Standard Operating Manual

STS MSEC Multiplex PECVD (PECVD2)

Contents

1. Picture and Location

Fig. 1a: **STS MSEC Multiplex PECVD** is located at NFF Phase II Room 2240

2. Process Capabilities

2.1 Cleanliness Standard

STS MSEC Multiplex PECVD (PECVD2) is “Non-Standard” equipment for thin film deposition.

2.2 Available Deposition Materials

The following deposition materials are available.
Silicon Dioxide, Silicon Nitride.

2.3 Wafer Size

The maximum wafer size is 150mm 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 PECVD2.

1. Read all materials on the NFF website concerning the PECVD2.
2. To register PECVD2 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. The gases then get excited and cause a chemical reaction on the substrate.

System Component Locations

Fig. 1b shows the locations of major system components.

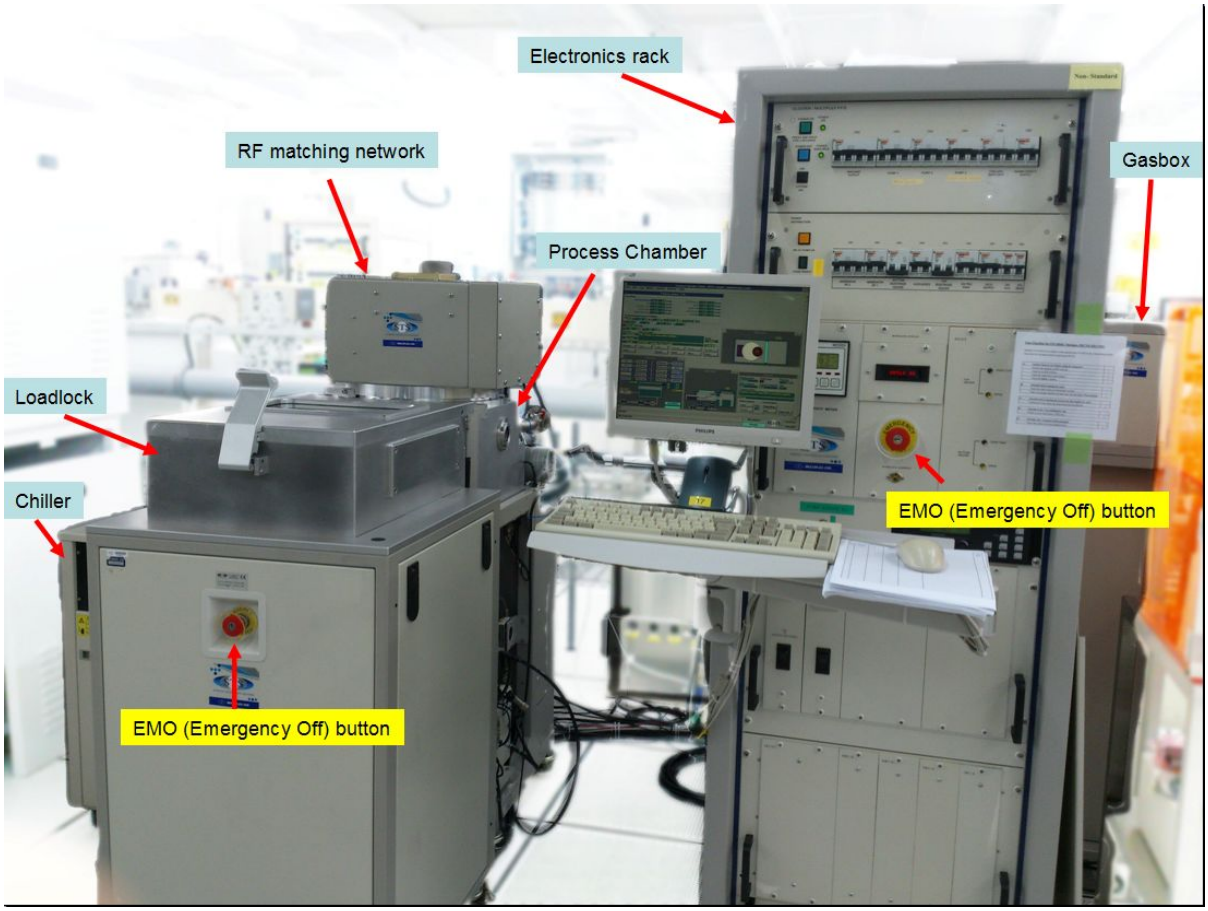

Fig. 1b: System component locations

Hazards

The gases such as SiH4 and NH3 used in PECVD2 are hazardous gases (toxic, corrosive, or flammable). 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 PECVD2.

Emergency Stop Procedure

If an emergency condition is suspected, depress fully one of the Red Emergency Off (EMO) Buttons located on the system as shown in Fig. 1b.

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 High frequency silicon oxide will be deposited first. It is so called coating. After that, deposition processes (Silicon Oxide or Silicon Nitride) can be made as long as the total deposited thickness has NOT accumulated over a certain thickness (the maximum allowed thickness). For Silicon Oxide, it is around 5μm. And for Silicon Nitride, it is around 3μm. 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 user control software is called Operator Station which is running under Windows 3.11 operating system. The main screen which consists of three control dialogs and three graphical views for the system status is shown in Fig. 1c. The control dialogs and the graphical views can be selected from the main menu bar at the top of the screen. To select control dialogs, click on **Control** then click on the corresponding dialog from the pull-down list (Do NOT select **Manual** and **Shutdown**.). To select graphical view, click on **Mimic** then click on the corresponding view from the pull-down list.

In the control dialogs, bold text buttons can be activated. Greyed text buttons are inoperable. For the data fields in the control dialogs, Yellow data fields are view only and cannot be edited. Blue data fields can be edited. Grey data fields are not available or are invalid under current conditions.

The Sequencer control dialog is used to run a process in the automatic mode. User is not allowed to use the Sequencer without permission.

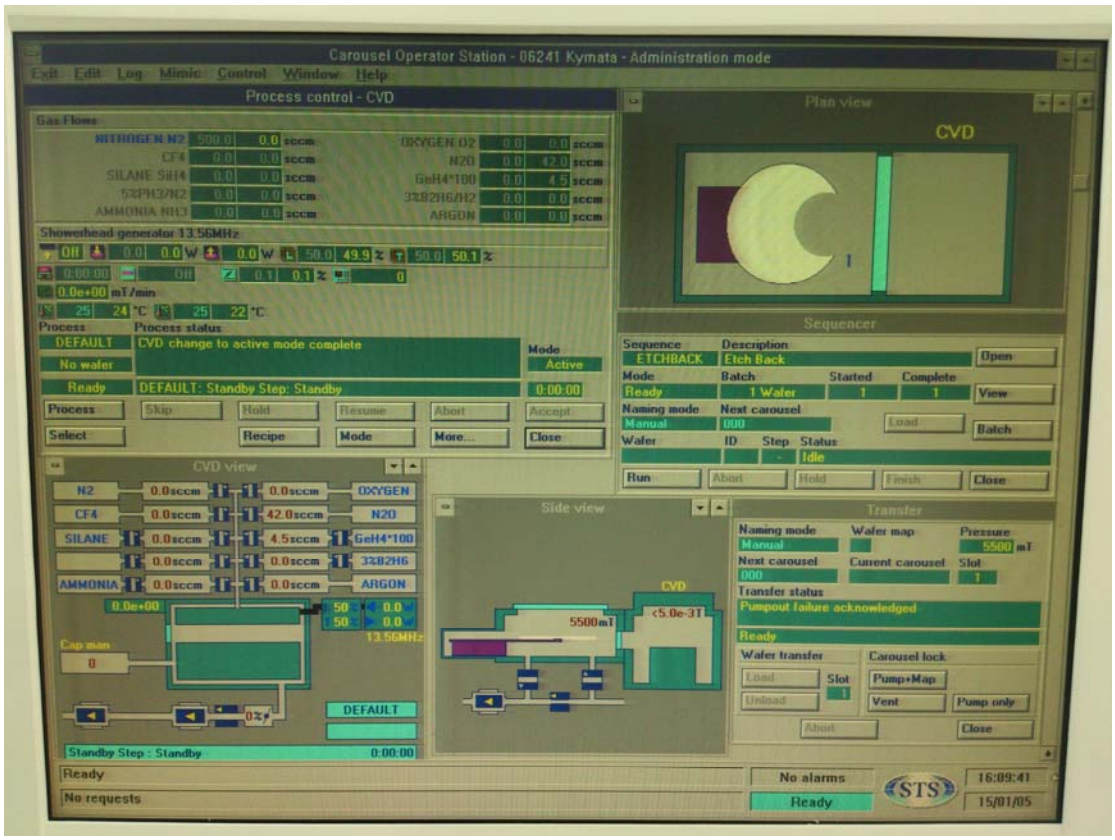

Fig. 1c: Main screen of Operator Station

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 before entering the PECVD.

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

(4) Non-Standard does not mean you can put everything into the machine. Follow your process flow. Materials which are not mentioned in the process flow are NOT allowed to put into the 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

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 top menu bar, select Control > A CVD process. The "Process control – CVD" dialog is displayed. Check that **Mode** is **Active**. If the **Mode** is **Inactive** or **Unknown**, contact NFF staff.

(2) Check also that there is no process running by looking at that the yellow data field just above the **Process** button is showing **Ready**. The PECVD system is now in the idle state (see Fig. 1d). In the idle state:

- There are no process gas flows. Note that the flow rates for each gas are controlled by its dedicated mass flow controller (MFC). For each process

gas line, there is a gas outlet valve at the downstream of the MFC. For those hazardous gas lines, there are two additional valves (gas inlet valve and N2 purge valve, these two valve do not open at the same time.) at the upstream of the MFC. Check that the measured flow rates of each MFC except that of the N2O are at zero (The measured valves are sometimes fluctuating around zero slightly. But for most of the time, they should be zero.). For N2O, the value is offset by about 40sccm.

Check also that all gas outlet valves, gas inlet valves and N2 purge valves are closed in the "CVD view" as shown in Fig. 1e. (For comparison of different graphical representations of the different valve status, the "CVD view"s during SiO2 deposition and N2 purging of SiH4 MFC are also shown in Fig. 1f. and Fig. 1g. respectively.)

- Check that the pressure of the capacitance manometer in the chamber is zero.
- Check that both the Showerhead forwarded RF power and reflected RF power are zero.
- Check that the Platen temperature and the Showerhead temperatures are below 380℃ and 280℃ respectively.

(3) Check that the wafer carrier is at the loadlock.

(4) Check that the loadlock lid is closed.

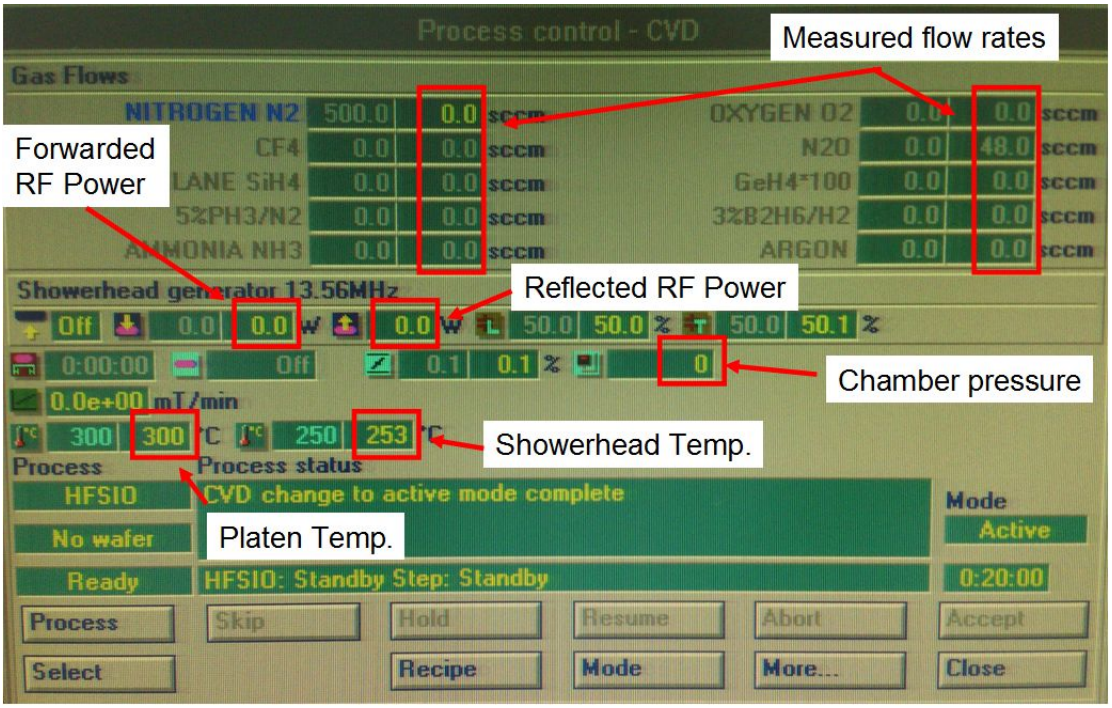

Fig. 1d: "Process control – CVD" dialog in system idle state. The highlighted regions show measured values of some system parameters.

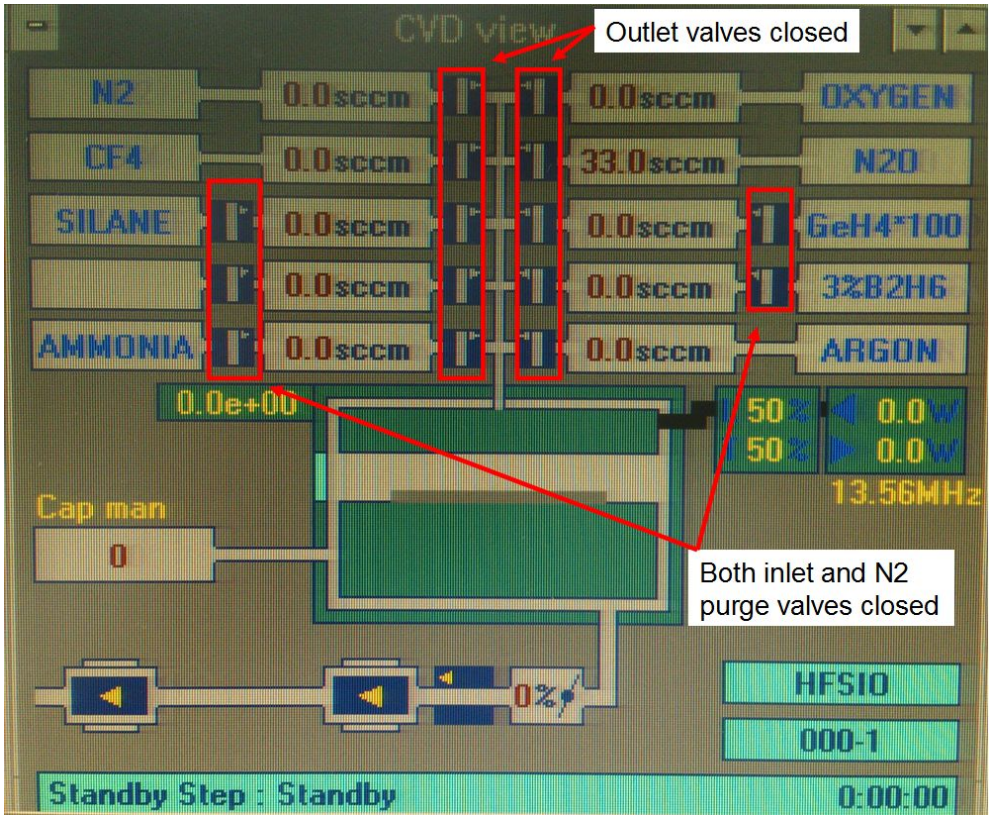

Fig. 1e: "CVD view" in system idle state. All gas valves are closed.

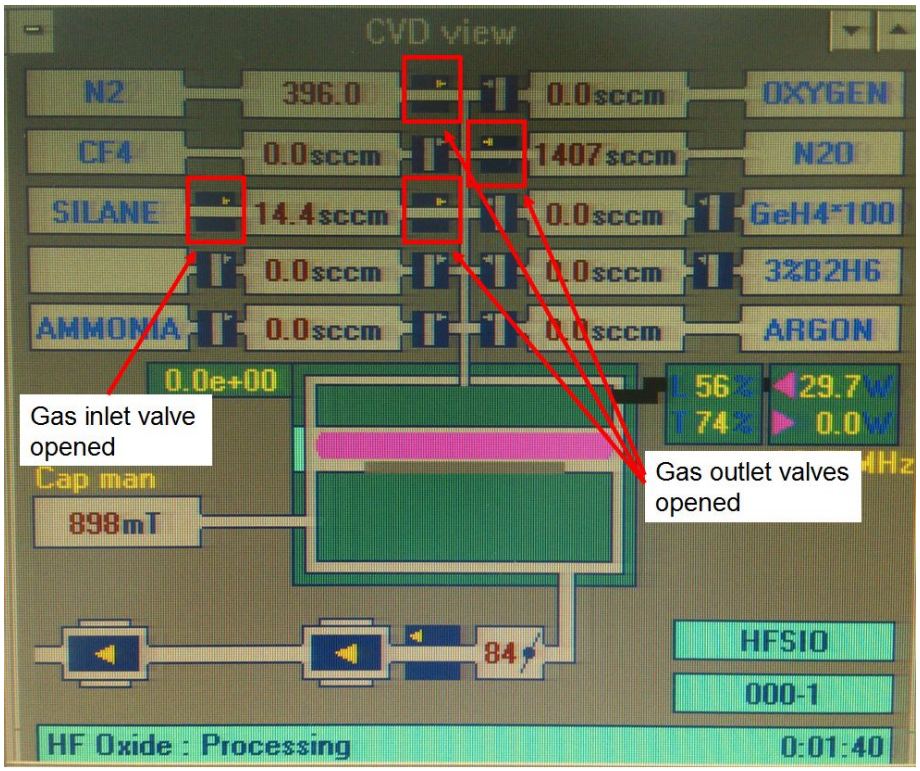

Fig. 1f: "CVD view" during SiO2 deposition. The outlet valves for SiH4, N2O and N2 are opened. The inlet valve for SiH4 is opened.

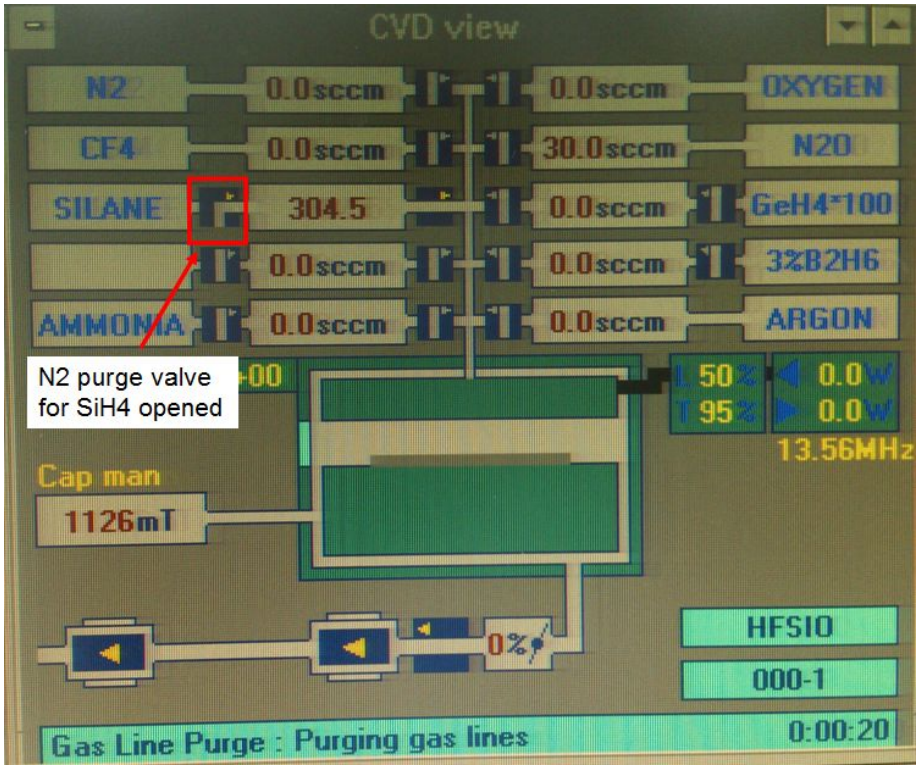

Fig. 1g: "CVD view" during N2 purging of SiH4 MFC

4.4 Temperature Settings

Set the Platen temperature and the Showerhead temperature according to the required value of the process you are going to do. For the temperatures of standard recipes, they are showed in the table 1.

(1) To switch on the heaters, push up the handles of MCB switches named BOTTOM ELECTRODE HEATER and TOP ELECTRODE HEATER located in the front of the electronics rack as shown in the figure below. For room temperature process, keep them off.

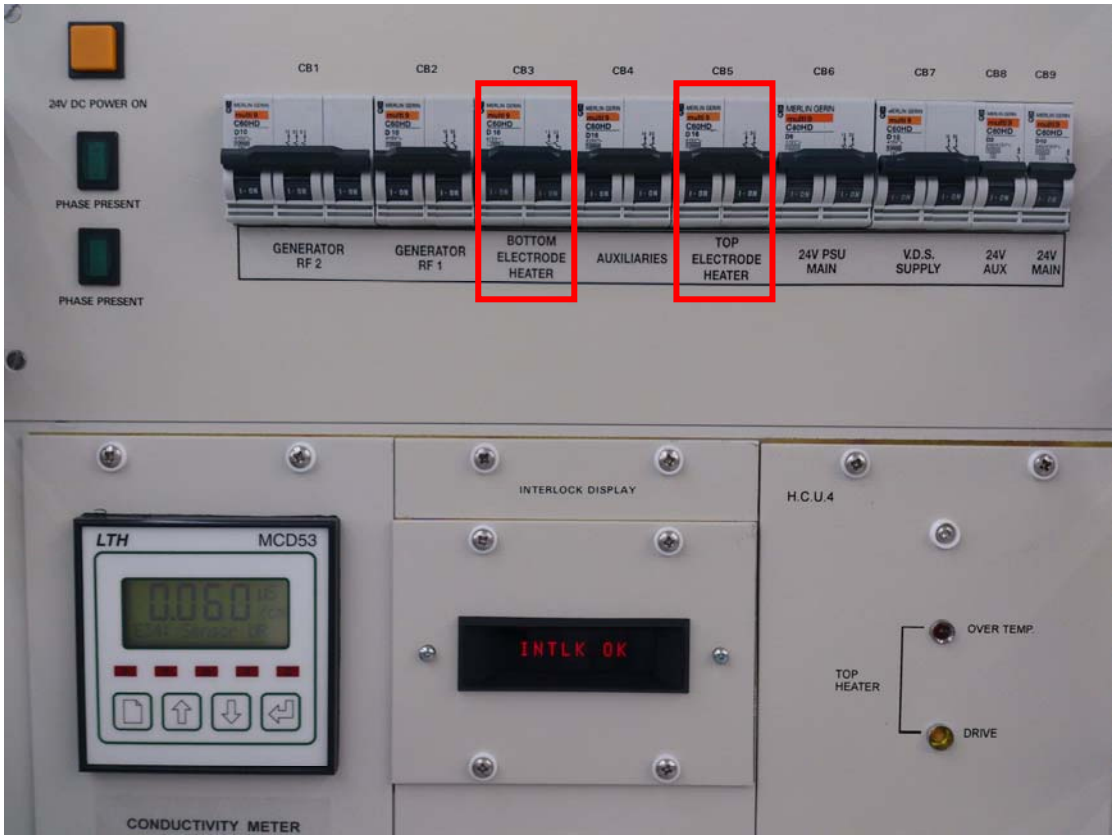

Fig 2: Position of the circuit breakers of top and bottom electrode heater

(2) Select Control > A CVD process. The “Process control – CVD” dialog is displayed.

(3) Click on the field of Platen temperature as showed in the figure below. Input the

required value and press enter.

(4) Click on the field of Showerhead temperature as showed in figure below. Input the required value and press enter.

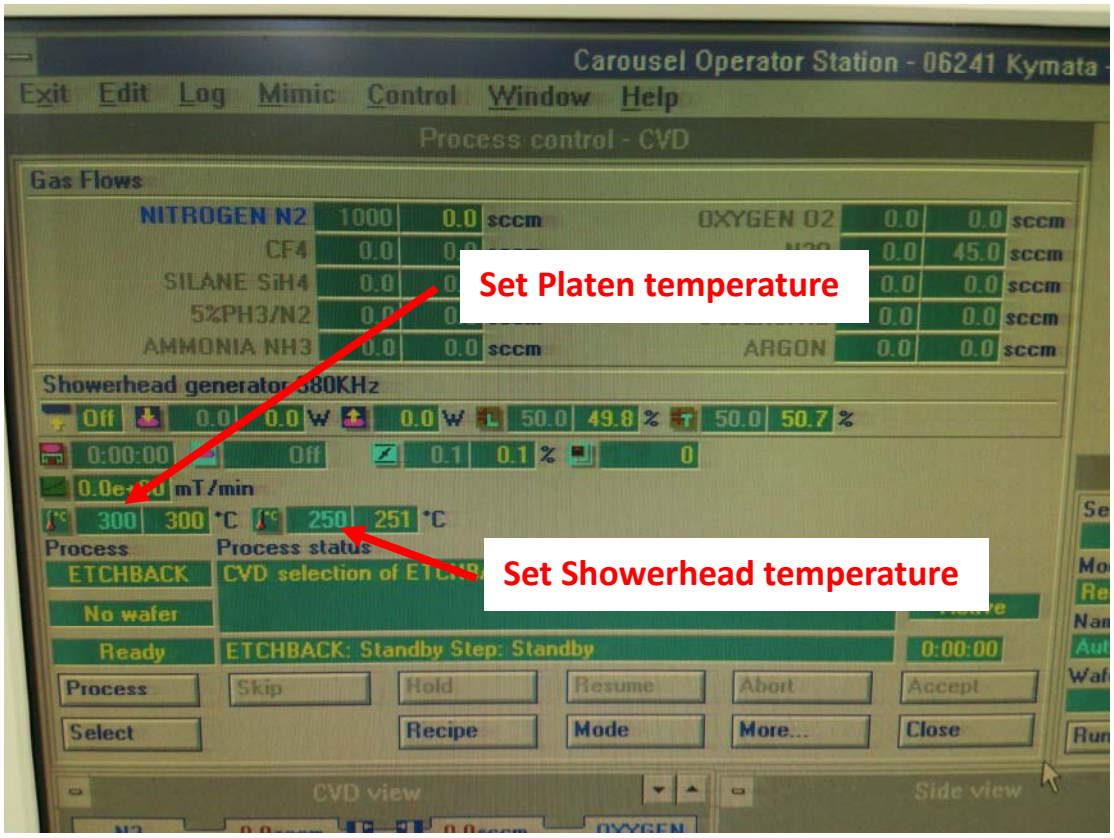

Fig. 3: The input fields of platen and showerhead temperature

(5) Wait for the temperatures to reach the target temperatures before any operation.

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) Select Control>Transfer to open the "Transfer" dialog.

(2) Select **Vent** to vent the loadlock to atmospheric pressure.

(3) When fully vented, lift the loadlock lid. Check that the wafer carrier is in the proper position on the white spatula as shown in the figure below. If the wafer carrier slips out, with the help of tweezers gently push it back to the spatula.

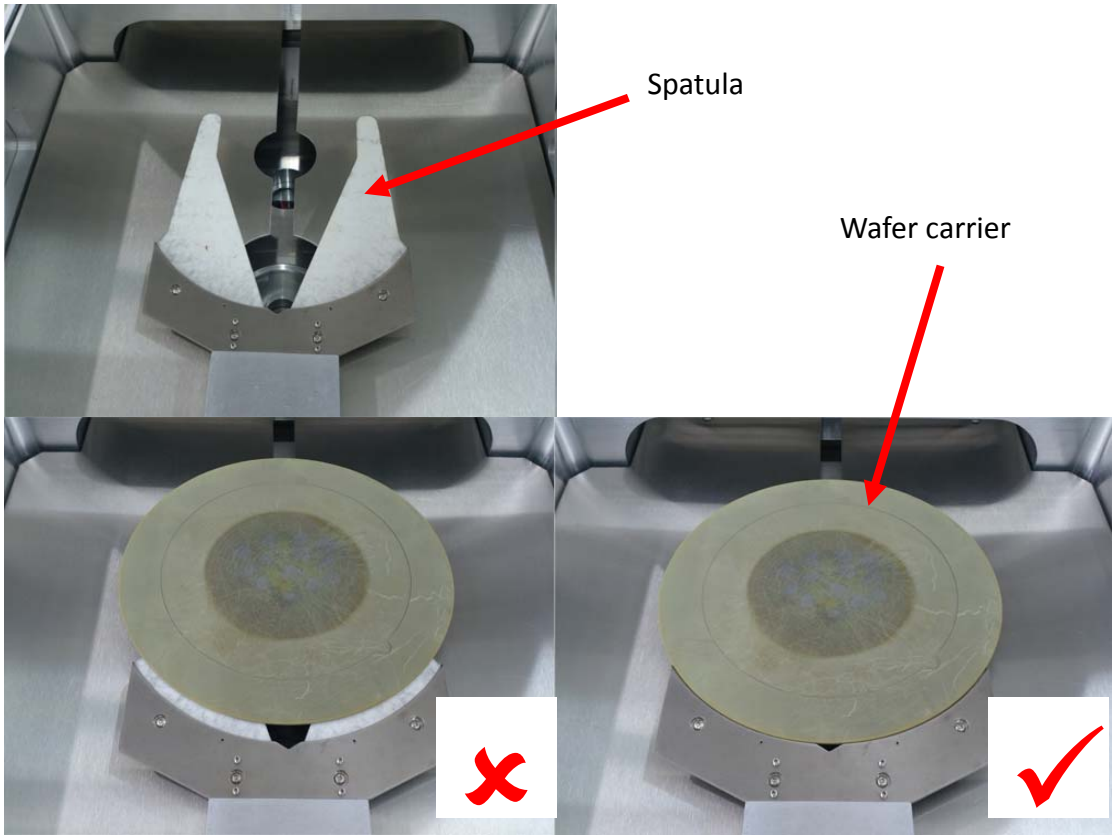

Fig. 4: Position of the wafer carrier on the white spatula

(4) Place the wafer onto the wafer carrier.

(5) Close the lid.

(6) If the alarm 'excessive vent time' appears, click on **Accept**.

(7) Click on the field **Next carousel**. Input your project number and press enter.

(8) Select **Pump+Map**. If the Confirmation dialog pops up, click on **Load**.

(9) After the loadlock pumped down to 80mTorr, select **Load**. The wafer carrier will be transferred 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** any time at the "Process control – CVD dialog". After Abort is activated, the system will run a pump-purge cycle and return to **Ready**. Confirm that the system can return to **Ready**, and the **Mode** is still **Active**. Perform "4.3 Initial system checks" again.

Warning – The system has a bug that there may be no NH3 flow. If the process needs to use NH3, check NH3 flow in the 'Gas stabilization' step before the plasma on. If the flow showed is zero, click on **Abort** and contact NFF staff.

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. For Silicon Nitride, please multiply a factor of 1.7 to the actual deposited thickness. If it is higher than 5μm, don't run deposition, go through steps of 'Etchback and Coating'.
(2) Make sure the wafer carrier has been loaded into the process chamber.
(3) At the "Process control – CVD dialog", click on the **Select** button, the "Run CVD process" dialog is displayed. Highlight the required process from the list and click on **Select**. The selected process is loaded and the system is running the stand-by

step (a pump-purge cycle).

(4) Select the **Recipe** button, a dialog showing the loaded process is displayed. Find the field **Process Time** and input the required deposition time in the field. Then select Recipe>Save. Select Recipe>Exit.

(5) At the "Process control – CVD dialog", click on the **Process**. The process will be activated, run to completion and then wait. During the deposition step (plasma-on), record the actual readings of some important process parameters as list 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, the process will hold and alarm message(s) will appear. During the process hold, RF power stops to apply and the plasma off, but other parameters such as gas flows are kept. There is no good if the process holds too long. Therefore, user should pay attention to that is there any alarm message may appear. After the alarm appeared, if the tolerance(s) or/and the system fault(s) are back to normal, click on the **Resume** to continue the process. If the alarm message persists, click on **Abort** to stop the process. Perform "4.3 Initial system checks".

(6) Fill in the log sheet. Write down the accumulated thickness by adding the thickness of the latest run and the previous accumulated thickness. For Silicon Nitride, please multiply a factor of 1.7 to the actual deposited thickness.

(7) If another process is needed on the same wafer, go to Step (1) of 'Deposition'.

4.7 Wafer Unloading

(1) After the process completed, at the "Transfer" dialog, click on **Unload**.

(2) When the unload action completed, click **Vent**.

(3) When fully vented, lift the loadlock lid. Remove the wafer.

(4) If the alarm 'excessive vent time' appears, click on **Accept**.

(5) If another run is needed immediately, go to step (3) of 'Wafer Loading'. Otherwise, close the lid and select **Pump Only**.

(6) Perform "4.3 Initial system checks"

4.8 Etchback and Coating

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

(1) If the wafer carrier is in the chamber, at the "Transfer" dialog, click on **Unload**.

(2) Remove all the wafers from the wafer carrier and close the loadlock lid.

(3) At the "Transfer" dialog, Click on the field **Next carousel**. Input your project number and press enter.

(4) Select **Pump+Map**. If the Confirmation dialog pops up, click on **Load**.

(5) After the loadlock pumped down to 80mTorr, select **Load**.

(6) After the wafer carrier has been loaded into the chamber, at the "Process control – CVD dialog", click on the **Select** button, the "Run CVD process" dialog is displayed. Highlight the 'etchback' from the list and click on **Select**.

(7) Select the **Recipe** button, a dialog showing the loaded process is displayed. Find the field **Process Time** in Step One (380kHz) and input 20min in the field. Find also the field **Process Time** in Step Two (13.56MHz) and input 20min in the field.

Then select Recipe>Save. Select Recipe>Exit.

(8) At the "Process control – CVD dialog", click on the **Process**.

(9) Fill in the log sheet. Write down '0' in the field of accumulated thickness.

(10) After the process completed, at the "Transfer" dialog, click on **Unload**.

(11) Check the wafer carrier. If there are particles or some peel-off material on the wafer carrier, contact NFF staff.

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

(13) Follow the 'Deposition' procedure to perform the system coating by running the recipe 'hfsio' for 4min process time.

Table 1: Standard Recipes

Process	**Recipe Name**	**Frequency of Plasma Power**	**Platen temperature**	**Showerhead temperature**	**Typical deposition rate**	**Time**
High frequency silicon oxide	hfsio	13.56MHz	300℃	250℃	550A/min	
High frequency silicon nitride	hfsin	13.56MHz	300℃	250℃	100A/min	
Low frequency silicon oxide	lfsio	380kHz	300℃	250℃	----A/min	
Low frequency silicon nitride	lfsin	380kHz	300℃	250℃	----A/min	
System cleaning	etchback	380kHz & 13.56MHz	300℃	250℃		20min (for 380kHz) & 20min (for 13.56Mhz) for etchback of ~5μm deposition
System coating	hfsio	13.56MHz	300℃	250℃		4min