

Document: Fiji2	Revision: A	Release Date: 11/28/22
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1. Equipment Purpose

- 1.1. Fiji2 is a Fiji F202 system from Cambridge Nanotech. It is a load-locked, Plasma-Enhanced Atomic Layer Deposition (PEALD) system capable of both thermal and plasma ALD of select dielectric and metallic films. The system can accommodate samples up to an 8" wafer. Fiji2 is currently classified as flexible cleanliness and is open to a wide range of materials.
- 1.2. Fiji1 and Fiji2 are physically contained in a single frame, although each tool is completely separate and autonomous from the other.

2. Equipment Specifications

- 2.1. Fiji Location: West side of SNF cleanroom, Allen Building
- 2.2. Maximum sample diameter: 8 in
- 2.3. Minimum sample diameter: No minimum, however samples smaller than 4" must use a carrier wafer to prevent being sucked into vacuum lines
- 2.4. Plasma Frequency: 13.56 MHz
- 2.5. Standard Plasma Power: 300W
- 2.6. Maximum deposition thickness: 50 nm unless explicitly approved by staff
- 2.7. Maximum Chamber Temperature: 300C
- 2.8. Calibration frequency: Monthly HfO₂ test wafers

3. Cleanliness Standard

- 3.1. Fiji 2 is classified as Flexible.

4. Processing Capabilities

- 4.1. See Section 11 "Process Data" for a complete list of films.

- 4.2. For the current list of installed precursors, check under the “maintenance” tab of Badger.
- 4.3. Not allowed materials:
 - 4.3.1. Polymers, unless specifically approved by the staff
 - 4.3.2. Wet samples
 - 4.3.3. Plastic, including teflon
 - 4.3.4. Non-encapsulated particles
 - 4.3.5. Very small samples that can fall into vacuum lines

5. Becoming a User

- 5.1. Read all documentation on the SNF website pertaining to Fiji 2.
- 5.2. Shadow a current Fiji 2 user until you become familiar with the operation of the tool. If you do not know a Fiji 2 user, check the upcoming reservations on Badger. Contact current users and see if they would be willing to let you shadow.
- 5.3. Contact Alex Denton for a copy of the written quiz.
- 5.4. Pass an in-person practical exam with Alex Denton. You may bring a sample, or a dummy wafer will be provided.

6. Safety

- 6.1. ALD systems use toxic and pyrophoric precursors, never open the back of the Fiji or tamper with precursors! This is for staff only. If you would like to request a precursor change, make a comment in Badger.
- 6.2. Use caution when near the chamber, the chamber is wrapped in a heating jacket that can burn you.
- 6.3. The sample plate is maintained at 250C, do not use anything that melts at low temperature when loading your sample. Use metal or teflon coated tweezers. Do not use vinyl gloves.

7. Required equipment

- 7.1. Metal or Teflon coated metal tweezers.
- 7.2. Cleanroom Garments as necessary for the SNF cleanroom.
- 7.3. Double glove with nitrile gloves, do not use Vinyl gloves near Fiji 2.

8. Magnetic Transfer Arm Operating Procedure

- The magnetic transfer arm moves the sample plate between the chamber and the loadlock
- The black sleeve on the outside of the tool is magnetically coupled to the transfer arm. It is possible for the transfer arm and black sleeve to become uncoupled if excessive force is used. If decoupling occurs, stop operation and find a staff member. **Figure 1.**
- It is helpful, and almost necessary, to stand on a step stool to be able to see into the loadlock and properly use the magnetic transfer arm.

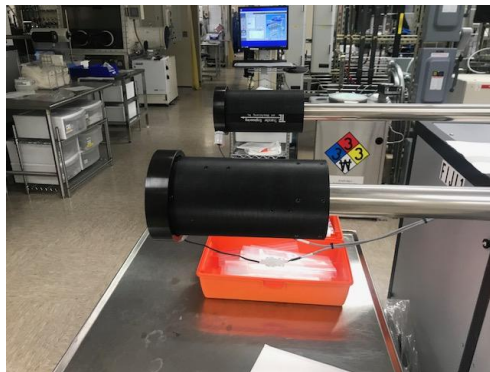


Figure 1: Sleeve magnetically coupled to transfer arm

- 8.1. Push the magnetic sleeve off of the stop until the fork is in view through the loadlock. **Figure 2**



Figure 2: View of transfer fork through loadlock window

- 8.2. Twist the sleeve towards you and away from you, taking note of the sleeve position when the forks are at their highest and lowest points
- 8.3. Slide the forks toward the sample in the highest possible position.
- 8.4. Firmly push the sleeve towards the chamber to make sure the forks are well engaged in the sample plate. The sleeve should be 1mm or less from the mark on the stainless steel tube. **Figure 3.**



Figure 3: Mark indicating full fork engagement. The front of the black sleeve must reach this line. The mark is drawn in Sharpie, and may change colors

- 8.5. With the fork still rotated into the high position, pull the sample plate back into the load lock.
- 8.6. Once the sleeve hits the stop, allow the forks to return to the neutral position.

9. Operating Procedure

9.1. Reservations

- 9.1.1. Maximum reservation window is 4 days.
- 9.1.2. Maximum length of primetime reservations on weekdays is 4 hours.
- 9.1.3. Maximum reservation length is 24 hours.

9.2. Precursor Requests

- 9.2.1. Precursor requests must be made 24 hours in advance of reservation time.
- 9.2.2. Precursors are swapped frequently. Do not assume the Fiji is equipped with the precursor you need!

9.3. Initial Checks

9.3.1. Enable Fiji 2 on Badger.

9.3.2. Under the “maintenance” tab, find the comment labeled “precursor status”

9.3.3. Verify your desired precursor is available.

9.4. Verify Standby Condition

9.4.1. Loadlock and chamber should be pumped down, approximately 150 mTorr under standby condition of 5 SCCM of N₂.

9.4.2. Verify heaters are on. The button below “Heaters” should show “Off” and be green.

9.4.2.1. On the system display, the temperature value in the red box should match the temperature value in the white box +/- 3 degrees

9.4.2.2. A blue box indicates the heater is not on, and NC means not connected.

9.4.2.3. If these do not match, wait a few minutes until they match. If a heater seems defective, contact staff.

9.4.3. Verify the precursor you would like to use is at the correct temperature.

The correct setpoint can be found in section 11: “Process Data”

9.4.3.1. If the temperature needs to be adjusted, select the number white box associated with the precursor. Type in the correct temperature and hit enter. **Figure 4.**

9.4.3.2. It may take a few minutes for the actual temperature displayed in red to match the setpoint in white.

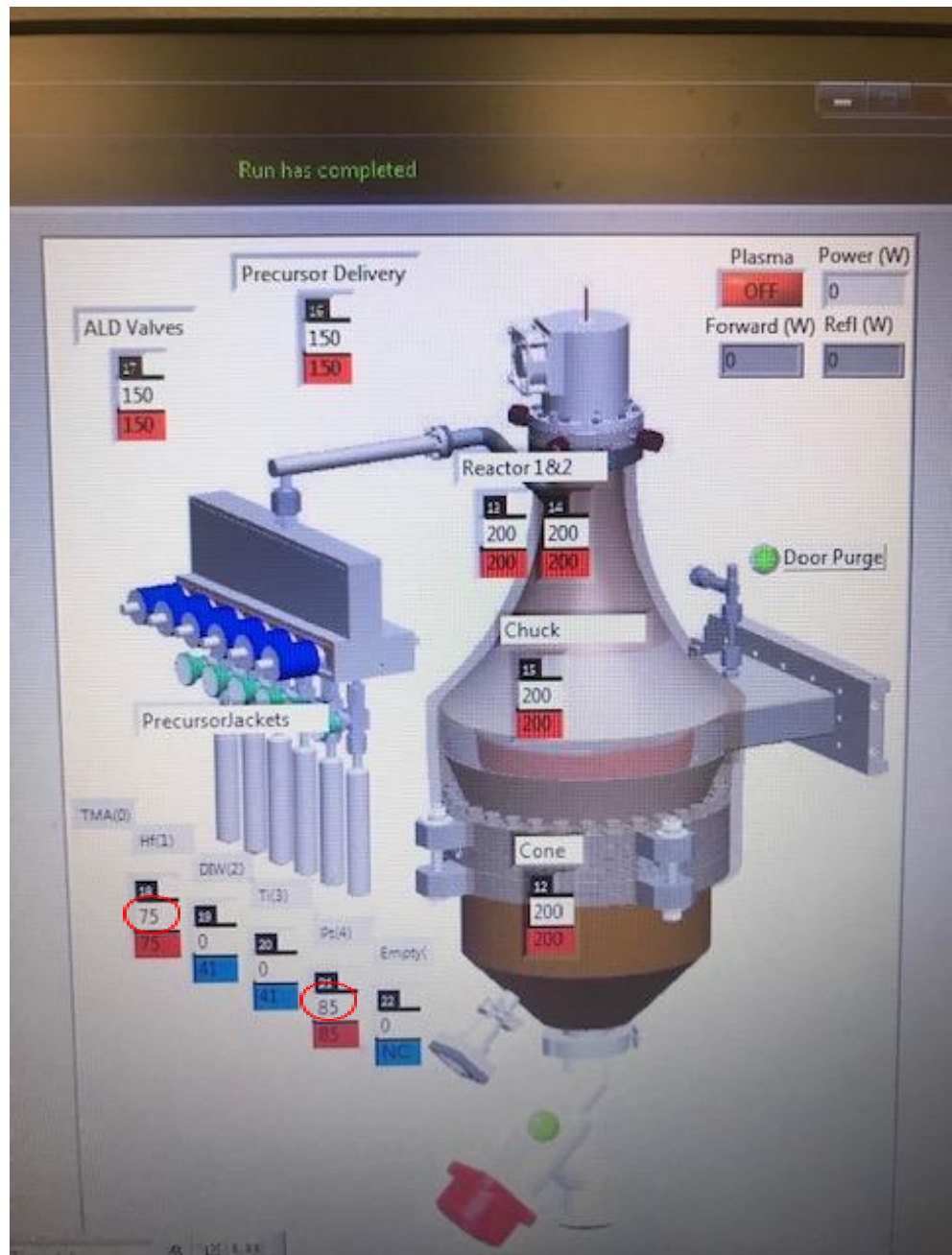


Figure 4: White box indicates temperature setpoint

9.5. Loading and Unloading Wafers

9.5.1. Under the “Vacuum System” tab, select “Transfer Sample”. **Figure 5.**

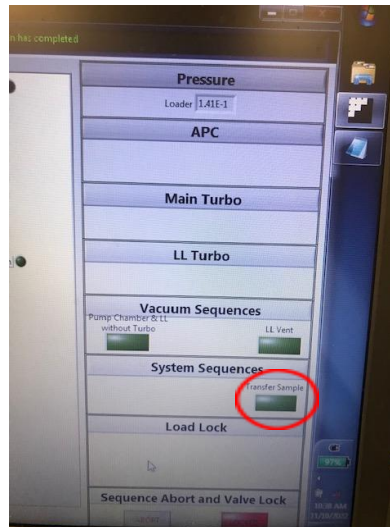


Figure 5: Transfer Sample Button

- 9.5.2. When the “please load” pop up is displayed, you are clear to remove the sample plate using the loading arm.
- 9.5.3. Follow the instructions in Section 8 to retrieve the sample plate from the chamber.
- 9.5.4. Vent load lock by clicking “LL Vent”. **Figure 6.**
 - 9.5.4.1. The load lock pressure gauge is not always accurate. The load lock may display atmospheric pressure but not be vented. If the chamber fails to vent, find a staff member.

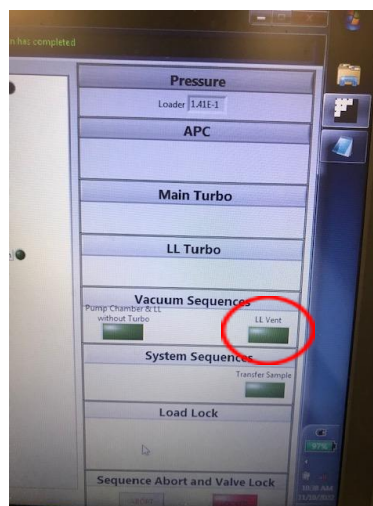


Figure 6: Load Lock Vent Button

- 9.5.5. Open the load lock and place your sample near the center of the plate.
 - 9.5.5.1. ALD is a very uniform process, and sample position on the plate should not affect the deposition. However, it is
- 9.5.6. Close the loadlock, and click “ok” in the pop up menu
- 9.5.7. Select “Transfer Sample”
 - 9.5.7.1. This may take a few moments as the Load Lock pumps down and the gate opens
- 9.5.8. Load the sample plate into the chamber, following the instructions in Section 8.
- 9.5.9. Click “OK” in popup window when finished loading
 - 9.5.9.1. This will automatically pump down the chamber.
- 9.6. Running the Recipe
 - 9.6.1. Make sure the chamber reaches base pressure in a couple minutes. The base pressure is approximately 150 mTorr with 5 SCCM Nitrogen flow.
 - 9.6.2. Right click in the white field, and select “load recipe”. **Figure 7.**

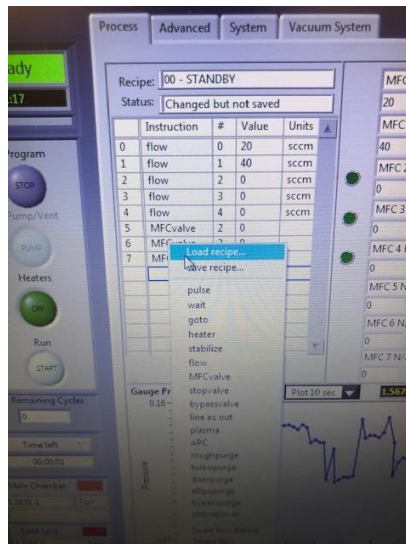


Figure 7: Right click in recipe area to access drop down menu

- 9.6.3. Select the recipe you would like to run. **Figure 8.**

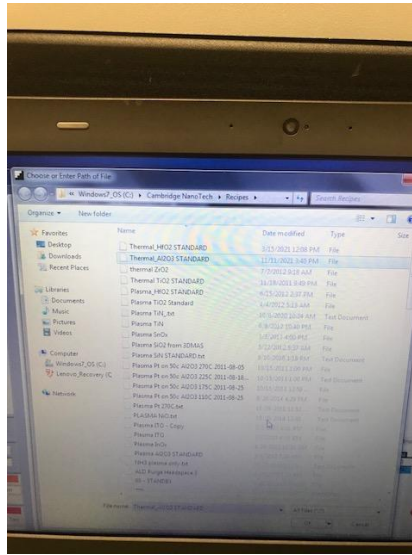


Figure 8: Recipe Window

- 9.6.4. Once the recipe is loaded, ensure the “pulse” and “goto” steps are set correctly for your process. **Figure 9.**
- 9.6.4.1. Pulse: in the # column, this value must match the position of the precursor inside the Fiji. Precursors move regularly, so make sure to check this value. Precursor position can be seen in **Figure 3.**
- 9.6.4.2. goto: in the value column, this controls the number of deposition cycles. Ensure the number of cycles is correct for your target thickness.
- 9.6.5. Edit the “go to” step to change the number of times the cycle repeats.

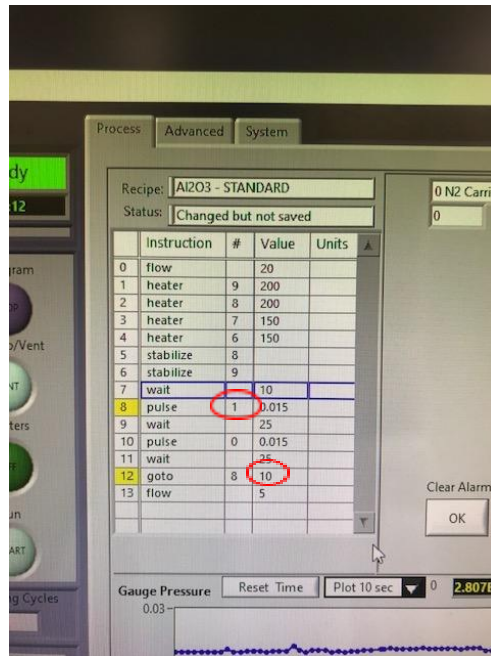


Figure 9: Recipe parameters to verify/modify before starting a deposition

9.6.6. With the sample loaded, temperatures verified, and recipe validated, you can now click the “Start” button. **Figure 10.**

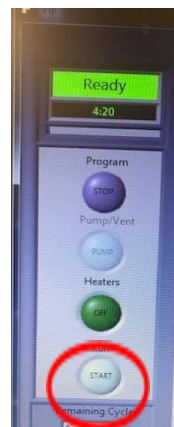


Figure 10: Recipe Start Button

9.7. Unloading the Sample

9.7.1. Under the “Vacuum System” tab, select “Transfer Samples”.

9.7.2. When the transfer sample is complete and the pop up menu comes up, DO NOT select “ok” until after you have finished transferring your sample.

- 9.7.3. Transfer sample as written in section 8.
- 9.7.4. When the transfer is finished, click “Ok” in the control software. This will close the gate and pump the chamber and load lock
- 9.7.5. Press “Vent LL” to vent the load lock.
- 9.8. Retrieving sample and shut down
 - 9.8.1. Open load lock and retrieve your sample with the proper gloves and tweezers.
 - 9.8.2. Close the loadlock .
 - 9.8.3. Select “Transfer Sample”.
 - 9.8.4. Transfer the sample plate using the technique found in Section 8.
 - 9.8.5. Click “Ok” to close the pop up window.
 - 9.8.6. Under the “Process” tab, select the “00-Standby” recipe.
 - 9.8.7. Run the recipe.
 - 9.8.7.1. This maintains the temperature in the system and flows a small amount of argon to maintain chamber cleanliness
 - 9.8.8. Disable Badger!

Fiji 2

10. Operating Guide

- 10.1. Reserve Fiji 2 on Badger.
- 10.2. Request desired precursor on Badger at least 24 hours in advance.
- 10.3. Enable Fiji 2 on Badger.
- 10.4. Change the precursor to the required temperature.
- 10.5. Under the “Vacuum System” tab, select “Transfer Sample”.
- 10.6. Using the transfer arm, move the sample plate to the load lock.
- 10.7. Click “Ok” to close the pop up window.
- 10.8. Click “LL Vent” to vent the load lock.
- 10.9. Open load lock and load samples.
- 10.10. Click “Ok” to close the pop up window.
- 10.11. Select “Transfer Sample”.
- 10.12. Transfer sample to chamber.
- 10.13. Click “Ok” to close the pop up window.
- 10.14. Under the “Process” tab, right click in the recipe field and load your recipe.
- 10.15. Modify the “pulse” and “go to” steps of your recipe.
- 10.16. Click the “Start” button.
- 10.17. When the process is finished, unload your sample.
- 10.18. Unloading is the reverse of loading.
- 10.19. Run the “00-Standby” recipe
- 10.20. Disable Fiji 2 in Badger.

11. Recipe Parameters

- Standard recipes are maintained in the C://Recipes/ folder.
- Below are the recipe parameters and a comment about each:

Parameter	Notes	User Modify?
Heater	Each heater has an unique item number and a value given in degrees Celsius. Do not overheat precursors (all precursors should be below 115C and some should not be heated at all - consult with the quality circle if unsure). The reaction chamber should always be hotter than the manifold which should always be hotter than the precursor lines. The upper limits on temperature are protected by setpoints internal to the system.	Yes, be careful!
Flow	The MFCs control the plasma and process gasses. It is defined in SCCM. Do not adjust the standard flow settings. The MFCs for H ₂ , N ₂ , and O ₂ have a hard off state and should be set to zero and then closed. This is already established in all recipes on the tool.	No
Pulse	This command is for pulsing a precursor line. It requires an ALD valve number and the amount of time you want the valve open in seconds. The shortest possible pulse is roughly .015 seconds. Even if you define a shorter time, the pulse will still be .015s. (The time in seconds needs a digit to the left of the decimal place; thus you should use "0.015" instead of ".015" for the minimum duration pulse.)	Should change/check valve number agrees with precursor you would like to use

goto	“goto” defines the loops in the recipe. This command takes the step to return to as an input. The value for this command defines how many times the loop will run.	Should change number of cycles based on target thickness
stabilize	This command is used to hold a recipe until a heater has reached the desired value. It takes as input a heater ID number and will wait until that heater demonstrates the set temperature with a degree C over a few seconds.	No
Wait	This command takes as input a value in seconds that you would like the system to wait before proceeding to the next command. (The time in seconds needs a digit to the left of the decimal place; thus you should use "0.1" instead of ".1")	No
Plasma	This command indicates the power that should be generated by the RF plasma system in Watts.	No
Stop Valve	This command will close or open the output valve for the reaction chamber depending on a Boolean input. This command is currently not used in any of the standard recipes, but development is beginning for recipes using this feature.	No

12. Process Data

Film	Process	Recipe Name	Deposition Rate @ 200C chamber temp unless otherwise noted (A/cycle)	Thickness Nonuniformity across chamber	Precursor or Label	Precursor Temp In Use	Precursor Temp Not In Use
Al2O3	Thermal	Thermal_Al2O3 STANDARD	1	1.00%	TMA	Unheated	Unheated
Al2O3	Plasma	Plasma Al2O3 STANDARD	1	0.50%	TMA	Unheated	Unheated
HfO2	Thermal	Thermal_HfO2 STANDARD	1	1.00%	Hf	75C	75C
HfO2	Plasma	Plasma_HfO2 STANDARD	1	1.00%	Hf	75C	75C
InOx	Plasma	Plasma InOx	??	??	In	140C	Unheated
ITO	Plasma	Plasma ITO	0.84 at 225C	??	In, Sn	In = 140C, Sn=65C	In = Unheated, Sn= 65C
NiO	Plasma	PLASMA NiO	??	??	Ni	User Sets	Unheated
Pt	Thermal	Thermal Pt	0.4	??	Pt	80C	80C
Pt	Plasma	Plasma Pt	0.5	??	Pt	80C	80C
Ru	Thermal	Thermal Ru	??	??	Ru	135C	135C
SiO2	Plasma	Plasma SiO2 from 3DMAS	0.8	1.00%	Si	Unheated	Unheated
SnOx	Plasma	Plasma SnOx	??	??	Sn	65C	65C
Ta2O5	Thermal	Thermal Ta2O3 STANDARD	??	??	Ta	120C	60C
Ta2O5	Plasma	Plasma Ta2O5	??	??	Ta	120C	60C
TaN	Plasma	Plasma TaN	??	??	Ta	120C	60C

TiN	Plasma	Plasma TiN	0.4	2.00%	Ti	75C	75C
TiO2	Thermal	Thermal TiO2 STANDARD	0.4	1.00%	Ti	75C	75C
TiO2	Plasma	Plasma TiO2 Standard	0.4	2.00%	Ti	75C	75C
WN	Plasma	Plasma Wn with H2	??	??	W	60C (TBD)	60C (TBD)
ZnO	Thermal	ZnO Standard	??	??	DEZ	Unheated	Unheated
ZrO2	Plasma	Plasma ZrO2	??	??	Zr	75C	50C
ZrO2	Thermal	Thermal ZrO2	0.8	1.00%	Zr	75C	50C

13. Troubleshooting

Symptom	Issue	Resolution
Can't open loadlock	<ul style="list-style-type: none"> Not enabled in Badger Chamber failed to vent 	<ul style="list-style-type: none"> Enable in Badger Under "Vacuum" tab, select "Vent LL" again
Dropped Sample Plate	<ul style="list-style-type: none"> Dropped Sample Plate 	<ul style="list-style-type: none"> DO NOT CLICK "OK" in Fiji software, contact Alex or Graham to vent chamber and retrieve plate
No precursor pulse seen on pressure gauge	<ul style="list-style-type: none"> No Issue Out of precursors Low precursor temp 	<ul style="list-style-type: none"> Some precursor pulses are weak, and cannot be seen over the baseline gas flow Contact staff for replacement precursor Consult Process Data table,

		check temp settings on precursor
Erratic deposition	<ul style="list-style-type: none"> • Wafer Cleanliness • Chamber Temperature • Base pressure 	<ul style="list-style-type: none"> • Consult Staff • Consult Staff • Consult Staff

14. Revision Block

Revision	Date	Description of Change	Author
A	11/28	Initial Release	A. Denton