Standard Operating Manual

AST Cede-200LTS TEOS PECVD
(TEOS PECVD)

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1. Picture and Location

Fig. 1: **AST Cede-200LTS TEOS PECVD** is located at NFF Phase II Room 2240

2. Process Capabilities

2.1 Cleanliness Standard

AST Cede-200LTS TEOS PECVD (TEOS PECVD) is "Semi-Clean" equipment for thin film deposition.

2.2 Available Deposition Materials

Silicon Dioxide

2.3 Wafer Size

The maximum wafer size is 100mm in diameter, 5mm thick. Wafer with any one dimension exceeds the maximum wafer size is not allowed to be put into the PECVD.

3. Contact List and How to Become a User

3.1 Emergency Responses and Communications

- Safety Officer: Mr. Wing Leong CHUNG 2358-7211 & 64406238
- Deputy Safety Officer: Mr. Man Wai LEE 2358-7900 & 9621-7708
- NFF Phase 2 Technicians: Mr. LI Ho ,or Mr. CHEN Yigong 2358 7896
- Security Control Center: 2358-8999 (24hr) & 2358-6565 (24hr)

3.2 Training to Become a Qualified User

Please follow the procedure below to become a qualified user of the TEOS PECVD.

1. Read all materials on the NFF website concerning the TEOS PECVD.
2. To register TEOS PECVD operation training, logon to NFF Equipment Reservation System. Go to User Info page. Select Equipment Operation Training. Please follow the instructions on the web page.

4. Operating Procedures

4.1 System Description

In brief, PECVD is a process performed in a vacuum chamber at some temperatures (typical ~300degC). Gases are supplied to the chamber at some pressure (typical 200~1000mTorr). And then plasma is generated by RF frequency (13.56MHz in our TEOS PECVD system). The gases then get excited and cause a chemical reaction on the substrate.

In TEOS PECVD, liquid tetraethoxysilane (TEOS) is used as a source of Si instead of SiH_4 gas. During deposition process, TEOS is bubbled out as vapor by the carrier gas Ar from the heated TEOS pot through the heated delivery line to the process chamber.

System Component Locations

Fig. 2a and Fig. 2b shows the locations of major system components.

Fig. 2a: System component locations

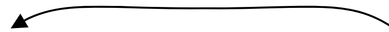
Fig. 2b: The heating bath for TEOS pot located at the rear of the main machine.

Hazards

SiF4 and NH3 are hazardous gases (toxic, corrosive, or flammable). The tetraethoxysilane (TEOS) used in TEOS PECVD is hazardous liquid/vapor. Exposure of RF frequency radiation can cause severe injury or burns if the system is not properly shielded. In addition, electricity, hot components, moving components, vacuum, compressed air, and etc in the PECVD system can produce hazards. User must be aware of possible hazards associated with using the TEOS PECVD.

Emergency Stop Procedure

If an emergency condition is suspected, depress fully the Red Emergency Off (EMO) Button located on the system as shown in Fig. 2a.



PECVD operating sequence – Coating→Deposition(s)→Etchback

In PECVD deposition, there is not only having deposition on the wafer, but also on the surfaces of wafer carrier, chamber wall, showerhead and etc. Once the accumulated deposition is thick enough, the deposited layer on those surfaces will

peel off and form particles. It will affect films quality.

In practice, for the fresh chamber (without any deposition) before normal runs, about 2000Å of silicon oxide will be deposited first. It is so called coating. After that, deposition processes can be made as long as the total deposited thickness has NOT accumulated over a certain thickness (the maximum allowed thickness). For TEOS Silicon Oxide, it is around 2µm. Once the total deposition reaches the maximum allowed thickness, etchback is needed to etch out all the deposition inside the chamber (Actually, it is any surface exposed to the plasma during processes including the wafer carrier.) to make it fresh again.

So, the basic sequence of operating the PECVD is the cycle: Coating→Deposition(s)→Etchback. In general, it is not necessary to perform Etchback and Coating when the deposited thickness on the chamber is less than the maximum allowed thickness. Chamber will deteriorate when there is often over etchback.

Computer user interface

The "Main List" screen of the computer user interface is shown in Fig. 3. To select an individual page, click on the corresponding rectangular button. After entering in any page, clicking on Exit button at the bottom right corner can back to the Main List screen again. User is allowed to select Main, Recipe, Process and Alarm pages only.

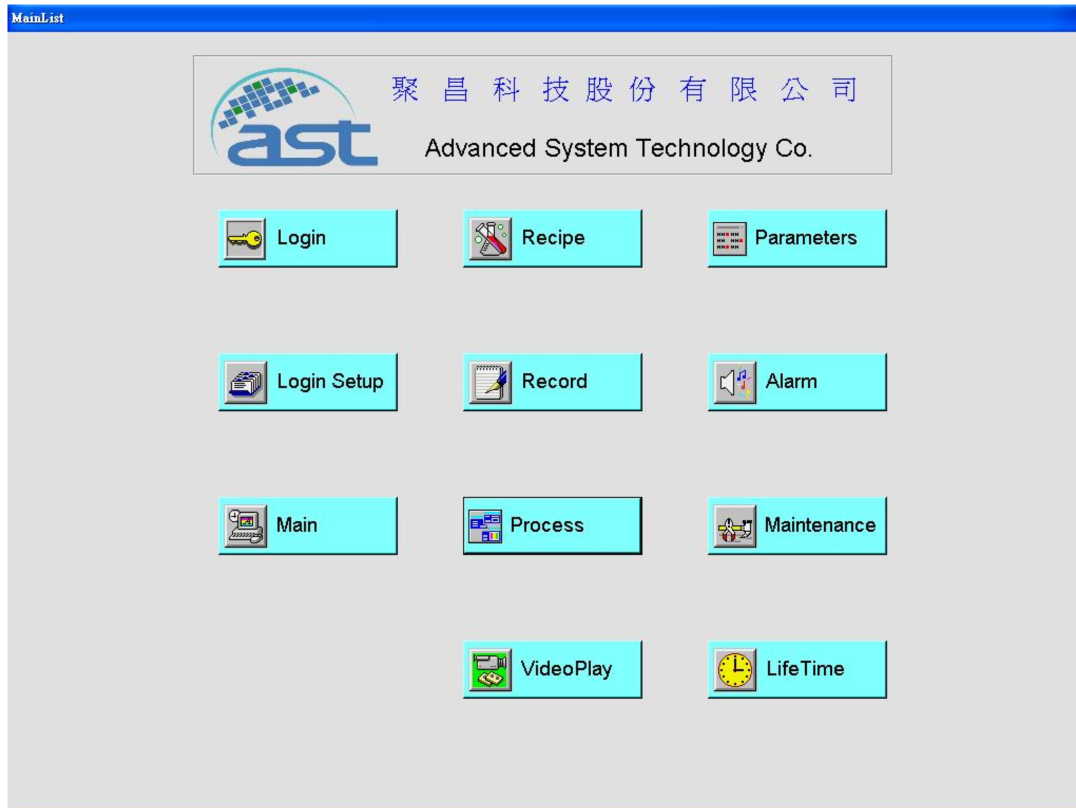


Fig. 3: Main List screen of the computer user interface

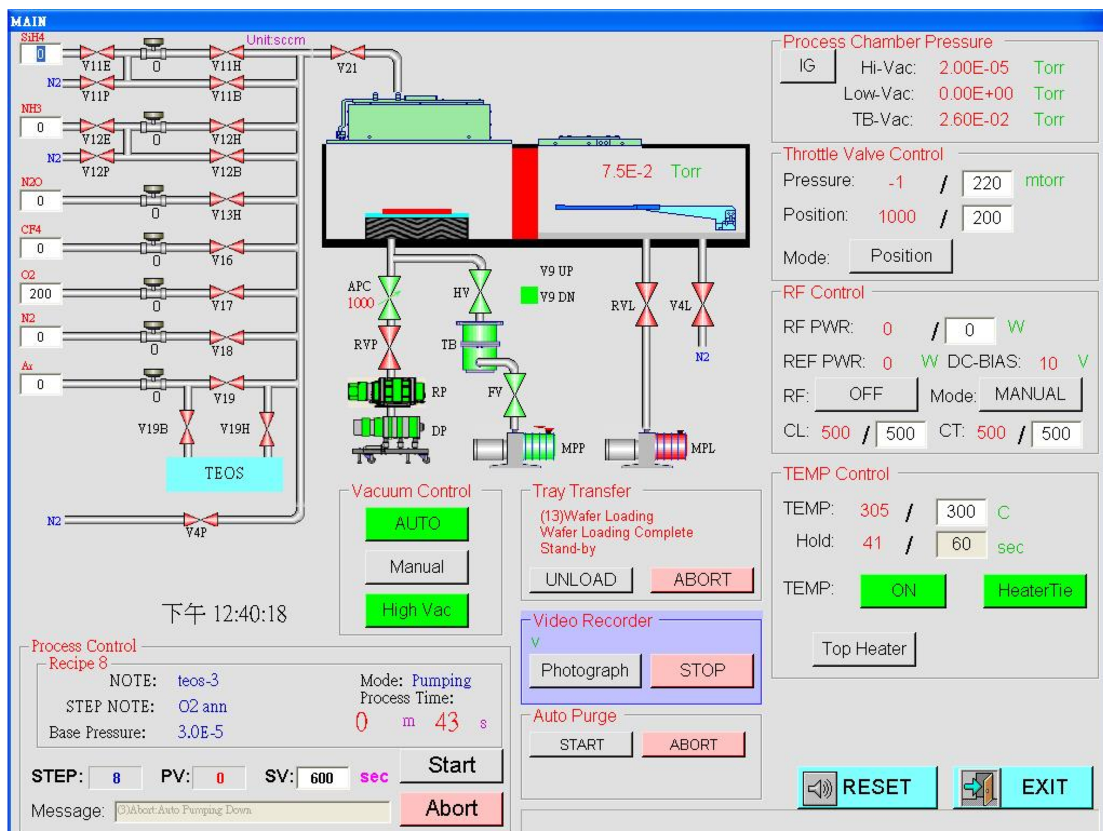


Fig. 4: Screen of the Main page

Fig. 4 shows the screen of the Main page (Not the Main List screen). In the Main page, although gas valves on/off, gas flow rates, vacuum pumps on/off, throttle valve position, RF powers and etc. can be manually set, user **is NOT** allowed to operate them unless otherwise specified in the operating procedures in this manual. User has to pay attention to avoid accidently click on the undesired icons/buttons.

The Recipe page with a selected recipe is shown in Fig. 5.

Recipe

teos-3 NOTE: teos-3 STEP: 5 BasePressure: 3.0E-5

	STEP1	STEP2	STEP3	STEP4	STEP5	STEP6	STEP7	STEP8	STEP9	STEP10	
SiH4	0	0	0	0	0	0	0	0	0	0	sccm
NH3	0	0	0	0	0	0	0	0	0	0	
N2O	200	200	200	0	0	0	0	0	0	0	
CF4	0	0	0	0	0	0	0	0	0	0	
O2	200	200	200	0	0	0	0	0	0	0	
N2	0	0	0	200	0	0	0	0	0	0	
Ar	30	30	30	0	0	0	0	0	0	0	
Pressure	220	220	220	0	0	0	0	0	0	0	mtorr
Position	200	200	200	1000	1000	0	0	0	0	0	
Pre/Mode	0	1	1	0	0	0	0	0	0	0	
RF PWR	0	0	30	0	0	0	0	0	0	0	w
CL	500	770	770	500	500	500	500	500	500	500	
CT	500	440	440	500	500	500	500	500	500	500	
Auto/Mode	0	0	1	0	0	0	0	0	0	0	
TIME	120	240	2000	120	60	0	0	0	0	0	sec
NOTE	gasin	stable	pwon	purge	pump						
Step Copy	->	->	->	->	->	->	->	->	->	->	

TEMP
TEMP: 300 C
Delay: 60 sec
Continue: 1

PassWord:
CHECK
SAVE

NEXT
SAVE
LOAD
EXIT

Fig. 5: Recipe- “teos-3”

In the recipe screen, a recipe is composed of steps in table form as shown in Fig. 5. In each step (a column), gas flow rate of each process gas is defined in unit of sccm. Note that the gas supply for SiH4 line has been changed to SiF4. Ar is as carrier gas to bubble the TEOS. Ar cannot be set to flow directly into the chamber without

bubbling.

For the pressure control, if “Pre/Mode” is set to 0, the system will set the APC valve at the “position” to define the pumping speed. The value of position can be set from 0 to 1000. The APC valve is closed at position 0, while it is fully opened at position 1000. If “Pre/Mode” is set to 1, the system will automatically adjust the position of the APC valve to achieve the pressure set in the step.

For the RF power control, “RF PWR” is the RF power. CL and CT are two adjustable parameters (range from 0 to 1000) for the RF matching. If “Auto/Mode” is set to 0, CL and CT will be fixed at the set values. If “Auto/Mode” is set to 1, the system will automatically adjust CL and CT so that the RF reflected power is as low as possible.

The “TIME” is duration of the step. The “NOTE” in each step gives a short description of the step and will be displayed in the Process screen during the corresponding step running.

Besides, in the top row of the recipe screen, recipe name is shown at the left. The NOTE next to the recipe name is the description of the recipe and will be shown in Process screen when the recipe is loaded. The “STEP” defines the final step in the recipe. STEP# in which the number # greater than the value defined in “STEP” would not be executed.

“TEMP” is the platen temperature. Once the recipe is started to run, the system will wait until the temperature is stabilized at the set value, and wait again for the “Delay” before executing the first step.

The Process page as shown in Fig. 6 is for the control of process start/abort, wafer load/unload, loadlock vent, as well as graphical display of status of system pumping and wafer transfer mechanism, and showing settings and/or actual readings of system parameters.

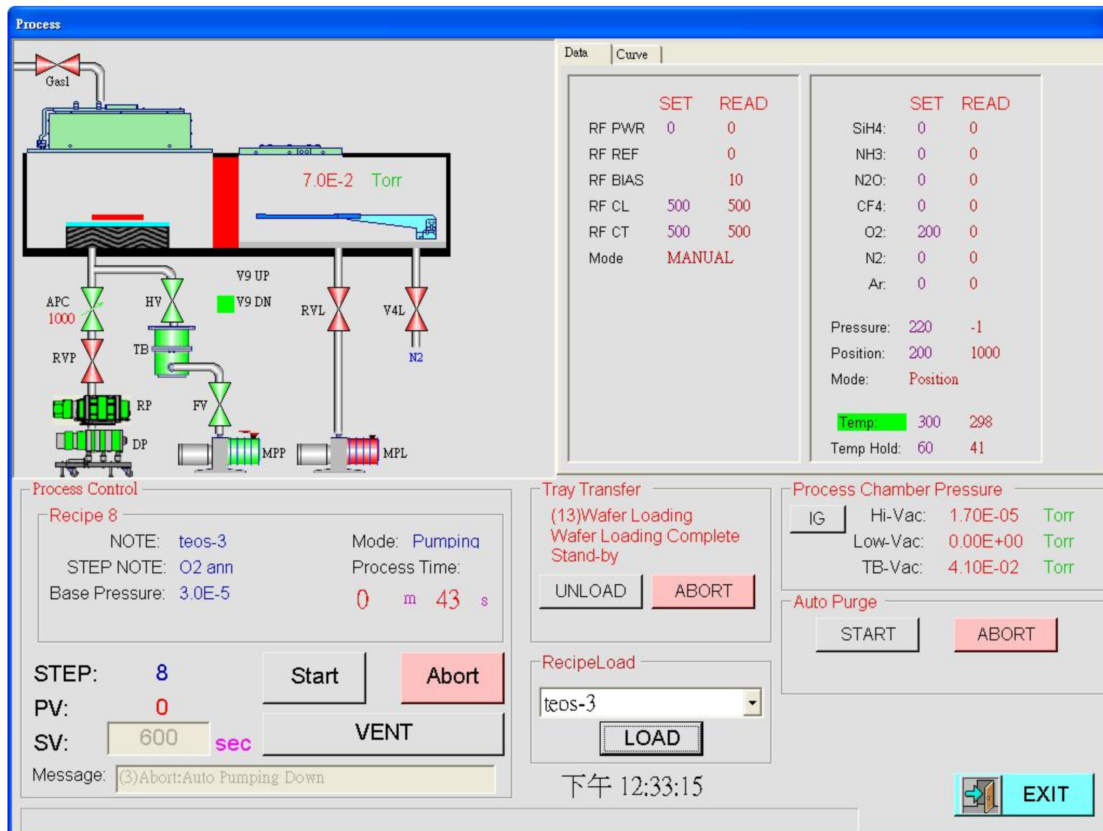


Fig. 6: The Process page

The Alarm page will shows those messages of alarm in active. In addition, the active alarm messages are also displayed at the bottom in the Process page and Main page.

4.2 Important Cautions

(1) If an equipment failure while being used, never try to fix the problem by yourself. Please contact NFF staff.

(2) Make sure your wafers have been cleaned in wetstation D before entering the PECVD.

(3) Also make sure your wafer container and handling tweezers are clean.

(4) Semi-clean does not mean you can put any of semi-clean materials into the machine. Some of semi-clean materials cannot sustain high temperature under vacuum and as a result it would seriously contaminate the chamber. Follow your process flow. Materials which are not mentioned in the process flow are NOT allowed to put into the TEOS PECVD.

(5) Processes (other than the 'Etchback and Coating' mentioned in this manual) which are not mentioned in the process flow are NOT allowed to be done in the PECVD.

(6) Remember to fill in the **Log Sheet**.

4.3 Initial system checks

To check that the system is in idle state.

Warning – The wafer carrier will be VERY HOT after unloading from the heated chamber. DON'T directly touch the wafer carrier with hands.

(1) From the Main List screen, select Process page. The Process screen is displayed. In the "Tray Transfer" frame, check that there is a message displayed "Wafer Loading Complete, Stand-by". Check also that the **Start** button is in grey color,

not in green color. **Start** button in green color means there is a process running.

(2) Check that there are no process gas flows. The readings of flow rate of all process gases are zero (The readings are sometimes fluctuating around zero slightly. But for most of the time, they should be zero.).

(3) Check that the gas valve "Gas1" is closed (ie. displayed in red color).

(4) Click on **Exit** to the Main List screen. Select Main page.

(5) Check that the system is pumping by high vacuum pumping line: the icons HV, TB, FV, MPP are in green color. And the icon RVP of the process pumping line is in red color while icon RP and DP are in green color. Note that the valves RVP and HV do not open at the same time. If RVP is opened while HV is closed, in the Vacuum Control frame, click on the **High Vac** and **AUTO** buttons so that they are both in the green color. Wait until the high vacuum line is pumping the process chamber.

(6) In the TEMP Control frame, check the platen temperature set point in the white field is the required value. The maximum temperature allowed is 300℃.

(7) Check that the actual platen temperature reading (the red number next to "Temp:") is below 320℃.

(8) Check that both **ON** and **HeaterTie** are in green color.

(9) Go back to the Process page.

(10) If "Hi-Vac" is showing 9.9E+09, the filament gauge is off. Click on **IG** to switch on the filament gauge. Check that the chamber pressure "Hi-Vac" is under 5E-5Torr and the turbo pump backing pressure "TB-Vac" is in the order of -2Torr.

(11) Check also the capacitance manometer reading of the chamber - "Pressure" is about -7mTorr (Noted the negative number is the offset of the gauge controller).

(12) Check that both the readings of forwarded RF power "RF PWR" and reflected

RF power “RF REF” are zero.

(13) Check that the loadlock door is closed.

(14) Open the top cover of the TEOS heating bath. Check that the reading of dial thermometer for the water bath temperature is about 40℃ (See Fig. 7).

Fig. 7: The dial thermometer of the TEOS heating bath

4.4 Recipe Loading

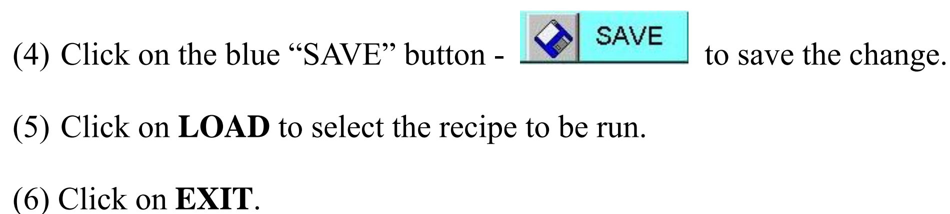
(1) Go to the Recipe page.

(2) From the top left of the screen, click on the pull-down menu and highlight the required recipe. Leave the field of PassWord blank. Click on **CHECK**. The required recipe will be displayed.

Warning – DON'T input any password and click on the grey "SAVE" button located under the **CHECK** button.

(3) Input the required process time (the time of the step where the RF PWR is applied).

Warning – User is not allowed to change any content of recipe except the process time. Ask NFF staff for creating a new recipe.

(4) Click on the blue "SAVE" button - 

to save the change.

(5) Click on **LOAD** to select the recipe to be run.

(6) Click on **EXIT**.

4.5 Wafer Loading

Warning – The wafer carrier will be VERY HOT after unloading from the heated chamber. DON'T directly touch the wafer carrier with hands.

(1) Go to the Process page.

(2) Click on **Unload**. The system will unload the wafer carrier to the loadlock and then vent the loadlock to atmospheric pressure.

(3) When fully vented, slide the loadlock door to the right to open the loadlock door. Check that the wafer carrier is in the proper position on the aluminum transfer robot arm. The wafer carrier should sit horizontally within the guiding edges (See Fig. 8).

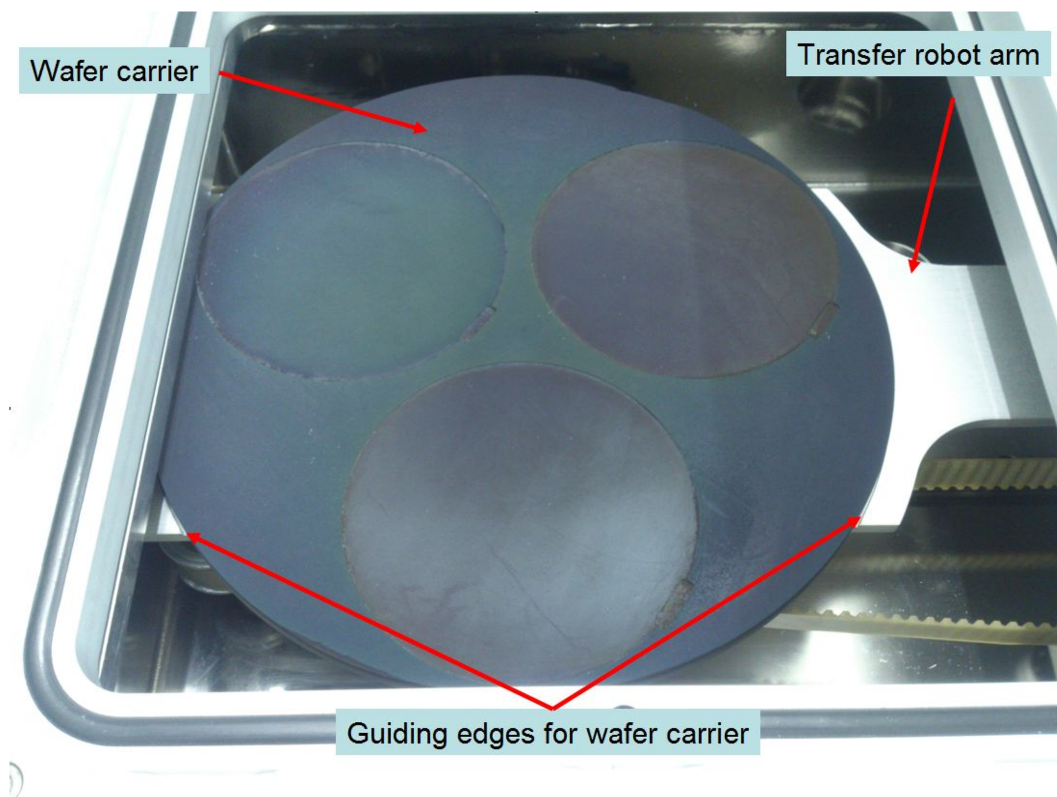


Fig. 8: Correct position of the wafer carrier on the robot arm

If the wafer carrier is not in the proper position, stop using the machine and contact NFF staff.

(4) There are three 4" shallow grooves on the wafer carrier. Place the wafer(s) onto

the wafer carrier within the 4” groove(s).

(5) Slide the loadlock door all the way to the left to close the loadlock door.

(6) Click on **LOAD**. The system will automatically pump down the loadlock and transfer the wafer carrier to the process chamber.

4.6 Deposition

Warning – During the process running, if there is something abnormal or some mistake has been made, you can click on **Abort** button (in the Process Control frame) any time. After Abort is activated, the system will return to idle state. Confirm that the system can return to idle state. Perform “4.3 Initial system checks” again.

Warning – REMEMBER to load the wafer carrier into the process chamber for all process including etchback and coating.

Warning – Unless otherwise approved, DON’T run any process NOT listed in the Table 1 – Standard Recipes. For other process, contact NFF staff.

(1) Check by adding the accumulated thickness (find it at the log sheet) with the expected thickness that you are going to deposit. If it is higher than 2µm, don’t run deposition, go through steps of ‘Etchback and Coating’.

(2) In the **Process** screen, check the Recipe Number and the NOTE to confirm the desired recipe is loaded.

(3) Click on **START**. A dialog “KeyinPN” is displayed. Input your project number NFFxxxx. Then click on **ENTER** to start the process. The system will run the selected recipe to completion, and then automatically unload the wafer carrier to

the loadlock and vent the loadlock to atmospheric pressure. During the deposition step (plasma-on), record the actual readings of some important process parameters as listed in the log sheet.

Warning – Do not leave an on-going process unattended. If the process parameter(s) is(are) out of tolerance(s), or/and some system fault(s) occurs, alarm message(s) will appear. Click on **Abort** to stop the process. Write down the alarm message(s) in the logsheet and report to NFF staff. Perform “4.3 Initial system checks”. Do not attempt to resume the process before the alarm/fault is verified.

(4) Wait unit the wafer carrier is unloaded to the loadlock and the loadlock is fully vented. Slide to open the loadlock door. Remove the wafer.
(5) Slide to close the loadlock door and click on LOAD to let the blank wafer carrier loading into the chamber.
(6) Fill in the log sheet. Write down the accumulated thickness by adding the thickness of the latest run and the previous accumulated thickness.
(7) Perform “4.3 Initial system checks”

4.7 Etchback and Coating

Warning – REMEMBER to load the wafer carrier into the process chamber for all process including etchback and coating.

(1) Please follow sections 4.3 to 4.7 for the operating steps. Remember to remove all the wafers from the wafer carrier. Perform etchback first by running the recipe “clean”. The process time is 30 mins. Fill in the log sheet. Write down ‘0’ in the field of accumulated thickness.

(2) Then perform coating by running the recipe “teos-3”. The process time is 15 mins. Fill in the log sheet.

(3) After the process completed, check the wafer carrier. If there are particles or some peel-off material on the wafer carrier, contact NFF staff.

(4) Click on **Load** to load the wafer carrier into the chamber.

(5) Perform “4.3 Initial system checks”

Table 1: Standard Recipes

Process	Recipe Name	Platen temperature	Typical deposition rate	Time
TEOS silicon oxide	teos-3	300℃	150A/min	
System etchback	clean	300℃		30 min
System coating	teos-3	300℃		15 min