Tool Identifier	Hotwire Chemical Vapor Deposition
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People List

Role	Name	Email ID	Mobile no.
System Owner	Anjum	anjum04@gmail.com	9920470606
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Faculty Incharge

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Training Procedure and Authorization:

1. Contact the system owner after getting permission from the respective Professor/lab supervisor.
2. Get through with the training notes to understand the system and participate in 3-4 process runs with the system owner or existing authorized user.
3. Get the training to open the gas cylinder depending on the required deposition.
4. To get authorization s/he must do 2-3 process runs on her/his own in presence of system owner and also answer and demonstrate the questions asked by system owner through operation of the system.

Violation policy:

1. The authorized user must follow the clean room protocol.
2. It is mandatory to follow the things mentioned in page 4.
3. H/she should ensure smooth operation of the system during their use.

If any authorized user found to violate any of above mentioned rules, her/his authorization will be cancelled and they will be required to go through the authorization process again.

MANDATORY:

- **NEVER** touch sample holder or wafers with your hands. Use **ONLY** the appropriate sample holder depending on the type of deposition.
- Use **ONLY** clean tweezers. Clean these implements often using isopropyl alcohol or methanol with clean wipes.
- **ALWAYS** clean wafers using either piranha or RCA before loading them into the loading or the process tube. Wafers must be clean and dry. Use spin rinse dryer whenever possible. Never load a contaminated wafer into the load lock chamber as this will contaminate the process chamber as well.
- **ALWAYS** wear a face mask when loading and unloading your wafers into load lock chamber to minimize contamination from your breath.

Specifications

- **Substrate:** Si only.
- **Substrate size:** 2" and small pieces.
- **Types of depositions:** Silicon Nitride, Intrinsic Polysilicon, p-doped Polysilicon
- **Pressure range** : Base Pressure 10^{-7} mbar
- **Temperature range:** from room temperature to 800˚ c
- **Gases presently connected to system:** Silane, Ammonia, Nitrogen, Hydrogen, Diborane
- **Mass Flow Controller (MFC) Limit/Range :**
  SiH4= 20sccm, H2= 200sccm, N2= 50sccm, B2H6=10sccm, NH3= 50sccm

Operating Procedure

1. Turn on Pump and Chiller.

2. Switch ‘ON’ the AC Mains.

3. Switch ‘ON’ the Blower (Press green button).

4. Loading the sample.

(a) First loosen the screws of the Load-Lock Chamber.

(b) Then vent the Chamber by opening the Air-Admission valve.

(c) Next slowly slide the Chamber door to open it

(d) Place the sample(s) carefully on the substrate holder , put the sample holder in the load lock chamber and push the door inside (If the sample is less than 2” then keep a clean dummy wafer beneath the original sample to support it.)

(f) Then, finally, tighten the screws and the air admission valve to complete the Loading procedure.

5. Switch ‘ON’ the Maxi Gauge. View the pressures in both chambers in Maxi gauge (Sensor 6 for central chamber i.e. Load lock chamber & Sensor 1/2/3 for respective reaction chamber). View the pirani gauge pressure beneath the gate valve.

6. Switch ‘ON’ the Rotary Pumps for both the chambers.

7. Open the gate valve of the Central chamber.

8. Wait for the Central Chamber Pressure to fall to 5.0E-1 mbar.

9. Then turn ‘ON’ the Turbo Pumps for Central Chamber.

10. If pressure in Reactor chamber initially was below 2e-1 mbar, then to equate the pressure above and below the gate valve; turbo will have to be started.

11. Open the gate valve of the respective reactor when the pressure below and above the gate valve are equal.

12. Wait till the pressures equalize in the 2 chambers.

13. Then open the Slit Valve, first slowly & then rapidly, to transfer the sample from the Central to the reactor.

14. During this procedure, ensure that the corresponding Gate Valves are 90% closed to avoid any accidental damage resulting from a fall.

15. After transfer is complete, close the Slit Valve; open the Gate Valves very slowly.

16. Turn 'ON' the heater and set its temperature to the desired value for substrate heating.

17. Then open the valve of Reactor chamber and adjust the valves of all the gas lines associated with the chamber.

18. Orient the gas line valves to a By-pass position to first allow quick evacuation of the gas lines.

19. Switch 'ON' the Mass Flow Meter (MFC) and set the flow ratios of the process gases to the desired values.

20. Once the desired vacuum has reached, close the bypass line and keep only the process line open. Ensure that only process lines of the particular reactor are open; All other lines are to be closed.

21. The flow ratios of the process gases specific to a particular type of deposition can be controlled using the MFC.

22. Next open the $R_1/R_2/R_3$ XL-Nitrogen gas line corresponding to the operational Reaction Chamber to allow the inflow of sealing gas. This is crucial to ensure that the corrosive gas does not come into contact with the bearing of Turbo pump, thereby reducing the life of the system. The XL-Nitrogen regulator pressure should be around 8E-01 to 1E bar. Also open the commercial nitrogen which is connected to exhaust.

23. Also orient the switch of the Rotary Pump to 1 –> 1 position at this juncture.

24. Ensure that the gas line valves are in a direct position before starting the process gases.

25. For depositing Silicon nitride, start releasing the process gases i.e. silane (SiH_4), Ammonia (NH_3) and Nitrogen (N_2). Reaction chamber for depositing silicon nitride is chamber 1 (R1). (Make sure you open the correct gas cylinders)

26. Wait till the set flow gas ratio gets stabilized in MFC.

26. Once this is done, turn 'ON' the Power Supply for the filament (Hot Wire) and increase the Voltage and Current value. This provides enough glow to the filament to

attain a temperature of about 1800 °C at which deposition can occur. Measure the temperature of the filament using a Pyrometer.

27. Connect the Pyrometer and place it just in front of the Reaction Chamber to sense the filament temperature. Ensure that the IR sensor of the pyrometer is focused at the filament to receive maximum radiation. Keep arrangements to cool the chamber wall using an electric fan.

28. Now open the 'Shutter' below the filament to begin deposition on the wafer. Turn 'ON' a timer and note the time. Note the gas pressure. Stop the deposition as soon as the desired time has elapsed.

29. Once deposition is complete, replace the 'Shutter'. Bring down the Supply Voltage and Current to zero and then switch it 'OFF'.

30. Then switch 'OFF' the heater (Do not switch off the heater mains) and stop the release of the process gases. Once the actual flow rates have subsided to zero, check line pressure (should be 8e-6 mbar range). Open the By-pass valves.

31. After this has been accomplished, close the Commercial and XL-N_2 cylinders and orient the red switch of the Rotary Pump to 0 –> 0 position.

32. Shut Down the MFC then turn 'OFF' the corresponding Channels in the MFC.

33. Then wait for pressures to equalize in the Central and Reaction Chambers before transferring the wafer into the Load-Lock. This also requires the substrate temperature to fall to a certain level (less than 80C).

34. While transferring take care to ensure that the Slit Valve is opened gradually so that the sample does not get displaced due to a sudden pressure difference.

35. Then unload the sample from the Load-Lock Chamber following the same steps which were used during Sample Loading.

36. Then switch 'OFF' the Turbo and Rotary Pumps for both chambers.

37. Keep the Load-Lock at vacuum so that moisture does not accumulate within it. For this bring the Load-Lock to rotary vacuum and vent the valve below the gate valve of the chamber.

38. Next turn 'OFF' the heater once the substrate temperature has fallen below 80 °C.

39. Switch 'OFF' the Maxi Gauge and Blower. Turn 'OFF' the Mains.

40. Finally turn 'OFF' the chiller and pump.

FOR DEPOSITING INTRINSIC POLY SILICON (i-poly):
Reaction chamber for depositing i-poly is chamber 2 (R2)

Follow step no.1-24

25. Start releasing the process gases i.e. Silane (SiH_4) and Hydrogen (H_2).

Follow step nos. 26-40.

FOR DEPOSITING P- TYPE POLY SILICON (p-poly):
Reaction chamber for depositing p-poly is chamber 3 (R3)

Follow step nos. 1 – 24.

25. Start releasing the process gases i.e. Silane (SiH_4), Diborane (B_2H_6), and Hydrogen (H_2).

Follow step nos. 26-40.

Precautions to be taken:-

1. Use the substrate holder dedicated to the deposition process. In case to deposit p poly after SiN, use holder for p poly. Do not contaminate nitride holder with p poly deposition.

2. Use Matheson gas leak detectors for Diborane and ammonia every time during deposition.

3. If there is a power failure during deposition or when system is running, first of all close the gate valve of the reactor chamber within 2 min., before venting of Turbo and then of central chamber. Then close all the gas lines and close the cylinder if open any. Switch off all the switches. Later on when power comes, Switch on the exhaust. First view the pressure in Maxi gauge, then equating the below and above pressure open the gate valve and allow the chamber to vent out through exhaust.

4. After the deposition is over, increase the flow ratio of silane to not more than 5.5 sccm and of Diborane to 10 sccm one by one to get evacuated. Diborane should be evacuated to below 0.05 sccm and Silane to 0.1 sccm.

5. Before starting deposition process, ensure that there is sufficient amount of commercial Nitrogen and other gases required in cylinder.

6. Ensure that pump and chiller are working properly and there is a continuous supply of chilled water to Turbo otherwise Turbo will stop.

7. Max. Heater temperature not to exceed 800C and max deposition time not to exceed 30 min. for filament temperature >1800ºC.

8. Always use XL grade N2 only for pump purging because the small oxygen content in commercial N2 may deposit some powdery SiO2 near turbo pump outlet.

9. Never use Acetone for cleaning or for any other purpose related to HWCVD. Use Methanol for cleaning purpose.

Data to be entered in Log Book:

Reactor Pressure before starting rotary pump.

Base pressure in the chamber before starting deposition.

Flow ratio of the gases used in deposition.

Gas pressure (Both before and after switching ON the filament).

Temperature of filament.

Temperature of heater.

Time for which filament was ON (deposition time).

Type of deposition and the person's name for whom it is done.

OTHER CONTACTS:

1. Pumps and Gauges: - Pfeiffer vacuum
www.pfeiffer-vacuum.net

2. Mass Flow Controller: - MKS
www.mksinst.com

3. Regulated D.C. power supply: - Aplab Instrument
www.aplab.com

4. Infrared Pyrometer: - IRCON
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