



BOISE STATE UNIVERSITY
ENVIRONMENTAL HEALTH, SAFETY
AND SUSTAINABILITY

STANDARD OPERATING PROCEDURE

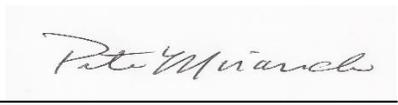
**AJA ORION 5 SPUTTERING SYSTEM
(AJA#1)**

College/Dept: College of Engineering	Building/Room: RUCH105
Laboratory Name: Idaho Microfabrication Lab	Revision: 2.0
Principal Investigator: Peter Miranda	Author: Marcus Marosvari

Before the worked detailed in this procedure may begin, the intended user must read and understand this document. This document must be approved by the PI, the college's safety liaison, and EHSS. Any changes to this document, however minor, must be submitted for approval by the PI, the college's safety liaison, and EHSS. The "buddy system" will be in place whenever any work is conducted.

REVISION BLOCK			
REV	CHANGES MADE	BY	DATE
1.0	New	P. Miranda	2/1/11
2.0	Updated document and format	M. Marosvari	8/3/18

Approval

Intended User:	_____	_____	_____
	Name, Title	Signature	Date
Reviewed and Approved by:	_____	_____	_____
	Name, Title	Signature	Date
Pete Miranda, Director - IML	_____		4-23-20
	Name, Title	Signature	Date
	_____	_____	_____
	Name, Title	Signature	Date

Overview

The Orion 5 is designed to deposit materials under a broad range of processing conditions. The system is equipped with two RF and three DC power sources to allow deposition of materials ranging from electrical insulators to electrically conductive materials. The system uses an Argon plasma source with chamber pressure control and gas flows controlled manually or automatically using the AJA Phase-II software. Sample heating up to 850°C can be done from an IR heat sources residing under the substrate holder. Sample loading can be done quickly using the on-board load lock system. The system is designed to accommodate two inch diameter sputtering target sources up to half an inch thick.

Scope

The following operating procedure will outline how to load a sample, important data, and running the machine in manual and automatic mode. Although many of the steps pertaining to this system can be used during the operation of AJA#2, there are some differences which require a separate procedure to be followed.

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Potential Hazards					
<input type="checkbox"/> Chemical	<input type="checkbox"/> Thermal	<input type="checkbox"/> Hydraulic	<input type="checkbox"/> Electrical	<input type="checkbox"/> Slip/Trip	<input type="checkbox"/> Biological
<input checked="" type="checkbox"/> Mechanical	<input type="checkbox"/> Radiation	<input type="checkbox"/> Pneumatic	<input type="checkbox"/> Fire	<input type="checkbox"/> Fall	<input checked="" type="checkbox"/> Other
Hazard Specifics: Mechanical: Pinch points at chamber and load lock lids. Other: Fumes produced from some processes can produce smells when opening chamber. Ensure that exhaust line is over main and/or load lock chamber when opening.					

Engineering Controls (EC)				
<input type="checkbox"/> Fume hood	<input type="checkbox"/> Biosafety Cabinet	<input checked="" type="checkbox"/> Other Local Exhaust	<input type="checkbox"/> Shielding	<input type="checkbox"/> Other
EC Specifics: Local exhaust: Exhaust line helps to remove odors and excess gas after opening main chamber.				

Training Requirements – except for classroom lab safety, must be completed prior to performing the procedure	
<input checked="" type="checkbox"/> Classroom Laboratory Safety Awareness	<input type="checkbox"/> Radiation Worker
<input type="checkbox"/> Online Safety Topics (specify):	
<input checked="" type="checkbox"/> Lab/Work Group Specific Training (specify): Tool specific training with experienced member of the IML staff.	
<input checked="" type="checkbox"/> Other (specify): IML Vacuum Science and Technology Handout	

Personal Protective Equipment (PPE)			
<input checked="" type="checkbox"/> Safety glasses	<input type="checkbox"/> Safety goggles	<input type="checkbox"/> Face shield & safety glasses	<input type="checkbox"/> Face shield & safety goggles
<input type="checkbox"/> Lab coat	<input type="checkbox"/> Apron	<input type="checkbox"/> Tyvek suit	<input type="checkbox"/> Tyvek sleeves
<input checked="" type="checkbox"/> Gloves	<input type="checkbox"/> Leg coverings	<input type="checkbox"/> Hard hat	<input type="checkbox"/> Hearing protection
<input type="checkbox"/> Respirator	<input type="checkbox"/> Shoes	<input type="checkbox"/> Fall protection	<input type="checkbox"/> Other
PPE Description: Safety glasses: Required at all times in RUCH105. Gloves: Required when handling samples and chuck.			

Equipment, Materials, Supplies, & Facility Requirements
Samples, IPA, wipes, kapton tape, scissors, N2, Argon.

Handling, Work Area & Storage Requirements
Keep workspace clean and ensure to leave system under vacuum when done.

Emergency Response Equipment & Supplies			
<input type="checkbox"/> Eyewash	<input type="checkbox"/> Fire extinguisher	<input checked="" type="checkbox"/> First aid kit	<input type="checkbox"/> Calcium gluconate gel (HF use)
<input type="checkbox"/> Safety shower	<input type="checkbox"/> Fire blanket	<input type="checkbox"/> Spill kit	<input type="checkbox"/> Emergency gas shutoffs
<input type="checkbox"/> Drench hose	<input type="checkbox"/> Other:		

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Description: First aid kit located in RUCH 106.

Decontamination & Waste Disposal

No waste should be creating by the machine. Items such as used wipes and kapton tape can be thrown away in the trash.

Spill Response

N/A

Additional Safety Information

Review of applicable safety references such as material safety data sheets to ensure appropriate protective measures, spill supplies, and first aid procedures.

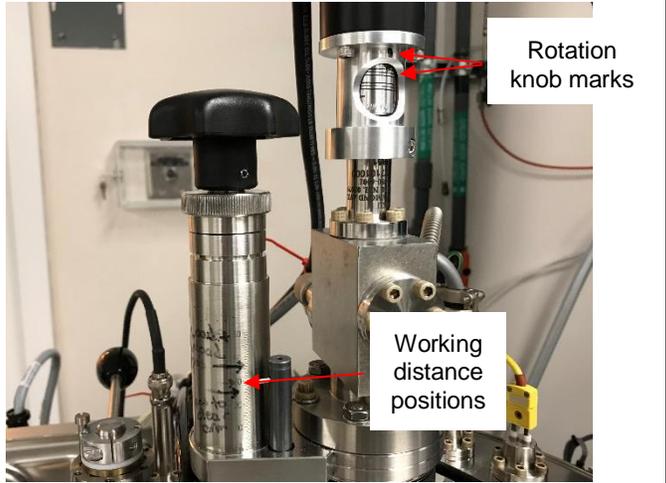
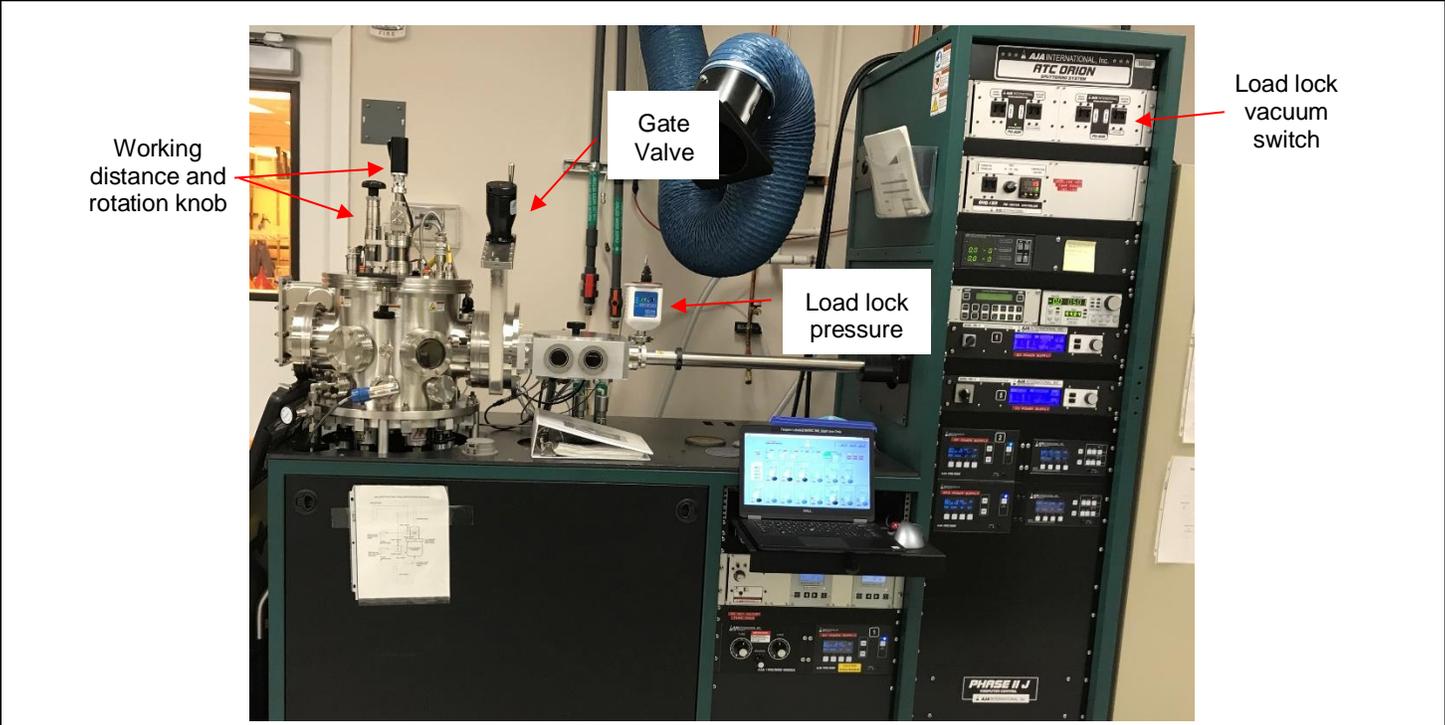
References

N/A

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Procedure		
STEPS		
	Potential Hazards	EC, Haz. Mitigation Device, PPE
1. Loading Sample	Mechanical: Pinch point	Safety glasses, gloves
<p>a. Ensure N₂ supply is on and turn the <i>Load Lock – Vacuum Pumps</i> switch to the downward, <i>OFF</i> position.</p> <p>b. The load lock chamber pressure readout will start to come up after a few moments. Remove the load lock lid when atmosphere pressure is reached.</p> <p>c. Clean sample and mount on chuck. This can be done with either kapton tape if it is a small sample, or the clamp ring if it is a whole wafer.</p> <p>d. Place chuck, sample side down, on the transfer arm. Ensure that one of the radial lines on top of the chuck is pointing directly to the left. Note, a screw on the under-side of the chuck can be used to prevent rotation of the chuck while loading.</p> <p>e. Place the load lock lid back on and turn the <i>Load Lock – Vacuum Pumps</i> switch the upward, <i>ON</i> position.</p> <p>f. Wait until the pressure in the load lock chamber comes down to within one order of magnitude of the main chamber. The main chamber pressure can be checked using the <i>IG1</i> or <i>IG2</i> buttons in the <i>Vacuum Gauge Controller</i>. Be sure to quickly turn off pressure readout after value is observed. Note, if the load lock chamber has a difficult time pumping down, turn off the pump and wipe down both the bottom of the lid and the O-ring with IPA.</p> <p>g. Once the crossover pressure is reached, open the gate valve by rotating handle counter-clockwise. A brass nut should rise up when fully open.</p> <p>h. Ensure that the working distance is set to <i>Position to clear arm</i>.</p> <p>i. Slowly slide the transfer arm to the left until clamp ring is met.</p> <p>j. Ensure top mark above the rotation knob is aligned to the left mark on the rotation knob.</p> <p>k. While looking in the chamber, lower the working distance to around the <i>Load/Unload</i> position. Visually, you should see the 3-pronged hook lower into the chuck. Note, this step can be very tedious. If the chuck seems to be disoriented and the hook will not lower into the chuck, remove the chuck and ensure that it is in the correct position.</p> <p>l. Once the hook is seated in the chuck, align the mark above the rotation knob with the right mark on the rotation knob.</p> <p>m. Move the working distance back up towards the <i>Position to clear arm</i>. The chuck should lift up off of the transfer arm.</p> <p>n. Check to see if chuck is level by turning the manual silver rotation switch to the upwards, <i>ON</i> position. If the chuck is not level, the loading process will have to be repeated. Turn rotation switch to <i>OFF</i> when done.</p> <p>o. Complete moving working distance back to <i>Position to clear arm</i> and move transfer arm back to the right.</p> <p>p. Close gate valve by rotating the handle clockwise. A quiet clicking sound should be heard indicating the valve is fully closed.</p> <p>q. Move to step 2. or 3. and run process.</p>		

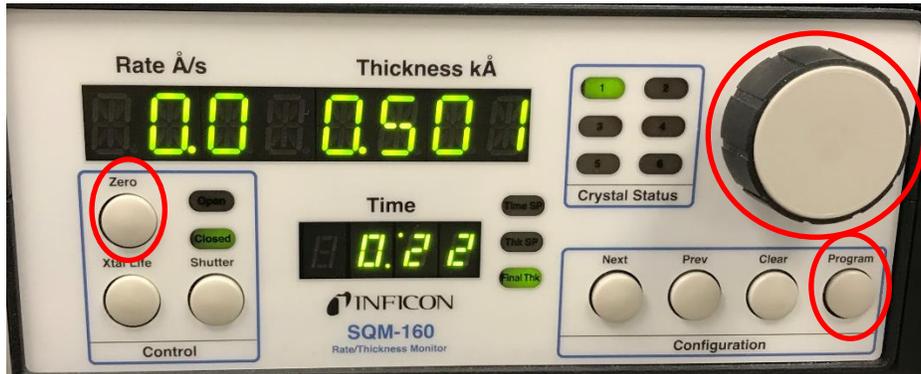
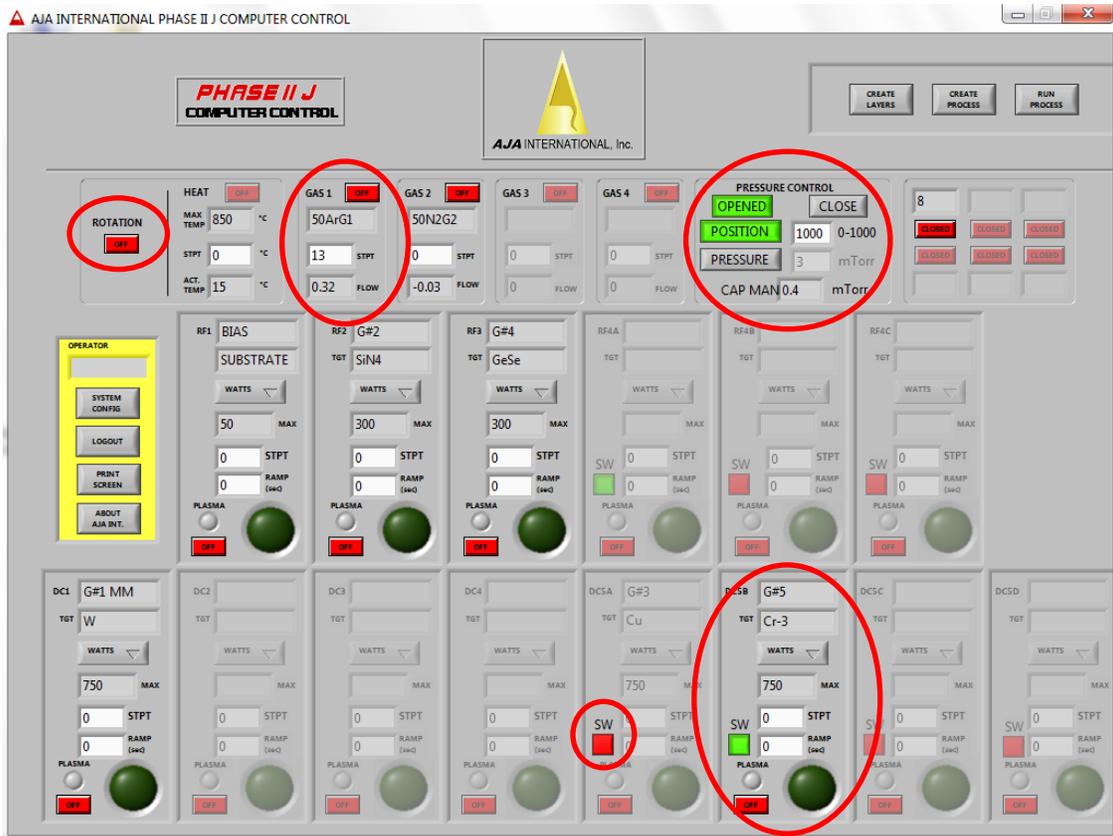
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	Potential Hazards	EC, Haz. Mitigation Device, PPE
<p>2. Running on Manual Mode</p>	N/A	Safety glasses, gloves
<ul style="list-style-type: none"> a. Set working distance. This is typically 30 and can be checked for each target. b. Turn rotation on by clicking the button below the <i>ROTATION</i> label. c. In the <i>GAS 1</i> area, ensure that Argon's <i>STPT</i> (Set-Point) is set to 13. Turn on the gas by clicking the button next to <i>GAS 1</i>. Note, ensure that the Argon bottle behind the tool is open. The pressure gauge should indicate around 10psi. d. In the <i>PRESSURE CONTROL</i> area, click the <i>PRESSURE</i> button. Enter 30 next to the button. e. Below, identify your desired target and which gun it is loaded on. If you are using a target that is on either gun 3 or 5, you will have to activate the correct gun by clicking the red square under the <i>SW</i> label. The square will turn green once activated. f. Determined the appropriate strike power for you target and enter this number into the box next to the <i>STPT</i> label in the corresponding gun. g. Turn on plasma by clicking the button below the <i>PLASMA</i> label and grey circle. When the target has struck, the circle will turn pink. Note, sometimes the target has a hard time striking, there can be many reasons that this is the case. One common method to help the target strike is to open the shutter (click the large, dark green button) while the target is trying to strike. If this doesn't work, consult IML staff for further assistance. h. Identify the process power for your target. The general rule is that targets can be ramped at a rate of 1W/s. To calculate the necessary ramp time, simply subtract the strike power from the process power. i. First, enter the ramp time in the box next to the <i>RAMP (sec)</i> label. j. Next, enter the process power where the strike power was, end hit enter on the keyboard. The process power will grey out and the ramp time will start counting down. k. Once the ramp time has reached zero and the target is at process power, change the <i>PRESSURE</i> to 3. l. If using the thickness monitor, ensure that it is set to the correct film. To change the film, press the <i>Program</i> menu and use the scroll wheel to find the desired film. Once on the film, press the scroll wheel to select it, and press the <i>Program</i> button again to exit. m. It is important to do the following two steps at the same time. Open the shutter by pressing the large green button and press the <i>Zero</i> button on the thickness monitor. n. Ensure the shutter has fully opened by looking in to the view port. If the target plasma is visible the shutter has opened properly. Close the view port shutter. o. Once the process time or film thickness has been reached, close the shutter by pressing the now big bright green button. p. Change <i>PRESSURE</i> to 30. q. First, enter in the same ramp time as calculated in step h. r. Next, enter the strike power and hit enter on the keyboard. s. Once the ramp time has reached zero, turn off plasma by pressing the green <i>ON</i> button below the pink circle. t. Click <i>OPEN</i> in the <i>PRESSURE CONTROLLER</i> section. Turn <i>GAS 1</i> off by clicking the green <i>ON</i> button. Turn <i>ROTATION</i> off by clicking the green <i>ON</i> button. u. Move to step 4. and remove sample. 		

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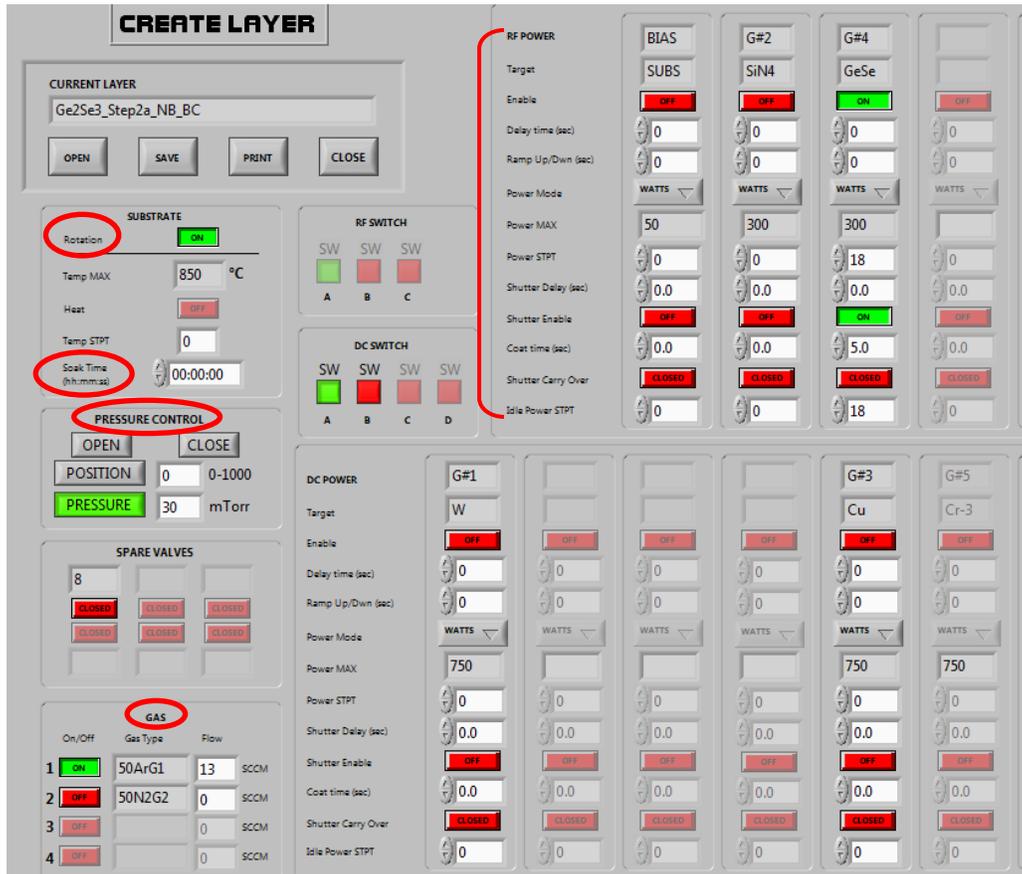


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	Potential Hazards	EC, Haz. Mitigation Device, PPE
3. Creating and Running a Recipe	N/A	Safety glasses, gloves

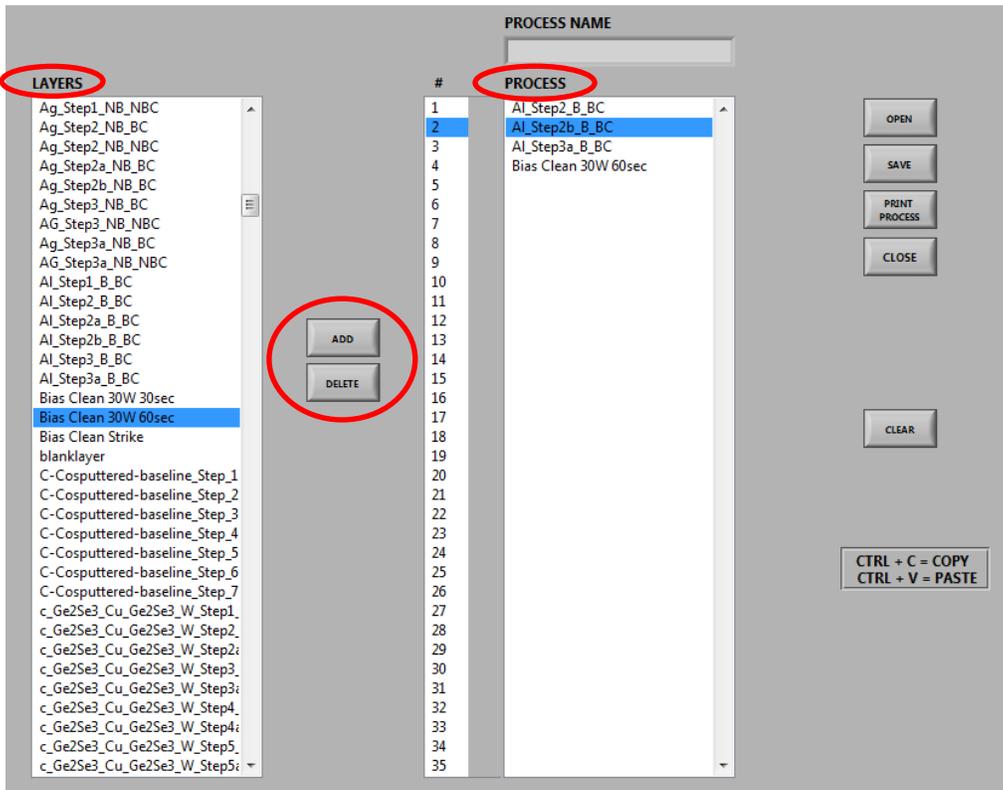
Note, before running a recipe, please ask a member of the IML staff do double check its steps.

- a. Click on the *CREATE LAYERS* button in the top right corner.
- b. It is important to create steps for all of the steps in your process. The steps you create to put in a recipe should mimic the steps that you do when running the tool in manual mode. Here are the parameters that you should take into consideration when creating a layer (step):
 - Rotation
 - Soak Time – used as a step duration for steps such as changing pressures are flowing process gas
 - Pressure
 - Gas
 - Enable – used to power on and off the target
 - Delay time – can be used to delay the target being enabled, useful after changing pressures
 - Ramp Up/Down
 - Power STPT
 - Shutter Delay – similar to delay time, but will delay the shutter opening
 - Shutter Enable
 - Coat time – same as process time
 - Idle Power STPT – it is important to set the idle power to whatever power the target ended the step on. This could be zero, the strike power, or the process power.

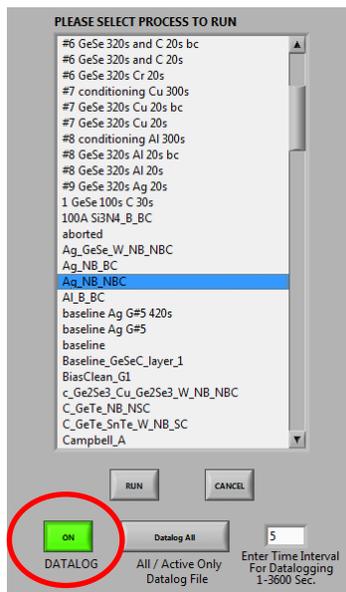


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- c. When finished with a step, click the *SAVE* button and give the step a descriptive name. If you wish to edit an existing step, click the *OPEN* button, edit the step, and save it with the same name. Click the *CREATE PROCESS* button in the top right corner.
- d. On the create process screen, you can scroll through the list of layers and select which to add to your recipe using the *ADD* button. You are also able to remove steps from the process by using the *DELETE* button.



- e. When finished with the recipe, click the *SAVE* button and give the recipe a descriptive name. To edit an existing process, use the same procedure as editing a step.
- f. Before running a recipe, it is always important to double check it's steps. Use the *OPEN* button to view the steps inside an existing recipe, and then examine the individual steps to make sure they are configured as expected.
- g. Click the *RUN PROCESS* button in the top right corner.
- h. A menu will pop up in which you can select your recipe. Be sure to turn *DATALOG* to *ON*. Click the *RUN* button to start the recipe.



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- i. After selecting *RUN*, a warning menu will pop up directing you to double check some items. Be sure to double check you have the correct working distance, process gases are open, and that the entire machine is configured as it should be.
- j. After clicking *OK*, the recipe will start. You can view the current layer in the top right corner and the current layer time. In the event that the process needs to be aborted, click the red *ABORT PROCESS* button near the top of the screen.
- k. Once the process has finished, move on to step 4. and remove sample.

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	Potential Hazards	EC, Haz. Mitigation Device, PPE
<p>4. Unloading Wafer</p>	<p>Mechanical: Pinch point</p>	<p>Safety glasses, gloves</p>
<p>a. Repeat steps <i>a</i> through <i>i</i> from 1. <i>Loading Wafer</i> section.</p> <p>b. Align the mark above the rotation knob with the right mark on the rotation knob.</p> <p>c. While looking in the chamber, lower the working distance to around the <i>Load/Unload</i> position. Visually, you should see the chuck lower onto the transfer arm.</p> <p>d. Align the mark above the rotation knob with the left mark on the rotation knob.</p> <p>e. Move the working distance back up towards the <i>Position to clear arm</i>. The hook should lift up out of the chuck.</p> <p>f. Complete moving working distance back to <i>Position to clear arm</i> and move transfer arm back to the right.</p> <p>g. Close gate valve by rotating the handle clockwise. A quiet clicking sound should be heard indicating the valve is fully closed.</p> <p>h. Turn the <i>Load Lock – Vacuum Pumps</i> switch to the downward, <i>OFF</i> position</p> <p>i. Once atmosphere is reached remove lid and remove sample.</p> <p>j. Replace load lock lid and turn the <i>Load Lock – Vacuum Pumps</i> switch to the upward, <i>ON</i> position.</p>		