



DEPARTMENT OF ELECTRICAL ENGINEERING

Atomic Layer Deposition (ALD) Oxford FlexAL User Instructions



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General Information

For problems, clarifications of procedures, or general information pertaining to this machine, please contact staff at staff-ndnf-list@nd.edu

Currently available precursors in this machine can be used for the depositions of both dielectric films and metal films, which include Al_2O_3 , SiN_x , SiO_2 , HfO_2 , Pt, TiN, TiO_2 , and ZrO_2 .

All users wanting to reserve the machine for longer than 8 hour periods and/or more than 4 days a week are required to apply for user to mrichmon@nd.edu and include how long of reservations and how often you are planning to use the machine. If Mark is unavailable then contact dheemstra@nd.edu or mthomas@nd.edu for approval. Once approval is received, send email to oxfordald-pcs@anemone.nano.nd.edu with the information of your use and your contact information.

ICP Tube clean: Build-up of a conductive film, such as Pt and TiN, can impede the ICP power or even prevent the ignition of the plasma. Cleaning (ICP Tube Clean) is therefore mandatory. However, neither the O_2 nor SF_6 plasma is effective in cleaning the Pt film. Bead blasting cleaning (significant tool down time) of the ICP tube may be required.

Only Clean wafers are allowed in the chamber. Pieces should be placed on the 6 inch plate. Deposition on Au is only allowed up to 200 °C. Absolutely NO photoresist, tape, other metals, or plastics etc! If you are not sure whether your desired process is allowed or not, get approval!!

NO Photoresist
NO Tape
NO Plastics
NO Thermal Grease
NO Metals without explicit approval
AU deposition only below 200-degree C
No TiCl_4 use with water precursor

*A list of the standard (OPT) recipes is stored in the process library. These OPT recipes were calibrated to balance between the film qualities, the throughput, and to prolong the lifetime of the tool. Applying significant deviations to the parameters (ex. dose time, purge time, the temperatures) in these recipes is strongly discouraged.

All user recipes will start with their NETID.

Standby Conditions

1. Table temp should be at 300-degree C
2. Overnight pumping will bring the base pressure down to e^{-6} Torr range.
3. The door for the precursor cabinet is closed and locked at all times.

Training procedure

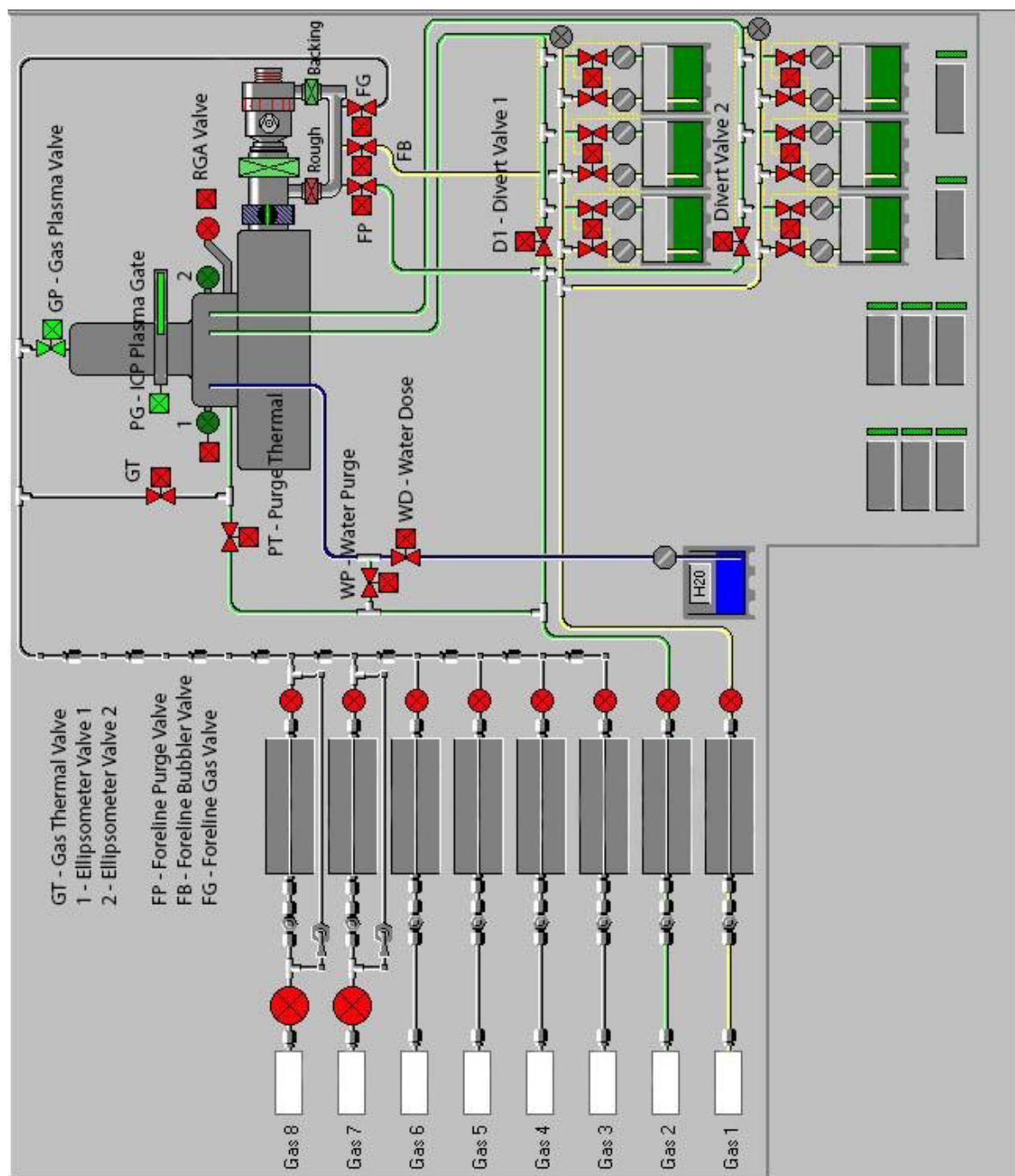
Contact **Siva Ramachandran** at sramacha@nd.edu for instructions on how to get trained on this machine.

Start Procedure (Running a Deposition)

1. Log into iLab and enable the machine. (Enables the 'Gas Pod' interlock)
2. Set the machine to your desired temperature.
3. Check your samples: clean? Yes. A carrier wafer should be used to load your sample. A conditioning run is also suggested on a dummy wafer before the real deposition process.
4. Go to Menu "System", click "Pump".
 - a. Go the bottom left of the page, click "Stop" and then "Vent". The loadlock chamber starts to vent and takes less than 5 minutes to reach the atmosphere.
 - b. Open the lid, and place your sample(s) on the wafer plate.
 - c. Close the lid and click "Stop" and then "Evacuate".
 - i. Enter wafer number or ID as appropriate.
5. Go to Menu "Process" and click "Recipe". Depending on what film you wish to deposit, make your own recipe referring to those recipes with the name beginning with "OPT".
 - a. Select the type of process you desire to run, automatic or manual process. (Automatic is recommended for ease of use)
 - b. Select "Load" and find your recipe.
 - c. Once loaded, select "Run" to start the recipe.
6. During the process, please check the process chamber condition and observe if the machine is following each step in the recipe.
7. When the process finishes, the sample will be automatically unloaded from the process chamber into the load lock chamber. A Yellow Alert will show "Process completed", click "OK" to dismiss.
8. Go to Menu "System", and click "Pump". Go to the bottom left of the page, and click "Stop" and "Vent". After 5 minutes, open the lid and take out the samples as well as the carrier wafer.

- a. Close the lid, click “Stop” and then “Evacuate”.
 - b. Click “CANCEL” if there’s no wafer in the LL.
9. If you have finished depositing a metal film (TiN or Pt), please run an ICP tube clean process.
10. Set the machine to the standby conditions.
11. In the iLab, disable the machine and complete the Run Data Collector.

Oxford demonstrated film rates in 2011						
Film @ 300°C	Cycles	Average Thickness(Å)	STD(Å)	n	k	GPC(Å/s)
TiN	400	144.582	2.3638	1.609	1.3764	0.361455
HfO ₂	300	288.3	19.62928	1.9025	0	0.961
Si ₃ N ₄	500	142.088	2.31944	1.8216	0	0.284176
Al ₂ O ₃	206	215.254	0.2885	1.671	0	1.045
SiO ₂	300	273.92	1.47078	1.4643	0	0.913067





DEPARTMENT OF ELECTRICAL ENGINEERING

USER MANUAL



IN SITU ELLIPSOMETER

FOR

OXFORD ALD



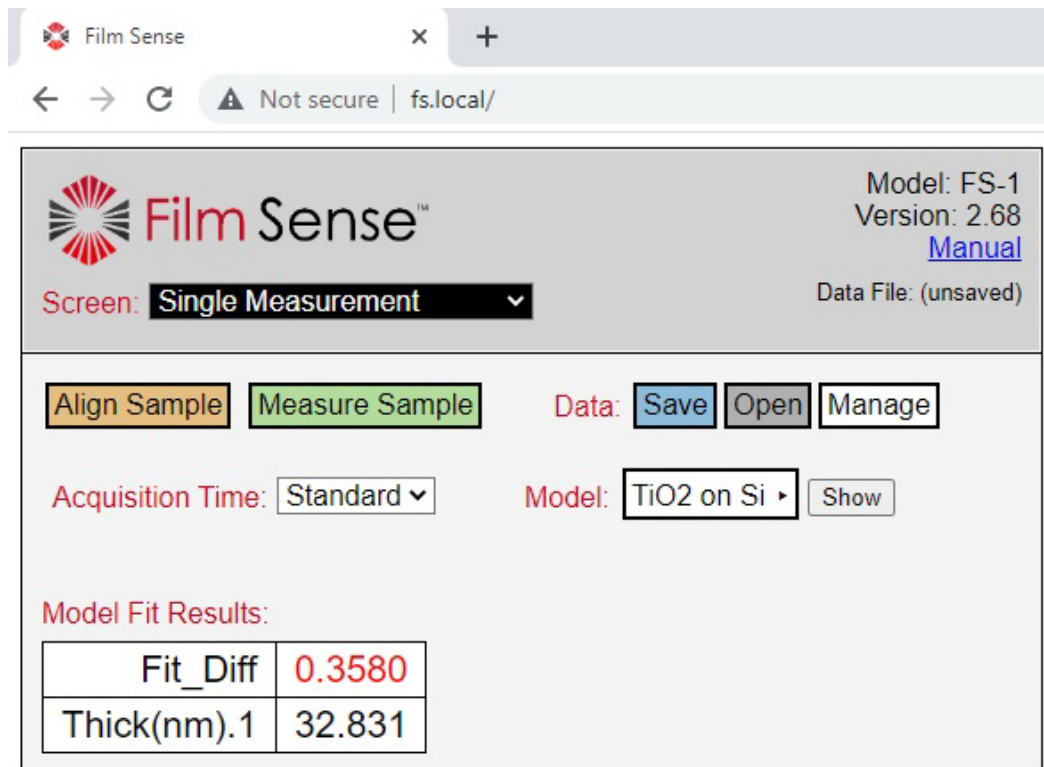
FS-1 Multi-Wavelength Ellipsometers are ideal for real time thickness monitoring of any film during deposition. The ability to watch a process in real-time by in situ ellipsometry measurements can be extremely beneficial for diagnosing problems in a process chamber and improving the efficiency of process development.

Standby Conditions:

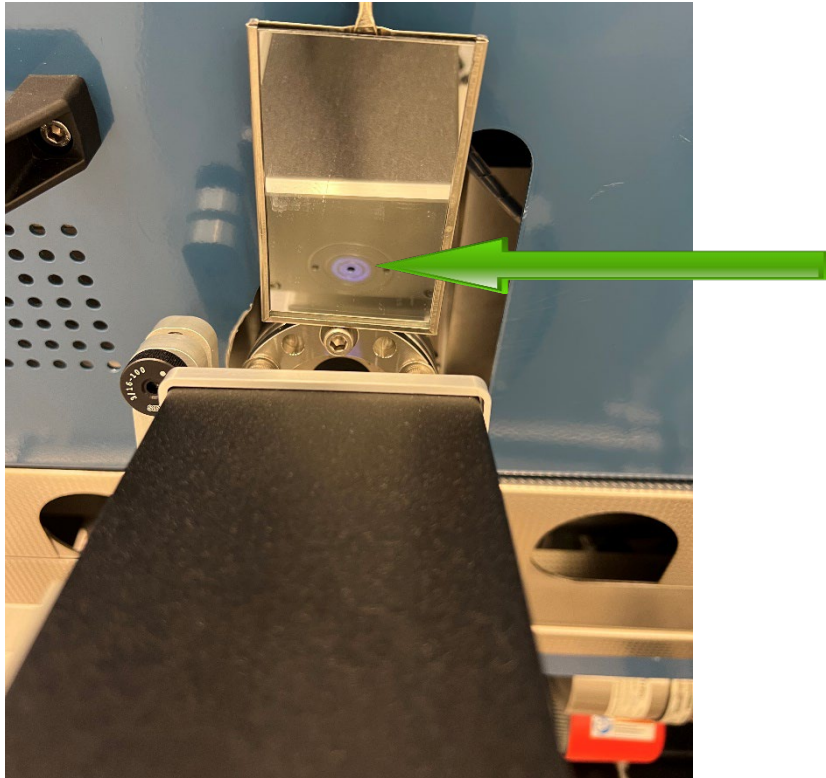
1. The “Power” LED and the “Ready” LED should be ON and green color on the detector side of the ellipsometer as shown in the above picture.
2. The laptop on top of the precursor cabinet should be ON. If it’s logged out, then login to windows using the credentials below:
Username: Oxford ALD
Password: OPT

Thickness Measurement:

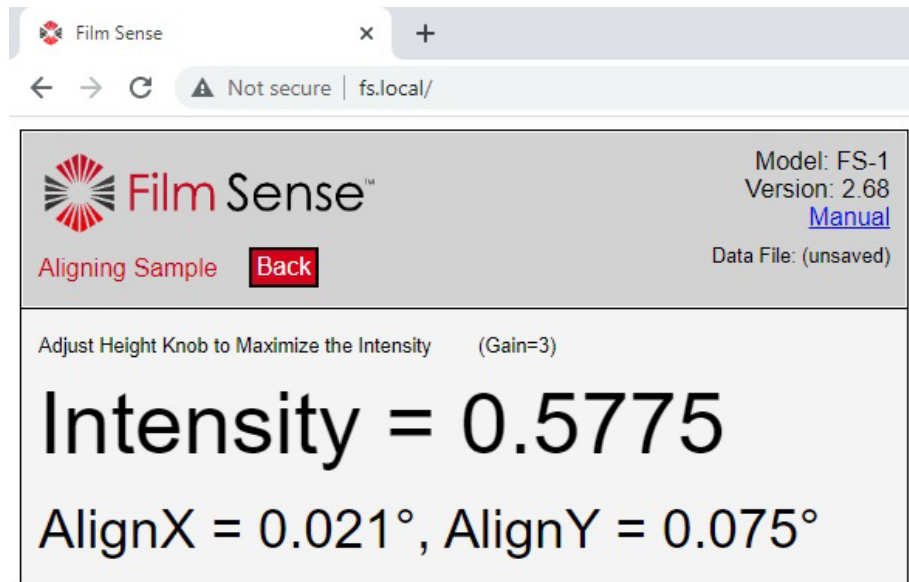
1. Open a web browser in the laptop (compatible browsers include Internet Explorer or Chrome)
2. Type the URL <http://fs.local/> in the address bar, and hit <Enter>.
3. The Film Sense software screen should appear in the browser window, similar to the screen shown below. It may take 10 – 60 seconds for the browser to connect. (If the browser is left opened already then just “Refresh” the browser.



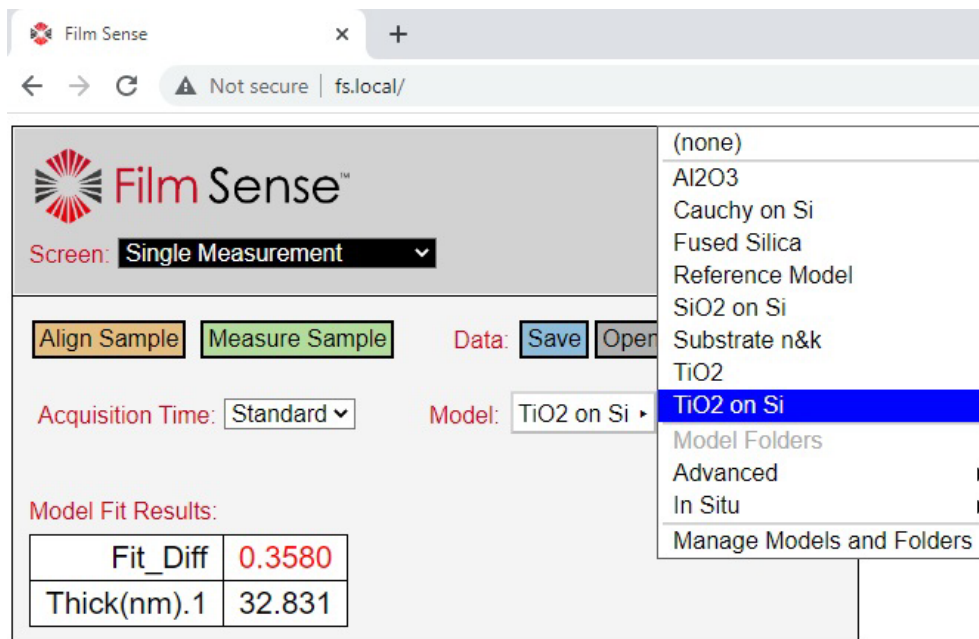
4. Load your sample into the load lock as per the Oxford ALD user manual and sample loading guidelines for the ellipsometer at the end of this manual.
5. At this point you will be at the step 4(C) of the Oxford ALD user manual. Before proceeding to step 5 manually move the wafer from load lock into the process chamber as per the “wafer handling” guide at the back of this manual.
6. Once the wafer is loaded into the chamber, go to the backside of the equipment to verify at the aperture of the ellipsometer detector using a mirror or your cell phone front camera to spot a blue light beam exactly at the center of the aperture as shown in the picture below.



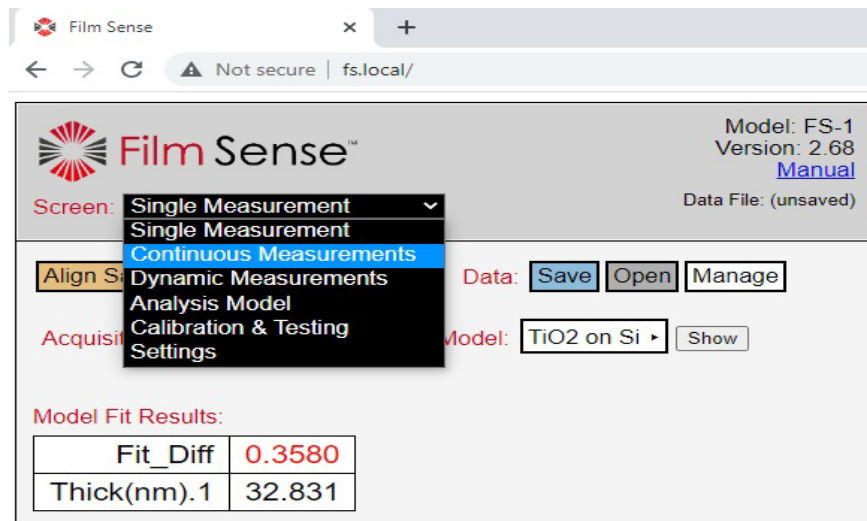
7. Now on the laptop browser screen opened earlier, press the “Align Sample” button on the left. You will see the screen as below. Verify the below parameters:
- a) Intensity should be > 0.5
 - b) AlignX should be at 0.0 ± 0.5
 - c) AlignY should be at 0.0 ± 0.5



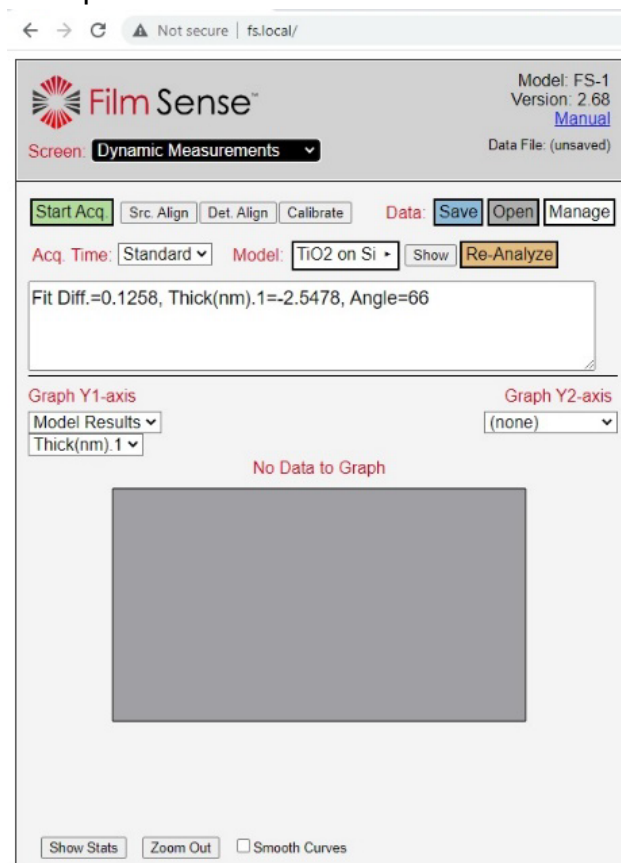
8. If all the parameters are within the spec. press “back” to go back to the previous screen.
9. Choose the type of the film model that you’re going to deposit as per the image below. If you can’t find the right layer then just choose “None”.



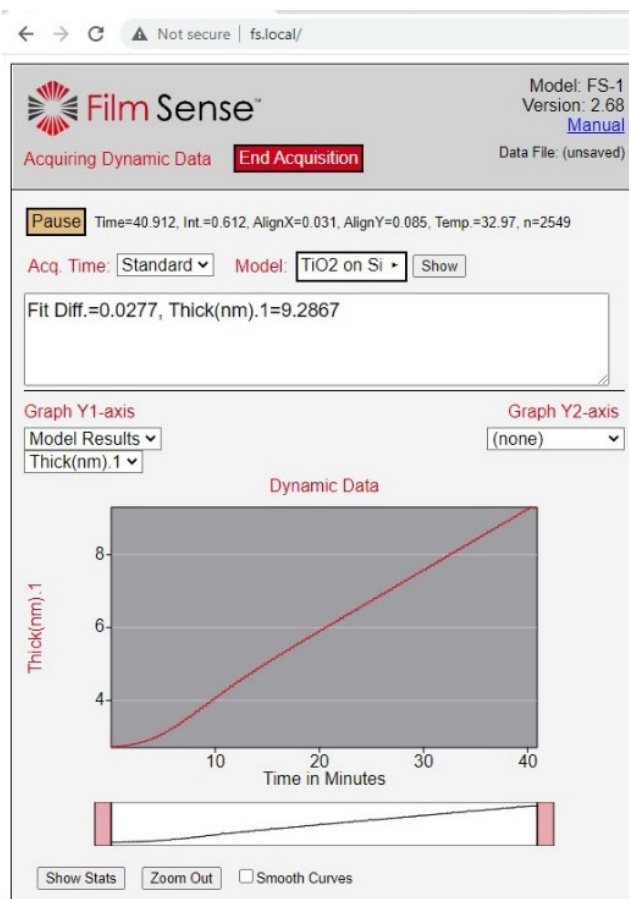
10. At this point you’re ready to make a pre-measurement of your wafer before you run the process.
11. Click the “Measure Sample” button to measure the current thickness of your wafer.
12. Move the wafer back to the load lock as per the “wafer handling” guide at the back of this manual.
13. Proceed to choose your recipe and go ahead with your automatic run as per the Oxford ALD user manual.
14. Once your wafer is loaded into the process chamber, you can start to monitor your wafer THK during the process while its growing by pressing the “Continuous Measurement” button as shown in the picture below. (If you would like to view your THK growth as a graphical chart with respect to time please skip this step and proceed to step 15.)



15. Choose “Dynamic Measurements” from the dropdown list. Choose the graphical parameters for Graph Y1-axis as “Model Results” and “Thick(nm)”. At this point you can view the pre-THK of your sample inside the white box as shown in the picture below.



16. Press the “Start acq” green button and the graphical chart of THK Vs Time will be active for monitoring. You can view the THK growth over time until the end of the process as shown in the picture below.



17. After the wafer processing is completed press the “End Acquisition” button and your wafer would be moved to the LL. In case if you want to measure the final THK of your wafer, move the wafer manually back to the chamber as per the “wafer handling” guide at the back of this manual.
18. Choose “Single measurement” in the laptop browser and press “Measure Sample”.
19. Once you are done, move the wafer back to the load lock as per the “wafer handling” guide at the back of this manual and proceed to venting as per the Oxford ALD user manual.

----- End -----

General Information:

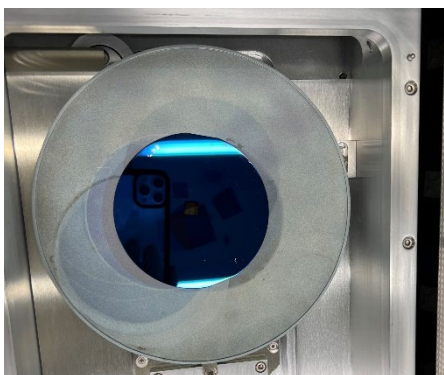
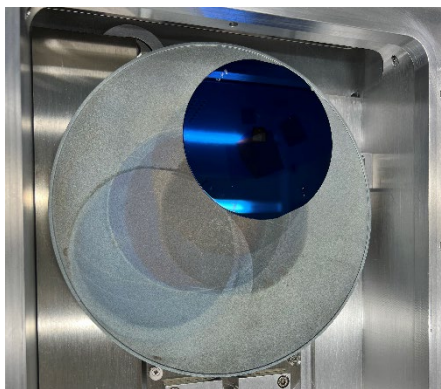
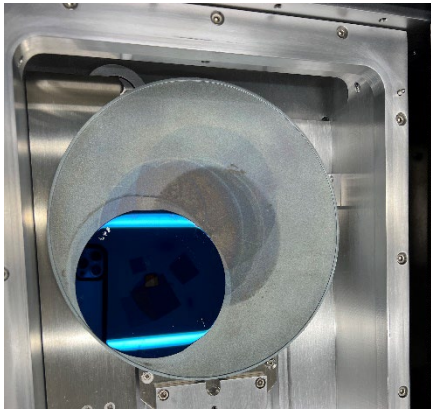
For any problems, clarifications of procedures, or general information pertaining to this machine, please contact one of the following lab staffs.

Siva Ramachandran	631-5497	sramacha@nd.edu
Mark Richmond	631-6478	mrichmon@nd.edu
Dave Heemstra	631-6733	dheemstr@nd.edu
Fei Cheng	631-3268	fcheng2@nd.edu

Guidelines to load sample in the load lock:

When you are loading your sample into the Oxford ALD chamber as per the usual manual, make sure your sample is placed exactly at the center of the carrier plate.

Refer to the below pictures for proper way of loading.

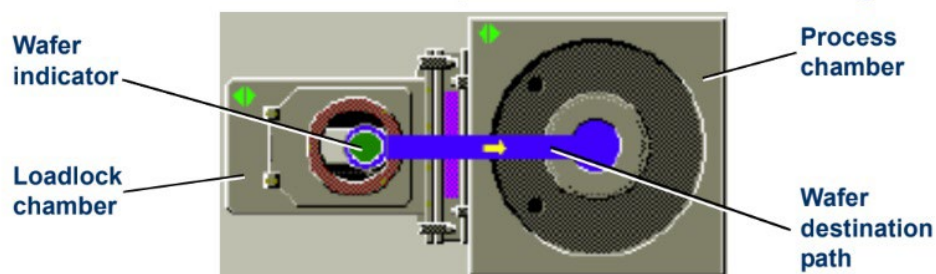


Wafer handling:

This procedure will guide you to move wafer manually in between the chambers.

Moving wafer from the load lock into the process chamber:

Click the wafer in the LL chamber then the system screen will show a blue directional line towards the process chamber as per the picture below. Now click the process chamber and then the system will move the sample from the LL to the process chamber.



Moving wafer from the process chamber into the load lock:

Click the wafer in the process chamber then the system screen will show a blue directional line towards the load lock as per the picture below. Now click the load chamber and then the system will move the sample from the process chamber to the load lock chamber.

