CORAL: PECVD-Oxford-TEOS

Location: Bay 4L
Purpose: Chemical Deposition (PECVD)
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MIT.nano	PECVD-Oxford-TEOS	
	User Standard Operating Procedure	
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Introduction



The PECVD-Oxford-TEOS is a Plasma Enhanced Chemical Vapor Deposition (PECVD) system that is used to deposit semiconductor thin films and dielectrics. The system has a loadlock (LL) chamber for faster sample loading, reduced etch chamber pump-down times, and improved safety by preventing accidental exposure to hazardous gases and etch byproducts. There are 8 process gases available and the system is capable of depositing the following films: silane-based or tetraethyl orthosilicate (TEOS) based Silicon Dioxide (SiO2), Silicon Nitride SiNx, and Amorphous Silicon (a-Si). TEOS is a liquid source organometallic precursor that is used to deposit silicon dioxide with the advantage of being much more conformal than standard silane SiO2.

The PECVD-Oxford-TEOS utilizes two power supplies: High Frequency, (13.56 MHz) and Low Frequency (350 KHz) to create the plasma. These power supplies can be used individually, simultaneously, or consecutively in order to control the stress of the film. The lower platen is at 300C and the chamber walls are at 70C. There is also an Optical Endpoint System (OES) which is used to determine when the CF4/O2 plasma is finished cleaning the chamber.

Safety

- Do not try to defeat any interlock on the system – many hazards are contained within the system.
  - Oxidizing gases – Oxygen (O_2), Nitrous Oxide (N_2O)
  - Corrosive chemicals (skin, eyes, nose, and lung irritant) – TEOS ($C_8H_{20}O_4Si$), Ammonia (NH_3)
  - Flammable gases – Ammonia (NH_3), Hydrogen (H_2)
  - Pyrophoric gases – Silane (SiH_4)
  - Inert gases (asphyxiation hazard) – Argon (Ar), Nitrogen (N_2), Carbon Tetrafluoride (CF_4)
  - High power RF energy
  - High temperatures.
- If you encounter any equipment problems while operating the system, contact the technical staff in charge of the system. Do not try repairs on your own.
- Do not try to force the door open. Forcing the door open while the system is under vacuum can damage the tool and/or cause harm to the operator or other users.
- **Use caution – the outside surface of the loadlock is hot!** The chamber, loadlock, and samples may be hot after a process.
- Be cautious when loading/unloading samples and carriers as there are mechanical pinch/crush points at the loadlock and the robot arm.
- Make note of the large, red **EMO** button below the loadlock. If the system is behaving erratically, press this button to immediately shut the system down.
- Do not attempt to run any recipes while the loadlock is vented (at atmosphere). The LL serves as an additional vacuum barrier between the hazardous gases and the User.

User Qualifications and Responsibilities

During training users will learn to run wafers and edit recipes. To be considered qualified you need to be trained

by the staff in charge of the equipment, be up to date with your safety trainings and have a PTC approved process. Running processes/materials that have not been approved by the PTC may lead to disqualification from the tool.

- Users are expected to run the STANDARD CLEAN (to completion, about 25min) and to pump down the loadlock before disengaging from CORAL.
- If you encounter any problems while operating the machine, report them immediately in CORAL so that the Staff can address them in a timely fashion.

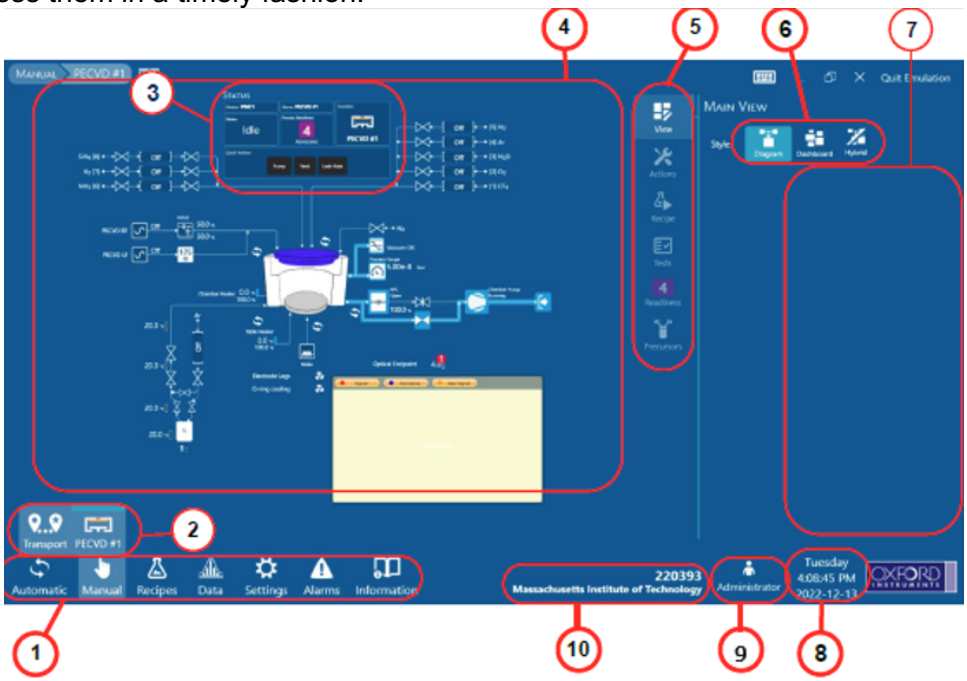


Figure 1: Overview of the system software

Table 1: Key to callouts in Figure 1

Number	Description		Number	Description
1	Main menu icons Click a menu icon to access its sub-menu. Use this menu to navigate between pages.		6	View menu Click on an icon to select the desired view in the Information panel (not all icons are available on all pages). Hybrid is a combination of diagram and dashboard.
2	Sub-menu icons Click on a sub-menu icon to access the page for that module. The name of the page currently selected is shown at top left of the page.		7	Right command panel Click on any device in the Information panel to display its possible actions in the upper part of the right command panel. In the lower part of the panel you can select actions, run a process recipe, examine the state of readiness of the module and alter settings for the device selected in the upper part of the panel.
3	Status panel Displays the status and actions for the process chamber.		8	Clock Displays the local time and date.
4	Information panel Displays all the devices included in the module using the view selected (Diagram, Dashboard or Hybrid).		9	User and login level The login privilege of the current user. Click on the icon to log out.
5	Panel icons Click on an icon to select the desired options in the right command panel (not all icons are available on all pages).		10	Identity The identity of the system.

The icon to the right is used to toggle between different views showing different details. It has no impact on a process or tool function. There is a list of other Icons used on this system listed in the appendix at the end of this procedure.

	Change View icon Click to change the mode of a group of icons between dashboard and diagram

Operating Procedures

Reserve and engage the PECVD-Oxford-TEOS on CORAL. Engaging CORAL closes a dry contact, so you need to do this before running any process on the tool. Verify that the system is not being used. If necessary, you'll logon as Operator, Password: **user** (see box 9 on Figure 1 System Overview)

Determine the deposition routine:

1. **For TEOS**: Starting with a clean chamber, edit the recipe, run the recipe on your sample, then run STANDARD CLEAN. Repeat these steps until all your samples are finished!
2. **For all other films:** Starting with a clean chamber, run the appropriate seasoning recipe on a 200mm dummy wafer (no editing required). This is for better uniformity and consistent results. After seasoning, edit the deposition recipe, then run it on your sample. Run STANDARD CLEAN and repeat these steps until all your samples are finished!
3. **Logbook:** Record the deposition recipe, times for each sample in the logbook. Also record the Endpoint time of all cleans that were performed.

Venting the Loadlock:

1. In the lower, left corner of the monitor: Click on MANUAL,
2. Next, select TRANSPORT, then VENT (see Figure 2). The Load- lock will cycle-purge twice and then vent to atmosphere (See Figure 3).
3. Open the Loadlock lid.

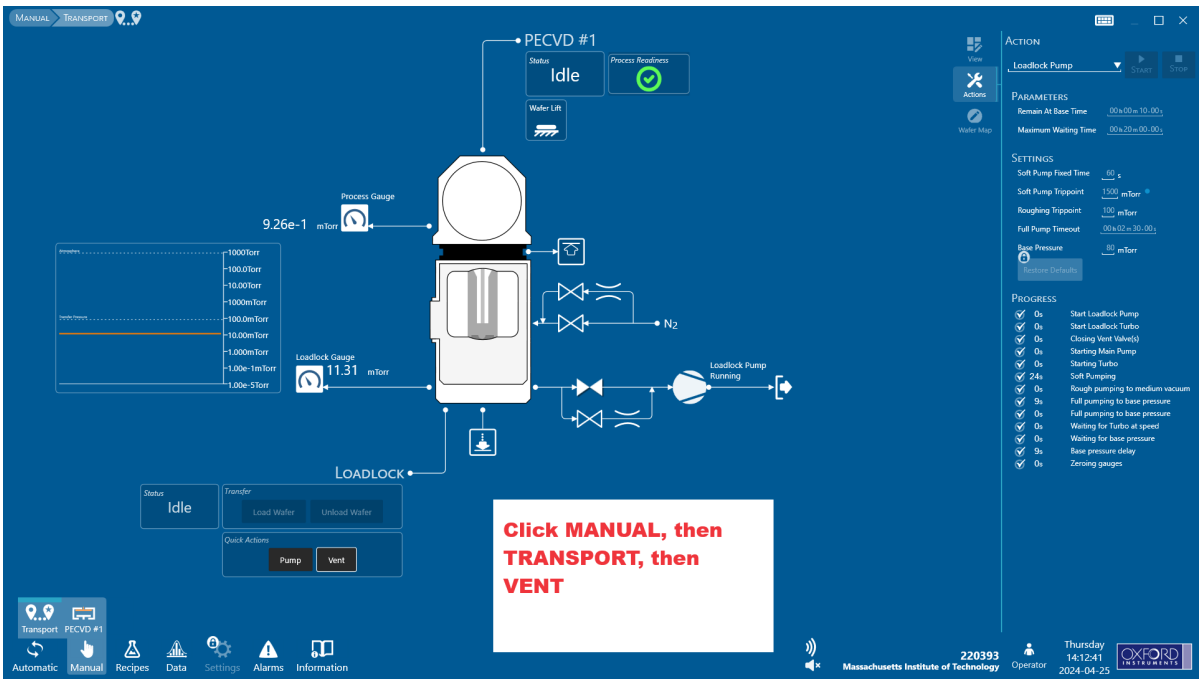


Figure 2: Venting the loadlock

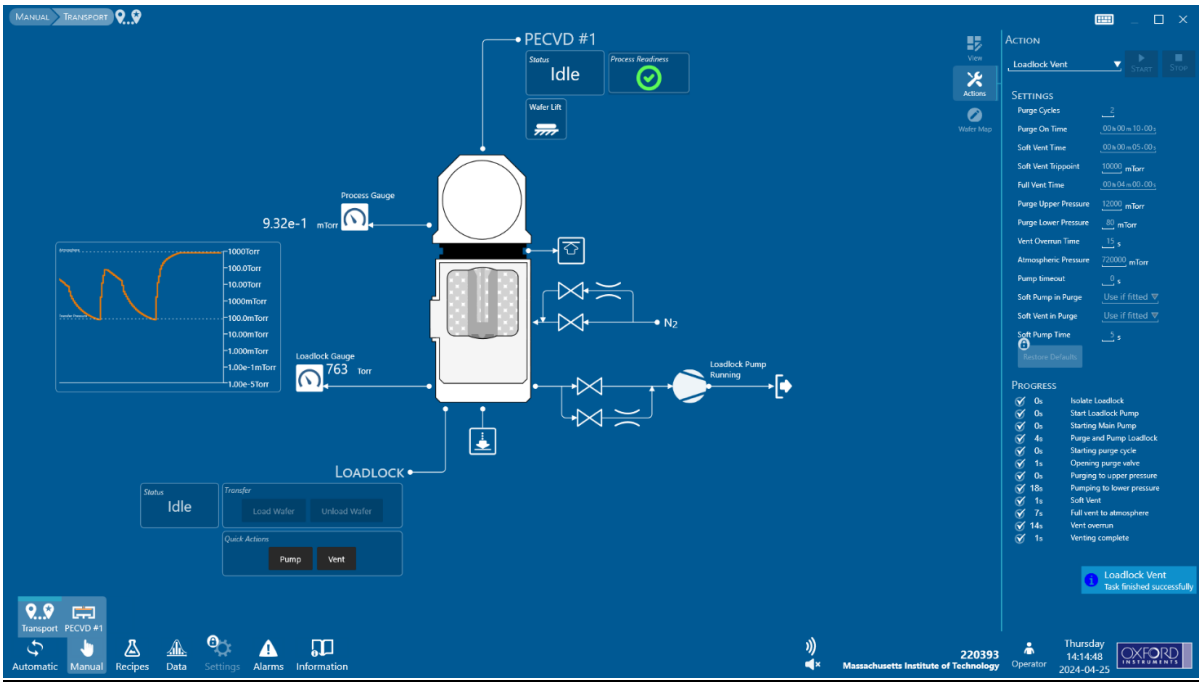


Figure 3: Loadlock in vented state

Loading a Sample:

Place your sample correctly on the arm (see Figure 4). The notch or the flat faces the User when loading.

NOTE: Pieces must be run on a 200mm dummy wafer!

By default the pins on the arm are permanently set for 200mm Wafers. Smaller wafers can be loaded directly by lining up the sample with the pin holes shown in Figure 4 (150mm, for example). Any other sample sizes including pieces must be placed on a 200mm dummy wafer. There is a box of 200mm dummy wafers on the table by the tool. (The dummy is not required to be bare silicon). Close the Loadlock Lid.

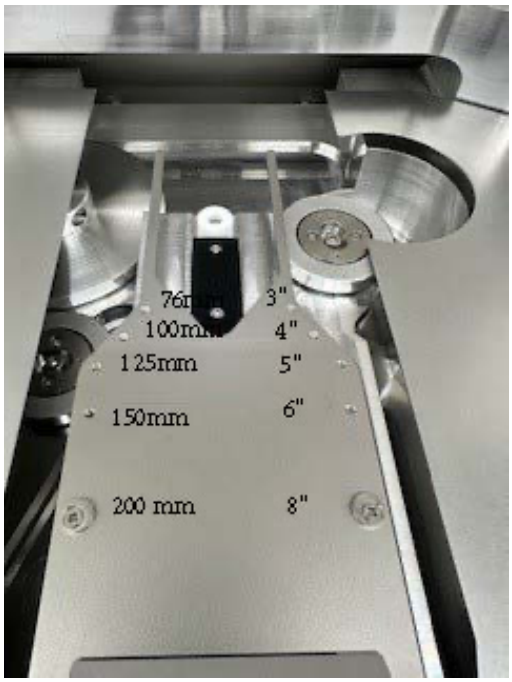


Figure 4: Loadlock Arm

Duplicating and Renaming a Recipe

1. Set up a new recipe by first copying an existing recipe and rename it.
2. In the lower, left corner of the monitor, click RECIPE.
3. Find the desired recipe and double-click on it.
4. Click Duplicate at the top of the page (See Figure 5). The copied version will be denoted with a (2).
5. Select the upper filename, replace OPT with your name or initials, and erase the (2). Click SAVE (See Figure 6)

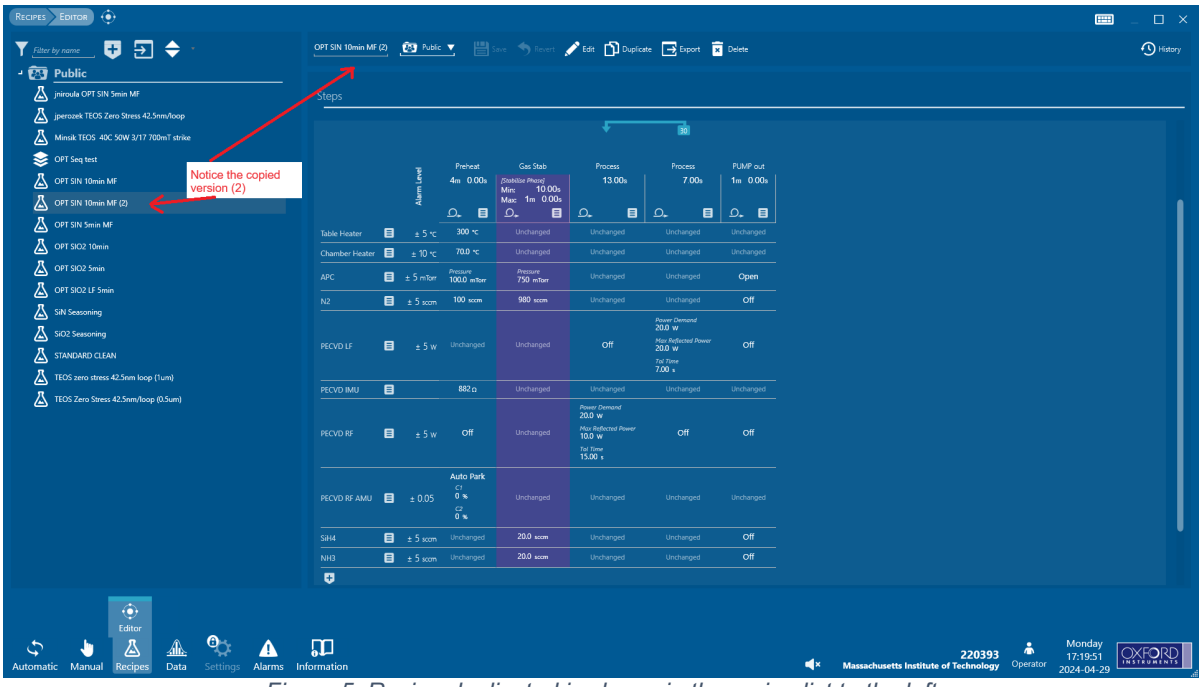


Figure 5: Recipe duplicated is shown in the recipe list to the left

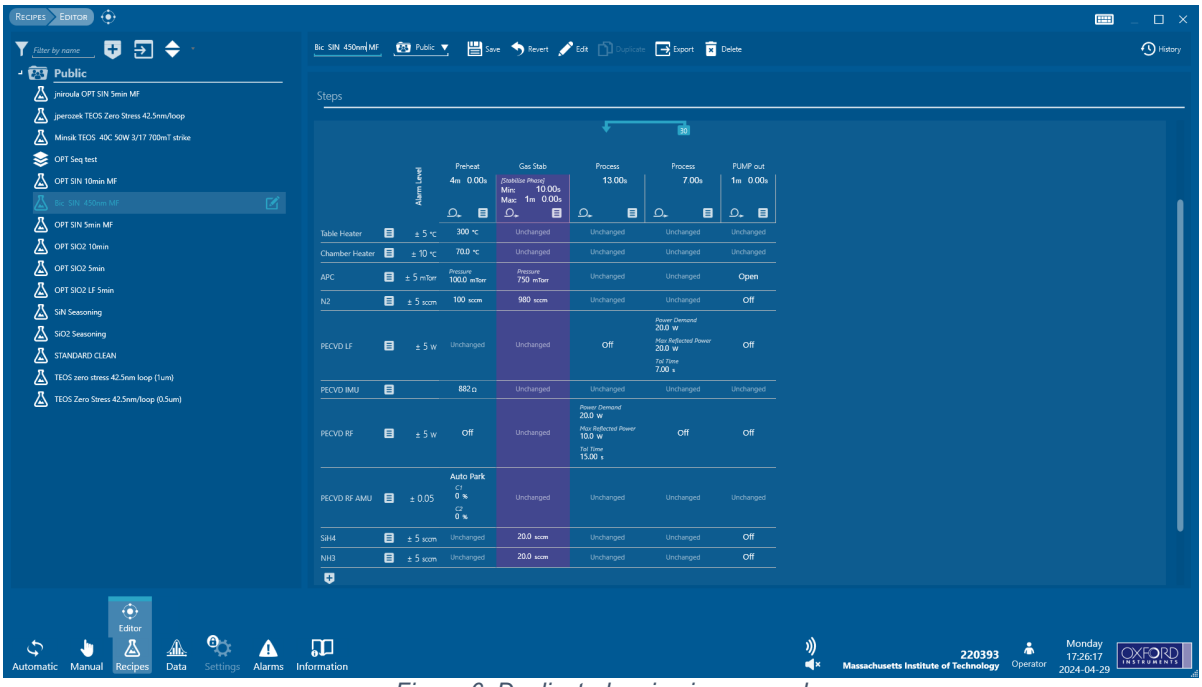


Figure 6: Duplicated recipe is renamed

Editing a Recipe:

Select the desired Recipe. Recipes that utilize both power supplies are based on 20 sec loops (see Figure 7):

1. Calculate the number of loops required to attain the desired thickness.
2. Highlight the number of loops and type in the amount you need.
3. You must press ENTER for the change to take affect!

In recipes using only a single power supply (see Figure 8):

1. Highlight the deposition time, type in the time required to attain the desired thickness.
2. Press ENTER (see Figure 9) for the change to take affect!
3. Press SAVE to make the changes permanent (see Figure 10).

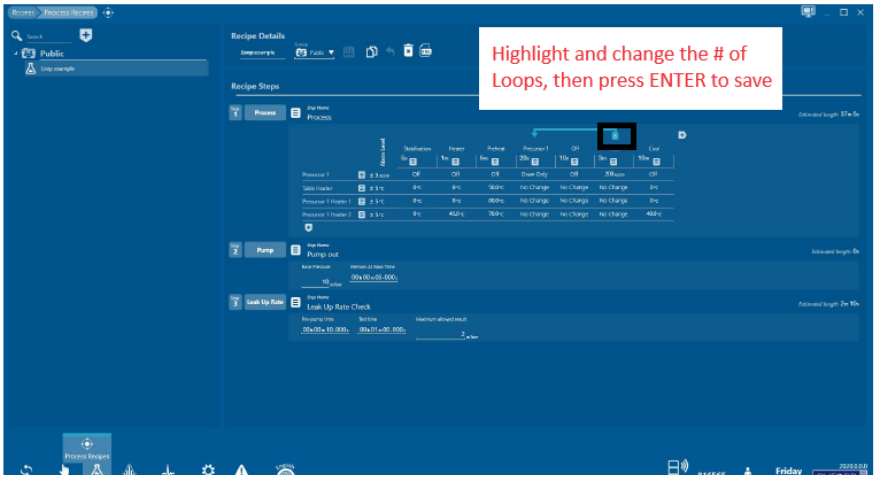


Figure 7: Changing the number of loops

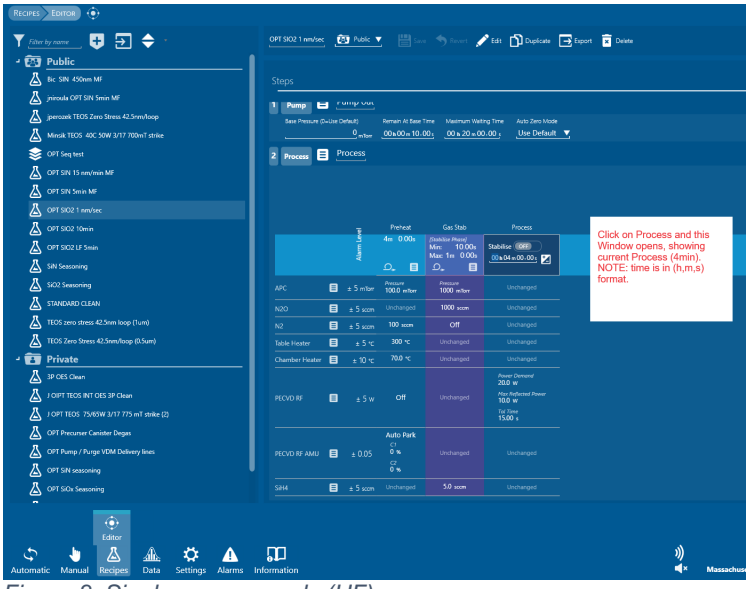


Figure 8: Single power supply (HF)

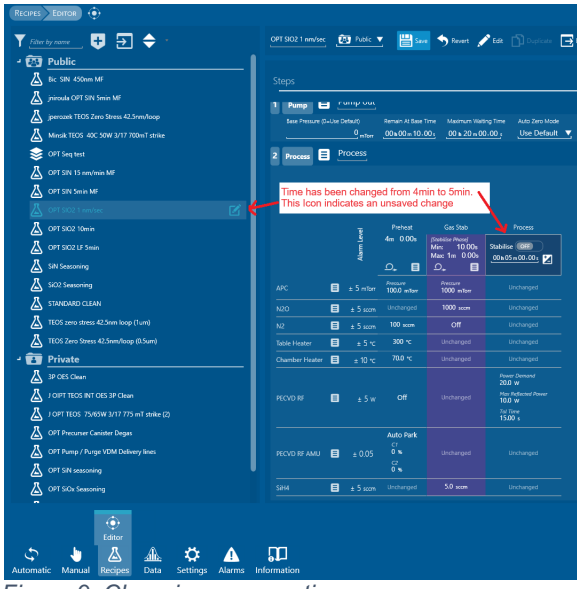


Figure 9: Changing process time

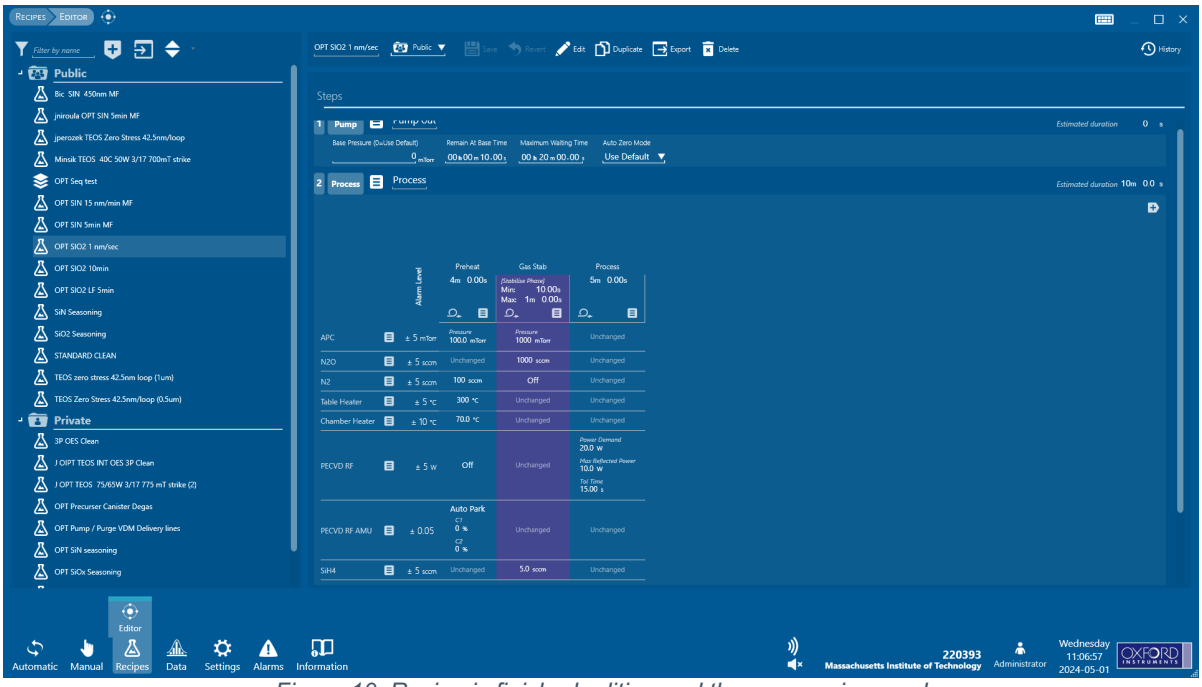


Figure 10: Recipe is finished editing and the process is saved

NOTE: If the standard recipes do not meet your needs, always discuss modifications with staff. Users should not create their own recipes without verifying that the desired parameters will not damage the tool.

Running a Recipe:

1. In the lower, left corner of the monitor, click AUTOMATIC (see Figure 1).
2. On the right, there is a pull-down menu labelled RECIPES. Click it and load the desired recipe (See Figure 11).
3. Add a Batch Name if desired. Then click RUN (see Figure12).
4. The Loadlock will pump down and the arm will load the sample into the PECVD chamber. Then the process will begin.
5. When finished, the arm will retrieve the sample, and return it to the Loadlock. The Loadlock will vent and a Process Complete notification will appear in the lower right of the monitor.
6. Click on MANUAL, then PECVD #1, to monitor the progress of the recipe.

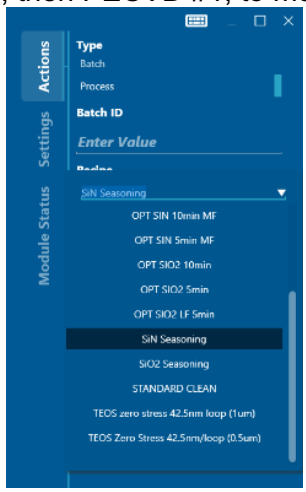


Figure 11: Select recipe

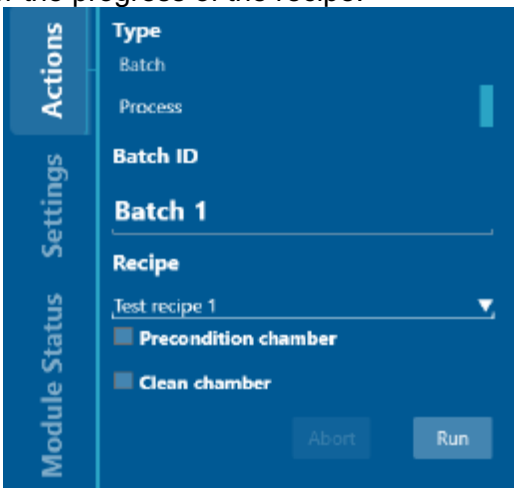


Figure 12: Recipe, Batch, Run

Pumping down the Loadlock:

1. Verify the Loadlock lid is closed.
2. In the lower, left corner of the monitor: Click on MANUAL.
3. Next, select TRANSPORT, then PUMP (see Figure 15).
4. The Load- lock will pump down.

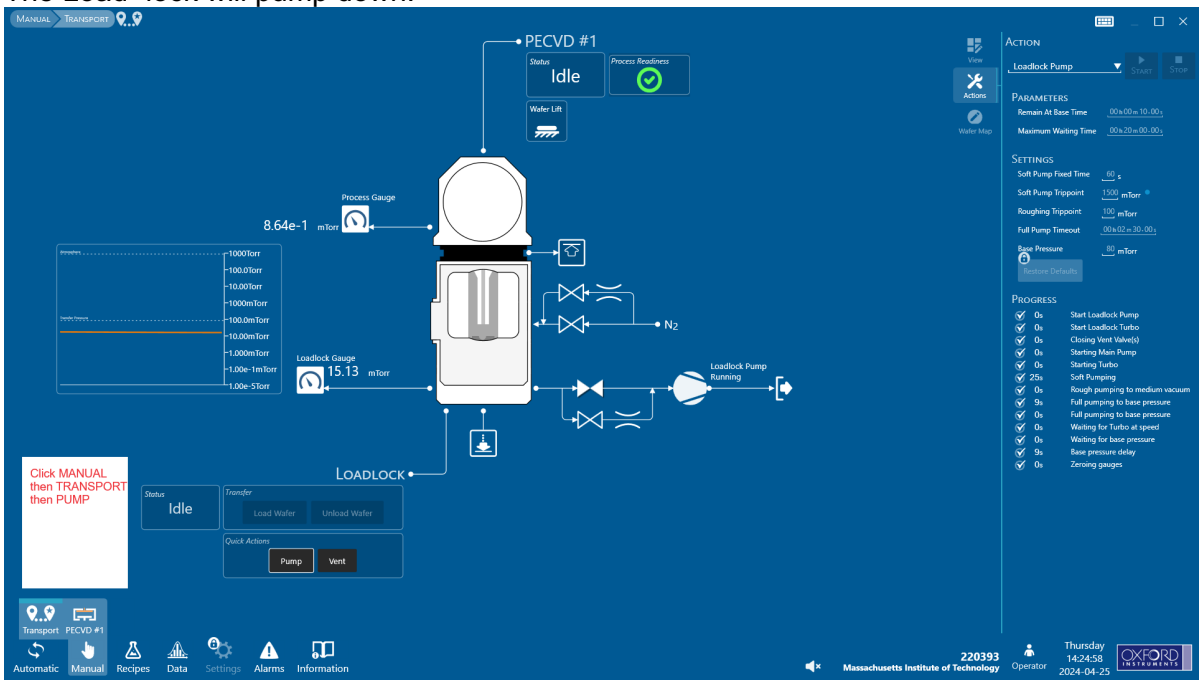


Figure 5: Manual pump down of the loadlock

Running the Standard Clean:

The Clean utilizes CF4/O2 plasma at 3 different pressures to clean the entire system, targeting the chamber, the showerhead, and the platen in each step. There is an Optical Endpoint Spectrometer (OES) enabled in the first plasma step (high pressure). Once the Endpoint (EP) is found the recipe goes to the second step (mid pressure) for 5 minutes. Finally, the third step (low pressure) for 5 minutes longer. **Be sure to record the Endpoint time in the logbook.**

Typical EP times are between 8-9 minutes and the total process time for the clean is 25-30 minutes. NOTE: The clean is performed with an empty chamber to ensure everything gets cleaned!

1. Verify the Loadlock is pumped down.
2. Click MANUAL, then PECVD #1 in lower left corner. Verify that the RECIPE Icon is active.
3. Go to the Recipe pulldown menu and select STANDARD CLEAN.
4. Click START, see Figure 13.
5. The OES EP trace looks like as shown in Figure 14.
6. The endpoint for this example is shown on Figure 18. Please remember to enter this data in the logbook, along with all your deposition details!

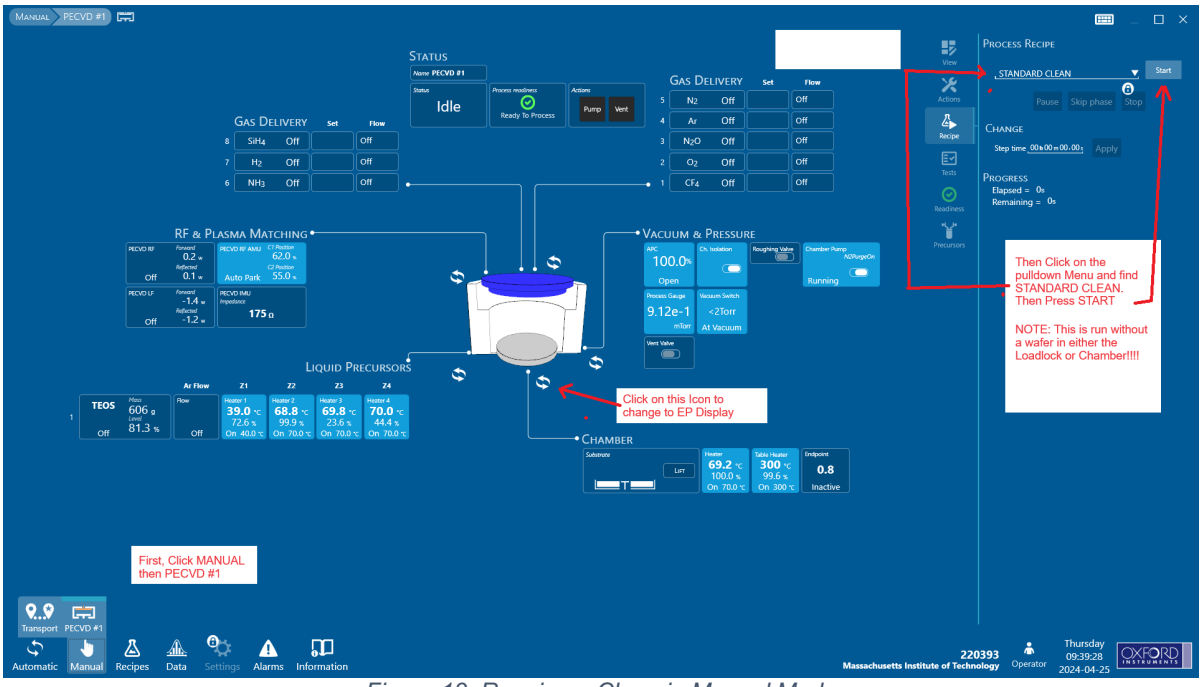


Figure 13: Running a Clean in Manual Mode

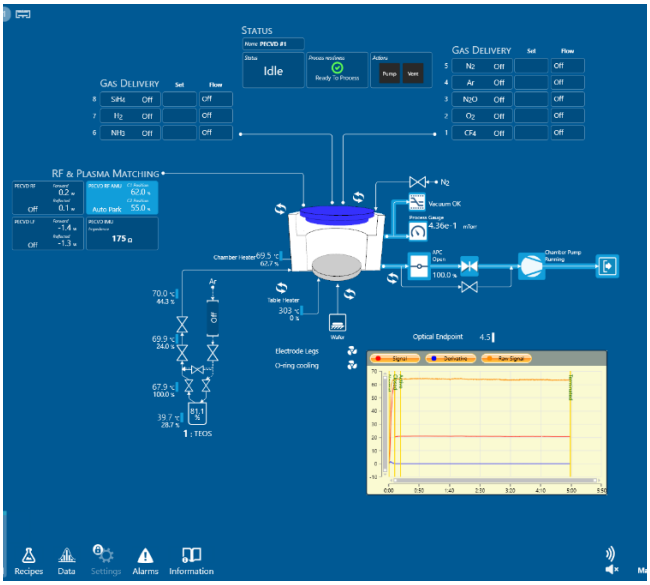


Figure 6: OES trace enabled

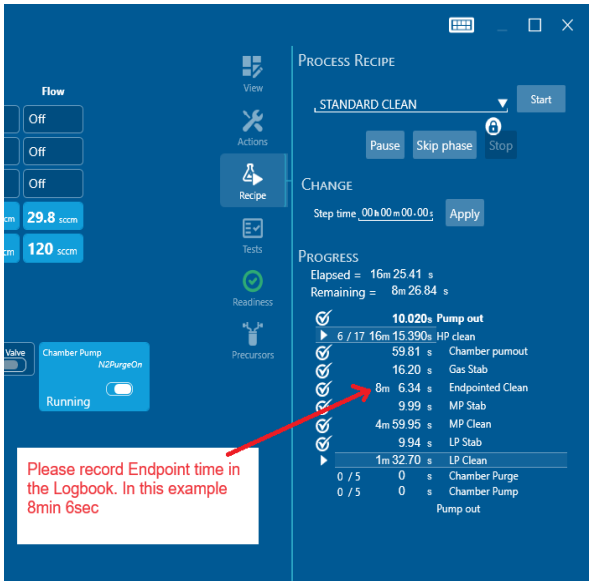


Figure 7: Showing endpoint time.

Disengage from CORAL

Verify the Loadlock is pumped down before disengaging. Remember to enter the deposition details in both CORAL and the logbook!

Appendix

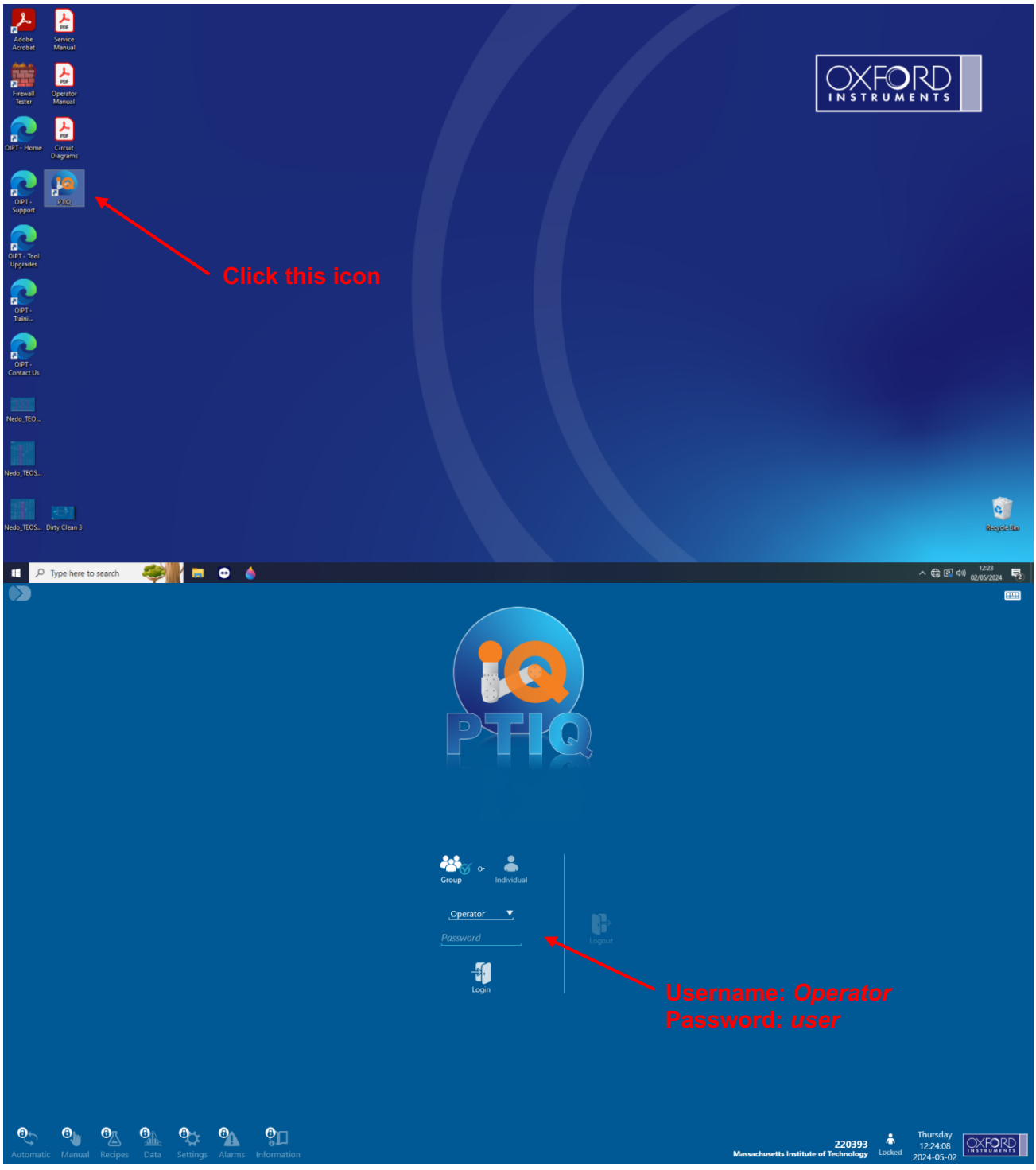
Other Icons Used on This System:

Graphical Symbol	Description	Graphical Symbol	Description
	A closed gate valve		A closed valve
	An open gate valve		An open valve
	Pressure gauge		Automatic pressure controller valve (shown fully open)
	Rotary backing pump		Gas supply MFC
	RF generator		Change View icon Click to change the mode of a group of icons between dashboard and diagram
	Auto matching unit (AMU)		Wafer lift down
	Impedance matching unit (IMU) for LF generator		Readiness icon Shows a green tick or shows a purple square with the number of readiness advisories
	Connection point to the foreline		Slit valve closed icon
	Wafer lift up		Run Recipe icon
	Actions icon		Vacuum switch icon

Common errors/failures:

System software is not responding:
Click the X in the uppermost right at the top of the window. It will ask if you wish to exit PTIQ? Click YES. Click the PTIQ Icon on the PC desktop. PTIQ will open in another window at the Operator level and ask for a password. Enter user and Click Logon

System Software is not on the Screen:
The tool runs on a PTIQ software, Oxford's proprietary platform. Click the PTIQ Icon on the PC desktop. A window will open at the Operator level and ask for a password. Enter user and Click Logon



List of Process Gases:

Table 2: List of all process gasses available on the tool and their maximum flow rates.

Gas #	Gas Name	Max Flow (sccm)
1	Silane (SiH_4)	50
2	Hydrogen (H_2)	100
3	Ammonia (NH3)	50
4	Nitrogen (N2)	2000
5	Argon (Ar)	2000
6	Nitrous Oxide (N2O)	2000
7	Oxygen (O2)	500
8	Carbon Tetrafluoride (CF4)	500
The following gas combinations are interlocked and cannot be combined $SiH_4 + O_2$, $H_2 + O_2$		