CORAL Name: Sputter-AJA-LL

Location: Bay 8U, room 12-3110C
Purpose: Deposition
Contacts: Gary Riggott, Eric Lim

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Introduction

The Sputter-AJA-LL is a sputter deposition system capable of processing samples from small pieces up to 8” diameter wafers. Samples up to 6” in diameter are processed using an aluminum carrier that is loaded into the chamber through a vacuum loadlock. Samples larger than 6” in diameter require manual loading and longer pumpdown times.



The system has a sample stage that can rotate for uniformity and be heated by quartz lamps up to 400°C. The sample can also be biased by a 100W RF generator, either for pre-cleaning of the sample or for densification of the film during deposition.

The Sputter-AJA-LL has 4 deposition guns which accept 3” diameter targets up to 0.25” thick. All 4 guns are normally connected to a 1500W DC generator for depositing conductive materials and can run sequentially. Additionally, one gun can be connected to a 600W RF generator to deposit conductive or dielectric materials, or to do co-sputtering with another gun (one DC, one RF). Default configuration is Ti, Mo, W, and Al in guns 1-4 respectively. Gun 3 is the only gun configured for running magnetic materials, and is the gun used for user installed targets.

Deposition rates can be measured as part of a preliminary conditioning run using a built-in quartz crystal monitor. Pure material sputtering is done with Argon (Ar) gas, but the system can also do reactive sputtering by adding a

low percentage of Nitrogen (N_2) or Oxygen (O_2) to the plasma.

Safety

Hazards present on system are high voltage, RF radiation, and pressurized gases. In case of a machine emergency, press the Emergency Stop button to power down the tool, and notify a member of the staff. The power supplies on the tool are capable of supplying 1500 watts of DC power or 600W of RF power to the deposition sources. This system is designed with a full array of electrical interlocks that should at no time be defeated or overridden. Do not attempt to open or remove any panels as you risk exposing yourself (and others) to these hazards.

Mechanical pinch/crush points exist with the loadlock lid and reaction chamber lid. Exercise care when loading/unloading samples and carriers from the loadlock and when changing targets in the reaction chamber.

Do not remove any panels or attempt any repairs on the system.

If the tool is behaving dangerously or making loud noises, press the red EMO button, alert the staff, and shutdown the system on Coral. DO NOT attempt to re-energize the tool!

User Qualifications and Responsibilities

During training users will learn to run wafers and edit recipes. To be considered qualified, users need to be trained by the staff in charge, be up to date with safety trainings, and have a PTC approved process. There are restrictions to what materials are allowed in the etch tool and what type of recipes can be run (see appendices). Circumventing these restrictions or running processes/materials that have not been approved by the PTC can lead to disqualification from the tool.

Users must ensure the carrier is in the chamber when running any deposition (including deposition rate tests). Without the carrier in place, material would be deposited onto the quartz heater window which will reduce heater efficiency and shorten its lifetime. Deposition should never be run without the carrier in the chamber.

Users are expected to leave the system with the carrier in the loadlock and to pump down the loadlock before disengaging from CORAL.

If there are problems while operating the machine, report them immediately in CORAL so that the staff can address them in a timely fashion.

Operating Procedures

1. Engage the Sputter-AJA-LL on CORAL. The CORAL interlock disables the monitor, so you must be engaged in order to operate the software.

Loading your samples

2. Check that the wafer carrier is in the loadlock.
3. Bring the loadlock chamber up to atmosphere by turning off the loadlock pump (Figure 1) and wait until the loadlock pressure gauge (Figure 2) reads greater than 760 Torr (7.6 x10^2).

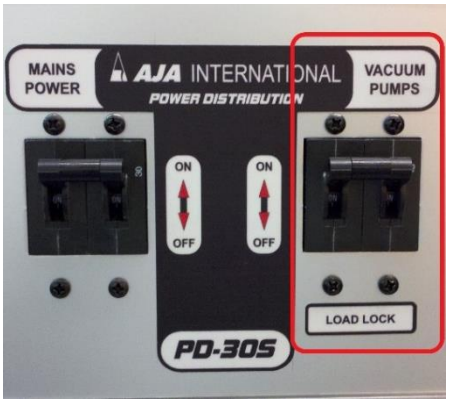


Figure 1 Loadlock pump control



Figure 2 Loadlock pressure gauge

4. Remove the loadlock lid and place it on the 3 rubber pads (Figure 3).

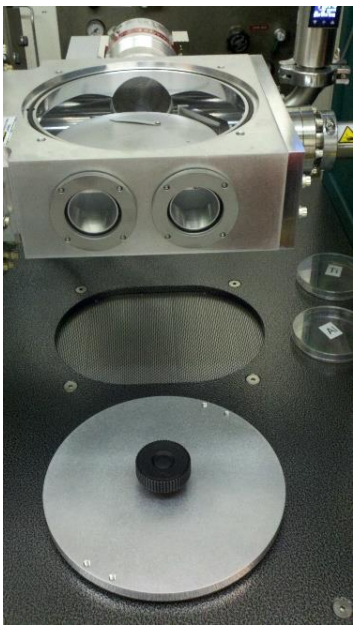


Figure 3 Loadlock lid off

5. Load sample(s) onto the carrier (Figure 4**Error! Reference source not found.**), deposition side up.

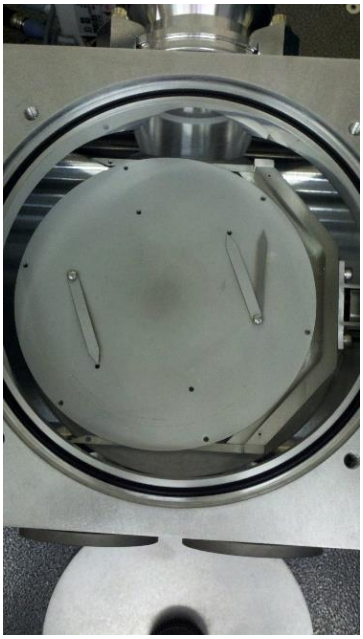


Figure 4 Sample carrier

6. Replace loadlock lid by tilting the lid so that the edge closest to you is in place, then lower the lid until it is sitting flat on the o-ring..
7. Turn on the loadlock pump and wait for the loadlock pressure gauge to read in the -6 range.

Transferring carrier in

8. Confirm that the loadlock pressure gauge and the chamber ion gauge (`Figure 5`) are both reading in the -6 range or lower.

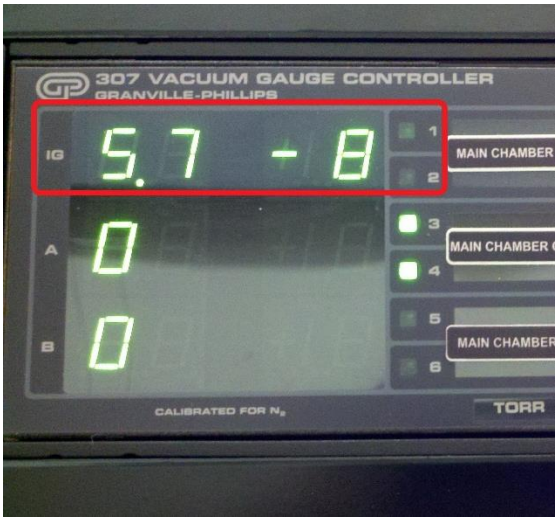


Figure 5 Chamber pressure readout

9. Open the shutters on both viewports and turn on the lamp.
10. Open the transfer gate valve (Figure 6).

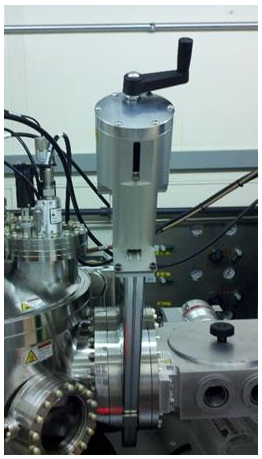


Figure 6 Transfer gate valve

11. Slowly push the transfer arm into the chamber (Figure 7).



Figure 7 Transfer arm partially inserted

12. Make sure the stage is low enough so that the carrier passes over the rotating hub (Figure 8). The pointer underneath the chamber (Figure 9) should be around 30. If the stage is too high, lower it using the stage control joystick (Figure 10).

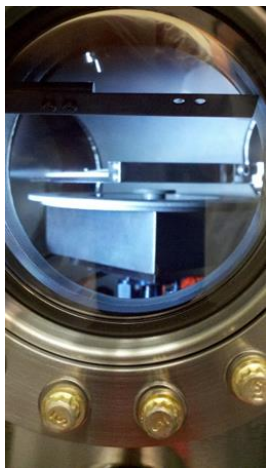


Figure 8 Stage lowered for transfer

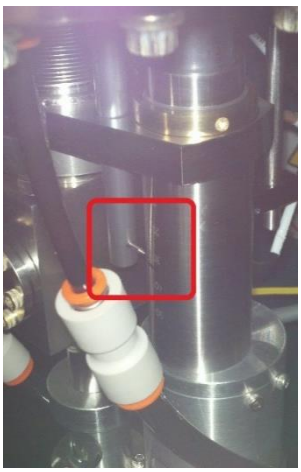


Figure 9 Stage position indicator



Figure 10 Stage control joystick

13. Once the arm is fully inserted, raise the stage so the hub fits into the pocket on the underside of the carrier. Continue raising the stage until the carrier is lifted off the transfer arm and the stage stops moving (Figure 11). The pointer underneath the chamber should be around 40.

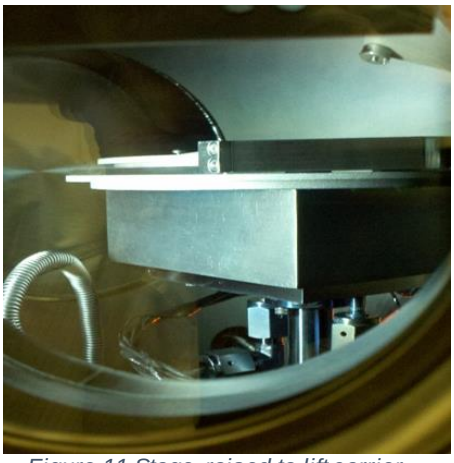


Figure 11 Stage raised to lift carrier

14. Retract the transfer arm.
15. Close the transfer gate valve.
16. Close both viewport shutters and turn off the lamp.

Deposition

17. Lower the stage to process position. This position is marked on the indicator underneath the chamber; the pointer should be around 34.
18. Login to the AJA Phase IIJ software using the password provided during training. Depending on the access level, you will be able to:
    - Run processes
    - Edit layers and stacks
    - Change target configurations
19. Select "Run Process" from the top right part of the screen.
20. Select the stack to run. If you do not see the stack you want to deposit, contact a staff member to have the proper stack written or to be trained to write layers and stacks.
21. If desired, turn data logging on with the appropriate sampling rate.
22. Click open. Verify that all the subsystems are ready to run. The checks are:
    a. The carrier has been correctly loaded into the chamber and the transfer gate valve is closed.
    b. The chamber ion gauge reads in the low -6 range or lower. If the ion gauge is not on, turn it on with the IG1 switch on the chamber pressure panel.
    c. The VAT pressure controller is in remote mode (Figure 12).



Figure 12 Chamber pressure controller

d. The heater control is in remote mode (Figure 13).



Figure 13 Substrate heater controller

e. The DC generator reads “ANLOG” on the front panel (Figure 14).

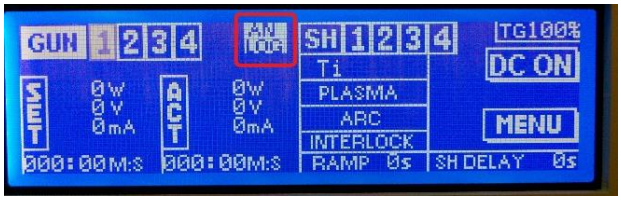


Figure 14 DC power supply display

f. The toggle switch on the stage controller is set to remote (down) and the rotation speed knob is set to 100% (approx. 20rpm) (Figure 15).

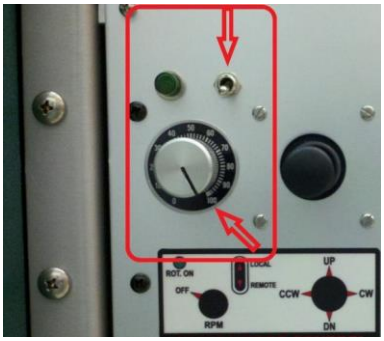


Figure 15 Stage position/rotation controller

g. The RF generator for the substrate bias says “ANALOG” on the front panel (Figure 16).



Figure 16 Substrate RF generator

23. Be sure the carrier is in the chamber (Figure 17). Without the carrier in place, material would be deposited onto the quartz heater window which will reduce heater efficiency and shorten its lifetime. **Deposition should never be run without the carrier in the chamber** (Figure 18).

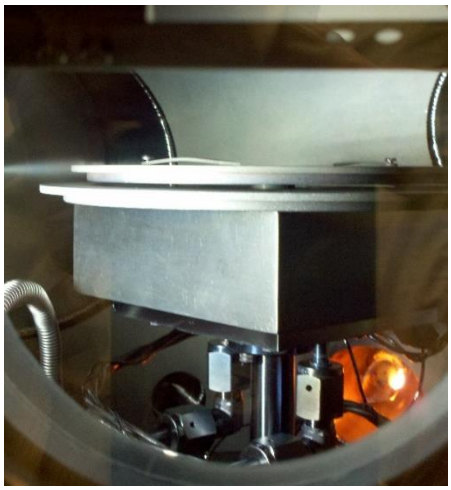


Figure 17 Stage lowered into process position



Figure 18 Stage with no carrier

24. If all the above conditions are met, press "OK" and the process should start, otherwise press "Cancel".
25. The process will run through all the cleans and layers that are programmed, then a dialog box will come up saying "Process Complete".

Unloading

26. Wait for the process chamber pressure to go back into the -6 range.
27. Confirm that the loadlock pressure is in the -6 range or lower.
28. Open the transfer gate valve.
29. Open both shutters and turn on the lamp.
30. Raise the stage to transfer position (pointer should be around 40).
31. Slowly insert the transfer arm.
32. Lower the stage so the hub clears the bottom of the carrier (pointer should be around 32).
33. Slowly retract the transfer arm.
34. Close both shutters and the lamp.
35. Close the transfer gate valve.
36. Turn off the loadlock pump.
37. Wait for the loadlock to come up to atmospheric pressure (7.6x102 Torr).
38. Remove the loadlock lid and place it on the three rubber pads.
39. Remove sample(s) from carrier.
40. Replace loadlock lid by tilting the lid so that the edge closest to you is in place, then lower the lid until it is sitting flat on the o-ring.
41. Turn on the loadlock pump and wait for the loadlock pressure gauge to read in the -6 range.
42. Logout of the AJA Phase IIJ software.
43. Disengage the system on CORAL.

Appendices

Gun Tilt Settings

Gun	tilt setting/mm	knob
1	11	13
2	11-12	2.5
3	13-14	14
4	12	20

QCM Parameters

Ti	4.5	0.628	1
Au	19.3	0.381	2
Al	2.7	1.08	3
Cu	8.93	0.437	4
Cr	7.2	0.305	5
Ni	8.91	0.331	6
Mo	10.2	0.257	7
W	19.3	0.163	8
Ag	10.5	0.529	9

Max power density by material

		area (cm^2)
3" round targets		45.60
Material	Max DC power density (W/cm^2)	max power
Al	20	912
Ag	18	821
Au	20	912
Cr	8	365
Cu	20	912
Mo	7	319
Ni	10	456
Ti	10	456
W	7	319

Common errors/failures:

Problems striking plasma

If there are problems striking a DC plasma at 3mTorr, insert a higher pressure layer as a strike step. Just remember to put the enter the strike power into the Idle power STPT field so that the plasma stays on as it transitions to the deposition step.

Running reactive processes can sometimes cause an insulating film to build up on the surface of the target. If this happens you may need to run an extended RF plasma with just Ar to clean off the target surface.