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**AJA Sputtering System**

**Operation Procedure**

**1.0 SCOPE**

This document establishes the procedures for Sputter deposition of thin metal and dielectric films on silicon, GaAs, and other substrates in the Nanofabrication Laboratory.

**2.0 APPLICABLE DOCUMENTS**

Sputter system logbook

This Operating Procedure

ATC and ATC Orion System Operation Manuals

**3.0 MATERIALS AND EQUIPMENT**

AJA Sputter System

Tweezers

Isopropyl Alcohol

Gloves, cleanroom nitrile

Facemasks

Protective Eyewear

Nitrogen and Argon tanks

**3.0 GENERAL**

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AJA Sputtering System Operation Manual

Note: Before operating the system, you should thoroughly read the manufacturer procedure manual (ATC and ATC ORION MANUAL - NOV 2005) for detailed system operations, safety concerns, and potential hazards.

Note: All key words and phrases are marked in **BOLD**

# Verify the following before operating the system:

* The **transfer valve** is closed
* Wear the proper protective eyewear
* Wear gloves while working on the system or replacing samples
* Check that the mechanical and turbo pumps are ON
* Verify that the pressure in both the **load-lock** and **main chambers** is < 1 x 10-6 torr
* Make sure that all the relevant **Power Supplies (2 DC and 2 RF)** are ON
* Sign in your information and start time on the LOG-Binder

**WARNING!!!**

Never attempt to open the **manual venting valve** when either or both the **transfer valve** or the **gate valve** are opened.

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Figure: Front view of the system

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Figure: High rack instruments and chiller

# Transferring a sample into the main chamber (when load-lock chamber is under vacuum):

1. Lower the **load-lock** breaker
   1. The pressure in the **load-lock** chamber will start increasing after a few seconds
2. Once the **load-lock** pressure reaches about 7.5 x 102 Torr, remove the cover.
   1. Place the cover over its designated area
      1. Make sure the three rubber pads are clean
3. Place the sample on the **sample holder** and place the holder back on the **transfer arm** as shown in figure below.
   1. Make sure the **alignment screws** are in their proper slots
   2. Make sure the **alignment marks** are in the orientation shown in the figure below

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Figure: Sample holder orientation

1. Make sure the **load-lock** **O-ring** is clean
   1. You can clean the **O-ring** by passing your finger (with gloves on) around it
2. Place back the cover and lift the **load-lock breaker** to start vacuum
3. Wait at least until the **load-lock turbo pump** reaches its full rotation (1500 Hz) or pressure below 9 x 10-6 Torr
4. Check the pressure inside the **main chamber**
   1. Press on the **IG1** button in order to read the pressure inside the **main chamber**
   2. **Note**: the pressure in both the **load-lock** and **main chambers** should be relatively low (below 9 x 10-6 Torr) before you attempt to open the **transfer valve**
5. Make sure the **transfer height (Z-motion)** is set to 32

**WARNING!!**

ONLY OPEN THE LOAD-LOCK GATE VALVE WHEN BOTH CHAMBERS ARE BELOW 9x10-6 TORR OR WHEN BOTH CHAMBERS ARE AT ATMOSPHERE. OPENING THE GATE VALVE OUTSIDE THESE PRESSURE REGIMES CAN DAMAGE PUMPS, VALVES AND GAUGES.

1. Open the **transfer valve**
2. Insert the **transfer arm** into the **main chamber** slowly and cautiously
   1. Monitor the motion of the **transfer arm** through the viewing window using a flashlight
3. Align one leg of the **propeller** with the **alignment mark** that is visible through the viewing window
4. Lower the **Z-motion** to 37 and rotate the **propeller** clockwise
5. Lift the **Z-motion** to 25 and check that the sample holder is well spaced from the platform by rotating the sample holder.
6. Slide the **transfer arm** out of the **main chamber**
7. Close the **transfer valve**
   1. Verify that a “clicking” sound is heard to confirm proper lock-down
8. Lower the **Z-motion** to 30

# Manual Sputtering Procedure

1. Record the **main chamber** base pressure and turn OFF the **IG1**
2. Turn ON the rotator to the desired rotation percentage
3. Make sure all relevant **Power Supplies** are ON
   1. As can be seen from the picture above, RF2 and DC1 and DC2 are at the bottom of the rack, while RF substrate is located at the top of the rack

## Striking plasma for substrate (RF-substrate bias) milling:

1. Set the Ar Gas flow to 10 sccm 
   1. Note: you will need to either press Enter or click outside a box in order to activate an entry
2. Turn On the Ar gas source 
3. Click on the pressure icon  and set the value to 40 mtorr
4. Set the ramp time to 5 sec 
5. Set the power percentage  to ~ 50%
6. Turn ON the power source🡺 
   1. Plasma should strike and a purple indicator will turn on within 2-5 seconds

🡺

* 1. Monitor the reflected power value on the RF power source (above the pressure gauge to the right) and make sure it’s not more than 2W

Note: ***DO NOT leave*** RF output power ON for more than 6 seconds if there is no plasma.

1. Once done with Ar-milling the substrate, turn OFF the power source 🡺 

## Striking plasma for Sputter-deposition:

1. Set the Ar Gas flow to 10 sccm 
   1. Note: you will need to either press Enter or click outside a box in order to activate an entry
2. Turn On the Ar gas source 
3. Click on the pressure icon  and set the value to 40 mtorr
4. Set the ramp time to 0 sec 
5. Set the power percentage  to 30%
6. Turn ON the power source🡺 
   1. Plasma should strike and a purple indicator will turn on within 2-5 seconds   
      🡺

Note: DO NOT leave RF output power ON for more than 6 seconds if there is no plasma.

## Starting a deposition process:

1. Change the pressure to the desired processing pressure value.
2. Change the power set point to the desired sputtering power  
   Note: To be safe, ramp up and down for power levels over 50 Watts.

Note: If ramping is required, first fill in the ramping time and then set the power percentage

1. Presputter for about 2 - 5 min.
2. Open the shutter and start timer (manual stopwatch) 🡺
3. Sputter for a designated time

## Ending a process:

* 1. Close the shutter 🡺
  2. Turn OFF the power source 🡺
  3. OPEN the pressure control valve 
  4. Turn OFF the Ar gas source🡺
  5. Turn OFF the **rotator**

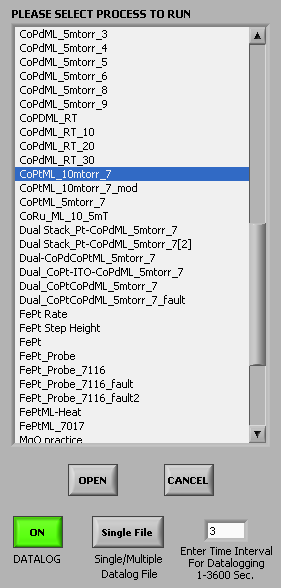
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Figure: Screen capture of a samples manual sputtering process

# Automatic Sputtering Procedure (must get prior approval from Staff):

1. Record the **main chamber** base pressure and turn OFF the **IG1**
2. Turn ON the rotator to the desired rotation percentage
3. Close the viewing window

## Starting a process:

1. Click on the “Run Process” icon
2. Highlight the process to be executed
3. Click on the “DATALOG” Icon to turn it ON  🡺 
4. Set the time interval to 3 sec
5. Verify that “Single File” is selected
6. Click on the OPEN icon to run process: 
7. Click “OK” to run the process

## During a process:

1. Verify with a stopwatch the proper timing for each material being sputtered. Do this at least once for every new process.
2. Once a shutter opens, check (through the viewing window) that the plasma is ON.

## Ending a process:

1. Verify that the process was completed and click “OK”
2. Turn OFF the **rotator**

# Transferring a sample out of the main chamber

1. Lift the **Z-motion** to 25
2. If heating was used, wait until the substrate cools down

**WARNING!!**

The substrate holder may be HOT! Use the substrate holder tool or wait until the holder is cool enough to handle. DO NOT unload the substrate or vent the chamber when the substrate temperature readout is > 150 C°.

ONLY OPEN THE LOAD-LOCK GATE VALVE WHEN BOTH CHAMBERS ARE BELOW 1x10-5 TORR OR WHEN BOTH CHAMBERS ARE AT ATMOSPHERE. OPENING THE GATE VALVE OUTSIDE THESE PRESSURE REGIMES CAN DAMAGE PUMPS, VALVES AND GAUGES.

1. Check Pressure in both the **main chamber** and **load-lock chamber**
2. Open the **transfer valve**
3. Insert the **transfer arm**
4. Align the **alignment screws** with the slots on the **transfer arm** panel
5. Lower the **Z-motion** to 37
6. Rotate the **propeller** counter-clockwise
7. Lift the **Z-motion** to 32
8. Take out the **transfer arm**
9. Close the **transfer valve**
   1. Verify that a “clicking” sound is heard to confirm proper lock-down
10. Lower the **load-lock breaker**
    1. Wait about 2 min or until the pressure inside the **load-lock** chamber reaches about 6.7 x 102 Torr
11. Take out the sample and place the **sample holder** back into the **load-lock** chamber
12. Verify that the **O-ring** is clean
13. Place back the cover
14. Lift the **load-lock breaker** to start vacuum

# System Idle mode procedure:

1. **Transfer valve** is CLOSED
2. **Pressure (VAT) controller** in remote mode and the gate valve is OPENED
3. **IG1** is turned OFF
4. **Rotator** is turned OFF
5. **Sign out your session in the LOG-Binder**

FRONT

Ar Outlet

Definitions:

* M = Magnetic Targets
* S = Standard (non- magnetic) Targets
* DC1 = Power supply number 1
* DC5 = Power supply number 5

Figure: sputtering guns’ location and specification

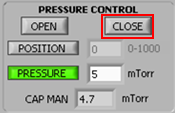
# Manual Venting of the Main Chamber (must get prior approval from Staff):

**WARNING!!!**

* **You must receive formal approval from John or Nissim before performing this operation by yourself!**
  + **The sputtering system may be seriously damaged if one or more of the steps below are not followed.**
* **Make sure you read the following procedure before attempting to run this process.**
  + **If you don’t understand or forgot the meaning of any of the steps below, please request clarification from CNSE staff.**

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1. After completing the deposition run,
   1. Turn OFF the sample rotation and
   2. lift the **Z-motion** to 28
2. Close the gate valve



NOTE: Do not turn OFF (lower the breaker for) the main chamber turbo pump

1. Rotate the vent valve from the “Nitrogen” to the “Oxygen” position
2. Turn off the ion gauge (**IG1**)
3. SLOWLY open the “Manual Venting Valve” while monitoring the pressure rise on the “Main Chamber Conv” gauge
4. Once the pressure reached the desired value, close the “Manual Venting Valve” and leave the chamber under pressure for your desired time.
5. Once done, release the knob that closes the main-chamber cover (located above the viewing window)
6. Open the “Manual Venting Valve” all the way
   1. Wait until atmospheric pressure is reached, and close the “Manual Venting Valve”
      1. For oxygen the pressure will read ~ 870 Torr for atmospheric pressure
   2. Rotate the vent valve from the “Oxygen” to the “Nitrogen” position
7. Lower the L**oad-Lock Breaker** and the M**ain-Chamber Breaker**
   1. Wait until both chambers (Main-Chamber and Load-Lock) reach atmospheric pressure
8. Slightly open the main chamber cover to balance the pressure with the load-lock
9. Open the **Transfer Valve**
10. Insert the **Transfer Arm**
11. Align the **Alignment Screws** with the slots on the T**ransfer Arm** panel
12. Lower the **Z-Motion** (sample) to position 37
13. Rotate the **Propeller** counter-clockwise
14. Lift the **Z-Motion** (sample) to position 32
15. Slide out the T**ransfer Arm**
16. Close the T**ransfer Valve (SLOWLY so it doesn’t vibrate)**
    1. Verify that a “clicking” sound is heard to confirm proper lock-down
17. Take out the sample and place the **Sample Holder** back into the L**oad-Lock** chamber
18. Verify that the **O-Ring** is clean
19. Place back the cover
20. Lift the **Load-Lock Breaker** to start vacuum
21. Slightly open the main-chamber cover to balance the pressure with the main-chamber
22. Open the gate valve



1. Lift the **Main-Chamber Breaker** to start vacuum
2. Record the process on the log-book and any comments

# Heater Operation Instructions (must get prior approval from Staff)

**Cleaning Sample Holder/Clips and Screws:**

1. Record the base pressure prior to heating
2. Turn ON rotation at ~ 40%
3. Preheat just sample holder with clips assembled at 500 C for about 15 min.
   1. Record the base pressure (before introducing Ar)
   2. Once at 500 C for about 15 min:
      1. Turn on Ar at 10 sccm
      2. Set pressure at 50 mtorr
      3. Leave at 500 C at 50 mtorr for about 5 – 10 minutes
   3. Open Pressure valve
   4. Turn off Ar gas
   5. Turn off heater
   6. NOTE: Leave rotation ON during cooling
   7. Wait until substrate temperature drops to about 25 C
      1. The estimated time for cooling is about 2 – 3 hours
4. Before removing the sample holder, make sure that it’s not too hot by hovering your hand above the holder
5. Use the aluminum cylinder to remove the sample holder.
6. Place the sample holder on a metal platform.
7. Load fresh (clean) silicon chips under each clip
8. Blow-clean with N2 gas
9. Use an Allen key to raise the clip and insert your sample underneath.
10. Blow-clean sample holder and samples with N2 gas
11. Load into load-lock
12. Resume deposition at desired temperature
13. Repeat steps 1 through 5 at desired temperature and pressures
14. When substrate is cooling in the chamber, make sure to leave a warning note on the system with your contact information. Also, note your operation in the log book

**Sample Deposition with first preheating the sample and then depositing at Room Temperature:**

1. Record the base pressure prior to heating
2. Turn ON rotation at ~ 40%
3. Set temperature to desired value (No more than 800 C).
   1. Record the base pressure after temperature set point is reached
      1. Verify through the view window that your sample is held firmly in place and that the clips are not bent. You can reduce rotation to verify this.
   2. Heat your sample for about X minutes (ALWAYS BE PRESENT NEXT TO THE SYSTEM WHEN THE HEATER IS ON). Check occasionally on the sample through the view window
   3. Once heating is completed, turn OFF the heater.
      1. NOTES:
         1. Leave rotation ON during cooling
         2. Leave a note on the system indicating that a sample is cooling in the chamber. Include your phone number
      2. The estimated time for cooling is about 2 – 3 hours
      3. Make sure you reserve the system online for the cooling time as well
   4. Once the sample is cool (~25 C), perform deposition as desired
4. Just in case, before removing the sample holder, make sure that it’s not too hot by hovering your hand above the holder
5. Use the aluminum cylinder to remove the sample holder, if still hot.
6. Place the sample holder on a metal platform.
7. Use an Allen key to raise the clip and remove your sample from underneath.
8. Place clips back in zip-lock bag
9. Blow-clean sample holder with N2 gas
10. Load sample holder back into the load-lock chamber
11. Lift breaker for Load-lock chamber