University of Minnesota Nano Center
Standard Operating Procedure

Equipment Name: PECVD

Coral Name:	pecvd	**Revision Number:**	2.0
Model:	Plasmatherm 340	**Revisionist**:	Mark Fisher
Location:	Bay 3	**Date:**	20 Sept 2013

1 Description

The Plasmatherm PECVD used to deposit thin films (Silicon Nitride, Silicon Dioxide, or Amorphous Silicon) from a gas state to a solid state on the substrate. The chemical reaction takes place after a RF plasma is created between the top electrode and the heated platen. The platen is heated by an embedded resistance heater with a range of 80-340 degrees Celsius. This system has processes setup for the deposition of Silicon Nitride, Silicon Dioxide and Amorphous Silicon. The system processes are in located in folder **c:\process**. The old processes are located in folder **c:\sysmon.** Program naming convention is the following, SIN340.prc is Silicon Nitride at 340 C, SiO2340 is Silicon dioxide at 340 C, or ASi340 is Amorphous Silicon at 340 C.

PECVD system.

PECVD chamber, the gas shower head, and platen.

2 Safety

The safety item beyond the normal electrical hazards is to watch out for are the platen temperatures can reach 340 degrees C. The process gases that are available in this system are N2, O2, CF4, N2O, 2%SiH4/He, NH3, and He. In the case of an Emergency press the RED EMO button and contact a MNC person about any problems.

3 Restrictions/Requirements

Must be a qualified customer on the Badger and PECVD system.

No Amorphous Silicon (ASi) deposition from Tuesday 12:00pm –Thursday 12:00pm

FYI. If you deposit SIO2, SIN, or ASi on substrates the PECVD system, those substrates **may not** go back into any oxide or LPCVD tubes, the except to the above is the alloy tube or RTA. Please use the

RTA in Bay 1 to denisfy the pecvd deposited film or contact a MNC staff person for additional options.

4 Required Facilities

The system needs electrical power, gases, cooling water.

5

6 Definitions

Process =A program that controls the sequence of events.
Platen=The main base plate that the wafers or substrates are placed.
Lid =The top bell jar cover of the system that opens up.

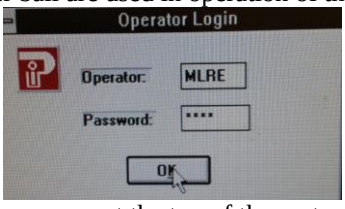
7 Setup

1. To hold your substrate in the center of the platen use 1x3 glass slides. Due to the placement of the pumping port your substrates will tend to move to the back right area of the platen.
2. It is a good idea to place a piece of bare silicon in with your process so that you can measure the thickness of your deposited film and refractive index of your deposited film.

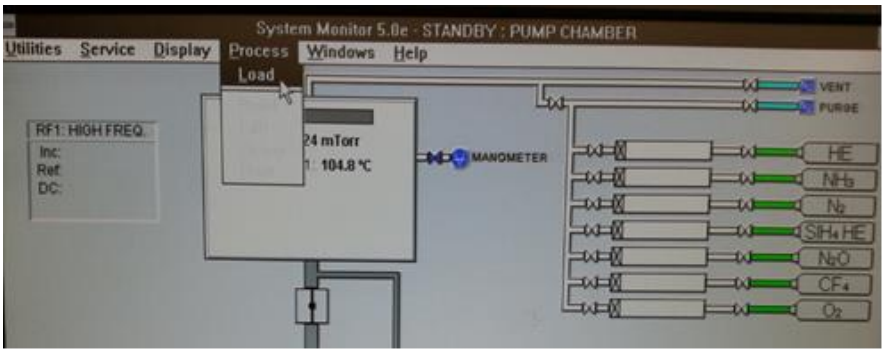
8 Operating Instructions

1. **Enable the PECVD.** To enable the PECVD in Badger, first highlight the PECVD by going to Chemical Vapor Deposition>PECVD, then under Equipment Actions select Enable, the green light should now be lit.

2. **Login to the system.** The Operator Login window should now be in the middle of the screen. In the **Operator** box enter **MLRE** and press TAB. In the Password box enter **1234** and then click **OK** box. The operator name and password are in uppercase letters. The system monitor window should now be on the screen. The system monitor gives you the status of the system parameters. (The top left trackball mouse button and the roller ball are used in operation of the PECVD system).



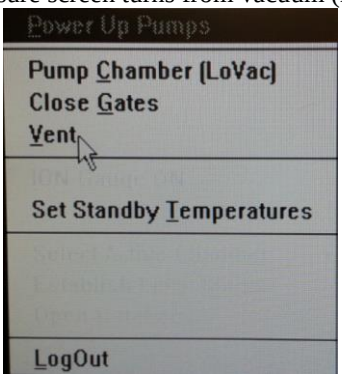
3. **Load a Process.** Using the pull down menus at the top of the system monitor screen **Select PROCESS>LOAD**. Please change the flip card to reflect the process you are running and fill out the log book on the table.



The list of process files right chamber window will appear. Check to see that the directory or folder should be **c:\process**. If not, change folders to c:\process. Then, highlight the process you would like to run by clicking on the name with the left hand mouse button (sin250, sin340, sio2250, sio2340, etc). The process you selected should now appear in the **File Name** box. Click **OK** in the upper right hand corner of the window. Your process should now be loaded. Check the process box for your process.

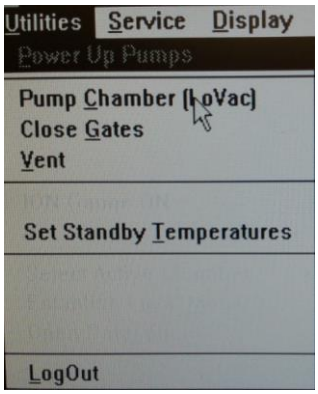
Films. The Nitride film is the cleanest film, then oxide film, while the amorphous films are the dirtiest films. So, the PECVD system should be cleaned when changing from an oxide deposition to a nitride deposition. If the last process ran was an amorphous silicon process the system should be cleaned before depositing nitride or oxide. See section 8, page 4 on cleaning the system.

4. **Vent the system.** Using the pull down menus at the top of the system monitor screen **Select Utilities>Vent**. The chamber will vent will take 1-2 minutes. The chamber lid will pop open when the chamber is vented and the pressure screen turns from vacuum (red/white) to atmosphere (blue).



5. **Load your substrates**. You can now lift chamber lid up by hand and load your samples or substrates. There is a chain available to hold the chamber lid open while you load your substrates. **CAUTION: THE PLATEN IS VERY HOT –AVOID CONTACT.** Use 1x3 glass slides to hold your substrates in the center of the platen. It is possible to load four 4" wafers, one 6" wafer, or one 8"wafer. To get the best uniformity on your substrates, load them in the center of the platen, using a couple 1x3 glass slides to hold them in the center of the platen. Remember a 1x3 glass slides are 1mm thick and most substrates are thinner than 1mm, so it is best if you hold your substrate in the center of the platen with the corner of the glass slide. This loading technique will allow the gas to flow over the glass slide more uniformly, thus getting a more uniform deposition on your substrate. The way to determine the deposited film thickness and refractive index is to load a piece of bare silicon along with your substrates and measure this piece of silicon on an ellipsometer in bay 1 when your run is complete.

6. **Pumping the system down.** Using the pull down menus at the top of the system monitor screen **Select Utilities>Pump Chamber (LoVac),** while holding the chamber lid closed with a little pressure. Hold down the chamber lid until the pressure screen turns from atmosphere (blue) to vacuum (red/white). You will notice that the gap from the top lid will get smaller as the chamber pumps down.



7. **To run your Process.** Click on **READY** in the **System Status** cluster at the bottom of the screen. **Wait until the process temperature has been reached.** (Note:This could take up to 45miutes for the higher temperatures.) When the system has met all initial parameter requirements the entire **READY** button will turn yellow and the status bar will give the following message"Ready Mode Temperature Compliance Achieved". Once the system is in the **READY** mode, click on **RUN** in the **System Status** cluster at the bottom of the screen. The process will now proceed

automatically steps 1-6, at step 4 you will need to stop your deposition at the correct time and advance the program to the next step by hitting the end step button during this step. See below.

Step 1 Initial Pumpdoun (1 minute)
Step 2 Prepurge- Important removes water vapor from the chamber. (3minutes)
Step 3 Gas stabilization (2 minutes)
Step 4 Process- This is the actual deposition step. (deposition time)
Step 5 Postpurge- Important removes hazards gases from the chamber. (2minutes)
Step 6 End and vent (3 minutes)

Since most processes in c:process are written with a standard 120 minute actual deposition time (Step 4 Process) you will need to time your deposition using the clock visible in the lower right side of the screen. When the time in the **Elapse** box has reached the deposition time, click on the **END STEP** button once only in the **System Status** cluster at the bottom of the screen. This will end your deposition and advanced the process to the step 5. If you make a mistake and click the END STEP button more than once, wait until the system has pumped the chamber for ~30seconds, then click the ABORT button in the **System Status** cluster, then click-Yes to abort. Select one of the following processes (Purge150, Purge250, or Purge300) select the process that is closest to your process temperature, run this process. These processes will purge the chamber of all gases and vent the system. Please see pages 7-10 for process summary sheets that include, deposition rates, stress, refractive index, etc.

8. **Remove your samples.** After the process is completed, the chamber will vent and the lid will open. Remove your substrates and place them on the glass plate on top of stainless steel top of the system until they cool. Cool your substrates slowly to minimize thermal shock. **CAUTION: THE PLATEN AND THE SAMPLES BEING REMOVED ARE VERY HOT - USE CAUTION WHEN HANDLING.** The process complete window appears stating that the process is done and the time the automatic process was completed. Click **OK**. If you would like to deposit on more sample go to step 5. If not, continue to next step.

9. **Pump the system down.** Using the pull down menus at the top of the system monitor screen. **Select Utilities>Pump Chamber (LoVac),** while holding the chamber lid closed. Hold down the chamber lid until the pressure screen turns from atmosphere (blue) to vacuum (red/white). You will notice that the gap from the top lid will get smaller as it pumps down. To measure the film thickness and refractive index of your samples use the ellipsometer in Bay 1. Please record this information in the log book on the table below the monitor.

10. **Return the system to standby.** After the system has pumped down, (the pressure box has turned white), click on the **STANDBY** button box in the **System Status** cluster at the bottom of the page. This should put the system in the **STANDBY** mode.
11. **Logout.** Click on the **Utilities>Log Out.** The system should now be in the **STANDBY** mode and logged out.

9 Cleaning the system

To clean the system. choose one of the following processes

clean1.prc -45minutes
clean2.prc -90minutes
clean3.prc-180 minutes

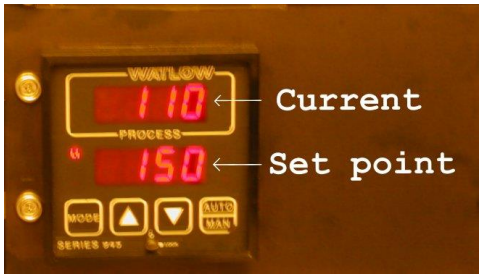
After the clean is done, wipe out the system with Kimwipes (see image below) and then use the N2 gun to blow out the chamber from the top to bottom. Then, run your planned process for 5 to 10 min to coat the chamber with SIN or SIO2 this will help coat and seal any particles that might be left over from the cleaning process.

Note:MNC Will clean the system every Tuesday morning, so the system will be ready by 12:00pm for Nitride and oxide depositions. If you have any questions please contact MNC staff.

10 Tip/Technigues

Deposition Rate. The deposition rates are on the Process Summary Sheets 7-10 of this SOP. If you need your deposition to be better than X +/- 10%. It is a good idea to do a dummy run (5-10 minutes) before the actual deposition, to get a more accurate deposition rate for your run. Please put your deposition rate in the log book.

Check Platen temperature. Check the system to see what the platen temperature, open the front panel door below the chamber, and the top temperature displayed should be what is in the process. See below for an example. In the photo the system is at 110 degrees and a 150 degree process was selected.



Deposition Rate. The deposition rates are on the Process Summary Sheets 7-10 of this SOP. If you need your deposition to be better than X +/- 10%. It is a good idea to do a dummy run (5-10 minutes) before the actual deposition, to get a more accurate deposition rate for your run. Please put your deposition rate in the log book.

To clean the system. To run a clean process chose one of the following processes (clean1.prc (45minutes), clean2.prc (90minutes), or clean3.prc (180 minutes). After the clean is done, wipe out the system with Kimwipes (see image below) and then use the N2 gun to blow out the chamber from the top to bottom. Then, run your planned process for 5 to 10 min to coat the chamber with SIN or SIO2 this will help coat and seal any particles that might be left over from the cleaning process.

To reduce pin holes in Films. Depositing more than one deposition for the total thickness, helps reduce the problems of film voids or pinholes. For example a 750 A film thickness could be split into three layers of 250 A each. This technique of depositing three layers have helped customers solve their film quality problems, to take advantage of this technique, just split your total thickness in three. Another technique customers have used is to blown off their wafers or substrates with N2 between deposition steps.

11 Problems/Troubleshooting

END STEP Problem
If you make a mistake and click the END STEP button more than once, wait until the system has pumped the chamber for ~30seconds, then click the ABORT button in the **System Status** cluster, then click-Yes to abort. Select one of the following processes (Purge150, Purge250, or Purge300) select the process that is closest to your process temperature, run this process. These processes will purge the chamber of all gases and vent the system.

Software issues and Rebooting system.
Sometimes the system will not accept passwords, or just operate in a strange fashion, this is a clue that the software has stopped working correctly. Rebooting the system by pressing the Crtl-Alt-Del keys will reboot the system. Once the software is running, login, pump the chamber down and continue with selecting a recipe and running a process.

Building Fire Alarm
Note the elapse time on the clock. Hit the Abort button in the system status cluster. Exit the lab through the closest door.
To restart the system after a fire alarm questions contact an MNC staff member.

If you have any questions contact an MNC staff member.

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Summary Sheet Silicon Nitride

Parameter

Gases……2%SiH4/He……..200sccm
N2……740sccm
NH3……...2.0sccm
Time……..120 minutes
Pressure……..900mtorr
Power…….....20W
Uniformity……...<+/-3.0% Across a 4" wafer

Process

SIN100.prc

Temperature……100 C
Deposition Rate…… 130 A/min
Refractive Index……1.85
Stress……..137 MPa (tensile)

SIN150.prc

Temperature……150 C
Deposition Rate…….~115 A/min
Refractive Index……1.90
Stress……. ? MPa(tensile)

SIN200.prc

Temperature……200 C
Deposition Rate……..102 A/min
Refractive Index……1.92
Stress……1317 MPa (tensile)

SIN250.prc

Temperature……250 C
Deposition Rate……~96 A/min
Refractive Index……1.95
Stress…….? MPa(tensile)

SIN300.prc

Temperature……300 C
Deposition Rate……83 A/min
Refractive Index……1.99
Stress……..1515 MPa(tensile)

SIN340.prc

Temperature……340 C
Deposition Rate……..78 A/min
Refractive Index……2.01
Stress……717 MPa

Summary Sheet Silicon Dioxide

Parameter

Gases……2%SiH4/He……..200sccm
N2O…….450sccm
Time……..120 minutes
Pressure……..900mtorr
Power…….....20W
Uniformity……...<+/-3.0% Across a 4" wafer

Process

SiO2100.prc

Temperature……100 C
Deposition Rate…….343 A/min
Refractive Index……1.42
Stress…….134 Mpa (compressive)

SiO2150.prc

Temperature……150 C
Deposition Rate……..~370 A/min
Refractive Index……..~1.45
Stress……..~250 MPa (compressive)

SiO2200.prc

Temperature……200 C
Deposition Rate…….372 A/min
Refractive Index……1.44
Stress…….321 MPa(compressive)

SiO2250.prc

Temperature……250 C
Deposition Rate……..~370 A/min
Refractive Index……..~1.45
Stress……..~250 MPa (compressive)

SiO2300.prc

Temperature……300 C
Deposition Rate……369 A/min
Refractive Index……1.45
Stress…….247 MPa (compressive)

SiO2340.prc

Temperature……340 C
Deposition Rate……378 A/min
Refractive Index……1.44
Stress…….251 MPa (compressive)

Summary Sheet Amorphous Silicon

Parameter

Gases……2%SiH4/He……..600sccm
He…….100sccm
Time……..120 minutes
Pressure……..900mtorr
Power…….....20W
Uniformity……...<+/-4.0% Across a 4” wafer

Process

ASi100.prc

Temperature……100 C
Deposition Rate……53 A/min
Refractive Index……~3.30
Stress…….385 MPa (compressive)

ASi150.prc

Temperature……150 C
Deposition Rate……~50 A/min
Refractive Index……~3.50
Stress……..?

ASi200.prc

Temperature……200 C
Deposition Rate……49 A/min
Refractive Index……..~3.50
Stress…….890 MPa (compressive)

ASi250.prc

Temperature……250 C
Deposition Rate……~50 A/min
Refractive Index……~3.50
Stress…….?

ASi300.prc

Temperature……300 C
Deposition Rate……50 A/min
Refractive Index……..~4.00
Stress…….....1028 MPa (compressive)

ASi340.prc

Temperature……340 C
Deposition Rate……~50 A/min
Refractive Index……~4.0
Stress…….?

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Summary Sheet Clean Recipes

Process

Clean1.prc

Parameter

Gases……CH4……..80sccm
O2……...8sccm
Time……..45 minutes
Pressure……..250, 500, 900mtorr
Power…….....350W
Temperature……100 C

Clean2.prc

Parameter

Gases……CH4……80sccm
O2…….8sccm
Time……..90 minutes
Pressure……..250, 500, 900mtorr
Power…….....350W
Temperature……100 C

Clean3.prc

Parameter

Gases……CH4……80sccm
O2…….8sccm
Time……..180 minutes
Pressure……..250, 500, 900mtorr
Power…….....350W
Temperature……100 C

Summary Sheet Purge Recipes

Parameter

Gases……N2……..……..200sccm
Pressure……..730mtorr
Time……..7 minutes
Power…….....0W

Purge150.prc

Parameter

Temperature……150 C

Purge250.prc

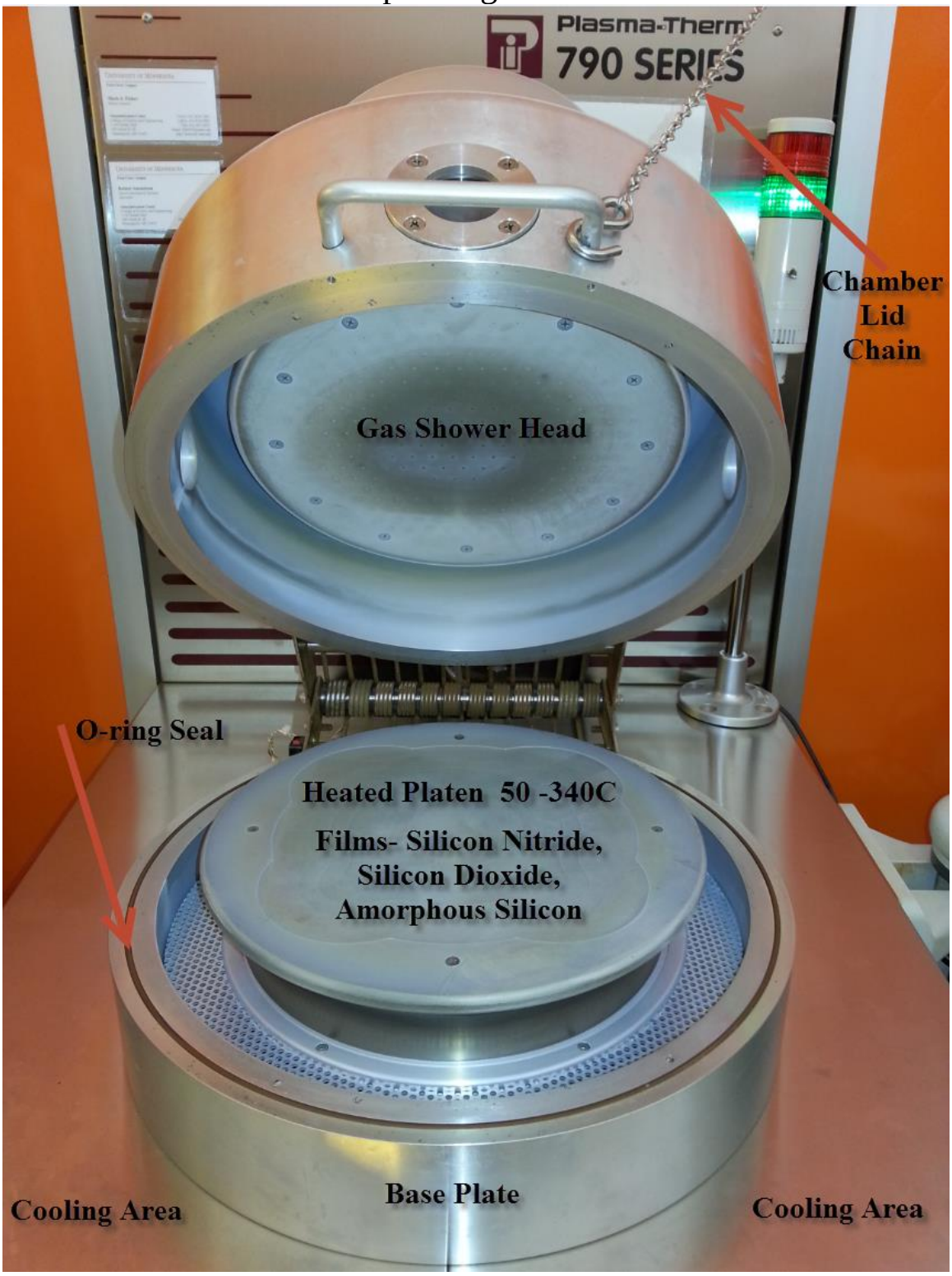
Parameter

Temperature……250 C

Purge300.prc

Parameter

Temperature……300 C


Plasma-Therm
790 SERIES
Chamber Lid Chain
Gas Shower Head
O-ring Seal
Heated Platen 50 -340C
Films- Silicon Nitride, Silicon Dioxide, Amorphous Silicon
Cooling Area
Base Plate
Cooling Area