Sputtering Procedures (2 of 5)

| | | | |
|---|---|---|---|
| 2. | E. Select desired sputter target material by pressing the SPUTTER HEAD SELECT button to toggle through the three different heads.<br>F. Turn on the MDX 1.5 K power supply.<br>G. Press the SET PT button and rotate the LEVEL knob to select the desired sputter power.<br>H. Turn on the ROTATION POWER button to start the samples rotating for more uniform sputter thickness. | | ☐ |

# JB6 – DC Sputtering Procedures (3 of 5)

**3.**

**Pre-sputter**

I. Ignite the plasma by pressing the OUTPUT ON button.

J. Press the RIGHT DISPLAY ACTUAL button a few times to toggle through the power, voltage, and current, to make sure you are sputtering with the right power settings.

K. If the voltage is high (approx 1200 V), this means that the plasma did not ignite. Do the following:

   a. Open the appropriate shutter then quickly close the shutter.

   b. If the voltage drops, the plasma ignited, continue pre-sputter, if not press OUTPUT OFF and contact lab staff.

   Allow the target to sputter with the shutter closed for about a minute to clean any oxides or absorbed contaminants off the surface of the target.

☐

# JB6 – DC Sputtering Procedures (4 of 5)

| | | | |
|---|---|---|---|
| 4. | **DC Sputter**<br>L. Note the deposition pressure, time, power, and other parameters for HSC data collections. After deposition, please note the measured thickness and sheet resistance of the material.<br>M. Open the shutter by pressing the SHUTTER # button that corresponds to the target you are sputtering from.<br>N. Let the system run for the desired sputter deposition time. There is no automatic timer to shut off the system.<br>O. Press the OUTPUT OFF button on the MDX power supply when the deposition time is reached.<br>P. Close the shutter by pressing the SHUTTER number button that corresponds to the target you have been sputtering.<br>Q. If another material is to be deposited on top of the current sample, follow the appropriate Job Breakdown. | | ☐ |

# JB6 – DC Sputtering Procedures (5 of 5)

**5.**

**<u>Shutdown</u>**

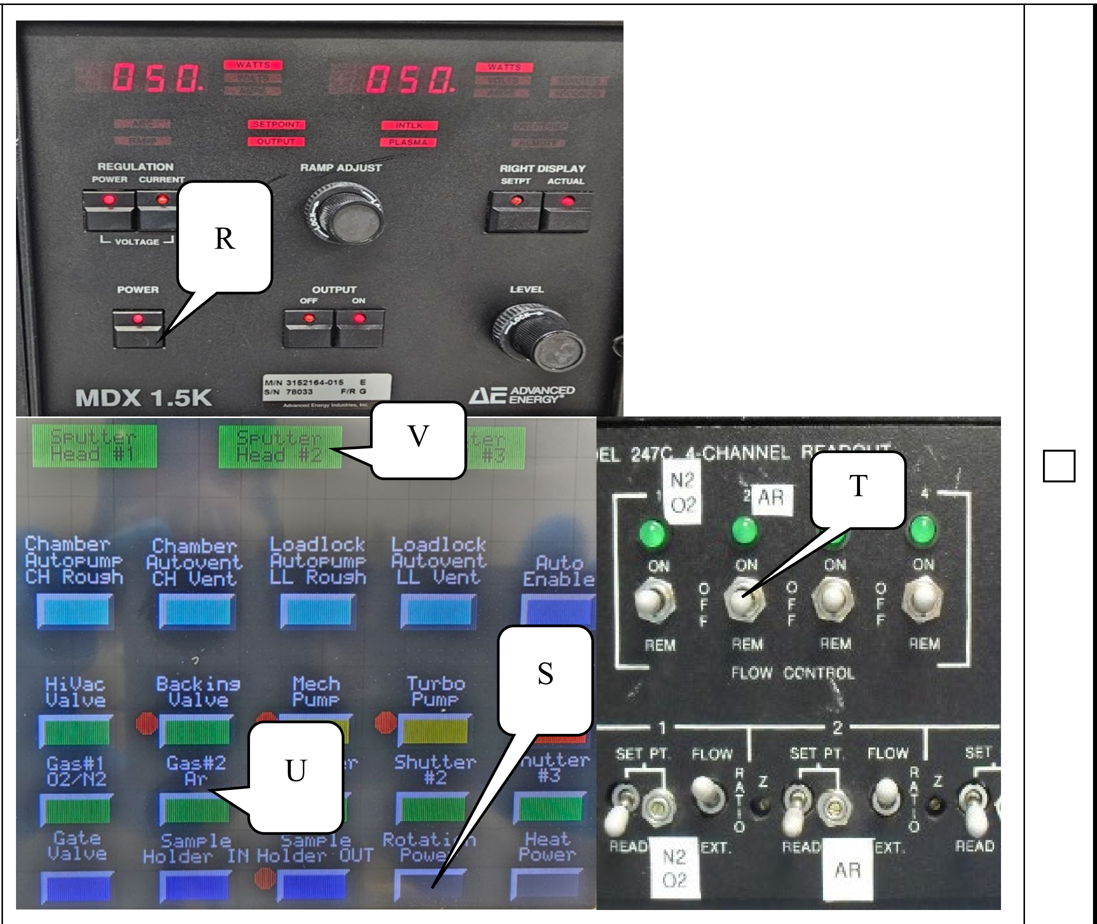
R. Turn off the MDX 1.5 K power supply.

S. Turn off Rotation Power.

T. Turn off Argon flow.

U. Turn off Gas 2.

V. Toggle through Sputter Head Select until none of them are selected.




☐

# JB7 – RF Sputtering Procedures (1 of 3)

**1.**

**Set up RF Sputter Parameters**

A. Turn on the RF power supply and tuning power supply that corresponds to the target you are going to sputter from (either cathode 1 or cathode 2).

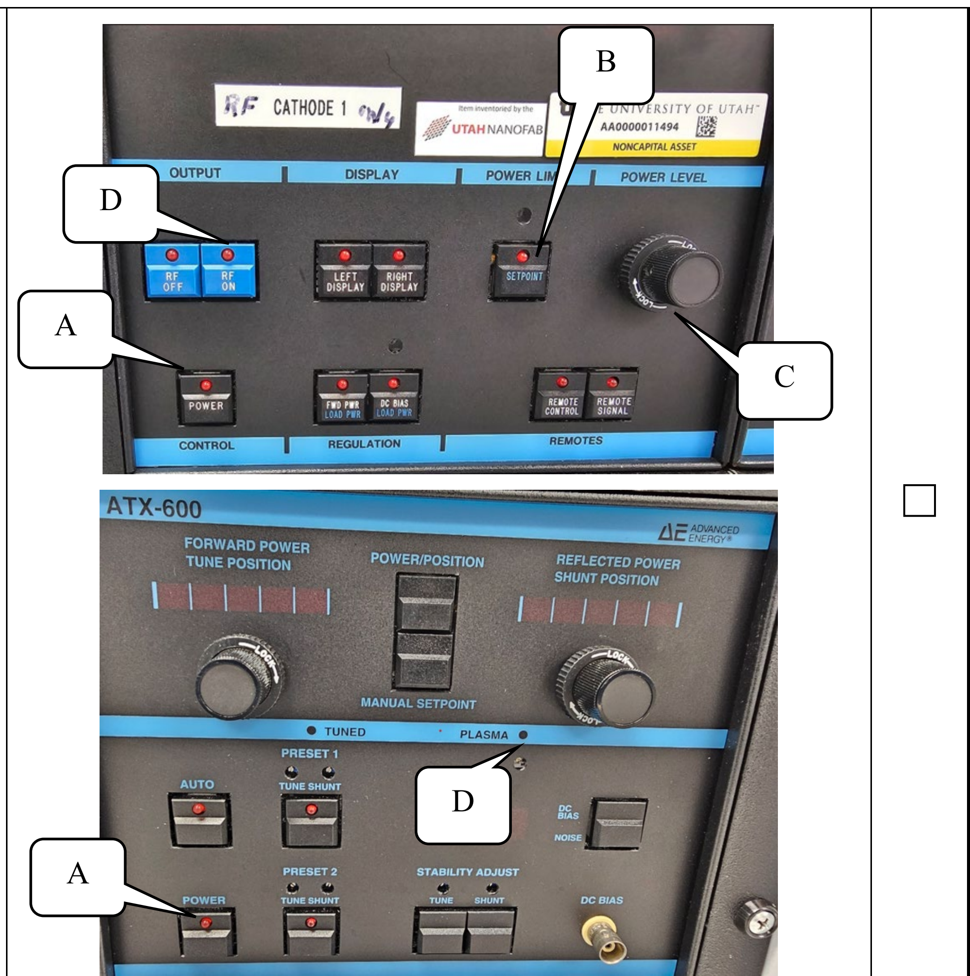
B. Press the SET PT button and rotate the LEVEL knob to select the desired sputter power.

C. Turn on the ROTATION POWER button to start the samples rotating for more uniform sputter thickness.

**Pre-sputter**

D. Ignite the plasma by pressing the RF ON button on the RF power supply. The tuning power supply will show if the plasma has ignited. If not, press the HI VAC valve to close it and allow the Argon pressure to build in the chamber. The plasma should ignite at about 110 mTorr (0.11 Torr) on the TC1 display. Press the HI VAC valve again to open it and allow the pressure to stabilize at the desired sputter pressure. DO NOT allow the TC1 pressure to exceed 140 mTorr or you will not be able to open the HI VAC valve until you do chamber autopump.

E. Allow the target to sputter with the shutter closed for about a minute to clean any absorbed contaminants off the surface of the target.




☐

# JB7 – RF Sputtering Procedures (2 of 3)

**2.**

**RF Sputter**

F. Note the deposition pressure, time, power, and other parameters for the HSC data collection form. After deposition, please note the measured thickness and sheet resistance of the material you sputtered.

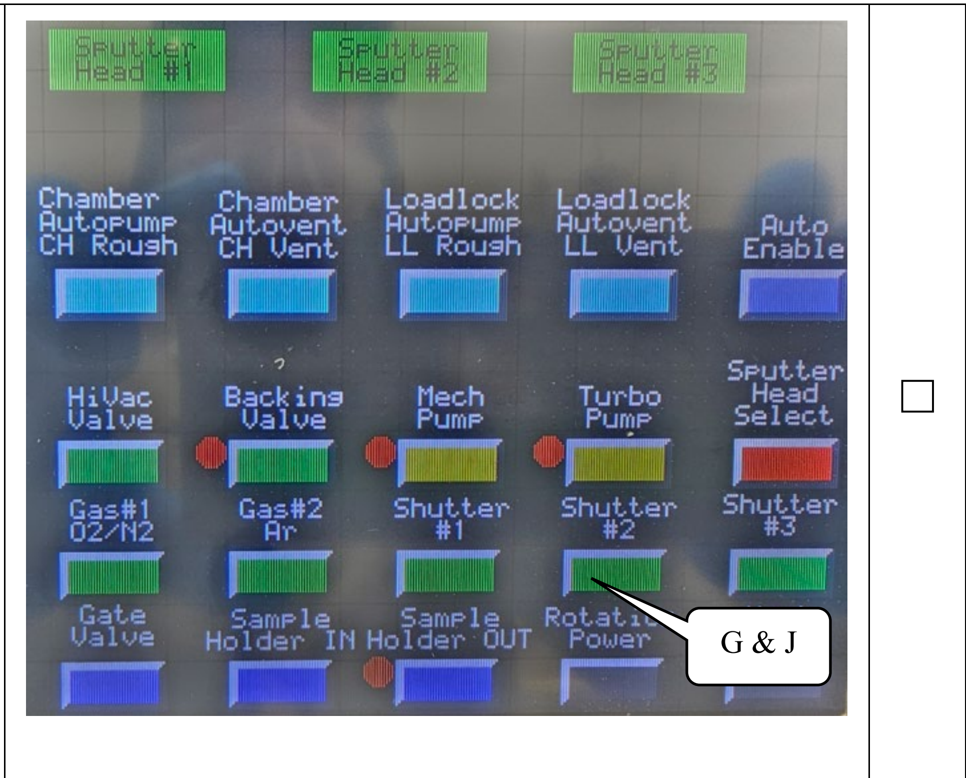
G. Begin sputtering on your samples by opening the shutter by pressing the SHUTTER # button that corresponds to the target you are sputtering from. Make sure the light turns on.

H. Let the system run for the desired sputter deposition time. There is no automatic timer to shut off the system.

I. Press the RF OFF button on the RF power supply when the deposition time is reached.

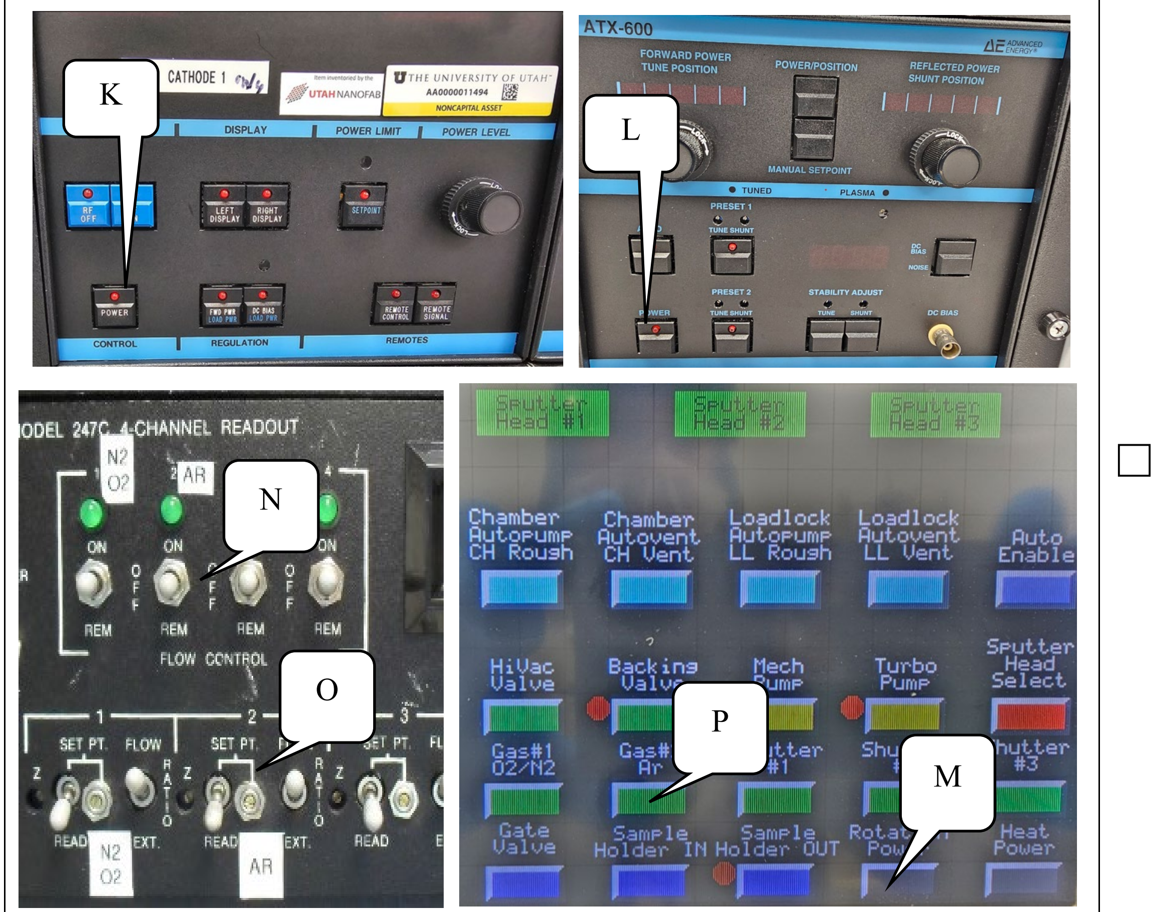
J. Close the shutter by pressing the SHUTTER # button that corresponds to the target you have been sputtering.

If another material is to be deposited on top of the current samples, follow the appropriate Job Breakdown for DC or RF sputtering




☐

# JB7 – RF Sputtering Procedures (3 of 3)

| | | | |
|---|---|---|---|
| 3. | **Shutdown**<br>K. Turn off power supplies.<br>L. Turn off the RF power supply and the tuning power supply.<br>M. Turn off Rotation Power.<br>N. Turn off Argon flow.<br>O. Turn off switch 2 on the flow control panel.<br>P. Turn off Gas 2.<br>Q. Continue to JB8 – Unloading Samples. |  | ☐ |

# JB8 – Unloading Samples (1 of 1)

| | | | |
|---|---|---|---|
| **1.** | A. Vent Main Chamber refer to JB2<br>B. Remove your samples and return the holder to the sputter tool.<br>C. Pump down the sputter tool refer to JB5.<br>D. Lock the tool in HSC refer to JB1.<br>E. Enter your run data and lock the Denton Discovery 18 Sputter system in HSC. | A<br>C<br>B | ☐ |

# JR1 – HSC Data Collection (1 of 3)

## Denton Disc 18 Data Entry Form

Submitting on behalf of

Jim Pierce

Save form for later | Load saved form

**Substrate** [Required]

-- Please Select A Value --

Select the type of substrate loaded onto the chuck.

**Other Substrate**

Describe the non-standard substrate.

**Changed a Target?** [Required]

- Yes
- No

Has any target been changed?

**Number of Repeat Runs**

Enter the number of times this exact process (with identical parameters) has been repeated. [1 to Any]

**Cryo Temp (°K)** [Required - No Value Set]

Enter the value of the Cryo temperature in °C [Any to Any]

**Base Pressure** [Required - No Value Set]

Enter the numeric value for the Base Pressure [Any to Any]

**Base Pressure Unit** [Required]

- 10E-6
- 10E-7

Select the unit recorded for the Base Pressure.

**General Comment/Note**

Provide any unique or important details of this run.

## Sputter Material 1 Parameters

**Layer 1 Material** [Required]

-- Please Select A Value --

Select the material of the Target used.

**Other Target Material**

Describe the non-standard target used for the sputtered film.

**Power Supply** [Required]

- DC
- RF1
- RF2

Select the Power Supply used for this material.

**Pre-Sputter Time (min)** [Required - No Value Set]

Enter the Pre-Sputter time in minutes [Any to Any]

**Sputter Time (min)** [Required - No Value Set]

Enter the time the material was sputtered in minutes [Any to Any]

**Sputter Power (W)** [Required - No Value Set]

Enter the power used to sputter the material in Watts [Any to Any]

**Argon Sputter Pressure (mTorr)** [Required - No Value Set]

Enter the pressure of the Argon Sputter in mTorr [Any to Any]

**Argon Flow (%)** [Required - No Value Set]

Enter the Argon Flow in percent. [Any to Any]

**Oxygen Flow (%)**

Enter the Oxygen flow in percent. [Any to Any]

**Material 1 Precious Metal Target Use**

If a precious metal target was used for this material, select it below and enter the applicable data to assign the appropriate charges.

Gold

Indium

Palladium

Platinum

# JR1 – HSC Data Collection (2 of 3)

## Sputter Material 2 Parameters

**Layer 2 Material** [Required]

-- Please Select A Value --

Select the material of the Target used.

**Other Target Material**

Describe the non-standard target used for the sputtered film.

**Pre-Sputter Time (min)**

Enter the Pre-Sputter time in minutes [Any to Any]

**Sputter Time (min)**

Enter the time the material was sputtered in minutes [Any to Any]

**Sputter Power (W)**

Enter the power used to sputter the material in Watts [Any to Any]

**Argon Sputter Pressure (mTorr)**

Enter the pressure of the Argon Sputter in mTorr [Any to Any]

**Argon Flow (%)**

Enter the Argon Flow in percent. [Any to Any]

**Oxygen Flow (%)**

Enter the Oxygen flow in percent. [Any to Any]

**Material 2 Precious Metal Target Use**

If a precious metal target was used for this material, select it below and enter the applicable data to assign the appropriate charges.

Gold

Indium

Palladium

Platinum

## Sputter Material 3 Parameters

**Layer 3 Material** [Required]

-- Please Select A Value --

Select the material of the Target used.

**Other Target Material**

Describe the non-standard target used for the sputtered film.

**Pre-Sputter Time (min)**

Enter the Pre-Sputter time in minutes [Any to Any]

**Sputter Time (min)**

Enter the time the material was sputtered in minutes [Any to Any]

**Sputter Power (W)**

Enter the power used to sputter the material in Watts [Any to Any]

**Argon Sputter Pressure (mTorr)**

Enter the pressure of the Argon Sputter in mTorr [Any to Any]

**Argon Flow (%)**

Enter the Argon Flow in percent. [Any to Any]

**Oxygen Flow (%)**

Enter the Oxygen flow in percent. [Any to Any]

**Material 3 Precious Metal Target Use**

If a precious metal target was used for this material, select it below and enter the applicable data to assign the appropriate charges.

Gold

Indium

Palladium

Platinum

# JR1 – HSC Data Collection (3 of 3)

## Measurement Results

**Measurement Sites**

1
2 3 4
5

T
L C R
B

**Film Thickness Unit**

- Angstrom (Å)
- Nanometer (nm)
- Micron (µm)

Select the unit for the Measured Thickness Value

**Film Thickness, Site 1**

Enter the measured value of the thickness for site 1 [Any to Any]

**Sheet Resistance, Site 1 (ohm/sq)**

Enter the measured value of the Sheet Resistance for Site 1 (in ohm/sq) [Any to Any]

**Film Stress (MPa)**

Enter the measured value of the Film Stress (in MPa) [Any to Any]

**Film Thickness, Site 2**

Enter the measured value of the thickness for site 2 [Any to Any]

**Sheet Resistance, Site 2 (ohm/sq)**

Enter the measured value of the Sheet Resistance for Site 2 (in ohm/sq) [Any to Any]

**Film Thickness, Site 3**

Enter the measured value of the thickness for site 3 [Any to Any]

**Sheet Resistance, Site 3 (ohm/sq)**

Enter the measured value of the Sheet Resistance for Site 3 (in ohm/sq) [Any to Any]

**Film Thickness, Site 4**

Enter the measured value of the thickness for site 4 [Any to Any]

**Sheet Resistance, Site 4 (ohm/sq)**

Enter the measured value of the Sheet Resistance for Site 4 (in ohm/sq) [Any to Any]

**Film Thickness, Site 5**

Enter the measured value of the thickness for site 5 [Any to Any]

**Sheet Resistance, Site 5 (ohm/sq)**

Enter the measured value of the Sheet Resistance for Site 5 (in ohm/sq) [Any to Any]

**Resistivity (uOhm-cm)**

Enter the measured value of the Sheet Resistance for Site 5 (in ohm/sq) [Any to Any]

**Measurement Comment**

Record any unique, important, or application information for any measurement of the deposited film(s).

## Staff Support

**Staff Support**

Click HERE to enter charges for Staff Support.

(Invalid/Missing Fields) | Save form for later | Load saved form

# Appendix

### Typical Film Characteristics

### Add Liquid Nitrogen

A. Fill dewar with LN2 from the tank by the Oxford 100.

B. Carry dewar back to clean room and slowly pour LN2 into metal funnel until 1/3 full. Funnel is on the back of the Denton sputter machine. See **Error! Reference source not found.**.

C. Continue to add LN2 as needed.

# Revision History

| Rev | Author | Date | Description of Change |
|---|---|---|---|
| F | Jim Pierce | 09 Sept 2024 | Update SOP format, added Training Form for training. |
| E | Kevin Hensley | 29 Nov 2011 | Ion gauge procedure, MFC change, and pressure readout |
| D | Kevin Hensley | 04 Aug 2011 | Changed gate valve instructions |
| C | Sam Bell | 12 Jul 2011 | Added instructions for cryopump and new touchscreen |
| B | Sam Bell | 15 Apr 2011 | Deleted load lock instructions |
| A | Sam Bell | 19 Jan 2010 | Initial |