



INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

MATERIALS MANAGEMENT DIVISION

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PR No.1000020717

RFx No. 6100000743

Technical specifications for Plasma Etcher with Deposition Capability

Plasma Etcher with Deposition Capability

References:

1. List of at least 5 international semiconductor industrial customers.
2. List of 5 international academic/lab customers.
3. List of Indian customers (note repeat purchases if any).

Documentation

1. The complete manuals of the system, the parts of the system, and troubleshooting
2. The system can etch Semiconductors, dielectrics, and Metals. System capabilities to be listed and the list of recipes to be provided.
3. The safety features and precautions for the system to prevent errors, emergency shut down options, and procedures should be provided.
4. Cleaning procedure of the chamber between the process to be provided.
5. The user manual, Maintenance, troubleshoot events, necessary and supporting documents for the system, and other parts used in the system to be provided.
6. The library of recipes and other necessary and supporting information for the etch materials and materials to be deposited needs to be provided.

Process:

1. Provide deposition process details where possible:
 - a. Deposition: Si, SiO₂, SiN
 - b. Etching: Si, SiO₂, SiN, HfO₂, TiN, W, Al
2. Deposition and etch rates tuning by controlling the process parameters such as pressure, substrate temperature, gas flow, etc.
3. Uniformity, Low surface roughness, and damage should be low in etching and deposition.

Configuration:

1. Wafer size: small piece- max. 4inch
2. Product yield: 1 wafer/run
3. 3-chamber type (RIE+PECVD+Loadlock)
4. Substrate size and load capacity: 4inch wafer- 1 wafer/run
5. Source(gas) injection type: Showerhead type
6. Water cooling chuck for RIE

7. Molded heater for PECVD, wafer temperature Max. 400 °C
8. RF generator 600W 1ea (include DC self bias reading) + Auto matcher 2ea + RF select module(2channel) 1ea
9. Dry pump -PECVD
10. Rotary pump -RIE
11. The vacuum pumps should be resistant for corrosion and compatible for Cl, F chemistry.
12. Auto pressure controller and Throttle valve- each per RIE and PECVD (the process pressure should be controlled automatically by given value)
13. MFC: Ar, N₂O, NH₃, SiH₄, CHF₃, CF₄, O₂, GAS#1, GAS#2 (the GAS #1 and GAS#2 for Cl chemistry)
14. Top plate open/close type by manual
15. PC control

Specifications (to meet or exceed):

Process Chamber Module for PECVD:

1. Process chamber
 - 1.1) Chamber material: Anodized aluminum
 - 1.2) Substrate loading/unloading: Automatic loading/unloading by Loadlock (Manually top plate open/close)
 - 1.3) Viewport with shutter
 - 1.4) Cleaning cover
 - 1.5) Chamber purge and vent
2. Showerhead unit
 - 2.1) Process gas injection through a showerhead
 - 2.2) Direct power type electrode
 - 2.3) Ceramic isolator
3. Substrate heater
 - 3.1) Heater type: Molded heater type
 - 3.2) Max. temperature: 400 °C (wafer temp.)
 - 3.3) Wafer size and capacity: 4inch 1wafer

Process Chamber Module for RIE:

4. Process chamber
 - 4.1) Chamber material: Anodized aluminum
 - 4.2) Substrate loading/unloading: Automatic loading/unloading by Loadlock (Manually top plate open/close)
 - 4.3) View port with shutter
 - 4.4) Chamber purge and vent
5. Showerhead unit
 - 5.1) Process gas injection through a showerhead
6. Substrate chuck
 - 6.1) Dark shield space within chuck assembly
 - 6.2) Focus ring: Quartz
 - 6.3) System shielded perfectly from RF noise
 - 6.4) Wafer size and capacity: 4inch 1wafer

Power Supply Module:

1. RF generator (1) to be shared with both chambers
 - 1.1) Output power: 600 W
 - 1.2) Frequency: 13.56MHz
 - 1.3) DC self-bias display

The system hardware and software should be capable of adding another independent RF generator to operate chambers independently

2. RF matching network (2ea)
 - 2.1) Automatic matching type
 - 2.2) Frequency: 13.56 MHz
3. RF cable Kit (2set)
4. Select switch (1set)
 - 4.1) 2 channel (2 chambers will be usable with single RF generator)

Vacuum Module for PECVD:

1. Vacuum pump
 - 1.1) Dry Pump: 1170 L/min (Preferably: anti-corrosion pumps)
 - 1.2) Ultimate pressure: less than 8×10^{-3} Torr
2. Pressure gauge
 - 2.1) Low vacuum gauge: Convectron gauge
 - 2.2) Pressure readout and cable kit
3. APC (Auto Pressure Control) (1set)
 - 3.1) Electrical throttle valve
 - 3.2) Pressure controller
 - 3.3) Baratron gauge
4. Vacuum valves and lines
 - 4.1) Pneumatic type angle valve
 - 4.2) Auto vent line
 - 4.3) Stainless steel hard line and flexible bellows line

Vacuum Module for RIE:

1. Vacuum pump
 - 1.1) Rotary Pump: 700 L/min anti-corrosion pumps compatible with Cl
 - 1.2) Ultimate pressure: less than 5×10^{-3} Torr
 - 1.3) The system hardware and software should be capable of replacing rotary pump with equivalent dry pump
2. Pressure gauge
 - 2.1) Low vacuum gauge: Convectron gauge
 - 2.2) Pressure readout and cable kit
3. APC (Auto Pressure Control) (1set)
 - 3.1) Electrical throttle valve
 - 3.2) Pressure controller
 - 3.3) Baratron gauge
4. Vacuum valves and lines
 - 4.1) Pneumatic type angle valve
 - 4.2) Auto vent line

4.3) Stainless steel hard line and flexible bellows line

Loadlock Module:

1. Loadlock chamber
 - 1.1) Substrate tray capacity: One (1) wafer
 - 1.2) Automatic transfer operation
2. Vacuum unit
 - 2.1) Rotary pump: 600L/min
 - 2.2) Ultimate pressure: less than 5×10^{-3} Torr
3. Pressure Gauge
 - 3.1) Low vacuum gauge: Convectron gauge
 - 3.2) Pressure readout and cable kit
4. Vacuum valves and lines
 - 4.1) Roughing line valve: Pneumatic type angle valve
 - 4.2) Soft pumping line valve: 1/2 inch Pneumatic type diaphragm valve
 - 4.3) Auto vent line
 - 4.4) Stainless steel hard line and flexible bellows line

Gas Delivery Module:

1. Used gases and flow control
 - 1.1) Process:
 - i. Ar: MFC
 - ii. N₂O: MFC
 - iii. NH₃: MFC
 - iv. SiH₄: MFC
 - v. CHF₃: MFC
 - vi. CF₄: MFC
 - vii. O₂: MFC
 - viii. GAS #1: MFC
 - ix. GAS#2: MFC
 - 1.2) Purge and Vent: N₂: Metering Valve
 - 1.3) Gas #1 and 2 are for BCl₃, Cl₂, diborane and phosphine, etc.
2. Gas valves and gas line
 - 2.1) Pneumatically operated diaphragm valve
 - 2.2) Metering valve for N₂ purge and vent
 - 2.3) The gas line is helium-leak tested to 10^{-9} Torr·L/s

Control Module:

- 1 System control
 - 1.1) The system is controlled by PC
 - 1.2) Automatic and manual override operation capability.
 - 1.3) MS Window 10 based control and operation software
 - 1.4) Industrial PC
 - 1.5) 21" wide monitor
 - 1.6) Including analog and digital input/output card
 - 1.7) UPRO Process control software
 - 1.8) User-friendly screen and easy Graphic User Interface (GUI)

- 1.9) Process data logging
- 1.10) Recipe edit, save, download, run

Main Frame with electrical contact mechanism

1. Electrical power drive panel (ON/OFF/Emergency switch)
2. RF power control panel
3. Pressure controller panel
4. MFC controller panel
5. Pump on/off operation panel

Frame Module:

1. System frame is mild steel
2. White and Blue colored panels & frame covers
3. 19inch control panel mountable
4. Easily movable casters and leveling foots

Warranty:

Manufacturer warrants for a period of one (1) year or more (preferable) from the final acceptance.

Etching:

1. Materials to be etch
 - 1.1) Semiconductors: Si
 - 1.2) Dielectrics: SiO₂, Si₃N₄, Al₂O₃, HfO₂ etc.
 - 1.3) Metals: TiN, Al, W, others if any

Demonstration of the following process for RIE for on-site acceptance:

1. Leak Check less than 3mTorr/min
2. Leak Rate 1e-10 Torr L/sec
3. Materials etch demo (NU less than 5%) -
 - 3.1) Si (Etch rate 100-500nm/min)
 - 3.2) SiO₂ (20-100 nm/min)
 - 3.3) HfO₂ etch (greater than 1A/min by Ar/CF₄ plasma of 500W at 100mT pressure) - using ellipsometer.
Etch rate tuning
 - 3.4) Si etch-rate (50-500 nm/min) – Tuning by Pressure, Flow, etc.
4. Selectivity
 - 4.1) High Selectivity - High Si (vs. SiO₂) greater than 10:1
 - 4.2) Low/No Selectivity - SiO₂ vs Si (less than 1.4)
5. Anisotropic etch of Si (Sidewall angle greater than 85 degrees) for 2-5um depth etching in line-space, edge pattern - based on SEM measurements
6. Etch surface Roughness (RMS) less than 2 nm for Si

Process Demonstration for PECVD:

1. Leak Check less than 3mTorr/min
2. Leak Rate 1e-10 Torr L/sec

3. Deposition thickness, Rate, RI, (NU less than 5%),
 - 3.1) SiO₂ (20-30nm/min)
 - 3.2) Si₃N₄ (20-30nm/min)
 - 3.3) amorphous Si (20-30nm/min)
4. Deposition rate tuning with process parameters (such as Gas Flow, Temperature, etc.) shown for the SiO₂ deposition
5. Clean recipe for process chamber
6. Heater temperature uniformity less than 3%.
7. Film quality is measured by a wet etch rate (6:1 BOE) data in the Si₃N₄ film. Etch rate should improve by >5x from 260 degC to 360degC. At 360 degC etch rate less than 10A/s

Packaging and shipment

- Each Package should not exceed 900mm W, 1900mm D and 1900mm H