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1. 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. 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. Equipment / Supplies

3.1 Clean room vacuum
3.2 Clean wipes
3.3 Touch screen stylus
3.4 Tweezers/Kapton tape.

4. Safety

4.1 Follow all safety procedures outlined in the NanoFab Handbook
4.2 Follow safety procedures for high voltage when working with high voltage or RF energy.
4.3 Follow safety and handling procedures when working with vacuum systems and target materials

5. Set-up of Magnetron Guns

5.1 Contamination protocol. Notify Engineering staff for assistance for complying.

5.1.1 Substrate platens used for these two categories. Platens are labeled on the backside as “Si compatible” and “Not Si compatible”.

5.1.2 Dark space shields used for these two categories. They are labeled on the backside as “Si compatible” and “Not Si compatible”.

5.1.2.1 Use dark space shields with no-chimneys for RF processing.
5.1.2.2 Use shields with chimneys for DC processing.

5.1.3 Power protocol.

5.1.3.1 Use RF power for dielectric or ceramic films. Use gun #3.
5.1.3.2 Use DC power for conductive films (metals). Can use guns #1 – 3.
5.1.4 Gun #1 dedicated to high magnetic films such as Nickle (DC 1/3 power supply).
5.1.5 Gun #2 is dedicated for metals or conductive films (DC 2 power supply).
5.1.6 Gun #3 can be used for DC (DC 1/3 power supply) or RF (RF 1/3 power supply).
5.1.7 It is required to notify Engineering staff at least 24 hours in advanced to have a target replaced.
5.1.8 The following table shows materials classified as Silicon compatible or Non-Silicon compatible. For materials not listed, please consult NanoFab staff.

<table>
<thead>
<tr>
<th>Si Compatible Materials</th>
<th>Non-Si Compatible Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>Copper</td>
</tr>
<tr>
<td>Bismuth Ferrite</td>
<td>Gold</td>
</tr>
<tr>
<td>Chrome</td>
<td>Indium Tin Oxide</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Iron</td>
</tr>
<tr>
<td>Molybdenum Disilicide</td>
<td>Nickel Iron</td>
</tr>
<tr>
<td>Nickel</td>
<td>Platinum</td>
</tr>
<tr>
<td>Nickel chrome</td>
<td>Silver</td>
</tr>
<tr>
<td>Niobium</td>
<td></td>
</tr>
<tr>
<td>Rhenium</td>
<td></td>
</tr>
<tr>
<td>Silicon</td>
<td></td>
</tr>
<tr>
<td>Silicon carbide</td>
<td></td>
</tr>
<tr>
<td>Silicon chrome</td>
<td></td>
</tr>
<tr>
<td>Silicon dioxide</td>
<td></td>
</tr>
<tr>
<td>Tantalum</td>
<td></td>
</tr>
<tr>
<td>Titanium</td>
<td></td>
</tr>
<tr>
<td>Titanium Nitride</td>
<td></td>
</tr>
<tr>
<td>Tungsten</td>
<td></td>
</tr>
<tr>
<td>Zirconium</td>
<td></td>
</tr>
</tbody>
</table>

6. Operation Procedures

6.1 Vent chamber.
6.1.1 On Vacuum screen, view the chamber pressure and the current turbo speed.
6.1.2 To Vent with recipe, turbo pump will be reduced to 50%. Could take 30-45mins.
   6.1.2.1 Depress Vent button on Vacuum Screen.
6.1.3 To Vent manually, set Turbo speed target to 50%.
   6.1.3.1 On VAC screen, enter 50% Turbo speed if not at 50%. Insure you do not turn Off the turbo pump.
   6.1.3.2 On the GAS screen, depress Gas Injection button to ON (Green).
   6.1.3.3 Enter 4.0 (mTorr) SETP pressure.
   6.1.3.4 On GAS Screen, depress the Ar gas CNTL button to On (Green).
6.1.4 Monitor Turbo screen for actual Turbo pump speed to 50%.
6.1.5 Reset gas flow and pressure.
   6.1.5.1 Depress Gas Injection button to Off (Green).
6.1.6 On RECIPE screen, Depress Vent button.
6.1.7 Open chamber when Vent Done button is displayed (@4.5e+2T).

6.2 Chamber is Opened
6.2.1 Update materials to be processed on NanoFab run log.
6.2.2 If not done so, replace the mylar viewport protective film.
6.2.3 Inspect chamber for particles or flakes. Vacuum if present.
6.2.4 Check that the correct target and DC/RF cable configuration is being used.
6.2.5 Open Substrate shutter on SUBST screen.
6.2.6 Remove wafer platen and place on table.
6.2.7 Load substrate(s) on wafer platen with clips or Kapton tape.
6.2.8 After wafer platen is reinstalled, Close Substrate shutter on SUBST screen.
6.2.9 On SQM Crystal controller, depress XTAL life button to get life remaining on XTAL. If less than 60% XTAL life remaining, notify engineering.
6.2.10 Close chamber door. Insure the substrate shutter is closed.

6.3 Pumpdown of Chamber.
6.3.1 Depress Pumpdown button on the RECIPE screen.
   6.3.1.1 Push and hold the chamber door until pressure reading drops.
6.3.2 Annotate Start pumpdown start and End time to 5.0e-5Torr pressure.
6.3.3 Monitor pressure to reach at least 5.0e-5Torr pressure for processing. Lower pressures can be used for more quality films.
6.3.4 Update NanoFab run log with material information. (Target position, ID, Target thickness, pump down time, base pressure and enter the current three targets).
6.3.5 Update material program on SQM-160 Crystal controller.
6.3.6 Enter correct material, density, tooling factor and Z ratio parameters.
   6.3.6.1 Use Program & Next & rotation knob to update material parameters.
   6.3.6.2 Tooling factor for guns 1 & 2 is 152%.
   6.3.6.3 Tooling factor for gun 3 is 399%.
   6.3.6.4 Insure XTAL life is greater than 60%.

6.4 Process Setup after the minimal pressure of 5.0e-5Torr is met.
6.4.1 On VAC screen, set Turbo speed to 50%.
6.4.2 Manual gas flow to slow down Turbo speed can be performed.
6.4.2.1 Depress GAS INJ button to ON (Green) on GAS screen.
6.4.2.2 Enter 4.0 (mTorr) SETP pressure. Enter your target pressure value if different.
6.4.2.3 Depress Ar gas CNTL button to On (Green).
6.4.2.4 On VAC screen, monitor Turbo speed to get to 50%.
6.4.3 Turn ON Substrate Rotation on the lower panel On/Off switch. Rotation set 31rpm.
6.4.4 Determine your intended material, gun and power source for you layer(s).
6.4.5 Depress Flow SW button on DEP screen to Open on your intended gun shutter.

6.5 RF Back Sputter Process- Optional to pre-clean your substrates.
6.5.1 Insure Turbo at 50%, at selected pressure and that gas flows are ON.
6.5.2 Insure the sample rotation is ON.
6.5.3 Turn ON power button on lower RF power supply for the back sputter clean.
6.5.4 Open the substrate shutter and turn on the RF. If the plasma does not form near the sample holder, temporarily turn on DC power to a gun to ignite RF plasma.
6.5.5 Slowly increase the RF power to 100W using the up-arrow key.
6.5.6 Adjust the Seren manual matching network Load & Tune knobs to minimize the reflected power. Load & Tune knobs are set in mid positions from previous runs.
6.5.7 The etch rate of thermal SiO2 is 2.2 nm/min. Using 2 mins is a common time.
6.5.8 When completed, turn down RF power to 0W using up down arrows,
6.5.9 Turn OFF power button on RF power supply.
6.5.10 Close substrate shutter.

6.6 Deposition using DC Magnetron for Metallic materials.
6.6.1 Insure Turbo at 50%, at selected pressure and that gas flows are ON.
6.6.2 Select the correct DC power supply (DC 1/3 or DC 2) based on the gun you use.
6.6.3 On the Right Display button, select Actual Power and Volt parameters to view.
6.6.4 Depress DC power supply Output to On.
6.6.5 Slowly ramp-up Level knob to desired 1 - 2Å/sec dep rate.
6.6.6 IMPORTANT. Insure the Voltage is not low and Current is high indicating a short of the gun target. Turn off power supply and notify engineering staff if so.
6.6.7 Watch rise in dep rate on the SQM-160 XTAL monitor.
6.6.8 Verify gun output through the chamber viewport.
6.6.9 It is recommended to perform target conditioning for a couple of mins.
6.6.10 On SUBST screen, depress SBST shutter to Open shutter (Green).
6.6.11 **Depress SQM-160 Zero button** to zero thickness.

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

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

6.6.14 Completion of DC Magnetron processing.
   6.6.14.1 On SUBST screen, **depress SBST shutter to close** the substrate shutter.
   6.6.14.2 **Ramp down the power level** on the DC power supply.
   6.6.14.3 **Turn Off the power supply button**.
   6.6.14.4 On DEP screen, **depress the gun FLOW Switch** to close gun shutter.
   6.6.14.5 On GAS screen, **Depress Gas Injection button to Off (Green)**.

6.6.15 Once all the layer(s) are completed, Vent the chamber. Otherwise start next layer.
   6.6.15.1 **Depress Vent button** on Vacuum Screen.

6.7 Deposition using RF Magnetron for Dielectric materials.

6.7.1 Select Lesker RF power supply and auto match network.

6.7.2 **Depress black Power button to ON** on both units.

6.7.3 **Depress RF power button** on power supply to turn On.

6.7.4 Slowly ramp Up RF power using Up arrow to 1 - 2Å/sec dep rate.

6.7.5 Monitor gun output through the chamber viewport.

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

6.7.7 When dep rate is at proper 1 - 2Å/sec rate, insure RF is stable and not arcing.

6.7.8 It is recommended to perform target conditioning for 5 mins.

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

6.7.10 **Depress SQM-160 Zero button** to zero thickness.

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

6.7.12 Completion of RF Magnetron process. Close shutters and gas flow.
   6.7.12.1 On SUBST screen depress SBST shutter to close the substrate shutter.
   6.7.12.2 **Depress RF power button** on power supply to turn Off.
   6.7.12.3 **Depress black Power button** on both units to turn Off.
   6.7.12.4 On DEP screen, **depress the gun FLOW Switch** to close gun shutter.
   6.7.12.5 On GAS screen, **depress Gas Injection button to Off (Green)**.

6.7.13 Once all the layer(s) are completed, Vent the chamber. Otherwise start next layer.
   6.7.13.1 **Depress Vent button** on Vacuum Screen.
7. Special Processing instructions

6.8 Standard recipes (reactive sputtering)

6.8.1 TiN Recipe:

- Pump to less than $5 \times 10^{-6}$ Torr. Set MFC selector switch to nitrogen.
- Preheat substrate to 200°C. Make sure lamp covers are removed before initiating pumpdown; wait for base pressure to reduce to $1 \times 10^{-5}$ Torr or better before proceeding.
- RF backspatter clean the substrate 100W/4mT/60 seconds
- Deposit 20 nm of pure Ti:
  - Pressure = 3 mT argon (may need to increase slightly for target to run); Power = 250W. Ramp target to set-point over 3 minutes and clean target at 250W for 3 minutes (gun shutter open). Open substrate shutter for 20 nm film. Rate is about 1.2 A/sec
- Deposit 100 nm of TiN:
  - Pressure = 3 mT (argon + 20% nitrogen). Condition target for 3 minutes (gun shutter open). Set bias sputter supply to 50 W. Open substrate shutter and turn on bias sputter supply for 100 nm film. Rate is about 0.5 to 0.7 A/sec. Close substrate shutter and turn off bias supply.
- Turn off heater now and monitor temperature while proceeding. It will take about 20 minutes to cool to 80°C at which time it is safe to vent.
- While waiting, clean/condition target for next user 3mT/argon/250W/2minutes (may need to increase the pressure slightly to get the plasma to run)

6.8.2 Ta$_2$O$_5$ Recipe:

- Pump to less than $5 \times 10^{-6}$ Torr. Set MFC selector switch to oxygen.
- Preheat substrate to 100°C. Make sure lamp covers are removed before initiating pumpdown; wait for base pressure to reduce to $1 \times 10^{-5}$ Torr or better before proceeding.
- Deposit desired thickness of Ta$_2$O$_5$:
  - Pressure = 4 mT (argon + 30% oxygen). Ramp and condition target at 150W for 3 minutes (gun shutter open). Set bias sputter supply to 50 W. Open substrate shutter and turn on bias sputter supply; deposit desired thickness. Rate is about 1.0A/sec. Close substrate shutter and turn off bias supply.
- Turn off heater now and wait for temperature to cool to 80°C at which time it is safe to vent.
- While waiting, clean/condition target for next user 4mT/argon only/150W.
8.0 Revision History

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>Originator</th>
<th>DESCRIPTION OF REVISION</th>
<th>Issue</th>
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</thead>
<tbody>
<tr>
<td>4/11/06</td>
<td>Paul Boland</td>
<td>Initial Release</td>
<td>A</td>
</tr>
<tr>
<td>4/11/07</td>
<td>Jon Martin</td>
<td>Updates &amp; improvements due to new materials</td>
<td>B</td>
</tr>
<tr>
<td>03/27/15</td>
<td>Clarence Tracy</td>
<td>Updates and change in contamination protocol</td>
<td>C</td>
</tr>
<tr>
<td>10/23/15</td>
<td>Clarence Tracy</td>
<td>New touch screen control system</td>
<td>D</td>
</tr>
<tr>
<td>08/28/18</td>
<td>Jaime Quintero</td>
<td>Checklist version of operating procedures.</td>
<td>E</td>
</tr>
</tbody>
</table>
