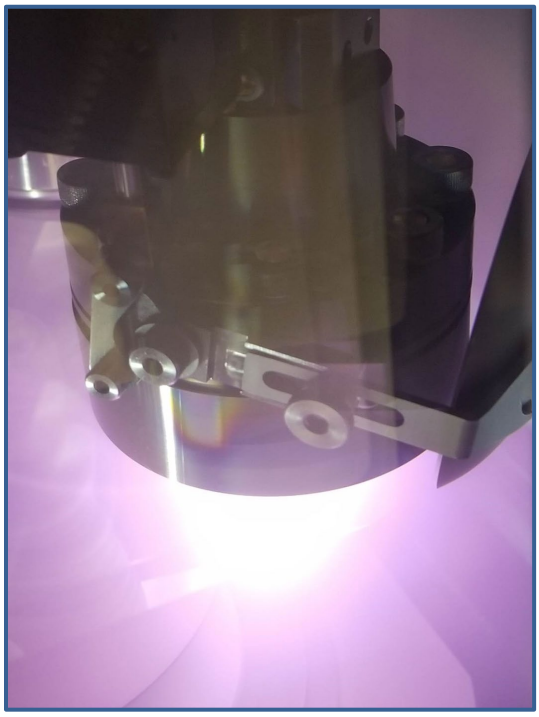
Knowledge Enterprise Development
Arizona State University

Arizona State University NanoFab

LESKER #1 SPUTTERER STANDARD OPERATION PROCEDURE

Rev I



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1.0 Purpose / Scope

1.1 This document covers the procedure that should be followed for normal operation of the Lesker PVD75 sputter coater for the purpose of depositing metals & dielectrics on substrate materials that might be used for research purposes. It is suggested that you review this document thoroughly before proceeding with the operation of this tool & always check with staff when using a new target material, to verify if special precautions need to be taken for safety or cross contamination issues.

2.0 Reference Documents

2.1 Chemical Safety & Hazardous Waste Management Rules & Procedures Handbook

2.2 PVD Series Operation Manual

2.3 Kurt J Lesker Circular Sputtering Source Torus 3" HV operations manual

3.0 Equipment / Supplies

3.1 Clean wipes

3.2 Touch screen stylus

3.3 Tweezers/Kapton tape.

3.4 Follow safety and handling procedures when working with vacuum systems and target materials.

3.5 Please do not perform maintenance on the Sputterer tool. Notify staff in event of issues.

4.0 Tool Reservation Policies

4.1 Scheduling for Lesker1 Sputterer occurs from 8am to 11am, from 11am to 2pm and from 2pm to 5pm during business hours.

4.2 Scheduling can only take place two consecutive three-hour segments per person or the same group of persons operating the tool for fairness to the other users.

4.3 Only trained users will be allowed to use this equipment.

4.4 Recommended to schedule your runs to secure you scheduling and to alert other potential users of the tool.

4.5 Our NanoFab 15-Minute rule.

4.5.1 Please start within 15 minutes of your equipment scheduled time or the tool becomes available to anyone. Place a 'Tool in Use' tag to indicate use.

4.5.2 Please have the equipment available for the next user within 15 minutes after your scheduled time.

4.6 Cancellations.

4.6.1 If you cannot meet the equipment schedule, please cancel your iLabs schedule to allow other users to utilize the equipment.

4.6.2 Scheduling on iLabs allows cancellation within 24 hours of your scheduled time. Please email staff if cancellation within 24 hours.

4.7 Scheduling Overnight runs.

4.7.1 Please complete overnight runs by the following morning at 8am.

6.0 Targets and Magnetron Guns

6.1 Please request targets for an upcoming scheduled run 24 hours ahead of time. 'Target requests' would be done using iLabs service requests.

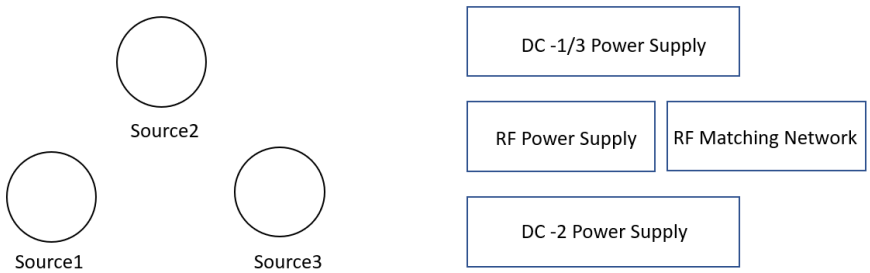
6.1.1 Please do not perform the swapping of the targets or the DC/RF cables.

6.2 The Lesker1 Sputterer will allow materials such as Au, Ag, Cu and ITO.

6.3 Please request by iLabs service request for the loan of our Au target. We will loan the target at the current rate of $80/gram during our business hours. Please give us a 24-hour notice. The target will be under your responsibility.

6.4 This tool has the capability to run reactive films using O2 and N2 gases.

6.5 Three DC & RF Magnetron guns on this tool allows for multi layers.



6.6 DC power for metallic targets. RF power for dielectric or ceramic films.

6.7 DC Dep Rates- Recommended 1.0 Å/sec unless 0.5 Å/sec for bonded targets.

6.8 RF Dep Rates- Please do not exceed 0.5 Å/sec.

6.9 Please allow gun cooling for films that exceed 500nm film thickness.

6.10 Substrate size limited to 5.5 inches in diameter.

Lesker1 Sputterer Materials

Approved Target Materials	Approved Target Materials
Ag	Si
Al	SiC
Au	SiO2
Cr	Ta
Cu	TaN
Hf	Ti
ITO	TiN
Nb	TiO2
NbN	W
Ni	Zr

7.0 Operation Procedures

Note: It is recommended to monitor your Sputterer depositions during DC/RF power, but please remain in the fab. You will be responsible to complete your own processing runs.

7.1 Use the touch screen user interface to control settings.

7.2 Note: You will be required to reduce the turbo speed to 50% to either perform the Vent or deposition processing.

7.3 **Vent chamber.**

7.3.1 On Vacuum screen, view the chamber pressure and the current turbo speed.

7.3.2 Set Turbo speed target to 50% to allow you to Vent.

7.3.2.1 On VAC screen, enter 50% Turbo speed if not at 50%. Insure you do not turn Off the turbo pump.

7.3.2.2 On the GAS screen, depress Gas Injection button to ON (Green).

7.3.2.3 On the GAS screen, enter 4.0 (mTorr) SETP pressure.

7.3.2.4 On the GAS Screen, depress the Ar gas CNTL button to ON (Green).

7.3.3 Monitor Turbo screen for actual Turbo pump speed to 50%.

7.3.4 Turn OFF gas flow to prepare for Vent.

7.3.5 On the GAS screen, Depress Gas Injection button to Off (Green).

7.3.6 On RECIPE screen, Depress Vent button.

7.3.7 Open chamber when Vent Done button is displayed and the chamber is at ATM.

7.4 **Chamber preparation.**

7.4.1 Please insure the mylar viewport protective film is clear.

7.4.2 Inspect chamber for particles or flakes. Vacuum if present.

7.4.3 On the SUBST screen, Open Substrate shutter.

7.4.4 Load substrate(s) on wafer platen. No need to clip or Kapton tape samples down.

7.4.5 On the SUBST screen, Close the Substrate shutter. Please note any possible clearance issues.

7.4.6 On SQM Crystal controller, depress XTAL life button to get life remaining on XTAL. If less than 60% XTAL life remaining, notify engineering.

7.4.7 Close chamber door. Please Ensure the substrate shutter is closed.

7.5 **Pumpdown of Chamber.**

7.5.1 On the RECIPE Screen, Depress the Pumpdown button.

7.5.1.1 Push and hold the chamber door until pressure reading drops.

7.5.2 Annotate the pumpdown start and end time to 5.0e-5Torr pressure.

7.5.3 Monitor pressure to reach at least 5.0e-5Torr pressure for processing. Lower pressures can be used for more quality films.

7.5.4 Update NanoFab run log with material information. (Target position, ID, Target thickness, pump down time, base pressure and enter the current three targets).

7.5.5 Update material program on SQM-160 Crystal controller.

7.5.6 Enter correct material, density, tooling factor and Z ratio parameters.

7.5.6.1 Use Program & Next & rotation knob to update material parameters.

7.5.6.2 Note the different Tooling factors for guns 1 & 2 & 3.

7.5.7 Pumpdown recipe completed at 5.0e-5Torr. Depress OK. You may continue to pump the chamber to lower pressures.

Note: You may leave the fab during the chamber pump downs. But you will be required to remain in the fab during tool RF or DC power operation.

7.6 **Set the turbopump to 50% and gas settings for Processing**

7.6.1 Set Turbo speed target to 50% using gas flows

7.6.1.1 On VAC screen, enter 50% Turbo speed if not at 50%. Insure you do not turn Off the turbo pump.

7.6.1.2 On the GAS screen, depress Gas Injection button to ON (Green).

7.6.1.3 On the GAS screen, enter 4.0 (mTorr) SETP pressure.

7.6.1.4 On the GAS Screen, depress the Ar gas CNTL button to ON (Green).

7.6.2 On VAC screen, monitor Turbo speed to get to 50%.

7.7 **RF Back Sputter Process- Optional to pre-clean your substrates.**

7.7.1 Set Turbo at 50%, at selected pressure and that gas flows are ON (See section 7.6).

7.7.2 Turn ON Substrate Rotation on the lower panel On/Off switch. Rotation set 30rpm

7.7.3 On Subst display, Depress SBST to open your substrate shutter.

7.7.4 Turn ON black power button on lower RF power supply

7.7.5 Turn ON RF ON/OFF button. Light should be Blue when OFF. RED when ON.

7.7.6 To strike an RF plasma, increase process pressure to 15mTorr on the Gas display.

7.7.6.1 Slowly increase the RF power initially to 50W using the up-arrow key. View for an RF plasma on gun.

7.7.6.2 Reduce the process pressure back to 4mTorr on the gas display screen.

7.7.7 Adjust the Seren manual matching Load knob to minimize the reflected power.

7.7.8 Watch Timer as Sputter starts. The etch rate of thermal SiO2 is @2.2 nm/min.

7.7.9 When completed, turn down RF power to 0W.

7.7.10 Turn OFF RF ON/Off button and the black power button on RF power supply.

7.7.11 Close substrate shutter.

7.8 **Deposition using DC Magnetron for Metallic materials.**

7.8.1 Set Turbo at 50%, at selected pressure and that gas flows are ON (See section 7.6).

7.8.2 Turn ON Substrate Rotation on the lower panel On/Off switch. Rotation set 30rpm.

7.8.3 On the DEP screen, Depress Flow SW button to Open to your intended gun shutter.

7.8.4 Select the DC power supply (DC 1/3 or DC 2) based on the gun you use.

7.8.5 Depress Power button to ON, on the DC power supply.

7.8.6 Depress DC power supply Output to ON, on the DC power supply.

7.8.7 On the Right Display button, select Actual Power and Volt parameters to view.

7.8.8 Slowly ramp-up Level knob to desired dep rate for Metal materials.

7.8.9 IMPORTANT. If gun does not turn ON and has abnormally high or low voltage, please turn OFF the power supply and notify engineering staff if so.

7.8.10 Watch for dep rate on the SQM-160 XTAL monitor.

7.8.11 Verify gun power operation through the chamber viewport.

7.8.12 It is recommended to first perform a target clean for two mins.

7.8.13 START of DC Magnetron gun processing.

7.8.13.1 On SUBST screen, depress SBST shutter to Open shutter (Green).

7.8.13.2 Depress SQM-160 controller Zero button to zero thickness.

7.8.14 Monitor processing through to your target thickness on XTAL controller. Watch the viewport, watch for stability of the power and voltage.

7.8.15 Record gun process conditions on the NanoFab run log when halfway through process (Dep Rate, Base and Dep pressure, Power, Voltage and Current).

7.9 **COMPLETION of DC Magnetron gun processing**.

7.9.1.1 On SUBST screen, depress SBST shutter to close the substrate shutter.

7.9.1.2 Ramp down the power level on the DC power supply.

7.9.1.3 Turn Off the power supply button.

7.9.2 If you are processing multiple layers, proceed back to step 7.6.

7.9.3 Turn OFF gas flows.

7.9.3.1 On DEP screen, depress the gun FLOW Switch to close gun shutter.

7.9.3.2 On GAS screen, Depress Gas Injection button to Off (Green).

7.9.4 Turn OFF the Substrate Rotation on the lower panel ON/Off switch.

7.9.5 Once completed, allow the gun 5 minutes to cool off before Venting the chamber.

7.9.6 Vent the chamber. Otherwise start next layer.

7.9.6.1 On the Vacuum screen, Depress Vent button on Vacuum Screen.

7.9.7 Pumpdown the chamber after processing. Depress the Pumpdown button on the RECIPE screen. Push and hold the chamber door until pressure reading drops.

7.9.8 Please complete your process on the NanoFab run log.

7.10 **Deposition using RF Magnetron for Dielectric or ceramic materials.**

7.10.1 Set Turbo at 50%, at selected pressure and that gas flows are ON (See section 7.6).

7.10.2 Turn ON Substrate Rotation on the lower panel On/Off switch. Rotation set 31rpm.

7.10.3 Determine your intended material, gun and power source for you layer(s).

7.10.4 On the DEP screen, Depress Flow SW button to Open on your intended gun shutter.

7.10.5 Select Lesker RF power supply and auto match network.

7.10.6 Depress black Power button to ON, on both units.

7.10.7 Depress RF power button to turn ON. Indicator light should be Red.

7.10.8 To strike an RF plasma, increase process pressure to 15mTorr on the Gas display.

7.10.8.1 Slowly increase the RF power initially to 50W using the up-arrow key. View for an RF plasma on gun.

7.10.8.2 Reduce the process pressure back to 4mTorr on the gas display screen.

7.10.9 Slowly ramp Up RF power using Up arrow to ensure plasma is on. Dial RF only up to 0.5cÅ/sec dep rates for dielectric or ceramic targets.

7.10.10 Monitor gun output through the chamber viewport.

7.10.11 Watch dep rate on the SQM -160 XTAL monitor.

7.10.12 It is recommended to perform target conditioning/cleaning for a couple minutes.

7.10.13 START of RF Magnetron gun processing.

7.10.13.1 On SUBST screen, depress SBST shutter to Open shutter (Green).

7.10.13.2 Depress SQM-160 Zero button to zero thickness.

7.10.14 Record gun process conditions on the NanoFab run log when halfway through process (Dep Rate, Base and Dep pressure, Power, Voltage and Current).

7.11 **COMPLETION of RF Magnetron gun processing.**

7.11.1.1 On SUBST screen depress SBST shutter to close the substrate shutter.

7.11.1.2 Depress RF power button on power supply to turn Off.

7.11.1.3 Depress black Power button on both units to turn Off.

7.11.1.4 On DEP screen, depress the gun FLOW Switch to close gun shutter.

7.11.1.5 On GAS screen, depress Gas Injection button to Off (Green).

7.11.2 Turn OFF Substrate Rotation on the lower panel On/Off switch.

7.11.3 Once completed, allow the gun 5 minutes to cool off before Venting the chamber.

7.11.4 Vent the chamber. Otherwise start next layer.

7.11.4.1 On the Recipe screen, Depress the Vent button.

7.11.5 Pumpdown the chamber after processing.

7.11.6 On the RECIPE screen, Depress the Pumpdown button. Push and hold the chamber door until pressure reading drops.

7.11.7 Please complete your process on the NanoFab run log.

8. Dielectric Film Processing

7.1 Sputtered Indium Tin Oxide (ITO) using Lesker *In2O3/SnO2, 90/10 wt% 3"* target.

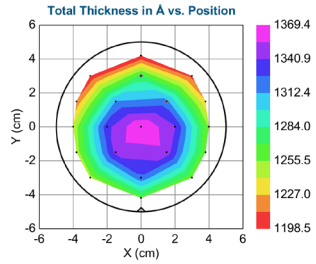
- 7.1.1 Pump the chamber to at least 3.0e-7Torr base pressure. Lesker1 equivalent to an overnight pumpdown.
- 7.1.2 Use RF sputter process with a dep rate of 0.5Å/min.
- 7.1.3 4mTorr process pressure.
- 7.1.4 Chamber at ambient temperature.
- 7.1.5 Expect a darkened film on glass post deposition.
- 7.1.6 Post ITO bake- Place your already coated glass substrate on an already heated hot plate at 300C for 30 minutes. ITO Film will lighted up.
- 7.1.7 Expected 4-point probe resistivity of 65nm film is @20Ωcm^2.

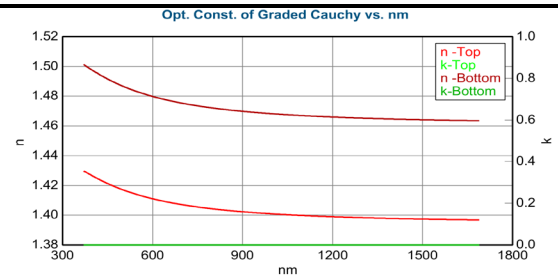
7.2 Sputtered Titanium Nitride (TiN) using Titanium 3" target.

- 7.2.1 Use Titanium target to sputter a reactive TiN process.
- 7.2.2 Chamber at ambient temperature.
- 7.2.3 Pump down the chamber to at least 2.0e-6 Torr pressure.
- 7.2.4 Use 50% N2/Ar gas ratio.
- 7.2.5 Use 3mTorr Process pressure.
- 7.2.6 Use DC power on gun.
- 7.2.7 Use 25W RF Bias during deposition.
- 7.2.8 Use 1.0 A/sec dep rate.

8.2 Sputtered Silicon Dioxide (SiO_2) using Lesker SiO2 3" target.

- 7.3.1 No additional O2 gas is require during processing.
- 7.3.2 Use RF sputter process with a dep rate of 0.5Å/min. Please ensure the target is properly conditioned for a 100Å thickness with the substrate shutter still closed.
- 7.3.3 4mTorr process pressure.
- 7.3.4 SiO_2 film 128nm (09/06/18) on silicon data.
  - 7.3.4.1 Woollam Ellipsometer film avg Index (*n*) is 1.4458 (@632.8nm.
  - 7.3.4.2 Woollam ellipsometer film avg Thickness is 1276Å.
  - 7.3.4.3 Woollam Ellipsometer 21pt. non-uniformity is 13.4%.





SiO_2 film thick map *SiO_2 film Graded Index(Cauchy)*

7.4 Sputtered Titanium Dioxide (TiO_2) using Lesker TiO2 3in target.

7.4.1 No additional O2 gas is require during processing.

7.4.2 Use RF sputter process with a dep rate of 0.5Å/min.

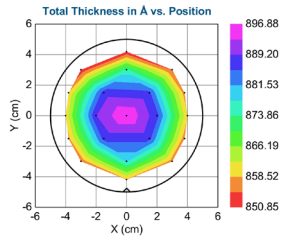
7.4.3 4mTorr process pressure.

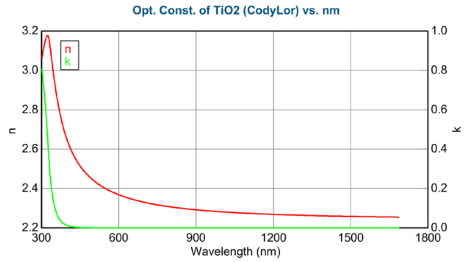
7.4.4 TiO_2 film 87nm (02/20/19) on silicon data.

7.4.4.1 Woollam Ellipsometer film avg Index (*n*) is 2.358 (@632.8nm.

7.4.4.2 Woollam ellipsometer film avg Thickness is 869.04Å.

7.4.4.3 Woollam Ellipsometer 21pt. non-uniformity is 4.90%.





87nm TiO_2 film thick map *87nm TiO_2 film Index and Absorption*

9.0 Revision History

Effective Date	Originator	DESCRIPTION OF REVISION	Issue
04/11/06	Paul Boland	Initial Release.	A
04/11/07	Jon Martin	Updates & improvements due to new materials	B
03/27/15	Clarence Tracy	Updates and change in contamination protocol.	C
10/23/15	Clarence Tracy	New touch screen control system.	D
11/06/18	Jaime Quintero	Checklist version of operating procedures.	E
05/21/19	Jaime Quintero	Updates, Process and Film updates.	F
08/23/19	Jaime Quintero	Reservations and Cancellation policies.	G
04/01/20	Jaime Quintero	Updates to operation.	H
09/10/20	Jaime Quintero	Review tool violation policies, Ignite RF policy.	I