Plasma Enhanced Chemical Vapor Deposition

(PECVD)

Standard Operating Procedure

Version 1.4

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System Information:

- **Instrument Provider: Oxford Instruments**
- **Gases Available: SiH_4, NH_3,N_2O,Ar, He, H_2, N_2, CF_4**
- **Films Deposited: SiN_x, SiO_x, SiO_xN_y, a-Si**
- **Wafer Dimensions Allowed : Small pieces, 125 x 125 mm, and 156 x 156 mm**

TRAINING PROCESS:

- **Get approval from your Guide/Faculty Advisor**
- **Contact the System Owner**
- **You need to attend at least two etch sessions with any authorized user**
- **After that you need to attend one or two hands-on session**
- **A test will be taken after that and authorization will be given if cleared, else you need to go for more training sessions before next test**

SAFETY HAZARDS & PRECAUTIONS:

- **Ensure that the Chiller is turned ON**
- **Ensure that the gases are turned ON at the service end by facility team members**
- **Ensure that the exhaust blower is ON before starting the tool.**
- **Ensure that the scrubber is turned ON before starting the tool.**
- **Always start the tool after consulting the facility team members.**

Procedure for Starting the Tool:

Before Entering the clean room :

1. Before turning on the instrument check whether the scrubber is turned ON. You should start the tool only after receiving the green signal from the facility in charge, regarding the status of the scrubber.
2. Check with facility in charge, whether the process gases are ON and nitrogen is pressure is at 6 bar.

Precautions:

1. Always exit SERVICE mode. Any operation in this beyond what is mentioned in SOP can severely damage the system.
2. Always wait for Load lock to pump below, 4e-2 bar, and starts indicating "Cycling Loadlock".
3. If in doubt, call the system Owner.

SWITCH ON Procedure

- Start the chiller
- PN2: 4 bar, High purity nitrogen used as a precursor gas, and to purge turbo molecular pump, process chamber, load lock chamber. We have 2 MFCs for PN_2. MFC rating for purging is 100sccm; MFC rating for process gas is 50sccm.
- GN2: 6bar, Commercial grade nitrogen used for operating solenoid valves and purging rotary pumps.
- Switch ON the mains of the system. Turn the green button on the System to turn system ON (If tool is ON, ignore the step, and proceed to next step).
- Open valves for PN_2, and GN_2 inside the lab.
- Turn ON the PC.
- Choose the software **PC2000**.
- We get a display as
  - Name **OPT** Password *******
- Click **OK** ……. Is load lock empty **OK**………Sure **OK**
- Go to **System**………**Service**………
- To activate both the Rotary pumps, click on the schematic for pumps. When a yellow lining appears around the pumps, we have control over them. The pumps will start working.
- Go to **System**……….**Service**……..**Exit Service**……
- We get a display: **Danger, Machine is about to reset, Stand clear….<u>This means the machine will reset to home position</u> ……..click on OK**.
- We are in the **Pump Control** page now.
- Wait for about 20min., for warming up of the pumps. This step is not required, if the tool is already powered up.
- Click on • EVAC **• STOP** • VENT **• EVAC** • STOP • VENT for both chambers.

- We get a display….**Enter Wafer ID**…**Cancel** if there is no wafer/give ID otherwise, and then click on **OK**.
- Wait for a few minutes, until the load lock and the process chamber are pumped down to base vacuum.
- When both the chambers are ready and in base vacuum, green arrows appear on both the chambers.
- Now the **system** is ready for all processes.

To increase substrate temperature

- Go to….**Process**…**Chamber1**.
- Give a relevant time to **STEP TIME**. **This time does not signify ramping time for increase in temperature.** This time is the process time that starts countdown after the electrode reaches the desired temperature.
- Feed the temperature parameter in **CRYO**.
- Please increase the temperature in steady steps and also take care of the overshooting of temperature. To avoid overshooting, increase the temperature in smaller steps as you get closer to the required temperature.
- For example, if the required temperature is 250degC. When we start at room temperature, say, 25degC, we increase temperature in steps of 50 degrees initially. When we reach 225degC, we increase temperature in steps of 5 degrees.
- **Maximum temperature to be used is 380°C.**
- **All other parameters in this page must be zero.** (Note: **Pump to pressure must not be ticked**)

Procedure for Deposition – Automatic Process Run

- Go to….**System**….**Pumping**…. • EVAC **• STOP** • VENT • EVAC • STOP **• VENT** for Load lock Chamber.
- After Load lock Chamber reaches atmospheric pressure, the Load lock Chamber lid can be opened.
- Load the appropriate carrier inside the chamber and place the sample on it. *A list of carriers used for different kinds of substrates is given in the table below*. **Utmost care must be taken to not drop the sample inside the Load Lock Chamber**.
- Close the lid • EVAC **• STOP** • VENT **• EVAC** • STOP • VENT the Load lock Chamber.
- A Dialogue Box appears for **Wafer ID**. Enter your wafer ID.
- After the Load lock Chamber attains $4x10^{-2}$Torr, green arrows appear on the Load lock Chamber.
- Please wait until the Load Lock shows "Cycling Loadlock". **This is very important and must be followed at all times.**
- Select **Process**, choose **Recipe** option.
- Open the valves for all the required process gases inside the lab.
- Drag the relevant recipe using the 'mouse'.
- **Run** the recipe. It can be **edit**ed according to the requirements.
- After deposition, a yellow alert saying **Process Complete** is displayed….**Accept**.
- Automatically the wafer moves from Process Chamber to Load lock Chamber.
- For Load lock Chamber.
- Open Load lock Chamber and remove the sample.

Evacuation of Gas Lines

- Close the gas cylinders and keep the regulators open or only the valves of the gases inside the lab as the case may be.
- At a time, one gas line is to be evacuated.
- Go to **Process**……….**Chamber1.**
- All parameters on this page must be zero. **PUMP TO PRESSURE**…**must not be ticked**.
- **CRYO**…..feed the temperature of the electrode at that point of time.
- Feed 15 min **Step Time** value for non toxic gas and 30 min for toxic.
- Give maximum possible suitable value for the MFC which is to be evacuated……..**Start**.
- Watch the flow rate, it must show 0sccm.
- If you do not get this flow rate, start the evacuation step again.
- This will evacuate the gas lines.

Procedure for Chamber Cleaning

- Chamber cleaning is done after a deposition of 2um. It is also done in case the process chamber is opened for any reason.
- Cleaning procedure is same as running any other recipe. Use the carrier wafer as the dummy wafer for cleaning.
- Recipes with the Header “Clean” are to be used for chamber cleaning. The recipe is a two step recipe, with each step running for 25 mins.
- Nitrogen purge steps precede and succeed the clean process.
- Make sure, you are present in lab during the clean process, as the temperature would keep on rising due to plasma exposure. Adjust the table temperature accordingly, so that the process is not aborted. Eg: If the chamber is showing 32C whereas set temp is 25C, increase the temperature to 32C, and press “Play” button in software.

Procedure for SHUTTING DOWN the system

- On completing the gas line evacuation, tool shutdown can be initiated.
- If system is at higher temperature, Set temperature as 25°C and run for 2 mins (as you would do for increasing the temperature). Accept, the **Yellow Alert,** and go to next step.
- Go to **Pumping page**…….click on ‘**STOP** for all automatic processes’ which is on right hand side top corner of the page.
- Click on **LOAD LOCK PUMP** and turn it **OFF.**
- **G**o to **System ……Exit ……Are You Sure**……**Yes**.
- **Switch OFF** the gases inside the lab, and inform facility to turn off cylinders, scrubber and exhaust.
- Keep the **chiller running** for another 30 mins to cool the substrate.
- The **System** and the **PC** are left ON usually. In order to shut down the system, please follow the steps below
    - Shut down the computer
    - **Switch OFF** using red button on System.
    - **Switch OFF** the mains for **the PC and the system**.