Unaxis 790 PECVD Reactor Operation

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1. Introduction

1.1. Purpose

The Unaxis 790 Plasma Enhanced Chemical Vapor Deposition (PECVD) reactor is used for depositing thin films of silicon-dioxide, silicon-nitride and amorphous silicon at temperatures from 100 to 350 C on silicon, quartz, plastic, and other substrates.

1.2. Scope

This document describes operational procedures for depositing oxide, nitride and amorphous silicon films in the Unaxis 790 PECVD reactor.

1.3. Audience

This document is intended for clean room personnel who have been trained by the staff to operate the Unaxis 790 reactor.

1.4. Definitions

Angstrom	*(Å)* A unit used to measure very small lengths, such as wave length. Equal to 10^{-10} m
Atmosphere	Unit of pressure corresponding to standard atmospheric pressure. It is taken as the pressure that will support a column of mercury 760 mm high. It is also equal to $1.013 * 10^5$ Pa
Base Pressure	The lowest achievable pressure attained after the vacuum chamber has been pumped down (to lower pressure), typically for several hours
Chamber	The part of the vacuum system where the process is performed
Substrate	The material of which something is made
Torr	Unit of pressure. 1 torr = 1 mm of Hg = 133.3 Pa
Wafer	A thin slice of semiconductor (such as silicon) used as a base or substrate for an electronic component

1.5. Acronyms

EMO	Emergency Machine Off button
PECVD	Plasma Enhanced Chemical Vapor Deposition

2. General

2.1. Unaxis 790 PECVD reactor

The PECVD reactor is configured for deposition of SiO_2, Si_xN_x, Silicon Oxynitride, and amorphous Silicon. If other films are desired, please consult with clean room staff.

2.2. Vacuum Integrity

Maintaining a low base pressure is essential for the deposition of quality thin films. To avoid chamber contamination, the following operating procedures should be followed.

2.2.1. Never touch any parts inside the chamber or going into the chamber with bare hands or contaminated gloves.

2.2.2. Handle samples going into the chamber with clean gloves, tweezers, or a vacuum pencil.

2.2.3. Load only clean substrates into the vacuum chamber.

2.3. Emergency Shut Off

In the event of an emergency, shut off the system power with the red emergency power off EMO button on the front of the reactor.

2.4. Hazard Alarms

This system contains hazardous gases under high pressure**.** The gas handling system for the Unaxis 790 reactor is equipped with sensors, alarms, and warnings to alert the user when a condition occurs that requires attention.

2.4.1. Gas Cabinets

The process gases for the PECVD reactor are stored in vented gas cabinets that are equipped with toxic gas sensors and a fire suppression system. In the event of a loss of cabinet exhaust, a toxic gas leak, or a fire, the gas cabinets are programmed to shut off the flow of process gases to the reactor and to sound an audible alarm. The gas cabinet alarms can also be activated by other less serious events such as a change in cabinet purge pressure. If an audible gas cabinet alarm occurs, immediately bring this to the attention of staff personnel.

2.4.2. Reactor Cabinet

The gas manifolds for the PECVD tool are located in a cabinet at the back of the tool. This cabinet is vented to the building exhaust, and the exhaust is continuously monitored for silane or ammonia gas leaks. These sensors are interlocked to the gas cabinets and to the building evacuation alarm. In the event of an ammonia or silane leak, the gas cabinets will shut off the flow of gases to the reactor and sound an audible alarm. In addition, the building evacuation alarm will be activated. In the event of a building evacuation alarm, immediately evacuate the building.

2.5. Safety

2.5.1. Burn Hazard

The wafer susceptor can be heated up to a temperature of 350^{o}C. Extreme care must be taken when loading/unloading samples onto the susceptor. Always use a vacuum pencil or tweezers when load/unloading samples.

2.5.2. RF, UV/Visible Radiation

Do not look into the plasma of a long period of time. Do not touch the RF cables and all other electrical wires.

3. Operating Procedures

The typical sequence of procedures for running a deposition process in the PECVD reactor is outlined below. Before installing new recipes on the tool, please have them reviewed by staff to insure that they are compatible with the tool configuration.

3.1. Log Book

Before beginning a process run, record the process details in the log book. At the end of the process run, note any problems that occurred during the run. If any post process characterization data was taken, such as film thickness, film stress, deposition rate, uniformity, please record this in the log sheet.

3.2. System Log-In

If the Log-In dialog box is displayed on the system CRT, you must log in. Type in “3333” at the Operator prompt, then hit the TAB key. Type in “3333” again for the Password, and hit ENTER, or click on OK.

3.3. Reactor State

Before beginning a process run, the reactor must be in either the “**STANDBY**” or “**READY**” state, as indicated by the buttons at the bottom of the screen. The reactor cannot be placed in the “**READY**” state unless a recipe is loaded. When in the “**READY**” state, the chamber wall and susceptor heaters will be actively trying to achieve their respective setpoint temperatures. When in “**STANDBY**”, the chamber wall and susceptor heaters will be off. When not in use, the PECVD reactor should be placed in the “**STANDBY**” state.

3.4. Reactor Vent

Before samples can be loaded, the chamber must be vented to atmospheric pressure. The **Vent** chamber option is located in the **Utilities** pull-down menu. Select “**Vent**” by left clicking on this option in the menu. “**Vent**” will appear on the top system status line, and the graphic chamber display will turn from White to Red to Blue. The chamber takes about ~1 minute to vent.

3.5. Sample Load

After the chamber is vented to atmosphere, raise the chamber lid, and load the samples into the recessed portion of the reactor susceptor using tweezers or a vacuum pencil. Take extra care not to not touch your gloved hand on any part of the susceptor, as it may be very hot. When finished loading samples, close the chamber lid.

3.6. Chamber Pump-Down

Select “**Pump Chamber(Lo Vac)**” from the **Utilities** menu and hold down the lid to the chamber to make the vacuum seal. “**Pump Chamber(Lo Vac)**” will appear in the system status bar, and the chamber should pump down to a base pressure below 10 mtorr in a few minutes. If a vacuum time-out error occurs, as signaled by an audible alarm, silence the alarm by selecting the “**Alarm Silence**” button on the bottom of the screen. Next clear the alarm hold by selecting the “**Hold**” button, and repeat the chamber pump-down procedure.

3.7. Recipe Load

To load a new process recipe, select "**Load**" from the "**Process**" menu, and click on the desired process recipe file to load the recipe into active status. Next, bring the reactor to the "**READY**" state by clicking on the "**READY**" button at the bottom of the screen. Check to make sure that the desired process is loaded by checking the process box at the lower right of the screen. When in the "**READY**" state, the chamber wall and susceptor temperature controllers will be actively seeking their respective process recipe temperature setpoint settings.

3.8. Recipe Run

To start the process, click on the "**RUN**" button at the bottom of the screen. A dialog box will then appear prompting the user to enter information about the process run, and possibly a deposition time depending upon how the recipe was set up. The actual process sequence will not begin until the initial conditions of process temperature and base pressure are met.

3.9. Process Monitoring

Most recipes will have a gas stabilization and plasma stabilization step before the deposition step. It is always a good idea to check the actual gas flows, process pressure, forward power, and reflected power settings to insure that the tool is operating in a stable manner. If it is desired to stop a particular process step, click on the "**END STEP**" button. This will cause the current process step to end, and the next programmed process step to begin. This capability can be very useful. For example, if a temperature ramp-down step, which can take several hours, has been programmed into the recipe, the operator may want to unload the samples while the reactor is hot, in order to save time. By using the "**END STEP**" feature, several hours can be saved by skipping the ramp-down step.

3.10. Process Completion

After the run is finished, a dialog box will appear stating that the process is complete. Close the dialog box. At this point the tool will be in the "**Ready**" state, and can be vented to atmosphere by selecting "**Vent**" from the "**Utilities**" menu. After the chamber vents, lift the chamber lid and unload the sample with tweezers. Take extreme care not to touch the heated susceptor with your gloves.

If another run is planned with the same process recipe, the tool can remain in the "**Ready**" state, which will maintain the process setpoint temperature. If no further runs are planned, the tool should be placed in "**STANDBY**" mode.

3.11. Chamber Pump-Down

After removing samples, select "**Pump Chamber(LoVac)**" from the "**Utilities**" menu, and hold down the lid to ensure a vacuum seal.

4. Appendix A: Shut-Down Checklist

The method outlined below is a general procedure for shutting down the Unaxis 790 PECVD reactor.

- ❑ 1. **Make sure the tool is not currently in use**.
  - ☐ 1.1 Check the log to verify that the system is not in use.
  - ☐ 1.2 The system should not be in the "**RUN**" state.
  - ☐ 1.3 The "**In Use**" sign should indicate "**Not In Use**."
- ❑ 2. **Put the tool in the "ON" state.**
- ❑ 3. **Exit the application by opening the "Utilities" menu and clicking on "Exit."**
- ❑ 4. **Exit Windows 98 in the usual way, i.e. Ctrl-Alt-Delete, then Shutdown.**
- ❑ 5. **Open the tool cabinet, and turn off the BLOWER switch.**
- ❑ 6. **Turn off the MECH PUMP switch.**
- ❑ 7. **Turn off system power by pressing the red button on the MACHINE switch.**
- ❑ 8. **Place the switch on the wall mounted disconnect box in the OFF (down) position.**
- ❑ 9. **CAUTION: At this time the system is shut down. DO NOT de-activate any of the system utilities unless necessary. DO NOT turn off cooling water until the susceptor has cooled to room temperature.**
- ❑ 10. **If the reactor has cooled to room temperature the two chillers may be shut off.**
  - ☐ 10.1 Turn off blue Neslab Chiller labeled PD01 Chiller in Chase #2.
  - ☐ 10.2 Turn off the yellow Neslab chiller labeled PD01 Heat EX1 in Chase #2.
- ❑ 11. **Turn off all PECVD process gases in Chase #2.**
- ❑ 12. **Turn off the silane and ammonia gas cabinets in Chase #2.**
- ❑ 13. **End of Shut-Down Procedure**

5. Appendix B: PECVD Reactor Start-Up Checklist

The method outlined below is a general procedure for starting up the Unaxis 790 PECVD reactor.

- ❑ 1. **Turn off the silane and ammonia gas cabinets in Chase #2. Make sure the tool is not currently in use**.
- ❑ 2. **Turn on all PECVD process gases in Chase #2.**

- ❑ 3. **Turn on the two Neslab chillers in Chase #2.**
  - ☐ 10.1 Blue Neslab Chiller labeled PD01 Chiller.
  - ☐ 10.2 Yellow Neslab chiller labeled PD01 Heat EX1.
- ❑ 4. **Place the switch on the wall mounted disconnect box in the ON (up) position.**
- ❑ 5. **Open the tool cabinet, and turn on the MACHINE switch.**
- ❑ 6. **Turn on the MECH PUMP switch located in the tool cabinet.**
- ❑ 7. **Turn on the BLOWER switch located in the tool cabinet.**
- ❑ 8. **At the Log In prompt enter 3333 for "Operator" and "Password."**
- ❑ 9. **Pump-down the chamber by selecting "Pump Chamber(LoVac)" from the "Utilities" menu.**
- ❑ 10. **Place the tool in the "STANDBY" state by clicking on the "STANDBY" button.**
- ❑ 11. **End of Start-Up Procedure.**