This SOP is for reference only. Training from an authorized staff member is required before using this equipment.

1. **Description**
   The AJA International Thermal Evaporator uses three evaporation sources (Al, Au, other approved materials) to evaporate/deposit a metal stack or single layer metal on 1”- 6” diameter wafers, glass slides and small samples with optional substrate heating and rotation for enhanced film properties.

2. **Safety**
   a) This machine is connected to **HIGH VOLTAGE**. All SOURCE (1,2,3) power switches must be in the OFF position when the evaporation process is completed. During chamber venting and when removing or loading your samples and evaporation materials (Al, Au pellets) these switches should already be in the OFF position. Be very careful and aware of electrical hazards. If you encounter any electrical malfunctions contact NanoFab staff immediately.
   b) This machine can heat substrates to high temperatures (850°C). Make sure you wait until the substrate temperature is < 100°C before removing your sample.
   c) Use sunglasses when viewing the material heating/evaporation process to prevent eye damage.
   d) This machine has only water flow interlocks to prevent over heating the substrate heater, turbo pump and quartz crystal. If you encounter any water flow malfunctions notify NanoFab staff immediately.

3. **Requirements/Restrictions**
   a) You must be a qualified user on AJA Thermal Evaporator.
   b) The evaporator can be used to deposit metal films on 1”- 4” diameter wafers, glass slides, and small samples by using the substrate holder clips. Also available is a 6” Aluminum wafer holder which can ONLY be used with no substrate heating (room temperature evaporation). Extremely small pieces can be processed by using longer holder clips or bonding to larger carrier wafer (bond with drop silver paint, drop of baked photo resist, MUNG II paste or other approved bonding material)
   c) **No substrate heating allowed if using bonding material.**
   d) **No heating allowed if using the Aluminum substrate holder.**
   e) If you are using the substrate heater be careful not to over heat your wafer/sample to prevent any wafer breakage, metal or any other material to flow.
   f) IF you are using the substrate heater the substrate rotation must be ON to avoid damage to the substrate holder.
   g) If you are using the substrate heater make sure you wait until the substrate temperature is < 100°C before venting system to remove your sample.
   h) ** USERS are responsible for supplying Al, Au evaporation pellets and boats.** For any other evaporation materials or contact NanoFab staff for approval.
4. **AJA System Checks (clean room side of system)**

   a) Open the AJA system water cooling valve (open position the valve lever is parallel to inlet pipe). This water is for cooling the heater, quartz crystal, and turbo pump.

   b) Open the AJA N2 chamber/ Turbo pump vent valve (position the valve pointer in parallel to inlet line). This valve is located at the right rear side of system.

   c) Check to ensure the turbo pump and chamber lid water connections and feed through have no water leaks.

   d) Check to ensure the manual gate valve is fully closed (CW).

   e) Check to ensure all SOURCE POWER switches /breakers are in the **OFF** position.

   f) Turn the switch/breaker for **MAINS POWER (PD-30A)** to ON position.

   g) Turn the switch/breaker for **MAINS POWER (PD-30S)** to ON position.

*The following visual aide pictures are for AJA System Checks sections 4a) to 4g)*
5. Operating Procedure: Wafer Loading / Evaporation Material Loading

a) When you first approach the system the processing chamber will be in vacuum, the manual gate valve is closed and the roughing pump and turbo pump will be OFF.
b) Vent the chamber by slowly turning the N2 vent valve CCW. The chamber should vent to atmospheric pressure in several minutes.
c) Check to ensure the Main chamber is vented by checking the Pfeiffer single gauge vacuum display.

d) **AFTER THE CHAMBER IS VENTED IMMEDIATELY CLOSE THE N2 VENT VALVE CW UNTIL IT STOPS!!**

e) To remove the wafer holder and to add more source material (pellets) open the side access door/ flange by slightly pulling outward. Place the access door/ flange on the rubber plate pads located on the AJA table top.
f) Carefully remove the wafer holder from the chamber by extending your arm into the chamber through the side access door; support the wafer holder with one hand while rotating manual rotator spindle assembly knob CCW about 30° with the other hand. This should unlatch from rotator spindle assembly from the wafer holder. Place the wafer holder on a clean piece of Aluminum foil.

g) Check to see if the evaporation boat you will be using has enough material (pellets) and check if the boat is not cracked or broken. For damaged or broken boats contact NanoFab staff for installation assistance. Evaporation boats can be purchased from MDC Vacuum Products Corp. Part number can be found with the following web links:
http://www.mdcvacuum.com/urd/uniface.urd/ecf0030w.display?992623-02
http://www.mdcvacuum.com/urd/uniface.urd/ecf0030w.display?992624-03

h) To add more material (pellets) open the appropriate source shutter by moving the source shutter toggle switch to the up position. The evaporation sources have dedicated boat locations as follows:

- **SOURCE 1** Unused (material needs Nanofab staff approval)
- **SOURCE 2** Gold located on the right side of the chamber (Moly boat)
- **SOURCE 3** Aluminum located on the left side of the chamber (Moly boat)

i) Using Teflon tweezers to add no more than three 1/8” x 1/8” pellets to the boat.

j) Close source shutter by moving the source shutter toggle switch to the down position.

k) Mount your wafer/samples to the wafer holder using the holder clips and 3/32” allen wrench. Place the wafer holder back on the rotator spindle assembly by extending you arm into the chamber through the side access door; support the wafer holder and align/mate the rotator spindle forks with the substrate holder latching groove with one hand while rotating manual rotator spindle assembly knob CW about 30° with the other hand. This should latch from rotator spindle to the wafer holder.

l) Mount the side access door/ flange back on the chamber.

m) Open the manual gate valve fully by turning the handle CCW until it stops.
The following visual aide pictures are for Operating Procedure: Wafer Loading / Evaporation Material Loading sections 5a) to 5m).

5b,d) Chamber vent valve is returned to stop after venting is completed.

5c) Check to ensure the Main chamber is vented by checking the Piranha single gauge vacuum display.

5e) Side access door open range.

5f,k) Support wafer, while rotating spindle integrally L/h.

5g) Source boat location and thickness monitor crystal sensor locations:
- Source 1 (exceed, need transfer approval)
- Source 2 (sensor 1)
- Source 3 (sensor 2)
- Source 4 (sensor 3)
- Source 5 (sensor 4)

5h) Source 2 (sensor 1) close.

5i) Manual gate valve fully by turning the hand.

5j) Mount wafer sample to header with clips and 5/12 stainless vise.

5k) Mount and secure wafer sample header to header on the bayonet.

5l) Open the manual gate valve fully by turning the handle CCW until it stops.
6. Operating Procedure: Chamber Pump Down / Substrate Rotation / Substrate Heating
   a) Check to ensure the switch/breaker for MAINS POWER (PD-30A) to ON position.
   b) Check to ensure for MAINS POWER (PD-30S) to ON position.
   c) Turn the switch/breaker for VACUUM PUMPS (PD-30A) to ON position.
   d) The turbo pump will accelerate to 1000Hz. Wait for the system to achieve high vacuum < 5E-6 Torr. This should take 1 hour.
   e) For improved across the wafer thickness uniformity set the Mounting Plate Rotational control dial to 50.
   f) IF you are using the substrate heater the substrate rotation must be ON to avoid damage substrate holder. For substrate heating set the Mounting Plate Rotational control dial to 50.
   g) To heat your substrate turn the switch/breaker for heater power(SHQ-15A) to ON position, turn the GREEN HEAT switch to ON position, and manually input temperature set point by using the arrow up key on temperature controller. On the temperature controller display, green is the set point and red is the temperature read. Use appropriate temperature set points for your samples. When you are finished using the heater set the green (SV) temperature set point to 25°C then turn the GREEN HEAT selector switch to the OFF position. IF you are finished with all wafer processing wait for the wafer holder temperature to cool down to < 100°C before venting and removing your wafer from the chamber.

The following visual aide pictures are for Chamber Pump Down/ Substrate Rotation and Heating sections 6a) to 6g).
7. **Operating Procedure: Thickness Monitor Set Up / Evaporation Sequence**
   a) Open thickness monitor shutter by moving the thickness monitor shutter toggle switch to #1 OPEN or #2 OPEN position.
   b) Turn the MAXTEK thickness monitor power switch to ON. If the display shows P FAIL message press STOP button to reset the thickness monitor, for any other FAIL displays (E, I) call NanoFab staff.
   c) Select the sensor by pressing SENSOR SWAP to toggle between sensor 1 and sensor 2 on MAXTEK TM that corresponds to same thickness monitor shutter opened in step 5h and 7a. The selected sensor green led will light up. Press FILM NUMBER button and use arrow up/down(▲/▼) buttons to select appropriate number that corresponds to evaporation material used (2 = Au, 3 = Al). Press MATERIAL DENSITY then ACOUSTIC IMPEDANCE buttons to verify values are correct. If the values are not correct use up/down(▲/▼) buttons to correct the values. After the correct values are verified press the STOP then START button.

   *(Note: Source #3 Al does not have a direct line of site to the thickness monitor sensors, you will need to keep Source #3 shutter toggle switch to the open position)*

   d) Check to ensure all switch/breakers for Source 1, 2, 3 power supplies (TEC-15A) are in the OFF position.
   e) Check to ensure all EVAPORATION selector switch/knob for Source 1, 2, 3 are in the OFF position (TEC-15A).
   f) Check to ensure all CURRENT CONTROL dials are pushed IN and are at zero setting (TEC-15A).
   g) Turn the switch/breaker for Source (1, 2, or 3) you will be using to the ON position (TEC-15A).
   h) Turn the EVAPORATION selector switch/knob for Source you are using to the ON position.
   i) Pull the CURRENT CONTROL knob OUT (the EVAPORATOR selector switch will light green).
   j) Open the view port window shutter to monitor the heating process.
   k) **VERY SLOWLY** increase the CURRENT CONTROL knob CW to begin heating the source material. At a CURRENT CONTROL setting of 30-40 you should be starting to melt and evaporating the material and be able to monitor the deposition rate.
   l) When the material starts to melt or you have a deposition rate displayed on the MAXTEK TM close the view port window shutter to avoid coating the window.
   m) Do not exceed a CURRENT CONTROL setting of 40. When you have an evaporation rate of 2-3A/sec press the STOP then START button on the MAXTEK thickness monitor.
   n) Open the appropriate source shutter by moving the source shutter toggle switch to the UP position to begin evaporating material on your sample.
   o) When you have deposited the desired thickness close the source shutter by moving the source shutter toggle switch to the DOWN position.
   p) **VERY SLOWLY** decrease the CURRENT CONTROL knob CCW to zero.
   q) Push the CURRENT CONTROL knob IN (the EVAPORATOR selector switch light will go off).
   r) Turn the EVAPORATION selector switch to the OFF position.
   s) Turn the switch/breaker for Source used to the OFF position (TEC-15A).
t) If you are depositing a different second layer open thickness monitor shutter for the next layer by moving the thickness monitor shutter toggle switch to the appropriate #1 OPEN or #2 OPEN position that corresponds to the correct sensor programmed on the MAXTEX TM (press SENSOR SWAP)

u) For the second layer deposit or more same layer deposits go back and follow steps 7d-7s.

v) For a third (different layer) layer deposit go back and follow steps 7a-7s.

The following visual aide pictures are for Thickness Monitor Set Up / Evaporation Sequence sections 7a) to 7t).
8. Venting Chamber/ Wafer Unload/ System Shutdown Procedure
   a) Check to ensure all CURRENT CONTROL knobs are at zero, all EVAPORATION selector switches are in the OFF position and all power switches/breakers are OFF (TEC-15A).
   b) If the substrate heater was used set the green (SV) temperature to 25°C then turn the GREEN HEAT selector switch to the OFF position and wait for the substrate holder temperature to cool down to < 100°C. When the wafer holder temperature < 100°C turn the switch/breaker for heater power (SHQ-15A) to the OFF position.
   c) Turn the Mounting Plate Rotational control dial to zero.
   d) Turn the MAXTEK thickness monitor power switch to OFF.
   e) Close the manual gate valve fully by turning the handle CW until it stops.
   f) Turn the switch/breaker for VACUUM PUMPS (PD-30A) to OFF position. This will turn off rough pump and turbo pump (N2 turbo purge on).
   g) Vent the chamber by slowly turning the N2 vent valve CCW. The chamber should vent to atmospheric pressure in several minutes.
   h) Check to ensure the Main chamber is vented by checking the Pfeiffer single gauge vacuum display.
   i) **AFTER THE CHAMBER IS VENTED IMMEDIATELY CLOSE THE N2 VENT VALVE CW UNTIL IT STOPS!!**
   j) To remove the wafer holder open the side access door/ flange by slightly pulling outward. Place the access door/ flange on the rubber plate pads located on the AJA table top.
   k) Carefully remove the wafer holder from the chamber by extending your arm into the chamber through the side access door; support the wafer holder with one hand while rotating manual rotator spindle assembly knob CCW about 30° with the other hand. This should unlatch from rotator spindle assembly from the wafer holder. Place the wafer holder on a clean piece of Aluminum foil.
   l) Remove your samples from the wafer holder using 3/32” allen wrench. Place the wafer holder back on the rotator spindle assembly by extending you arm into the chamber through the side access door; support the wafer holder and align/mate the rotator spindle forks with the substrate holder latching groove with one hand while rotating manual rotator spindle assembly knob CW about 30° with the other hand. This should latch from rotator spindle to the wafer holder.
   m) Mount the side access door/ flange back on the chamber.
   n) Before opening manual gate valve make sure turbo pump has stopped spinning completely.
   o) Open the manual gate valve by turning valve CCW until it stops.
   p) Turn the switch/breaker for VACUUM PUMPS (PD-30A) to ON position. Wait for the turbo to spin up to 1000Hz and chamber to pump down to < 5E-5 Torr.
8. Venting Chamber/ Wafer Unload/
System Shutdown Procedure (Continued)

q) Close the manual gate valve fully by turning the handle CW until it stops.
r) Turn the switch/breaker for VACUUM PUMPS (PD-30A) to OFF position.
s) Turn the switch/breaker for MAINS POWER (PD-30S) to OFF position.
t) Turn the switch/breaker for MAINS POWER (PD-30A) to OFF position.
u) Wait for turbo pump to stop spinning completely.
v) Close the AJA water cooling valve and N2 vent valve(clean room side).
w) Enter the required information in the logbook.

The following visual aide pictures are for Venting Chamber / Wafer Unloading /
System Shutdown Procedure sections 8a) to 8i).