INDIAN INSTITUTE OF TECHNOLOGY BOMBAY MATERIALS MANAGEMENT DIVISION Powai, Mumbai 400076.	
Ref. PR No.: 1000059312	**RFQ NO. 3600003136**

Technical Specification - Plasma Etching and Deposition Assembly

NOTE

1. This procurement consists of a bundle of five etching and four deposition tools, all of which make use of Radio-Frequency (RF) plasma for the respective processes:

- **Reactive Ion Etch (RIE)-ICP- Dielectric (SiO2/SiN-back-end)**
- **Reactive Ion Etch (RIE)-ICP-Clean Si**
- **Reactive Ion Etch (RIE)-ICP – Supercon**
- **Reactive Ion Etch (RIE)- ICP- Metal etcher**
- **One Deep Reactive Ion Etch (DRIE)**
- **Atomic Layer Deposition System (ALD)/plasma/thermal -- Oxides (Al2O3, HfO2)**
- **Atomic Layer Deposition System (ALD)/plasma/thermal- Nitrides - (TiN, NbTiN etc.)**
- **Two Plasma Enhanced Chemical Vapour Deposition (PECVD)-Dielectric SiN/SiO2**

2. The tools listed above are being tendered together under one tender (RFQ).

3. Please note that bidders can participate by submitting bids for any or all items (tools) of the tender.

4. The technical and financial bids will be received simultaneously in separate sealed envelopes (sealed using adhesive or sealing tape; stapling is not permitted.)

5. The technical evaluation will be based on individual technical specifications (item-wise evaluation).

6. The financial L1 will be based on tool-wise comparison of financial bids.

7. Kindly ensure that the prices for each tool is clearly stated and specified separately in the quotation.

8. Since the tender will be evaluated on an item-wise basis, vendors who do not wish to participate in any particular item (tool) may enter **"NA"** for that item in the financial bid while submitting their bid.

Additionally, vendors are requested to clearly specify in their Technical Bid the items for which they are participating in the tender.

Item Description : 1. Reactive Ion Etch (RIE)-ICP- Dielectric (SiO2/SiN-back-end) - [Qty - 1]

Sr. No	Item Description	Detailed Technical Specification	Technical Compliance (Yes / No)	Additional Information (if any)
1.	**Process chamber**	• The process chamber shall be manufactured from a single solid block of aluminium or other plasma compatible metals/ materials with suitable provisions for mounting the plasma source, vacuum pumping system, load-lock, viewport, and process monitoring accessories. • The chamber construction shall be free from additional sealing joints or welds. • The chamber shall be provided with a viewport having a flange size of at least KF40 together, with a suitable RF shielded plasma viewing arrangement. • An additional side port shall be provided for optical emission spectroscopy (OES) or equivalent optical plasma monitoring. • The chamber shall have an electrical heating arrangement capable of maintaining the chamber temperature at 60 °C or higher, using external heating pads, heating jackets etc. • The plasma source and chamber pumping arrangement shall be designed with radial symmetry, to provide uniform plasma distribution and wafer-scale etching over a wide range of process parameters. • The chamber design shall facilitate easy routine cleaning, maintenance, and replacement of internal consumable components without having to dismantle any process gas line joints to open the chamber.		
2.	**System Console**	• The system console shall accommodate the turbomolecular pump, vacuum valves, and associated control components as required by the equipment design. • The system shall incorporate comprehensive hardware and software interlocks to protect the equipment against service failures, including loss of cooling water, inadequate compressed air, abnormal vacuum conditions, and any other critical faults. • Appropriate safety provisions shall be incorporated to protect personnel from electrical hazards during operation and maintenance. • In the event of a system or utility failure, the equipment shall transition to a safe state and maintain vacuum in the chamber. • The console shall provide convenient access for routine inspection, servicing, and preventive maintenance.		
3.	**Substrate Electrode & Clamping**	• The substrate electrode shall be of diameter of at least 225 mm and shall be suitable for processing wafers up to 200 mm (8 inches) in diameter. • The electrode shall support direct mounting and processing of complete wafers, without requiring carrier wafers or change of full electrode, for wafers of size 4”, 6” and 8”. • The chamber should also allow small irregular wafer pieces to be loaded, using carrier wafers. • The permissible substrate thickness shall be 5 mm or higher. • The substrate electrode shall employ helium heat transfer with suitable wafer clamping for 4”, 6” and 8” wafer sizes. • Helium cooling pressure shall be adjustable and programmable as a process parameter. • Helium flow shall be measured automatically through a suitable mass flow meter, and displayed on the system control computer. • Continuous clamping shall be provided using a quartz clamping ring, or an equivalent suitable arrangement. • Wafer-size-specific clamps shall be supplied for 100 mm (4-inch), 150 mm (6-inch), and 200 mm (8-inch) wafers. • The electrode shall be designed without seals or O-rings in the wafer backside helium cooling interface.		

4.	**Electrode Heating and Cooling**	• The substrate electrode shall be connected to a remotely controlled recirculating heater/chiller unit operating over a range of 0 °C to +50 °C with a temperature accuracy of ±0.5 °C or better, maintaining a substrate electrode temperature uniformity of ±2 °C over the aforementioned range. • Electrode temperature shall be measured using a thermocouple embedded in the electrode. • The complete temperature range shall be controlled automatically through the process recipe, without requiring manual intervention, when changing between heating and cooling setpoints. • Temperature setpoints, measured values, and relevant alarms shall be accessible through the system control software.		
5.	**Plasma Sources**	• Radio-Frequency (RF) generator power and all matching parameters shall be programmable and monitored through the system software. • The system shall support independent adjustment of ICP source power and substrate electrode bias power. • The RF system shall include appropriate interlocks to prevent operation under unsafe or out-of-range conditions.		

5.1	**Inductively Coupled Plasma Source (ICP Source)**	• The system shall be equipped with inductively coupled plasma source suitable for wafer processing up to 200 mm (8 inches).
		• The plasma source shall provide remote plasma, via inductively coupled plasma generation, designed to support low-damage dielectric etching.
		• The ICP generator shall have a rated power of at least 3000 W and shall operate at 2 MHz or 13.56 MHz frequencies.
		• The ICP source shall be capable of sustaining stable plasma operation at an ICP power range of 100 W or lower, to 3000 W.
		• An automatic impedance-matching network shall be provided for the ICP source, with vacuum capacitors.
		• The matching network shall support the following operating modes:
		  • Automatic impedance matching.
		  • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps.
		  • Fixed capacitor positions, programmable for individual recipe steps.		

5.2	**RF Power Supply for the Substrate Electrode**	• The substrate electrode shall be powered by an RF generator rated at 600 W or higher and operating at 13.56 MHz.
		• The RF power supply shall be coupled with automatic impedance-matching network, with vacuum capacitors.
		• The matching network shall support the following operating modes:
		  • Automatic impedance matching.
		  • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps.
		  • Fixed capacitor positions, programmable for individual recipe steps.		

6.	**Vacuum System**	• The main chamber vacuum system shall include a turbomolecular pump with a minimum pumping speed of 1300 l/s. • A dry turbo backing pump with a pumping capacity of at least 90 m^3/h shall be supplied for the main chamber roughing and turbo backing. • The pumping arrangement shall be designed to provide adequate effective pumping speed, and stable pressure control to achieve ultimate chamber pressure of 10^{-6} Torr, or lower. • A 200 mm automatic throttle valve shall be supplied for process pressure control. The throttle valve shall be suitably sized to avoid unnecessary restriction of the pumping conductance. • The vacuum system shall include a heated capacitance manometer suitable for pressure measurement of up to 100 mTorr, and a temperature-compensated Penning gauge. • Internal vacuum pipework shall be provided with electrical heating to 60 °C or higher. • The system shall provide suitable monitoring of chamber pressure, pump operation, and vacuum-system status through the control software.		

7.	**Process Gas Delivery Gas Box**	• The system shall be supplied with a ventilated gas box accommodating at least eight MFC-controlled gas lines, fitted with 8 Mass flow controllers (MFCs) as listed below:
		  • 6 non-hazardous gas lines, with Viton-sealed MFCs (for O_2, Ar, N_2, SF_6, CHF_3, CF_4)
		  • 2 hazardous gas lines with metal-sealed MFCs, and with a bypass line (for Cl, BCl_3)
		• Each gas line shall be provided with an electropneumatic isolation valve, and an in-line filter with a nominal filtration rating of 2 µm or better.
		• C_4F_8 & BCl_3 line must be electrically heated inside the gas box.
		• All lines should only be made of SS316L electropolished tubes and only Vacuum Coupling Radiation (VCR) fittings to be used on process gas lines.
		• The system shall include automatic MFC checking and gas-line leak-checking provisions through the control software.		

8.	**Vacuum Load-Lock and Wafer Transfer**	• The system shall include a vacuum load-lock, suitable for loading of 4", 6" and 8" wafers, and wafer pieces of arbitrary shape and size, no less than 3 mm x 3 mm. • The load-lock shall be connected to the process chamber through an isolation gate valve. • An independent dry pump with a minimum pumping capacity of 14 m^3/h shall be supplied for the load-lock. • On initiation of a process request through the control computer, the system shall automatically transfer the wafer from the load-lock to the process chamber, execute the recipe, and return the wafer to the load-lock. • A soft-pumping and soft-venting mechanism shall be provided to enable gradual evacuation and venting, thereby reducing unwanted wafer movement and particle generation. • A wafer-tracking sensor shall be provided to monitor wafer presence in load lock. • The wafer-tracking sensor shall include a software-controlled disable function for authorised users. • The loading and unloading sequence shall be controlled through the system software, with appropriate interlocks to prevent unsafe transfer operations, and shall allow manual transfer as well.		

9.	**Through-the-Wall Installation and Cleanroom Interface**	• The system shall be supplied with a cleanroom-compatible interface panel for through-the-wall installation.
		• The arrangement shall permit operation of the single-wafer load-lock from an ISO Class 6 cleanroom or substantially equivalent while the remaining equipment is installed in the service chase.
		• The cleanroom-side interface shall include:
		  • A display screen and cleanroom-compatible keyboard.
		  • A system PC interface for equipment monitoring and control.
		  • An emergency machine-off (EMO) switch accessible from the cleanroom side.
		  • A cleanroom-compatible status light tower.
		• The status light tower shall provide the following indications:
		  • Red: Alarm or fault.
		  • Amber: Idle or standby.
		  • Green: System running or busy.
		• All mounting hardware, cabling, feedthroughs, and accessories necessary for through-the-wall installation shall be included.
		• The wall interface panel shall be sealed and designed to maintain the integrity of the ISO Class 6 or substantially equivalent cleanroom.
		• The supplier shall provide installation drawings and define the required wall opening, service clearances, and facility interfaces along with bid.		

10.	**Control System and Process Software**	• The equipment shall be controlled by a programmable logic controller (PLC)-based system with suitable control software. • The software shall provide recipe-based and manual operation of the complete system. • Recipes shall support programmable control of gas flows, ICP power, RF bias power, chamber pressure, electrode temperature, helium cooling pressure, and other available process parameters. • The software shall include automatic leak-checking and automatic MFC-checking functions. • The system shall support storage of at least 200 recipes. • Advanced users shall be able to configure system tolerances through the graphical user interface, subject to the applicable access permissions and safety limits. • Multiple level password-protected user access levels shall be provided. • The software shall provide channel-by-channel input/output diagnostics, including operational states such as ON/OFF and fault states such as OK, short circuit, or open circuit, wherever supported by the installed I/O hardware. • Software shall support a configurable sampling interval of few tens of milliseconds (ms) for process & system data logging. • All relevant setpoints, measured values, alarms, and equipment status information shall be available for monitoring and logging.		

11.	**Data Logging and Graphical Analysis**	• The software shall provide graphical visualisation of logged process parameters.
		• Users shall be able to load and analyse data from multiple process steps and plot selected parameters.
		• The graphical analysis tools shall support the following representations:
		  • Measured values & setpoints.
		  • Measured values together with setpoints.
		• The software shall allow multiple Process runs to be loaded and their process parameters to be compared graphically Online and Offline.
		• Alarms and alerts associated with the loaded recipe steps shall be displayed alongside the corresponding process data.
		• Data shall be exportable in a suitable format for offline analysis and process verification.
		• The system shall support a configurable sampling interval in few tens of milliseconds (ms) for process & system data log data.		

12.	**Communications and Regulatory Compliance**	• System shall be SECS/GEM compliant for semiconductor equipment communication and integration. • The equipment shall comply with applicable electrical, electromagnetic compatibility (EMC), process gas, and machinery safety standards. Bidders must submit valid **CE conformity** (covering LVD, EMC, and Machinery Directives) **OR** equivalent global/national compliance certifications/test reports from an **ILAC / NABL-accredited** laboratory or recognized third-party evaluator, specifically: 1. **Equipment, Electrical & Machinery Safety:** Third-party evaluation/certification to **SEMI S2**, **UL / ETL (NRTL)**, or **IEC 61010-1** along with **IEC 60204-1 / ISO 12100** (or equivalent **IS/IEC** standards). 2. **Electromagnetic Compatibility (EMC):** Compliance with **IEC 61326-1**, **CISPR 11** (mandatory for RF plasma systems), or **FCC Part 15/18** • OEM must comply with ISO quality management certification.		

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<td>13.</td>
<td>Documentation</td>
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• The following documents shall be submitted with the technical bid:
  • Valid ISO certificates for ISO 14001, ISO 45001, ISO 9001 etc. for quality management certification of the manufacturer.
  • Installation and facility requirement documentation.
  • CE Conformity Declaration or as specified above, refer item no. 12
  • System footprint Drawings along with subsystems
  • Through-the-Wall cleanroom Interface panel drawing
  • Utility requirements, including but not limited to, electrical power, cooling water, compressed air, process gases, and exhaust gas abatement requirements.
• The following documents shall be supplied with the equipment:
  • Complete system operation and maintenance manuals in electronic format.
  • Original equipment manufacturer (OEM) manuals for the major subsystems and components.
  • Electrical, gas, vacuum, and control schematics.
  • Installation, commissioning, and preventive maintenance instructions.
  • Utility requirements, including electrical power, cooling water or coolant, compressed air, process gases, and exhaust requirements.
• A signed compliance certificate or written undertakings verifying adherence to all material, component, and process requirements must be provided as requested.
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<td>14.</td>
<td>SiO_2 and SiN Etching Performance and Acceptance Criteria</td>
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• The supplier shall demonstrate the dielectric etching performance of the proposed system as below. Also the supplier shall provide starting-point recipes and process trends for other materials.
<table>
<tr><th>Process reference</th><th>1</th><th>2</th></tr>
<tr><td>Etched material</td><td>SiO2</td><td>SiNx</td></tr>
<tr><td>Etch mode</td><td>ICP</td><td>ICP</td></tr>
<tr><td>Substrate</td><td>Si/sapphire/SiC</td><td>Si/sapphire/SiC</td></tr>
<tr><td>Wafer size</td><td>200 mm</td><td>200 mm</td></tr>
<tr><td>Feature size/type</td><td>minimum 250 nm line with > 50 µm space</td><td>minimum 250 nm line with > 50 µm space</td></tr>
<tr><td>Etch depth</td><td>< 200 nm</td><td>< 200 nm</td></tr>
<tr><td>Etch rate</td><td>< 100 nm/min</td><td>< 100 nm/min</td></tr>
<tr><td>Selectivity to PR mask</td><td>> 1:1</td><td>> 1:1</td></tr>
<tr><td>Profile</td><td>> 80°</td><td>> 80°</td></tr>
<tr><td>Aspect ratio</td><td>≤ 3</td><td>≤ 3</td></tr>
<tr><td>CD uniformity</td><td>< ±5%</td><td>< ±5%</td></tr>
<tr><td>Within-wafer uniformity</td><td>< ±5%</td><td>< ±5%</td></tr>
<tr><td>Run-to-run uniformity</td><td>< ±4%</td><td>< ±4%</td></tr>
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15.	**Supplier Qualification Criteria**	• The manufacturer should have experience of operating its own cleanroom facility with at least one installed system of the same type as the system being quoted. • The manufacturer's application laboratory shall have at least 5 plasma processing systems and at least 1 process engineer, fully trained to operate the system being quoted. • The manufacturer shall demonstrate its through-the-wall installation capability by providing a functional demonstration of a fully integrated installation either at its own facility or at an operational customer site where a comparable system has previously been installed. • The manufacturer should include the provision for a visit by the client or client's representative to the factory premises during factory testing, quality assurance review. • The bidder shall provide at least seven references for comparable systems supplied to research institutions, universities, or industrial semiconductor facilities that are operational 5 years post installation. • Spare parts for the quoted system shall be available ex-stock in India for at least seven years from the date of supply. • The supplier shall confirm that a free-of-charge service hotline has been operational for at least ten years. • The supplier shall provide the service hotline telephone number, email address, and contact details of the responsible service personnel. • The guaranteed maximum telephone response time from the OEM (Not by Local Agent/Distributor) shall be 30 minutes or less. • The guaranteed onsite service response time by an OEM engineer (Not by Local Agent/Distributor), shall be no more than five working days from notification of a service issue.		
16.	**Installation, Commissioning, and Acceptance**	• Installation and commissioning shall be performed by OEM personnel only. • The supplier shall coordinate with the purchaser to confirm the installation layout, service-chase requirements, cleanroom interface, and utility connections before delivery. • The supplier shall provide the required installation drawings, facility specifications, and utility consumption details in advance. • The supplier shall demonstrate at least three of the requested etching processes during commissioning. • Process acceptance shall include demonstration of SiO_2 and SiN_x etching in accordance with the acceptance criteria specified above. • The supplier shall provide starting-point recipes and process trend information for all requested processes.		
17.	**Training**	• The OEM Engineer shall provide five days of onsite training after installation and commissioning. • Training shall be provided for up to three personnel, nominated by IIT Bombay. • The training shall include: - System operation and recipe execution. - Recipe creation, parameter adjustment, and process optimization. - Plasma source and substrate bias operation. - Vacuum system operation and basic leak checking & troubleshooting. - Gas safety - System interlocks, emergency shutdown, and safe operating procedures. - Process data logging, graphical analysis, and interpretation of process trends. • Training shall include practical operation of the equipment and execution of representative etching processes. • Training materials and relevant operating instructions shall be provided to the trainees.		
18.	**Warranty**	• The complete system along with subsystems supplied with the system should have a warranty period of minimum one year.		
19.	**Electrical Supply**	• The electrical supplies available at the Institute are as follows: • Three-phase supply: 400 V (±5%), 50 Hz (±1%). • Single-phase supply: 230 V (±5%), 50 Hz (±1%). • If any power-conditioning equipment, such as a step down or step up voltage transformer, is required to ensure that the equipment supplied by the Vendor operates properly with the electrical supplies available at the Institute, the Vendor shall supply such power-conditioning equipment.		

Item Description : 2. Reactive Ion Etch (RIE)-ICP-Clean Si - [Qty - 1]

Sr. No	Item Description	Detailed Technical Specification	Technical Compliance (Yes / No)	Additional Information (if any)
1.	**Process chamber**	• The process chamber shall be manufactured from a single solid block of aluminium or other plasma compatible metals/ materials with suitable provisions for mounting the plasma source, vacuum pumping system, load-lock, viewport, and process monitoring accessories. • The chamber construction shall be free from additional sealing joints or welds. • The chamber shall be provided with a viewport having a flange size of at least KF40 together, with a suitable RF shielded plasma viewing arrangement. • An additional side port shall be provided for optical emission spectroscopy (OES) or equivalent optical plasma monitoring. • The chamber shall have an electrical heating arrangement capable of maintaining the chamber temperature at 60 °C or higher, using external heating pads, heating jackets etc. • The plasma source and chamber pumping arrangement shall be designed with radial symmetry, to provide uniform plasma distribution and wafer-scale etching over a wide range of process parameters. • The chamber design shall facilitate easy routine cleaning, maintenance, and replacement of internal consumable components without having to dismantle any process gas line joints to open the chamber.		
2.	**System Console**	• The system console shall accommodate the turbomolecular pump, vacuum valves, and associated control components as required by the equipment design. • The system shall incorporate comprehensive hardware and software interlocks to protect the equipment against service failures, including loss of cooling water, inadequate compressed air, abnormal vacuum conditions, and any other critical faults. • Appropriate safety provisions shall be incorporated to protect personnel from electrical hazards during operation and maintenance. • In the event of a system or utility failure, the equipment shall transition to a safe state and maintain vacuum in the chamber. • The console shall provide convenient access for routine inspection, servicing, and preventive maintenance.		
3.	**Substrate Electrode & Clamping**	• The substrate electrode shall be of diameter of at least 225 mm and shall be suitable for processing wafers up to 200 mm (8 inches) in diameter. • The electrode shall support direct mounting and processing of complete wafers, without requiring carrier wafers or change of full electrode, for wafers of size 4”, 6” and 8”. • The chamber should also allow small irregular wafer pieces to be loaded, using carrier wafers. • The permissible substrate thickness shall be 5 mm or higher. • The substrate electrode shall employ helium heat transfer with suitable wafer clamping for 4”, 6” and 8” wafer sizes. • Helium cooling pressure shall be adjustable and programmable as a process parameter. • Helium flow shall be measured automatically through a suitable mass flow meter, and displayed on the system control computer. • Continuous clamping shall be provided using a quartz clamping ring, or an equivalent suitable arrangement. • Wafer-size-specific clamps shall be supplied for 100 mm (4-inch), 150 mm (6-inch), and 200 mm (8-inch) wafers. • The electrode shall be designed without seals or O-rings in the wafer backside helium cooling interface.		

4.	**Electrode Heating and Cooling**	• The substrate electrode shall be connected to a remotely controlled recirculating heater/chiller/LN2 unit operating over a range of -150 °C to +250 °C with a temperature accuracy of ±0.5 °C or better, maintaining a substrate electrode temperature uniformity of ±2 °C over the aforementioned range. • Electrode temperature shall be measured using a thermocouple embedded in the electrode. • Suitable liquid nitrogen (LN_2) cooling arrangement to electrode with an appropriate LN_2 Dewar and heater as may be needed shall also be provided. • The complete temperature range shall be controlled automatically through the process recipe, without requiring manual intervention, when changing between heating and cooling setpoints for selected temperature control method i.e. chiller or liquid nitrogen (LN_2). • Automatic software controlled changeover between all temperature control methods: heater, chiller and Liquid Nitrogen shall be provided. • Temperature setpoints, measured values, and relevant alarms shall be accessible through the system control software.		
5.	**Plasma Sources**	• Radio-Frequency (RF) generator power and all matching parameters shall be programmable and monitored through the system software. • The system shall support independent adjustment of ICP source power and substrate electrode bias power. • The RF system shall include appropriate interlocks to prevent operation under unsafe or out-of-range conditions.		

5.1	**Inductively Coupled Plasma Source (ICP Source)**	• The system shall be equipped with inductively coupled plasma source suitable for wafer processing up to 200 mm (8 inches).
		• The plasma source shall provide remote plasma, via inductively coupled plasma generation, designed to support low-damage dielectric etching.
		• The ICP generator shall have a rated power of at least 3000 W and shall operate at 2 MHz or 13.56 MHz frequencies.
		• The ICP source shall be capable of sustaining stable plasma operation at an ICP power range of 100 W or lower, to 3000 W.
		• An automatic impedance-matching network shall be provided for the ICP source, with vacuum capacitors.
		• The matching network shall support the following operating modes:
		  • Automatic impedance matching.
		  • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps.
		  • Fixed capacitor positions, programmable for individual recipe steps.		

5.2	**RF Power Supply for the Substrate Electrode**	• The substrate electrode shall be powered by an RF generator rated at 600 W or higher and operating at 13.56 MHz.
		• The RF power supply shall be coupled with automatic impedance-matching network, with vacuum capacitors.
		• The matching network shall support the following operating modes:
		  • Automatic impedance matching.
		  • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps.
		  • Fixed capacitor positions, programmable for individual recipe steps.		

6.	**Vacuum System**	• The main chamber vacuum system shall include a turbomolecular pump with a minimum pumping speed of 1300 l/s. • A dry turbo backing pump with a pumping capacity of at least 90 m^3/h shall be supplied for the main chamber roughing and turbo backing. • The pumping arrangement shall be designed to provide adequate effective pumping speed, and stable pressure control to achieve ultimate chamber pressure of 10^{-6} Torr, or lower. • A 200 mm automatic throttle valve shall be supplied for process pressure control. The throttle valve shall be suitably sized to avoid unnecessary restriction of the pumping conductance. • The vacuum system shall include a heated capacitance manometer suitable for pressure measurement of up to 100 mTorr, and a temperature-compensated Penning gauge. • Internal vacuum pipework shall be provided with electrical heating to 60 °C or higher. • The system shall provide suitable monitoring of chamber pressure, pump operation, and vacuum-system status through the control software.		

7.	**Process Gas Delivery Gas Box**	• The system shall be supplied with a ventilated gas box accommodating at least eight MFC-controlled gas lines, fitted with 8 Mass flow controllers (MFCs) as listed below:
		  • 6 non-hazardous gas lines, with Viton-sealed MFCs (for O_2, Ar, N_2, SF_6, CHF_3, CF_4)
		  • 2 hazardous gas lines with metal-sealed MFCs, and with a bypass line (for Cl, BCl_3)
		• Each gas line shall be provided with an electropneumatic isolation valve, and an in-line filter with a nominal filtration rating of 2 µm or better.
		• C_4F_8 & BCl_3 line must be electrically heated inside the gas box.
		• All lines should only be made of SS316L electropolished tubes and only Vacuum Coupling Radiation (VCR) fittings to be used on process gas lines.
		• The system shall include automatic MFC checking and gas-line leak-checking provisions through the control software.		

8.	**Vacuum Load-Lock and Wafer Transfer**	• The system shall include a vacuum load-lock, suitable for loading of 4", 6" and 8" wafers, and wafer pieces of arbitrary shape and size, no less than 3 mm x 3 mm. • The load-lock shall be connected to the process chamber through an isolation gate valve. • An independent dry pump with a minimum pumping capacity of 14 m^3/h shall be supplied for the load-lock. • On initiation of a process request through the control computer, the system shall automatically transfer the wafer from the load-lock to the process chamber, execute the recipe, and return the wafer to the load-lock. • A soft-pumping and soft-venting mechanism shall be provided to enable gradual evacuation and venting, thereby reducing unwanted wafer movement and particle generation. • A wafer-tracking sensor shall be provided to monitor wafer presence in load lock. • The wafer-tracking sensor shall include a software-controlled disable function for authorised users. • The loading and unloading sequence shall be controlled through the system software, with appropriate interlocks to prevent unsafe transfer operations, and shall allow manual transfer as well.		

9.	**Through-the-Wall Installation and Cleanroom Interface**	• The system shall be supplied with a cleanroom-compatible interface panel for through-the-wall installation.
		• The arrangement shall permit operation of the single-wafer load-lock from an ISO Class 6 cleanroom or substantially equivalent while the remaining equipment is installed in the service chase.
		• The cleanroom-side interface shall include:
		  • A display screen and cleanroom-compatible keyboard.
		  • A system PC interface for equipment monitoring and control.
		  • An emergency machine-off (EMO) switch accessible from the cleanroom side.
		  • A cleanroom-compatible status light tower.
		• The status light tower shall provide the following indications:
		  • Red: Alarm or fault.
		  • Amber: Idle or standby.
		  • Green: System running or busy.
		• All mounting hardware, cabling, feedthroughs, and accessories necessary for through-the-wall installation shall be included.
		• The wall interface panel shall be sealed and designed to maintain the integrity of the ISO Class 6 or substantially equivalent cleanroom.
		• The supplier shall provide installation drawings and define the required wall opening, service clearances, and facility interfaces along with bid.		

10.	**Control System and Process Software**	• The equipment shall be controlled by a programmable logic controller (PLC)-based system with suitable control software. • The software shall provide recipe-based and manual operation of the complete system. • Recipes shall support programmable control of gas flows, ICP power, RF bias power, chamber pressure, electrode temperature, helium cooling pressure, and other available process parameters. • The software shall include automatic leak-checking and automatic MFC-checking functions. • The system shall support storage of at least 200 recipes. • Advanced users shall be able to configure system tolerances through the graphical user interface, subject to the applicable access permissions and safety limits. • Multiple level password-protected user access levels shall be provided. • The software shall provide channel-by-channel input/output diagnostics, including operational states such as ON/OFF and fault states such as OK, short circuit, or open circuit, wherever supported by the installed I/O hardware. • Software shall support a configurable sampling interval of few tens of milliseconds (ms) for process & system data logging. • All relevant setpoints, measured values, alarms, and equipment status information shall be available for monitoring and logging.		

11.	**Data Logging and Graphical Analysis**	• The software shall provide graphical visualisation of logged process parameters.
		• Users shall be able to load and analyse data from multiple process steps and plot selected parameters.
		• The graphical analysis tools shall support the following representations:
		  • Measured values & setpoints.
		  • Measured values together with setpoints.
		• The software shall allow multiple Process runs to be loaded and their process parameters to be compared graphically Online and Offline.
		• Alarms and alerts associated with the loaded recipe steps shall be displayed alongside the corresponding process data.
		• Data shall be exportable in a suitable format for offline analysis and process verification.
		• The system shall support a configurable sampling interval in few tens of milliseconds (ms) for process & system data log data.		

12.	**Communications and Regulatory Compliance**	• System shall be SECS/GEM compliant for semiconductor equipment communication and integration. • The equipment shall comply with applicable electrical, electromagnetic compatibility (EMC), process gas, and machinery safety standards. Bidders must submit valid **CE conformity** (covering LVD, EMC, and Machinery Directives) **OR** equivalent global/national compliance certifications/test reports from an **ILAC / NABL-accredited** laboratory or recognized third-party evaluator, specifically: 1. **Equipment, Electrical & Machinery Safety:** Third-party evaluation/certification to **SEMI S2**, **UL / ETL (NRTL)**, or **IEC 61010-1** along with **IEC 60204-1 / ISO 12100** (or equivalent **IS/IEC** standards). 2. **Electromagnetic Compatibility (EMC):** Compliance with **IEC 61326-1**, **CISPR 11** (mandatory for RF plasma systems), or **FCC Part 15/18** • OEM must comply with ISO quality management certification.		

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<td>13.</td>
<td>Documentation</td>
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The following documents shall be submitted with the technical bid:

Valid ISO certificates for ISO 14001, ISO 45001, ISO 9001 etc. for quality management certification of the manufacturer.
Installation and facility requirement documentation.
CE Conformity Declaration or as specified above, refer item no. 12
System footprint Drawings along with subsystems
Through-the-Wall cleanroom Interface panel drawing
Utility requirements, including but not limited to, electrical power, cooling water, compressed air, process gases, and exhaust gas abatement requirements.

The following documents shall be supplied with the equipment:

• Complete system operation and maintenance manuals in electronic format.
• Original equipment manufacturer (OEM) manuals for the major subsystems and components.
• Electrical, gas, vacuum, and control schematics.
• Installation, commissioning, and preventive maintenance instructions.
• Utility requirements, including electrical power, cooling water or coolant, compressed air, process gases, and exhaust requirements.
• A signed compliance certificate or written undertakings verifying adherence to all material, component, and process requirements must be provided as requested.
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<td>14.</td>
<td>Shallow Si and Cryo Si Etching Performance and Acceptance Criteria</td>
<td>

The supplier shall demonstrate the Si etching performance of the proposed system as below. Also the supplier shall provide starting-point recipes and process trends for other materials.

<table>
<tr><th>Process reference</th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Etched material</td><td>Si</td><td>Si</td><td>Nano Scale Si Etching</td></tr>
<tr><td>Etch mode</td><td>ICP</td><td>Cryo ICP</td><td>Cryo or Mix gas</td></tr>
<tr><td>Substrate</td><td>Si</td><td>Si</td><td>Si</td></tr>
<tr><td>Wafer size</td><td>200 mm</td><td>200 mm</td><td>200 mm</td></tr>
<tr><td>Feature size/type</td><td>minimum 250 nm line with > 50 µm space</td><td>minimum 10 µm line with > 50 µm space</td><td>minimum 50 nm line with > 50 nm space</td></tr>
<tr><td>Etch Depth</td><td>< 200 nm</td><td>20 µm</td><td>100 nm</td></tr>
<tr><td>Etch rate</td><td>> 100 nm/min</td><td>> 2 µm/min</td><td>> 50 nm/min</td></tr>
<tr><td>Selectivity to PR</td><td>> 5</td><td>> 50</td><td>> 1</td></tr>
<tr><td>Selectivity to SiO2</td><td>> 10</td><td>> 100</td><td>> 2</td></tr>
<tr><td>Uniformity (%)</td><td>< ±5%</td><td>< ±5%</td><td>< ±5%</td></tr>
<tr><td>Profile control (°)</td><td>90° ± <1°</td><td>90° ± <1°</td><td>90° ± <1°</td></tr>
<tr><td>CD uniformity</td><td>< ±5%</td><td>< ±5%</td><td>-N/A-</td></tr>
<tr><td>Within-wafer uniformity</td><td>< ±5%</td><td>< ±5%</td><td>< ±5%</td></tr>
<tr><td>Added Roughness</td><td>< 10 nm</td><td>< 2 nm</td><td>< 1 nm</td></tr>
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15.	**Supplier Qualification Criteria**	• The manufacturer should have experience of operating its own cleanroom facility with at least one installed system of the same type as the system being quoted. • The manufacturer's application laboratory shall have at least 5 plasma processing systems and at least 1 process engineer, fully trained to operate the system being quoted. • The manufacturer shall demonstrate its through-the-wall installation capability by providing a functional demonstration of a fully integrated installation either at its own facility or at an operational customer site where a comparable system has previously been installed. • The manufacturer should include the provision for a visit by the client or client's representative to the factory premises during factory testing, quality assurance review. • The bidder shall provide at least seven references for comparable systems supplied to research institutions, universities, or industrial semiconductor facilities that are operational 5 years post installation. • Spare parts for the quoted system shall be available ex-stock in India for at least seven years from the date of supply. • The supplier shall confirm that a free-of-charge service hotline has been operational for at least ten years. • The supplier shall provide the service hotline telephone number, email address, and contact details of the responsible service personnel. • The guaranteed maximum telephone response time from the OEM (Not by Local Agent/Distributor) shall be 30 minutes or less. • The guaranteed onsite service response time by an OEM engineer (Not by Local Agent/Distributor), shall be no more than five working days from notification of a service issue.		
16.	**Installation, Commissioning, and Acceptance**	• Installation and commissioning shall be performed by OEM personnel only. • The supplier shall coordinate with the purchaser to confirm the installation layout, service-chase requirements, cleanroom interface, and utility connections before delivery. • The supplier shall provide the required installation drawings, facility specifications, and utility consumption details in advance. • The supplier shall demonstrate at least three of the requested etching processes during commissioning. • Process acceptance shall include demonstration of SiO_2 and SiN_x etching in accordance with the acceptance criteria specified above. • The supplier shall provide starting-point recipes and process trend information for all requested processes.		
17.	**Training**	• The OEM Engineer shall provide five days of onsite training after installation and commissioning. • Training shall be provided for up to three personnel, nominated by IIT Bombay. • The training shall include: - System operation and recipe execution. - Recipe creation, parameter adjustment, and process optimization. - Plasma source and substrate bias operation. - Vacuum system operation and basic leak checking & troubleshooting. - Gas safety - System interlocks, emergency shutdown, and safe operating procedures. - Process data logging, graphical analysis, and interpretation of process trends. - Training shall include practical operation of the equipment and execution of representative etching processes. - Training materials and relevant operating instructions shall be provided to the trainees.		
18.	**Warranty**	• The complete system along with subsystems supplied with the system should have a warranty period of minimum one year.		
19.	**Electrical Supply**	• The electrical supplies available at the Institute are as follows: • Three-phase supply: 400 V (±5%), 50 Hz (±1%). • Single-phase supply: 230 V (±5%), 50 Hz (±1%). • If any power-conditioning equipment, such as a step down or step up voltage transformer, is required to ensure that the equipment supplied by the Vendor operates properly with the electrical supplies available at the Institute, the Vendor shall supply such power-conditioning equipment.		

Item Description : 3. Reactive Ion Etch (RIE)-ICP - Supercon - [Qty - 1]

Sr. No	Item Description	Detailed Technical Specification	Technical Compliance (Yes / No)	Additional Information (if any)
1.	**Process chamber**	• The process chamber shall be manufactured from a single solid block of aluminium or other plasma compatible metals/ materials with suitable provisions for mounting the plasma source, vacuum pumping system, load-lock, viewport, and process monitoring accessories. • The chamber construction shall be free from additional sealing joints or welds. • The chamber shall be provided with a viewport having a flange size of at least KF40 together, with a suitable RF shielded plasma viewing arrangement. • An additional side port shall be provided for optical emission spectroscopy (OES) or equivalent optical plasma monitoring. • The chamber shall have an electrical heating arrangement capable of maintaining the chamber temperature at 60 °C or higher, using external heating pads, heating jackets etc. • The plasma source and chamber pumping arrangement shall be designed with radial symmetry, to provide uniform plasma distribution and wafer-scale etching over a wide range of process parameters. • The chamber design shall facilitate easy routine cleaning, maintenance, and replacement of internal consumable components without having to dismantle any process gas line joints to open the chamber.		
2.	**System Console**	• The system console shall accommodate the turbomolecular pump, vacuum valves, and associated control components as required by the equipment design. • The system shall incorporate comprehensive hardware and software interlocks to protect the equipment against service failures, including loss of cooling water, inadequate compressed air, abnormal vacuum conditions, and any other critical faults. • Appropriate safety provisions shall be incorporated to protect personnel from electrical hazards during operation and maintenance. • In the event of a system or utility failure, the equipment shall transition to a safe state and maintain vacuum in the chamber. • The console shall provide convenient access for routine inspection, servicing, and preventive maintenance.		
3.	**Substrate Electrode & Clamping**	• The substrate electrode shall be of diameter of at least 225 mm and shall be suitable for processing wafers up to 200 mm (8 inches) in diameter. • The electrode shall support direct mounting and processing of complete wafers, without requiring carrier wafers or change of full electrode, for wafers of size 4”, 6” and 8”. • The chamber should also allow small irregular wafer pieces to be loaded, using carrier wafers. • The permissible substrate thickness shall be 5 mm or higher. • The substrate electrode shall employ helium heat transfer with suitable wafer clamping for 4”, 6” and 8” wafer sizes. • Helium cooling pressure shall be adjustable and programmable as a process parameter. • Helium flow shall be measured automatically through a suitable mass flow meter, and displayed on the system control computer. • Continuous clamping shall be provided using a quartz clamping ring, or an equivalent suitable arrangement. • Wafer-size-specific clamps shall be supplied for 100 mm (4-inch), 150 mm (6-inch), and 200 mm (8-inch) wafers. • The electrode shall be designed without seals or O-rings in the wafer backside helium cooling interface.		

4.	**Electrode Heating and Cooling**	• The substrate electrode shall be connected to a remotely controlled recirculating heater/chiller unit operating over a range of 0 °C to +50 °C with a temperature accuracy of ±0.5 °C or better, maintaining a substrate electrode temperature uniformity of ±2 °C over the aforementioned range. • Electrode temperature shall be measured using a thermocouple embedded in the electrode. • The complete temperature range shall be controlled automatically through the process recipe, without requiring manual intervention, when changing between heating and cooling setpoints. • Temperature setpoints, measured values, and relevant alarms shall be accessible through the system control software.		
5.	**Plasma Sources**	• Radio-Frequency (RF) generator power and all matching parameters shall be programmable and monitored through the system software. • The system shall support independent adjustment of ICP source power and substrate electrode bias power. • The RF system shall include appropriate interlocks to prevent operation under unsafe or out-of-range conditions.		

5.1	**Inductively Coupled Plasma Source (ICP Source)**	• The system shall be equipped with inductively coupled plasma source suitable for wafer processing up to 200 mm (8 inches).
		• The plasma source shall provide remote plasma, via inductively coupled plasma generation, designed to support low-damage dielectric etching.
		• The ICP generator shall have a rated power of at least 3000 W and shall operate at 2 MHz or 13.56 MHz frequencies.
		• The ICP source shall be capable of sustaining stable plasma operation at an ICP power range of 100 W or lower, to 3000 W.
		• An automatic impedance-matching network shall be provided for the ICP source, with vacuum capacitors.
		• The matching network shall support the following operating modes:
		  • Automatic impedance matching.
		  • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps.
		  • Fixed capacitor positions, programmable for individual recipe steps.		

5.2	**RF Power Supply for the Substrate Electrode**	• The substrate electrode shall be powered by an RF generator rated at 600 W or higher and operating at 13.56 MHz.
		• The RF power supply shall be coupled with automatic impedance-matching network, with vacuum capacitors.
		• The matching network shall support the following operating modes:
		  • Automatic impedance matching.
		  • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps.
		  • Fixed capacitor positions, programmable for individual recipe steps.		

6.	**Vacuum System**	• The main chamber vacuum system shall include a turbomolecular pump with a minimum pumping speed of 1300 l/s. • A dry turbo backing pump with a pumping capacity of at least 90 m^3/h shall be supplied for the main chamber roughing and turbo backing. • The pumping arrangement shall be designed to provide adequate effective pumping speed, and stable pressure control to achieve ultimate chamber pressure of 10^{-6} Torr, or lower. • A 200 mm automatic throttle valve shall be supplied for process pressure control. The throttle valve shall be suitably sized to avoid unnecessary restriction of the pumping conductance. • The vacuum system shall include a heated capacitance manometer suitable for pressure measurement of up to 100 mTorr, and a temperature-compensated Penning gauge. • Internal vacuum pipework shall be provided with electrical heating to 60 °C or higher. • The system shall provide suitable monitoring of chamber pressure, pump operation, and vacuum-system status through the control software.		

7.	**Process Gas Delivery Gas Box**	• The system shall be supplied with a ventilated gas box accommodating at least eight MFC-controlled gas lines, fitted with 8 Mass flow controllers (MFCs) as listed below:
		  • 6 non-hazardous gas lines, with Viton-sealed MFCs (for O_2, Ar, N_2, SF_6, CHF_3, CF_4)
		  • 2 hazardous gas lines with metal-sealed MFCs, and with a bypass line (for Cl, BCl_3)
		• Each gas line shall be provided with an electropneumatic isolation valve, and an in-line filter with a nominal filtration rating of 2 µm or better.
		• C_4F_8 & BCl_3 line must be electrically heated inside the gas box.
		• All lines should only be made of SS316L electropolished tubes and only Vacuum Coupling Radiation (VCR) fittings to be used on process gas lines.
		• The system shall include automatic MFC checking and gas-line leak-checking provisions through the control software.		

8.	**Vacuum Load-Lock and Wafer Transfer**	• The system shall include a vacuum load-lock, suitable for loading of 4", 6" and 8" wafers, and wafer pieces of arbitrary shape and size, no less than 3 mm x 3 mm. • The load-lock shall be connected to the process chamber through an isolation gate valve. • An independent dry pump with a minimum pumping capacity of 14 m^3/h shall be supplied for the load-lock. • On initiation of a process request through the control computer, the system shall automatically transfer the wafer from the load-lock to the process chamber, execute the recipe, and return the wafer to the load-lock. • A soft-pumping and soft-venting mechanism shall be provided to enable gradual evacuation and venting, thereby reducing unwanted wafer movement and particle generation. • A wafer-tracking sensor shall be provided to monitor wafer presence in load lock. • The wafer-tracking sensor shall include a software-controlled disable function for authorised users. • The loading and unloading sequence shall be controlled through the system software, with appropriate interlocks to prevent unsafe transfer operations, and shall allow manual transfer as well.		

9.	**Through-the-Wall Installation and Cleanroom Interface**	• The system shall be supplied with a cleanroom-compatible interface panel for through-the-wall installation.
		• The arrangement shall permit operation of the single-wafer load-lock from an ISO Class 6 cleanroom or substantially equivalent while the remaining equipment is installed in the service chase.
		• The cleanroom-side interface shall include:
		  • A display screen and cleanroom-compatible keyboard.
		  • A system PC interface for equipment monitoring and control.
		  • An emergency machine-off (EMO) switch accessible from the cleanroom side.
		  • A cleanroom-compatible status light tower.
		• The status light tower shall provide the following indications:
		  • Red: Alarm or fault.
		  • Amber: Idle or standby.
		  • Green: System running or busy.
		• All mounting hardware, cabling, feedthroughs, and accessories necessary for through-the-wall installation shall be included.
		• The wall interface panel shall be sealed and designed to maintain the integrity of the ISO Class 6 or substantially equivalent cleanroom.
		• The supplier shall provide installation drawings and define the required wall opening, service clearances, and facility interfaces along with bid.		

10.	**Control System and Process Software**	• The equipment shall be controlled by a programmable logic controller (PLC)-based system with suitable control software. • The software shall provide recipe-based and manual operation of the complete system. • Recipes shall support programmable control of gas flows, ICP power, RF bias power, chamber pressure, electrode temperature, helium cooling pressure, and other available process parameters. • The software shall include automatic leak-checking and automatic MFC-checking functions. • The system shall support storage of at least 200 recipes. • Advanced users shall be able to configure system tolerances through the graphical user interface, subject to the applicable access permissions and safety limits. • Multiple level password-protected user access levels shall be provided. • The software shall provide channel-by-channel input/output diagnostics, including operational states such as ON/OFF and fault states such as OK, short circuit, or open circuit, wherever supported by the installed I/O hardware. • Software shall support a configurable sampling interval of few tens of milliseconds (ms) for process & system data logging. • All relevant setpoints, measured values, alarms, and equipment status information shall be available for monitoring and logging.		

11.	**Data Logging and Graphical Analysis**	• The software shall provide graphical visualisation of logged process parameters.
		• Users shall be able to load and analyse data from multiple process steps and plot selected parameters.
		• The graphical analysis tools shall support the following representations:
		  ◦ Measured values & setpoints.
		  ◦ Measured values together with setpoints.
		• The software shall allow multiple Process runs to be loaded and their process parameters to be compared graphically Online and Offline.
		• Alarms and alerts associated with the loaded recipe steps shall be displayed alongside the corresponding process data.
		• Data shall be exportable in a suitable format for offline analysis and process verification.
		• The system shall support a configurable sampling interval in few tens of milliseconds (ms) for process & system data log data.		

12.	**Communications and Regulatory Compliance**	• System shall be SECS/GEM compliant for semiconductor equipment communication and integration. • The equipment shall comply with applicable electrical, electromagnetic compatibility (EMC), process gas, and machinery safety standards. Bidders must submit valid **CE conformity** (covering LVD, EMC, and Machinery Directives) **OR** equivalent global/national compliance certifications/test reports from an **ILAC / NABL-accredited** laboratory or recognized third-party evaluator, specifically: 1. **Equipment, Electrical & Machinery Safety:** Third-party evaluation/certification to **SEMI S2**, **UL / ETL (NRTL)**, or **IEC 61010-1** along with **IEC 60204-1 / ISO 12100** (or equivalent **IS/IEC** standards). 2. **Electromagnetic Compatibility (EMC):** Compliance with **IEC 61326-1**, **CISPR 11** (mandatory for RF plasma systems), or **FCC Part 15/18** • OEM must comply with ISO quality management certification.		

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<td>13.</td>
<td>Documentation</td>
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• The following documents shall be submitted with the technical bid:
• Valid ISO certificates for ISO 14001, ISO 45001, ISO 9001 etc. for quality management certification of the manufacturer.
• Installation and facility requirement documentation.
• CE Conformity Declaration or as specified above, refer item no. 12
• System footprint Drawings along with subsystems
• Through-the-Wall cleanroom Interface panel drawing
• Utility requirements, including but not limited to, electrical power, cooling water, compressed air, process gases, and exhaust gas abatement requirements.
• The following documents shall be supplied with the equipment:
• Complete system operation and maintenance manuals in electronic format.
• Original equipment manufacturer (OEM) manuals for the major subsystems and components.
• Electrical, gas, vacuum, and control schematics.
• Installation, commissioning, and preventive maintenance instructions.
• Utility requirements, including electrical power, cooling water or coolant, compressed air, process gases, and exhaust requirements.
• A signed compliance certificate or written undertakings verifying adherence to all material, component, and process requirements must be provided as requested.
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<td>14.</td>
<td>Superconducting materials Etching Performance and Acceptance Criteria</td>
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• The supplier shall demonstrate the etching performance of the proposed system as below. Also the supplier shall provide starting-point recipes and process trends for other materials.
<table>
<tr><th>Process reference</th><th>Nb / NbN ICP Etching</th><th>TiN ICP</th><th>Ta ICP</th><th>W ICP</th></tr>
<tr><td>Etched Material</td><td>Nb (or NbN)</td><td>TiN</td><td>Ta</td><td>W</td></tr>
<tr><td>Substrate</td><td>Si</td><td>Si</td><td>Si</td><td>Si</td></tr>
<tr><td>Wafer Size</td><td>200 mm</td><td>200 mm</td><td>100 mm</td><td>100 mm</td></tr>
<tr><td>Feature Size / Type</td><td>> 10 µm trench</td><td>> 10 µm trench</td><td>> 10 µm trench</td><td>> 10 µm trench</td></tr>
<tr><td>Etch Depth</td><td>< 200 nm</td><td>< 200 nm</td><td>< 200 nm</td><td>< 200 nm</td></tr>
<tr><td>Required Etch Rate</td><td>~35 nm/min</td><td>~20 nm/min</td><td>~35 nm/min</td><td>~50 nm/min</td></tr>
<tr><td>Selectivity to PR Mask</td><td>> 0.5:1</td><td>> 0.3:1</td><td>> 0.3:1</td><td>> 0.3:1</td></tr>
<tr><td>Profile</td><td>> 75°</td><td>> 80°</td><td>> 80°</td><td>> 70°</td></tr>
<tr><td>Roughness (5 x 5 µm area)</td><td>< 10 nm added roughness</td><td>< 10 nm added roughness</td><td>< 10 nm added roughness</td><td>< 10 nm added roughness</td></tr>
<tr><td>Within wafer uniformity</td><td>< ±5%</td><td>< ±5%</td><td>< ±5%</td><td>< ±5%</td></tr>
<tr><td>Run-To-Run Uniformity</td><td>< ±5%</td><td>< ±5%</td><td>< ±5%</td><td>< ±5%</td></tr>
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15.	**Supplier Qualification Criteria**	• The manufacturer should have experience of operating its own cleanroom facility with at least one installed system of the same type as the system being quoted. • The manufacturer's application laboratory shall have at least 5 plasma processing systems and at least 1 process engineer, fully trained to operate the system being quoted. • The manufacturer shall demonstrate its through-the-wall installation capability by providing a functional demonstration of a fully integrated installation either at its own facility or at an operational customer site where a comparable system has previously been installed. • The manufacturer should include the provision for a visit by the client or client's representative to the factory premises during factory testing, quality assurance review. • The bidder shall provide at least seven references for comparable systems supplied to research institutions, universities, or industrial semiconductor facilities that are operational 5 years post installation. • Spare parts for the quoted system shall be available ex-stock in India for at least seven years from the date of supply. • The supplier shall confirm that a free-of-charge service hotline has been operational for at least ten years. • The supplier shall provide the service hotline telephone number, email address, and contact details of the responsible service personnel. • The guaranteed maximum telephone response time from the OEM (Not by Local Agent/Distributor) shall be 30 minutes or less. • The guaranteed onsite service response time by an OEM engineer (Not by Local Agent/Distributor), shall be no more than five working days from notification of a service issue.		
16.	**Installation, Commissioning, and Acceptance**	• Installation and commissioning shall be performed by OEM personnel only. • The supplier shall coordinate with the purchaser to confirm the installation layout, service-chase requirements, cleanroom interface, and utility connections before delivery. • The supplier shall provide the required installation drawings, facility specifications, and utility consumption details in advance. • The supplier shall demonstrate at least three of the requested etching processes during commissioning. • Process acceptance shall include demonstration of SiO_2 and SiN_x etching in accordance with the acceptance criteria specified above. • The supplier shall provide starting-point recipes and process trend information for all requested processes.		
17.	**Training**	• The OEM Engineer shall provide five days of onsite training after installation and commissioning. • Training shall be provided for up to three personnel, nominated by IIT Bombay. • The training shall include: - System operation and recipe execution. - Recipe creation, parameter adjustment, and process optimization. - Plasma source and substrate bias operation. - Vacuum system operation and basic leak checking & troubleshooting. - Gas safety - System interlocks, emergency shutdown, and safe operating procedures. - Process data logging, graphical analysis, and interpretation of process trends. - Training shall include practical operation of the equipment and execution of representative etching processes. - Training materials and relevant operating instructions shall be provided to the trainees.		
18.	**Warranty**	• The complete system along with subsystems supplied with the system should have a warranty period of minimum one year.		
19.	**Electrical Supply**	• The electrical supplies available at the Institute are as follows: • Three-phase supply: 400 V (±5%), 50 Hz (±1%). • Single-phase supply: 230 V (±5%), 50 Hz (±1%). • If any power-conditioning equipment, such as a step down or step up voltage transformer, is required to ensure that the equipment supplied by the Vendor operates properly with the electrical supplies available at the Institute, the Vendor shall supply such power-conditioning equipment.		

Item Description : 4. Reactive Ion Etch (RIE)- ICP- Metal etcher - [Qty - 1]

Sr. No	Item Description	Detailed Technical Specification	Technical Compliance (Yes / No)	Additional Information (if any)
1.	**Process chamber**	• The process chamber shall be manufactured from a single solid block of aluminium or other plasma compatible metals/ materials with suitable provisions for mounting the plasma source, vacuum pumping system, load-lock, viewport, and process monitoring accessories. • The chamber construction shall be free from additional sealing joints or welds. • The chamber shall be provided with a viewport having a flange size of at least KF40 together, with a suitable RF shielded plasma viewing arrangement. • An additional side port shall be provided for optical emission spectroscopy (OES) or equivalent optical plasma monitoring. • The chamber shall have an electrical heating arrangement capable of maintaining the chamber temperature at 60 °C or higher, using external heating pads, heating jackets etc. • The plasma source and chamber pumping arrangement shall be designed with radial symmetry, to provide uniform plasma distribution and wafer-scale etching over a wide range of process parameters. • The chamber design shall facilitate easy routine cleaning, maintenance, and replacement of internal consumable components without having to dismantle any process gas line joints to open the chamber.		
2.	**System Console**	• The system console shall accommodate the turbomolecular pump, vacuum valves, and associated control components as required by the equipment design. • The system shall incorporate comprehensive hardware and software interlocks to protect the equipment against service failures, including loss of cooling water, inadequate compressed air, abnormal vacuum conditions, and any other critical faults. • Appropriate safety provisions shall be incorporated to protect personnel from electrical hazards during operation and maintenance. • In the event of a system or utility failure, the equipment shall transition to a safe state and maintain vacuum in the chamber. • The console shall provide convenient access for routine inspection, servicing, and preventive maintenance.		
3.	**Substrate Electrode & Clamping**	• The substrate electrode shall be of diameter of at least 225 mm and shall be suitable for processing wafers up to 200 mm (8 inches) in diameter. • The electrode shall support direct mounting and processing of complete wafers, without requiring carrier wafers or change of full electrode, for wafers of size 4”, 6” and 8”. • The chamber should also allow small irregular wafer pieces to be loaded, using carrier wafers. • The permissible substrate thickness shall be 5 mm or higher. • The substrate electrode shall employ helium heat transfer with suitable wafer clamping for 4”, 6” and 8” wafer sizes. • Helium cooling pressure shall be adjustable and programmable as a process parameter. • Helium flow shall be measured automatically through a suitable mass flow meter, and displayed on the system control computer. • Continuous clamping shall be provided using a quartz clamping ring, or an equivalent suitable arrangement. • Wafer-size-specific clamps shall be supplied for 100 mm (4-inch), 150 mm (6-inch), and 200 mm (8-inch) wafers. • The electrode shall be designed without seals or O-rings in the wafer backside helium cooling interface.		

4.	**Electrode Heating and Cooling**	• The substrate electrode shall be connected to a remotely controlled recirculating heater/chiller unit operating over a range of 0 °C to +50 °C with a temperature accuracy of ±0.5 °C or better, maintaining a substrate electrode temperature uniformity of ±2 °C over the aforementioned range. • Electrode temperature shall be measured using a thermocouple embedded in the electrode. • The complete temperature range shall be controlled automatically through the process recipe, without requiring manual intervention, when changing between heating and cooling setpoints. • Temperature setpoints, measured values, and relevant alarms shall be accessible through the system control software.		
5.	**Plasma Sources**	• Radio-Frequency (RF) generator power and all matching parameters shall be programmable and monitored through the system software. • The system shall support independent adjustment of ICP source power and substrate electrode bias power. • The RF system shall include appropriate interlocks to prevent operation under unsafe or out-of-range conditions.		

5.1	**Inductively Coupled Plasma Source (ICP Source)**	• The system shall be equipped with inductively coupled plasma source suitable for wafer processing up to 200 mm (8 inches).
		• The plasma source shall provide remote plasma, via inductively coupled plasma generation, designed to support low-damage dielectric etching.
		• The ICP generator shall have a rated power of at least 3000 W and shall operate at 2 MHz or 13.56 MHz frequencies.
		• The ICP source shall be capable of sustaining stable plasma operation at an ICP power range of 100 W or lower, to 3000 W.
		• An automatic impedance-matching network shall be provided for the ICP source, with vacuum capacitors.
		• The matching network shall support the following operating modes:
		  • Automatic impedance matching.
		  • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps.
		  • Fixed capacitor positions, programmable for individual recipe steps.		

5.2	**RF Power Supply for the Substrate Electrode**	• The substrate electrode shall be powered by an RF generator rated at 600 W or higher and operating at 13.56 MHz.
		• The RF power supply shall be coupled with automatic impedance-matching network, with vacuum capacitors.
		• The matching network shall support the following operating modes:
		  • Automatic impedance matching.
		  • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps.
		  • Fixed capacitor positions, programmable for individual recipe steps.		

6.	**Vacuum System**	• The main chamber vacuum system shall include a turbomolecular pump with a minimum pumping speed of 1300 l/s. • A dry turbo backing pump with a pumping capacity of at least 90 m^3/h shall be supplied for the main chamber roughing and turbo backing. • The pumping arrangement shall be designed to provide adequate effective pumping speed, and stable pressure control to achieve ultimate chamber pressure of 10^{-6} Torr, or lower. • A 200 mm automatic throttle valve shall be supplied for process pressure control. The throttle valve shall be suitably sized to avoid unnecessary restriction of the pumping conductance. • The vacuum system shall include a heated capacitance manometer suitable for pressure measurement of up to 100 mTorr, and a temperature-compensated Penning gauge. • Internal vacuum pipework shall be provided with electrical heating to 60 °C or higher. • The system shall provide suitable monitoring of chamber pressure, pump operation, and vacuum-system status through the control software.		

7.	**Process Gas Delivery Gas Box**	• The system shall be supplied with a ventilated gas box accommodating at least eight MFC-controlled gas lines, fitted with 8 Mass flow controllers (MFCs) as listed below:
		  • 6 non-hazardous gas lines, with Viton-sealed MFCs (for O_2, Ar, N_2, SF_6, CHF_3, CF_4)
		  • 2 hazardous gas lines with metal-sealed MFCs, and with a bypass line (for Cl, BCl_3)
		• Each gas line shall be provided with an electropneumatic isolation valve, and an in-line filter with a nominal filtration rating of 2 µm or better.
		• C_4F_8 & BCl_3 line must be electrically heated inside the gas box.
		• All lines should only be made of SS316L electropolished tubes and only Vacuum Coupling Radiation (VCR) fittings to be used on process gas lines.
		• The system shall include automatic MFC checking and gas-line leak-checking provisions through the control software.		

8.	**Vacuum Load-Lock and Wafer Transfer**	• The system shall include a vacuum load-lock, suitable for loading of 4", 6" and 8" wafers, and wafer pieces of arbitrary shape and size, no less than 3 mm x 3 mm. • The load-lock shall be connected to the process chamber through an isolation gate valve. • An independent dry pump with a minimum pumping capacity of 14 m^3/h shall be supplied for the load-lock. • On initiation of a process request through the control computer, the system shall automatically transfer the wafer from the load-lock to the process chamber, execute the recipe, and return the wafer to the load-lock. • A soft-pumping and soft-venting mechanism shall be provided to enable gradual evacuation and venting, thereby reducing unwanted wafer movement and particle generation. • A wafer-tracking sensor shall be provided to monitor wafer presence in load lock. • The wafer-tracking sensor shall include a software-controlled disable function for authorised users. • The loading and unloading sequence shall be controlled through the system software, with appropriate interlocks to prevent unsafe transfer operations, and shall allow manual transfer as well.		

9.	**Through-the-Wall Installation and Cleanroom Interface**	• The system shall be supplied with a cleanroom-compatible interface panel for through-the-wall installation.
		• The arrangement shall permit operation of the single-wafer load-lock from an ISO Class 6 cleanroom or substantially equivalent while the remaining equipment is installed in the service chase.
		• The cleanroom-side interface shall include:
		  • A display screen and cleanroom-compatible keyboard.
		  • A system PC interface for equipment monitoring and control.
		  • An emergency machine-off (EMO) switch accessible from the cleanroom side.
		  • A cleanroom-compatible status light tower.
		• The status light tower shall provide the following indications:
		  • Red: Alarm or fault.
		  • Amber: Idle or standby.
		  • Green: System running or busy.
		• All mounting hardware, cabling, feedthroughs, and accessories necessary for through-the-wall installation shall be included.
		• The wall interface panel shall be sealed and designed to maintain the integrity of the ISO Class 6 or substantially equivalent cleanroom.
		• The supplier shall provide installation drawings and define the required wall opening, service clearances, and facility interfaces along with bid.		

10.	**Control System and Process Software**	• The equipment shall be controlled by a programmable logic controller (PLC)-based system with suitable control software. • The software shall provide recipe-based and manual operation of the complete system. • Recipes shall support programmable control of gas flows, ICP power, RF bias power, chamber pressure, electrode temperature, helium cooling pressure, and other available process parameters. • The software shall include automatic leak-checking and automatic MFC-checking functions. • The system shall support storage of at least 200 recipes. • Advanced users shall be able to configure system tolerances through the graphical user interface, subject to the applicable access permissions and safety limits. • Multiple level password-protected user access levels shall be provided. • The software shall provide channel-by-channel input/output diagnostics, including operational states such as ON/OFF and fault states such as OK, short circuit, or open circuit, wherever supported by the installed I/O hardware. • Software shall support a configurable sampling interval of few tens of milliseconds (ms) for process & system data logging. • All relevant setpoints, measured values, alarms, and equipment status information shall be available for monitoring and logging.		

11.	**Data Logging and Graphical Analysis**	• The software shall provide graphical visualisation of logged process parameters.
		• Users shall be able to load and analyse data from multiple process steps and plot selected parameters.
		• The graphical analysis tools shall support the following representations:
		  ◦ Measured values & setpoints.
		  ◦ Measured values together with setpoints.
		• The software shall allow multiple Process runs to be loaded and their process parameters to be compared graphically Online and Offline.
		• Alarms and alerts associated with the loaded recipe steps shall be displayed alongside the corresponding process data.
		• Data shall be exportable in a suitable format for offline analysis and process verification.
		• The system shall support a configurable sampling interval in few tens of milliseconds (ms) for process & system data log data.		

12.	**Communications and Regulatory Compliance**	• System shall be SECS/GEM compliant for semiconductor equipment communication and integration. • The equipment shall comply with applicable electrical, electromagnetic compatibility (EMC), process gas, and machinery safety standards. Bidders must submit valid **CE conformity** (covering LVD, EMC, and Machinery Directives) **OR** equivalent global/national compliance certifications/test reports from an **ILAC / NABL-accredited** laboratory or recognized third-party evaluator, specifically: 1. **Equipment, Electrical & Machinery Safety:** Third-party evaluation/certification to **SEMI S2**, **UL / ETL (NRTL)**, or **IEC 61010-1** along with **IEC 60204-1 / ISO 12100** (or equivalent **IS/IEC** standards). 2. **Electromagnetic Compatibility (EMC):** Compliance with **IEC 61326-1**, **CISPR 11** (mandatory for RF plasma systems), or **FCC Part 15/18** • OEM must comply with ISO quality management certification.		

<table>
<tr>
<td>13.</td>
<td>Documentation</td>
<td>
• The following documents shall be submitted with the technical bid:
  • Valid ISO certificates for ISO 14001, ISO 45001, ISO 9001 etc. for quality management certification of the manufacturer.
  • Installation and facility requirement documentation.
  • CE Conformity Declaration or as specified above, refer item no. 12
  • System footprint Drawings along with subsystems
  • Through-the-Wall cleanroom Interface panel drawing
  • Utility requirements, including but not limited to, electrical power, cooling water, compressed air, process gases, and exhaust gas abatement requirements.
• The following documents shall be supplied with the equipment:
  • Complete system operation and maintenance manuals in electronic format.
  • Original equipment manufacturer (OEM) manuals for the major subsystems and components.
  • Electrical, gas, vacuum, and control schematics.
  • Installation, commissioning, and preventive maintenance instructions.
  • Utility requirements, including electrical power, cooling water or coolant, compressed air, process gases, and exhaust requirements.
• A signed compliance certificate or written undertakings verifying adherence to all material, component, and process requirements must be provided as requested.
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<tr>
<td>14.</td>
<td>Superconducting / Metal materials Etching Performance and Acceptance Criteria</td>
<td>
• The supplier shall demonstrate the etching performance of the proposed system as below. Also the supplier shall provide starting-point recipes and process trends for other materials.
<table>
<tr><th>Process reference</th><th>Al ICP Etching</th><th>$LiNbO_3$ ICP Etching</th><th>Low Rate W ICP Etching</th><th>Low Rate Ta ICP Etching</th></tr>
<tr><td>Etched Material</td><td>Al</td><td>$LiNbO_3$</td><td>Ta</td><td>W</td></tr>
<tr><td>Substrate</td><td>Si</td><td>Si / Sapphire / $LiNbO_3$</td><td>Si</td><td>Si</td></tr>
<tr><td>Wafer Size</td><td>200 mm</td><td>200 mm</td><td>100 mm</td><td>100 mm</td></tr>
<tr><td>Feature Size / Type</td><td>> 10 µm trench</td><td>≥ 1 µm trench</td><td>> 10 µm trench</td><td>> 10 µm trench</td></tr>
<tr><td>Assumed Etch Depth</td><td>< 2 µm</td><td>Up to 200 nm</td><td>< 200 nm</td><td>< 200 nm</td></tr>
<tr><td>Required Etch Rate</td><td>> 200 nm/min</td><td>< 25 nm/min</td><td>~35 nm/min</td><td>~50 nm/min</td></tr>
<tr><td>Selectivity to Mask</td><td>> 1:1 (PR)</td><td>> 0.5:1 (PR), > 3:1 (Cr mask)</td><td>> 0.3:1</td><td>> 0.3:1</td></tr>
<tr><td>Profile Angle</td><td>> 85°</td><td>> 70° (with Cr mask), > 60° (with PR mask)</td><td>> 80°</td><td>> 70°</td></tr>
<tr><td>Within-Wafer Uniformity</td><td>< ±5%</td><td>< ±5%</td><td>< ±5%</td><td>< ±5%</td></tr>
<tr><td>Run-to-Run Uniformity</td><td>< ±3%</td><td>< ±5%</td><td>< ±3%</td><td>< ±3%</td></tr>
</table>
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<td></td>
<td></td>
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</table>

15.	**Supplier Qualification Criteria**	• The manufacturer should have experience of operating its own cleanroom facility with at least one installed system of the same type as the system being quoted. • The manufacturer's application laboratory shall have at least 5 plasma processing systems and at least 1 process engineer, fully trained to operate the system being quoted. • The manufacturer shall demonstrate its through-the-wall installation capability by providing a functional demonstration of a fully integrated installation either at its own facility or at an operational customer site where a comparable system has previously been installed. • The manufacturer should include the provision for a visit by the client or client's representative to the factory premises during factory testing, quality assurance review. • The bidder shall provide at least seven references for comparable systems supplied to research institutions, universities, or industrial semiconductor facilities that are operational 5 years post installation. • Spare parts for the quoted system shall be available ex-stock in India for at least seven years from the date of supply. • The supplier shall confirm that a free-of-charge service hotline has been operational for at least ten years. • The supplier shall provide the service hotline telephone number, email address, and contact details of the responsible service personnel. • The guaranteed maximum telephone response time from the OEM (Not by Local Agent/Distributor) shall be 30 minutes or less. • The guaranteed onsite service response time by an OEM engineer (Not by Local Agent/Distributor), shall be no more than five working days from notification of a service issue.		
16.	**Installation, Commissioning, and Acceptance**	• Installation and commissioning shall be performed by OEM personnel only. • The supplier shall coordinate with the purchaser to confirm the installation layout, service-chase requirements, cleanroom interface, and utility connections before delivery. • The supplier shall provide the required installation drawings, facility specifications, and utility consumption details in advance. • The supplier shall demonstrate at least three of the requested etching processes during commissioning. • Process acceptance shall include demonstration of SiO_2 and SiN_x etching in accordance with the acceptance criteria specified above. • The supplier shall provide starting-point recipes and process trend information for all requested processes.		
17.	**Training**	• The OEM Engineer shall provide five days of onsite training after installation and commissioning. • Training shall be provided for up to three personnel, nominated by IIT Bombay. • The training shall include: - System operation and recipe execution. - Recipe creation, parameter adjustment, and process optimization. - Plasma source and substrate bias operation. - Vacuum system operation and basic leak checking & troubleshooting. - Gas safety - System interlocks, emergency shutdown, and safe operating procedures. - Process data logging, graphical analysis, and interpretation of process trends. - Training shall include practical operation of the equipment and execution of representative etching processes. - Training materials and relevant operating instructions shall be provided to the trainees.		
18.	**Warranty**	• The complete system along with subsystems supplied with the system should have a warranty period of minimum one year.		
19.	**Electrical Supply**	• The electrical supplies available at the Institute are as follows: • Three-phase supply: 400 V (±5%), 50 Hz (±1%). • Single-phase supply: 230 V (±5%), 50 Hz (±1%). • If any power-conditioning equipment, such as a step down or step up voltage transformer, is required to ensure that the equipment supplied by the Vendor operates properly with the electrical supplies available at the Institute, the Vendor shall supply such power-conditioning equipment.		

Item Description : 5. Deep Reactive Ion Etch (DRIE) - [Qty - 1]

Sr. No	Item Description	Detailed Technical Specification	Technical Compliance (Yes / No)	Additional Information (if any)
1.	**Process chamber**	• The process chamber shall be manufactured from a single solid block of aluminium or other plasma compatible metals/materials with suitable provisions for mounting the plasma source, vacuum pumping system, load-lock, viewport, and process monitoring accessories. • The chamber construction shall be free from additional sealing joints or welds. • The chamber shall be provided with a viewport having a flange size of at least KF40 together, with a suitable RF shielded plasma viewing arrangement. • An additional side port shall be provided for optical emission spectroscopy (OES) or equivalent optical plasma monitoring. • The chamber shall have an electrically heated removable liner arrangement capable of maintaining the inner chamber liner temperature up to 100 °C or higher. • The plasma source and chamber pumping arrangement shall be designed with radial symmetry to provide uniform plasma distribution and wafer-scale etching over a wide range of process parameters. • The chamber design shall facilitate easy routine cleaning, maintenance, and replacement of internal consumable components without having to dismantle any process gas line joints to open the chamber.		
2.	**System Console**	• The system console shall accommodate the turbomolecular pump, vacuum valves, and associated control components as required by the equipment design. • The system shall incorporate comprehensive hardware and software interlocks to protect the equipment against service failures, including loss of cooling water, inadequate compressed air, abnormal vacuum conditions, and any other critical faults. • Appropriate safety provisions shall be incorporated to protect personnel from electrical hazards during operation and maintenance. • In the event of a system or utility failure, the equipment shall transition to a safe state and maintain vacuum in the chamber. • The console shall provide convenient access for routine inspection, servicing, and preventive maintenance.		
3.	**Substrate Electrode & Clamping**	• The substrate electrode shall be of diameter of at least 225 mm and shall be suitable for processing wafers up to 200 mm (8 inches) in diameter. • The electrode shall support direct mounting and processing of complete wafers, without requiring carrier wafers or change of full electrode, for wafers of size 4”, 6” and 8”. • The chamber should also allow small irregular wafer pieces to be loaded, using carrier wafers. • The permissible substrate thickness shall be 5 mm or higher. • The substrate electrode shall employ helium heat transfer with suitable wafer clamping for 4”, 6” and 8” wafer sizes. • Helium cooling pressure shall be adjustable and programmable as a process parameter. • Helium flow shall be measured automatically through a suitable mass flow meter, and displayed on the system control computer. • Continuous clamping shall be provided using a quartz/Alumina clamping ring, or an equivalent suitable arrangement. • Wafer-size-specific clamps shall be supplied for 100 mm (4-inch), 150 mm (6-inch), and 200 mm (8-inch) wafers. • The electrode shall be designed without seals or O-rings in the wafer backside helium cooling interface.		

4.	**Electrode Heating and Cooling**	• The substrate electrode shall be connected to a remotely controlled recirculating heater/chiller unit operating over a range of 0 °C to +50 °C with a temperature accuracy of ±0.5 °C or better, maintaining a substrate electrode temperature uniformity of ±2 °C over the aforementioned range. • Electrode temperature shall be measured using a thermocouple embedded in the electrode. • The complete temperature range shall be controlled automatically through the process recipe, without requiring manual intervention, when changing between heating and cooling setpoints. • Temperature setpoints, measured values, and relevant alarms shall be accessible through the system control software.		
5.	**Plasma Sources**	• Radio-Frequency (RF) generator power and all matching parameters shall be programmable and monitored through the system software. • The system shall support independent adjustment of ICP source power and substrate electrode bias power. • The RF system shall include appropriate interlocks to prevent operation under unsafe or out-of-range conditions.		

5.1	**Inductively Coupled Plasma Source (ICP Source)**	• The system shall be equipped with inductively coupled plasma source suitable for wafer processing up to 200 mm (8 inches).
		• The plasma source shall provide remote plasma, via inductively coupled plasma generation, designed to support low-damage dielectric etching.
		• The ICP generator shall have a rated power of at least 5000 W and shall operate at 2 MHz or 13.56 MHz frequencies.
		• The ICP source shall be capable of sustaining stable plasma operation at an ICP power range of 150 W or lower, to 3000 W or higher.
		• ICP Generator shall have load forward power mode to allow fast repeatable power delivery to ICP source during fast switching between etch and passivation steps.
		• An automatic impedance-matching network shall be provided for the ICP source, with vacuum capacitors.
		• The matching network shall support the following operating modes:
		  • Automatic impedance matching.
		  • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps.
		  • Fixed capacitor positions, programmable for individual recipe steps.		

5.2	**RF Power Supply for the Substrate Electrode**	• The substrate electrode shall be powered by an RF generator rated at 600 W or higher and operating at 13.56 MHz.
		• The RF power supply shall be coupled with automatic impedance-matching network, with vacuum capacitors.
		• The matching network shall support the following operating modes:
		  • Automatic impedance matching.
		  • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps.
		  • Fixed capacitor positions, programmable for individual recipe steps.		

6.	**Vacuum System**	• The main chamber vacuum system shall include a turbomolecular pump with a minimum pumping speed of 2200 l/s. • A dry turbo backing pump with a pumping capacity of at least 450 m^3/h shall be supplied for the main chamber roughing and turbo backing. • The pumping arrangement shall be designed to provide adequate effective pumping speed, and stable pressure control to achieve ultimate chamber pressure of 10^{-6} Torr, or lower. • Fast acting 250 mm automatic throttle valve with ≤ 1s open/close time shall be supplied for process pressure control. • The high-speed throttle valve shall be suitably sized to allow quick pressure changes for ultrafast switching between SF_6 etching and C_4F_8 passivation steps in the Bosch process. • The vacuum system shall include a heated capacitance manometer suitable for pressure measurement of up to 250 mTorr, and a temperature-compensated Penning gauge. • Vacuum pipework shall be provided with electrical heating to 70 °C or higher up to backing pump. • The system shall provide suitable monitoring of chamber pressure, pump operation, and vacuum-system status through the control software.		

7.	**Process Gas Delivery Gas Box**	• The DRIE system shall be supplied with a ventilated gas delivery box mounted on the process chamber, accommodating a minimum of six (6) independently controlled gas lines. • **Two (2) ultrafast-response Mass flow controllers (MFCs):** One dedicated to SF_6 and one dedicated to C_4F_8, preferably Sensirion or equivalent make, with a gas flow rise time of ≤ 100 ms or faster. These MFCs shall be closely coupled to the process chamber and configured to enable ultrafast sub-second switching between SF_6 etching and C_4F_8 passivation steps in the Bosch process. • **One (1) high-flow SF6 MFC:** With a maximum flow capacity of at least 1,000 sccm or higher and standard response characteristics, to support high-flow SF_6 process requirements for high-rate Bosch processes. • **Two (2) additional standard-response MFCs:** Configured for O_2, CHF_3, or Ar gases, as may be required for process flexibility. • Each gas line shall be provided with an electropneumatic isolation valve, and an in-line filter with a nominal filtration rating of 2 µm or better. • All lines inside the gas box should only be made of SS316L electropolished tubes and only Vacuum Coupling Radiation (VCR) fittings to be used on process gas lines. • The system shall be designed to permit the addition of up to four further gas lines in future. • The system shall include automatic MFC checking and gas-line leak-checking provisions through the control software.		
8.	**Vacuum Load-Lock and Wafer Transfer**	• The system shall include a vacuum load-lock, suitable for loading of 4", 6" and 8" wafers, and wafer pieces of arbitrary shape and size, no less than 3 mm x 3 mm. • The load-lock shall be connected to the process chamber through an isolation gate valve. • An independent dry pump with a minimum pumping capacity of 14 m^3/h shall be supplied for the load-lock. • On initiation of a process request through the control computer, the system shall automatically transfer the wafer from the load-lock to the process chamber, execute the recipe, and return the wafer to the load-lock. • A wafer-tracking sensor shall be provided to monitor wafer presence in load lock. • The wafer-tracking sensor shall include a software-controlled disable function for authorised users. • The loading and unloading sequence shall be controlled through the system software, with appropriate interlocks to prevent unsafe transfer operations, and shall allow manual transfer as well.		

9.	**Through-the-Wall Installation and Cleanroom Interface**	• The system shall be supplied with a cleanroom-compatible interface panel for through-the-wall installation.
		• The arrangement shall permit operation of the single-wafer load-lock from an ISO Class 6 cleanroom or substantially equivalent while the remaining equipment is installed in the service chase.
		• The cleanroom-side interface shall include:
		  • A display screen and cleanroom-compatible keyboard.
		  • A system PC interface for equipment monitoring and control.
		  • An emergency machine-off (EMO) switch accessible from the cleanroom side.
		  • A cleanroom-compatible status light tower.
		• The status light tower shall provide the following indications:
		  • Red: Alarm or fault.
		  • Amber: Idle or standby.
		  • Green: System running or busy.
		• All mounting hardware, cabling, feedthroughs, and accessories necessary for through-the-wall installation shall be included.
		• The wall interface panel shall be sealed and designed to maintain the integrity of the ISO Class 6 or substantially equivalent cleanroom.
		• The supplier shall provide installation drawings and define the required wall opening, service clearances, and facility interfaces along with bid.		

10.	**Control System and Process Software**	• The equipment shall be controlled by a programmable logic controller (PLC)-based system with suitable control software. • The software shall provide recipe-based and manual operation of the complete system. • Recipes shall support programmable control of ultra-fast switching of gas flows, ICP power, RF bias power, chamber pressure, electrode temperature, helium cooling pressure, and other available process parameters. • The software shall include automatic leak-checking and automatic MFC-checking functions. • The system shall support storage of at least 200 recipes. • Advanced users shall be able to configure system tolerances through the graphical user interface, subject to the applicable access permissions and safety limits. • Multiple level password-protected user access levels shall be provided. • The software shall provide channel-by-channel input/output diagnostics, including operational states such as ON/OFF and fault states such as OK, short circuit, or open circuit, wherever supported by the installed I/O hardware. • Software & Control system shall support defining switching Bosch process recipe steps in short sub-second time intervals. • Software shall support a configurable sampling interval of few tens of milliseconds (ms) for process & system data logging. • All relevant setpoints, measured values, alarms, and equipment status information shall be available for monitoring and logging.		

11.	**Data Logging and Graphical Analysis**	• The software shall provide graphical visualisation of logged process parameters.
		• Users shall be able to load and analyse data from multiple process steps and plot selected parameters.
		• The graphical analysis tools shall support the following representations:
		  • Measured values & setpoints.
		  • Measured values together with setpoints.
		• The software shall allow multiple Process runs to be loaded and their process parameters to be compared graphically Online and Offline.
		• Alarms and alerts associated with the loaded recipe steps shall be displayed alongside the corresponding process data.
		• Data shall be exportable in a suitable format for offline analysis and process verification.
		• The system shall support a configurable sampling interval in few tens of milliseconds (ms) for process & system data log data.		

12.	**Communications and Regulatory Compliance**	• System shall be SECS/GEM compliant for semiconductor equipment communication and integration. • The equipment shall comply with applicable electrical, electromagnetic compatibility (EMC), process gas, and machinery safety standards. Bidders must submit valid **CE conformity** (covering LVD, EMC, and Machinery Directives) **OR** equivalent global/national compliance certifications/test reports from an **ILAC / NABL-accredited** laboratory or recognized third-party evaluator, specifically: 1. **Equipment, Electrical & Machinery Safety:** Third-party evaluation/certification to **SEMI S2**, **UL / ETL (NRTL)**, or **IEC 61010-1** along with **IEC 60204-1 / ISO 12100** (or equivalent **IS/IEC** standards). 2. **Electromagnetic Compatibility (EMC):** Compliance with **IEC 61326-1**, **CISPR 11** (mandatory for RF plasma systems), or **FCC Part 15/18** • OEM must comply with ISO quality management certification.		

<table>
<tr>
<td>13.</td>
<td>Documentation</td>
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The following documents shall be submitted with the technical bid:

Valid ISO certificates for ISO 14001, ISO 45001, ISO 9001 etc. for quality management certification of the manufacturer.
Installation and facility requirement documentation.
CE Conformity Declaration or as specified above, refer item no. 12
System footprint Drawings along with subsystems
Through-the-Wall cleanroom Interface panel drawing
Utility requirements, including but not limited to, electrical power, cooling water, compressed air, process gases, and exhaust gas abatement requirements.

The following documents shall be supplied with the equipment:

Complete system operation and maintenance manuals in electronic format.
Original equipment manufacturer (OEM) manuals for the major subsystems and components.
Electrical, gas, vacuum, and control schematics.
Installation, commissioning, and preventive maintenance instructions.
Utility requirements, including electrical power, cooling water or coolant, compressed air, process gases, and exhaust requirements.

• A signed compliance certificate or written undertakings verifying adherence to all material, component, and process requirements must be provided as requested.
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<td>14.</td>
<td>Deep Silicon Etching Performance and Acceptance Criteria</td>
<td>

The supplier shall demonstrate the dielectric/deep silicon etching performance of the proposed system as below. Also the supplier shall provide starting-point recipes and process trends for other materials.

<table>
<tr><th>Process Type</th><th>TSV</th><th>High Rate / Selectivity</th><th>Low Scallop</th></tr>
<tr><td>Wafer Size</td><td>200 mm</td><td>200 mm</td><td>200 mm</td></tr>
<tr><td>Mask Feature Size (µm)</td><td>50 µm via</td><td>50 µm Trench</td><td>5 µm trench</td></tr>
<tr><td>Etch Depth (µm)</td><td>350 µm</td><td>150 µm</td><td>30 µm</td></tr>
<tr><td>Etch rate (µm/min)</td><td>> 10 (µm/min)</td><td>> 20 (µm/min)</td><td>> 3 (µm/min)</td></tr>
<tr><td>Selectivity to PR</td><td>> 120</td><td>> 150</td><td>> 20</td></tr>
<tr><td>Selectivity to SiO2</td><td>> 220</td><td>> 280</td><td>> 30</td></tr>
<tr><td>Within wafer Uniformity (%)</td><td>< ±5%</td><td>< ±5%</td><td>< ±5%</td></tr>
<tr><td>Profile control (°)</td><td>90° ± <1°</td><td>90° ± <1°</td><td>90° ± <1°</td></tr>
<tr><td>Scallops (nm)</td><td>< 550 nm</td><td>< 330 nm</td><td>< 25 nm</td></tr>
<tr><td>Loading on (200mm wafer)</td><td>< 5%</td><td>< 5%</td><td>< 5%</td></tr>
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<td></td>
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</table>

15.	**Supplier Qualification Criteria**	• The manufacturer should have experience of operating its own cleanroom facility with at least one installed system of the same type as the system being quoted. • The manufacturer's application laboratory shall have at least 5 plasma processing systems and at least 1 process engineer, fully trained to operate the system being quoted. • The manufacturer shall demonstrate its through-the-wall installation capability by providing a functional demonstration of a fully integrated installation either at its own facility or at an operational customer site where a comparable system has previously been installed. • The manufacturer should include the provision for a visit by the client or client's representative to the factory premises during factory testing, quality assurance review. • The bidder shall provide at least three references for comparable systems supplied to research institutions, universities, or industrial semiconductor facilities that are operational 5 years post installation. • Spare parts for the quoted system shall be available ex-stock in India for at least seven years from the date of supply. • The supplier shall confirm that a free-of-charge service hotline has been operational for at least ten years. • The supplier shall provide the service hotline telephone number, email address, and contact details of the responsible service personnel. • The guaranteed maximum telephone response time from the OEM (Not by Local Agent/Distributor) shall be 30 minutes or less. • The guaranteed onsite service response time by an OEM engineer (Not by Local Agent/Distributor), shall be no more than five working days from notification of a service issue.		
16.	**Installation, Commissioning, and Acceptance**	• Installation and commissioning shall be performed by OEM personnel only. • The supplier shall coordinate with the purchaser to confirm the installation layout, service-chase requirements, cleanroom interface, and utility connections before delivery. • The supplier shall provide the required installation drawings, facility specifications, and utility consumption details in advance. • The supplier shall demonstrate at least three of the requested etching processes during commissioning. • Process acceptance shall include demonstration of Bosch process Deep Silicon Etching including TVS in accordance with the acceptance criteria specified above. • The supplier shall provide starting-point recipes and process trend information for all requested processes.		
17.	**Training**	• The OEM Engineer shall provide five days of onsite training after installation and commissioning. • Training shall be provided for up to three personnel, nominated by IIT Bombay. • The training shall include: - System operation and recipe execution. - Recipe creation, parameter adjustment, and process optimization. - Plasma source and substrate bias operation. - Vacuum system operation and basic leak checking & troubleshooting. - Gas safety - System interlocks, emergency shutdown, and safe operating procedures. - Process data logging, graphical analysis, and interpretation of process trends. - Training shall include practical operation of the equipment and execution of representative etching processes. - Training materials and relevant operating instructions shall be provided to the trainees.		
18.	**Warranty**	• The complete system along with subsystems supplied with the system should have a warranty period of minimum one year.		
19.	**Electrical Supply**	• The electrical supplies available at the Institute are as follows: • Three-phase supply: 400 V (±5%), 50 Hz (±1%). • Single-phase supply: 230 V (±5%), 50 Hz (±1%). • If any power-conditioning equipment, such as a step down or step up voltage transformer, is required to ensure that the equipment supplied by the Vendor operates properly with the electrical supplies available at the Institute, the Vendor shall supply such power-conditioning equipment.		

Item Description : 6. Atomic Layer Deposition System (ALD)/plasma/thermal -- Oxides (Al2O3, HfO2) - [Qty - 1]

Sr. No	Item Description	Detailed Technical Specification	Technical Compliance (Yes / No)	Additional Information (if any)
1.	Process chamber	● The process chamber shall be manufactured from a single solid block of aluminium or other plasma compatible metals/materials with suitable provisions for mounting the plasma source, vacuum pumping system, load-lock, ellipsometer, and other process monitoring accessories. ● The chamber construction shall be free from additional sealing joints or welds. ● The chamber shall be provided with provisions for angled ports having a suitable flange size for mounting in situ ellipsometer. ● The chamber shall have an electrically heated inner removable liner arrangement capable of maintaining the inner chamber temperature up to 200 °C or higher. ● The plasma source and chamber pumping arrangement shall be designed with radial symmetry to provide uniform plasma distribution and wafer-scale deposition over a wide range of process parameters. ● The chamber design shall facilitate easy routine cleaning, maintenance, and replacement of internal consumable components without having to dismantle any process gas line or precursor line joints to open the chamber.		
2.	System Console	● The system console shall accommodate the vacuum valves, and associated control components as required by the equipment design. ● The system shall incorporate comprehensive hardware and software interlocks to protect the equipment against service failures, including loss of cooling water, inadequate compressed air, abnormal vacuum conditions, and any other critical faults. ● Appropriate safety provisions shall be incorporated to protect personnel from electrical hazards during operation and maintenance. ● In the event of a system or utility failure, the equipment shall transition to a safe state and maintain vacuum in chamber. ● The console shall provide convenient access for routine inspection, servicing, and preventive maintenance.		
3.	Substrate Electrode	● The substrate electrode shall be of diameter of at least 225 mm and shall be suitable for processing wafers up to 200 mm (8 inches) in diameter. ● The electrode shall support direct mounting and processing of complete wafers, without requiring carrier wafers or change of full electrode, for wafers of size 4” 6’’ and 8’’. ● The chamber should also allow small irregular wafer pieces to be loaded, using carrier wafers. ● The permissible substrate thickness shall be 5 mm or higher.		
4.	Electrode Heating	● The system shall provide substrate electrode temperature control over the range of +100 °C to +400 °C with ±2 °C temperature uniformity. ● Electrode temperature shall be measured using a thermocouple embedded in the electrode. ● Suitable heater control shall be provided with temperature range of +100°C to + 400 °C. ● The complete temperature range shall be controlled automatically through		

		the process recipe, without requiring manual intervention, when changing between heating setpoints. ● Temperature setpoints, measured values, and relevant alarms shall be accessible through the system control software.		
5.	Plasma ALD Source	● RF generator power and all matching parameters shall be programmable and monitored through the system software. ● The RF system shall include appropriate interlocks to prevent operation under unsafe or out-of-range conditions. ● The system shall be equipped with a remote plasma source suitable for wafer processing up to 200 mm (8 inches).		
5.1	Remote Plasma Source	● Remote plasma source shall have a rated power of at least 600W or higher and shall operate at 13.56 MHz frequency connected to upper electrode. ● An automatic impedance-matching network shall be provided, with vacuum capacitors. ● The matching network shall support the following operating modes: ○ Automatic impedance matching. ○ Automatic matching with pre-set capacitor positions, programmable for individual recipe steps. ○ Fixed capacitor positions, programmable for individual recipe steps.		
6.	Vacuum System	● A multistage dry pump with a pumping capacity of at least 450 m^3/h shall be supplied for the main chamber roughing and vacuum or an equivalent capacity pumping arrangement via suitable Turbo pumping station. ● The pumping arrangement shall be designed to provide adequate effective pumping speed, and stable pressure control to achieve pressure of ~10^{-3} Torr, or better. ● At least 100 mm or larger automatic throttle valve shall be supplied for process pressure control. The throttle valve shall be suitably sized to avoid unnecessary restriction of the pumping conductance. ● The vacuum system shall include suitable no. of heated capacitance manometer gauges for pressure measurement in the process chamber, lower chamber sections and bubbler lines. ● Internal & External Vacuum pipework shall be provided with electrical heating to 70 °C or higher up to dry pump using external heating pads, heating jackets etc. ● The system shall provide suitable monitoring of chamber pressure, pump operation, and vacuum-system status through the control software.		
7.	Process Gas Delivery & Ozone Generator	● The system shall be supplied with a ventilated gas box accommodating at least five MFC-controlled gas lines, fitted with 5 MFCs as listed below: ○ 3 non-hazardous gas lines, with Viton-sealed MFCs (for O_2, N_2, Ar) ○ 2 hazardous gas lines with Metal sealed MFC and with bypass line (for NH_3, H_2) ● Each gas line shall be provided with an electropneumatic isolation valve, and an in-line filter with a nominal filtration rating of 2 µm or better. ● All Lines should only be made of SS316L electropolished tubes and only VCR fittings to be used on process gas lines. ● The system shall include automatic MFC checking and gas-line leak-checking provisions through the control software. ● The system shall be supplied with one high-concentration ozone generator capable of generating an ozone concentration of approximately 100 g/Nm^3 or higher, suitable for integration with the ALD system. ● The ALD system shall include integrated ozone flow control and monitoring, with provision for controlling ozone delivery & flow as may be required by process. ● The supplier shall include all necessary accessories, connections,		

		interfaces, and components required for complete installation, operation, and integration of the ozone generator with the ALD system.		
8.	ALD Precursor Delivery Cabinet & H_2O vapour Pot for Thermal ALD	● The system shall be supplied with a ventilated precursor delivery cabinet suitable for accommodating at least six independent precursor ports and six independent delivery lines (one line dedicated to each port) extending up to the ALD chamber with dedicated dosing valves for each line. ● Precursor Delivery system shall be configured with necessary dosing hardware & controls systems on four ports and four lines and two spare ports & line spaces should be left empty for future upgrades. ● Each precursor delivery line shall be equipped with a dedicated fast-acting precursor dosing valve and a second fast-acting purge/divert valve, both valves shall be with ultra-fast actuation capability to allow dosing pulsing of a few tens of milliseconds. ● Each Precursor delivery line shall have multiple (2 or more) heating zones to provide a positive temperature gradient along each precursor delivery path up to the chamber. ● All precursor delivery lines, valves and dosing manifold shall be heated up to 200°C temperatures using heater jackets or equivalent arrangements, with independent temperature controls for each line and each heating zone. ● **The cabinet precursor ports shall be configured as follows:** ○ **Two Ar-bubbling precursor ports:** Each port shall accommodate a precursor container with a capacity of at least 150 mL, and configured with controlled heating for up to 150°C or higher and bubbling arrangement. The bubbling arrangement shall support rapid bubbling through an argon diversion system without requiring pressurization of the precursor containers. ○ **One heated vapour-draw precursor port:** The port shall accommodate a vapour-draw precursor container with a capacity of at least 150 mL and configured with controlled heating for up to 150°C or higher. Necessary control valves, MFCs/MFMs as may be required for controlled vapour draw shall be provided. ○ **One cooled vapour-draw precursor port:** The port shall accommodate a vapour-draw precursor container with a capacity of at least 150 mL and configured with Peltier or equivalent cooling capable of achieving a temperature of 15°C or lower. Necessary control valves, MFCs/MFMs as may be required for controlled vapour draw shall be provided. ○ **Two spare ports:** Two port spaces shall remain available for future upgrades. ● The system shall include a dedicated H_2O vapour source port with suitable size H_2O Pot and heated pulsed vapour delivery system for thermal ALD processes. ● A glove panel shall be provided for the precursor cabinet to enable safe handling and changing of the precursor pots.		
9.	Vacuum Load-Lock and Wafer Transfer	● The system shall include a vacuum load-lock, suitable for loading of 4”, 6” and 8” wafers, and wafer pieces of arbitrary shape and size, no less than 3 mm x 3 mm. ● The load-lock shall be connected to the process chamber through an isolation gate valve. ● An independent dry pump with a minimum pumping capacity of 14 m^3/h shall be supplied for the load-lock. ● On initiation of a process request through the control computer, the system shall automatically transfer the wafer from the load-lock to the process chamber, execute the recipe, and return the wafer to the load-lock. ● A soft-pumping and soft-venting mechanism shall be provided to enable gradual evacuation and venting, thereby reducing unwanted wafer		

		movement and particle generation. ● A wafer-tracking sensor shall be provided to monitor wafer presence in load lock. ● The wafer-tracking sensor shall include a software-controlled disable function for authorised users. ● The loading and unloading sequence shall be controlled through the system software, with appropriate interlocks to prevent unsafe transfer operations, and shall allow manual transfer as well.		
10.	Through-the-Wall Installation and Cleanroom Interface	● The system shall be supplied with a cleanroom-compatible interface panel for through-the-wall installation. ● The arrangement shall permit operation of the single-wafer load-lock from an ISO Class 6 cleanroom or substantially equivalent while the remaining equipment is installed in the service chase. ● The cleanroom-side interface shall include: ○ A display screen and cleanroom-compatible keyboard. ○ A system PC interface for equipment monitoring and control. ○ An emergency machine-off (EMO) switch accessible from the cleanroom side. ○ A cleanroom-compatible status light tower. ● The status light tower shall provide the following indications: ○ Red: Alarm or fault. ○ Amber: Idle or standby. ○ Green: System running or busy. ● All mounting hardware, cabling, feedthroughs, and accessories necessary for through-the-wall installation shall be included. ● The wall interface panel shall be sealed and designed to maintain the integrity of the ISO Class 6 or substantially equivalent cleanroom. ● The supplier shall provide installation drawings and define the required wall opening, service clearances, and facility interfaces along with bid.		
11.	Control System and Process Software	● The equipment shall be controlled by a programmable logic controller (PLC)-based system with suitable control software. ● The software shall provide recipe-based and manual operation of the complete system. ● Recipes shall support programmable control of gas flows, power, Ultra-fast dosing of few tens of milliseconds, chamber pressure, electrode temperature, and other available process parameters. ● The software shall include automatic leak-checking and automatic MFC-checking functions. ● The system shall support storage of at least 200 recipes. ● Advanced users shall be able to configure system tolerances through the graphical user interface, subject to the applicable access permissions and safety limits. ● Multiple level password-protected user access levels shall be provided. ● The software shall provide channel-by-channel input/output diagnostics, including operational states such as ON/OFF and fault states such as OK, short circuit, or open circuit, wherever supported by the installed I/O hardware. ● Software shall support a configurable sampling interval of few tens of milliseconds (ms) for process & system data logging. ● Software & Control system shall support to define dosing time in few tens of milliseconds (ms) time intervals. ● All relevant setpoints, measured values, alarms, and equipment status information shall be available for monitoring and logging.		
12.	Data Logging and Graphical Analysis	● The software shall provide graphical visualisation of logged process parameters.		

		● Users shall be able to load and analyse data from multiple process steps and plot selected parameters. ● The graphical analysis tools shall support the following representations: ○ Measured values & setpoints. ○ Measured values together with setpoints. ● The software shall allow multiple Process runs to be loaded and their process parameters to be compared graphically Online and Offline. ● Alarms and alerts associated with the loaded recipe steps shall be displayed alongside the corresponding process data. ● Data shall be exportable in a suitable format for offline analysis and process verification. ● The system shall support a configurable sampling interval in few tens of milliseconds (ms) for process & system data log data.		
13.	Communications and Regulatory Compliance	● System shall be SECS/GEM compliant for semiconductor equipment communication and integration. ● The equipment shall comply with applicable electrical, electromagnetic compatibility (EMC), process gas, and machinery safety standards. Bidders must submit valid **CE conformity** (covering LVD, EMC, and Machinery Directives) **OR** equivalent global/national compliance certifications/test reports from an **ILAC / NABL-accredited** laboratory or recognized third-party evaluator, specifically: 1. **Equipment, Electrical & Machinery Safety:** Third-party evaluation/certification to **SEMI S2**, **UL / ETL (NRTL)**, or **IEC 61010-1** along with **IEC 60204-1 / ISO 12100** (or equivalent **IS/IEC** standards). 2. **Electromagnetic Compatibility (EMC):** Compliance with **IEC 61326-1**, **CISPR 11** (mandatory for RF plasma systems), or **FCC Part 15/18** ● OEM must comply with ISO quality management certification.		
14.	Documentation	● The following documents shall be submitted with the technical bid: ○ Valid ISO certificates for ISO 14001, ISO 45001, ISO 9001 etc. for quality management certification of the manufacturer. ○ Installation and facility requirement documentation. ○ CE Conformity Declaration or as specified above, refer item no. 12 ○ System footprint Drawings along with subsystems ○ Through-the-Wall cleanroom Interface panel drawing ○ Utility requirements, including but not limited to, electrical power, cooling water, compressed air, process gases, and exhaust gas abetment requirements. ● The following documents shall be supplied with the equipment: ○ Complete system operation and maintenance manuals in electronic format. ○ Original equipment manufacturer (OEM) manuals for the major subsystems and components. ○ Electrical, gas, vacuum, and control schematics. ○ Installation, commissioning, and preventive maintenance instructions. ○ Utility requirements, including electrical power, cooling water or coolant, compressed air, process gases, and exhaust requirements. ○ A signed compliance certificate or written undertakings verifying adherence to all material, component, and process requirements must be provided as requested.		

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<td>15.</td>
<td>ALD deposited Oxides Performance and Acceptance Criteria</td>
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The supplier shall demonstrate the performance of the proposed system as below. Also the supplier shall provide starting-point recipes and process trends for other materials.

<table>
<tr><th>Deposited Material</th><th>Al2O3 (Plasma)</th><th>SiO2</th><th>Al2O3 (Thermal)</th><th>TiO2</th><th>HfO2</th></tr>
<tr><td>Precursor</td><td>TMA</td><td>BTBAS</td><td>TMA</td><td>TDMAT</td><td>TDMAHf</td></tr>
<tr><td>Substrate</td><td>Si</td><td>Si</td><td>Si</td><td>Si</td><td>Si</td></tr>
<tr><td>Process Gas</td><td>O_2, Ar</td><td>O_2, Ar</td><td>H_2O, Ar</td><td>O_2, Ar</td><td>O_2, Ar</td></tr>
<tr><td>Precursor Delivery Method</td><td>Cooled /Vapour Draw</td><td>Heated / Vapour Draw</td><td>Water vapour</td><td>Heated - Bubbled</td><td>Heated - Bubbled</td></tr>
<tr><td>Wafer Size</td><td>200mm</td><td>200 mm</td><td>200 mm</td><td>200 mm</td><td>200 mm</td></tr>
<tr><td>Dep rate (nm/hr)</td><td>> 150</td><td>> 100</td><td>> 90</td><td>> 45</td><td>> 78</td></tr>
<tr><td>RI @632.8 nm</td><td>1.64 ± 0.01</td><td>1.45 ± 0.01</td><td>1.66 ± 0.01</td><td>2.41 ± 0.01</td><td>2.01 ± 0.02</td></tr>
<tr><td>Within-Wafer Uniformity</td><td>±1.5%</td><td>±2%</td><td>±2.0%</td><td>±3.0%</td><td>2%</td></tr>
<tr><td>Run-to-Run Uniformity</td><td>±1.0%</td><td>±1.0%</td><td>±1.0%</td><td>±1.0%</td><td>1.0%</td></tr>
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<td>16.</td>
<td>Supplier Qualification Criteria</td>
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The manufacturer should have experience of operating its own cleanroom facility with at least one installed system of the same type as the system being quoted.
The manufacturer's application laboratory shall have at least 5 plasma processing systems and at least 1 process engineer, fully trained to operate the system being quoted.
The manufacturer shall demonstrate its through-the-wall installation capability by providing a functional demonstration of a fully integrated installation either at its own facility or at an operational customer site where a comparable system has previously been installed.
The manufacturer should include the provision for a visit by the client or client’s representative to the factory premises during factory testing, quality assurance review.

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		● The bidder shall provide at least three references for comparable systems supplied to research institutions, universities, or industrial semiconductor facilities that are operational 5 years post installation. ● Spare parts for the quoted system shall be available ex-stock in India for at least seven years from the date of supply. ● The supplier shall confirm that a free-of-charge service hotline has been operational for at least ten years. ● The supplier shall provide the service hotline telephone number, email address, and contact details of the responsible service personnel. ● The guaranteed maximum telephone response time from the OEM (Not by Local Agent/Distributor) shall be 30 minutes or less. ● The guaranteed onsite service response time by an OEM engineer (Not by Local Agent/Distributor), shall be no more than five working days from notification of a service issue.		
17.	Installation, Commissioning, and Acceptance	● Installation and commissioning shall be performed by OEM personnel only. ● The supplier shall coordinate with the purchaser to confirm the installation layout, service-chase requirements, cleanroom interface, and utility connections before delivery. ● The supplier shall provide the required installation drawings, facility specifications, and utility consumption details in advance. ● The supplier shall demonstrate at least three of the requested Deposition processes during commissioning. ● Process acceptance shall include demonstration ALD Oxides Deposition in accordance with the acceptance criteria specified above. ● The supplier shall provide starting-point recipes and process trend information for all requested processes.		
18.	Training	● The OEM Engineer shall provide five days of onsite training after installation and commissioning. ● Training shall be provided for up to three personnel, nominated by IIT Bombay. ● The training shall include: ○ System operation and recipe execution. ○ Recipe creation, parameter adjustment, and process optimisation. ○ Plasma source and substrate bias operation. ○ Vacuum system operation and basic leak checking & troubleshooting. ○ Gas safety ○ System interlocks, emergency shutdown, and safe operating procedures. ○ Process data logging, graphical analysis, and interpretation of process trends. ● Training shall include practical operation of the equipment and execution of representative Deposition processes. ● Training materials and relevant operating instructions shall be provided to the trainees.		
19.	Warranty	● The complete system along with subsystems supplied with the system should have a warranty period of minimum one year.		
20.	Electrical Supply	● The electrical supplies available at the Institute are as follows: ○ Three-phase supply: 400 V (±5%), 50 Hz (±1%). ○ Single-phase supply: 230 V (±5%), 50 Hz (±1%). ● If any power-conditioning equipment, such as a step down or step up voltage transformer, is required to ensure that the equipment supplied by the Vendor operates properly with the electrical supplies available at		

		the Institute, the Vendor shall supply such power-conditioning equipment.		

Item Description: 7. Atomic Layer Deposition System (ALD)/plasma/thermal- Nitrides - (TiN, NbTiN etc.) - [Qty - 1]

Sr. No	Item Description	Detailed Technical Specification	Technical Compliance (Yes / No)	Additional Information (if any)
1.	Process chamber	● The process chamber shall be manufactured from a single solid block of aluminium or other plasma compatible metals/materials with suitable provisions for mounting the plasma source, vacuum pumping system, load-lock, ellipsometer, and other process monitoring accessories. ● The chamber construction shall be free from additional sealing joints or welds. ● The chamber shall be provided with angled ports having a suitable flange size for mounting in situ ellipsometer. ● The chamber shall have an electrically heated inner removable liner arrangement capable of maintaining the inner chamber temperature up to 200 °C or higher. ● The plasma source and chamber pumping arrangement shall be designed with radial symmetry to provide uniform plasma distribution and wafer-scale deposition over a wide range of process parameters. ● The chamber design shall facilitate easy routine cleaning, maintenance, and replacement of internal consumable components without dismantling any process gas line or precursor line joints to open the chamber.		
2.	System Console	● The system console shall accommodate the vacuum valves, and associated control components as required by the equipment design. ● The system shall incorporate comprehensive hardware and software interlocks to protect the equipment against service failures, including loss of cooling water, inadequate compressed air, abnormal vacuum conditions, and any other critical faults. ● Appropriate safety provisions shall be incorporated to protect personnel from electrical hazards during operation and maintenance. ● In the event of a system or utility failure, the equipment shall transition to a safe state and maintain vacuum in chamber. ● The console shall provide convenient access for routine inspection, servicing, and preventive maintenance.		
3.	Substrate Electrode	● The substrate electrode shall be of diameter of at least 225 mm and shall be suitable for processing wafers up to 200 mm (8 inches) in diameter. ● The electrode shall support direct mounting and processing of complete wafers, without requiring carrier wafers or change of full electrode, for wafers of size 4” 6’’ and 8’’. ● The chamber should also allow small irregular wafer pieces to be loaded, using carrier wafers. ● The permissible substrate thickness shall be 5 mm or higher.		

4.	Electrode Heating	● The system shall provide substrate electrode temperature control over the range of +100 °C to +400 °C with ±2 °C temperature uniformity. ● Electrode temperature shall be measured using a thermocouple embedded in the electrode. ● Suitable heater control shall be provided with temperature range of +100°C to + 400 °C. ● The complete temperature range shall be controlled automatically through the process recipe, without requiring manual intervention, when changing between heating setpoints. ● Temperature setpoints, measured values, and relevant alarms shall be accessible through the system control software.		
5.	Plasma ALD Source	● RF generator power and all matching parameters shall be programmable and monitored through the system software. ● The system shall support independent adjustment of plasma source and Bias power. ● The RF system shall include appropriate interlocks to prevent operation under unsafe or out-of-range conditions. ● The system shall be equipped with a remote plasma source suitable for wafer processing up to 200 mm (8 inches).		
5.1	Remote Plasma Source	● Remote plasma source shall have a rated power of at least 600W or higher and shall operate at 13.56 MHz frequency connected to upper electrode. ● An automatic impedance-matching network shall be provided, with vacuum capacitors. ● The matching network shall support the following operating modes: • Automatic impedance matching. • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps. • Fixed capacitor positions, programmable for individual recipe steps.		
5.2	Bias RF Power Supply for the Substrate Electrode	● The substrate electrode shall be powered by an RF generator rated at 300 W or higher and operating at 13.56 MHz. ● The RF power supply shall be coupled with automatic impedance-matching network, with vacuum capacitors. ● The matching network shall support the following operating modes: • Automatic impedance matching. • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps. • Fixed capacitor positions, programmable for individual recipe steps.		
6.	Vacuum System	● A multistage dry pump with a pumping capacity of at least 450 m^3/h shall be supplied for the main chamber roughing and vacuum or an equivalent capacity pumping arrangement via suitable Turbo pumping station. ● The pumping arrangement shall be designed to provide adequate effective pumping speed, and stable pressure control to achieve pressure of ~10^{-3} Torr, or better. ● At least 100 mm or larger automatic throttle valve shall be supplied for process pressure control. The throttle valve shall be suitably sized to avoid unnecessary restriction of the pumping conductance. ● The vacuum system shall include suitable no of heated capacitance manometer gauges for pressure measurement in the process chamber, lower chamber sections and bubbler lines.		

		● Internal & External Vacuum pipework shall be provided with electrical heating to 70 °C or higher up to dry pump using external heating pads, heating jackets etc. ● The system shall provide suitable monitoring of chamber pressure, pump operation, and vacuum-system status through the control software.		
7.	Process Gas Delivery	● The system shall be supplied with a ventilated gas box accommodating at least five MFC-controlled gas lines, fitted with 5 MFCs as listed below: • 3 non-hazardous gas lines, with Viton-sealed MFCs (for O_2, N_2, Ar) • 2 hazardous gas lines with Metal sealed MFC and with bypass line (for H_2, NH_3) ● Each gas line shall be provided with an electropneumatic isolation valve, and an in-line filter with a nominal filtration rating of 2 µm or better. ● All Lines should only be made of SS316L electropolished tubes and only VCR fittings to be used on process gas lines. ● The system shall include automatic MFC checking and gas-line leak-checking provisions through the control software.		
8.	ALD Precursor Delivery Cabinet & H2O vapour Pot for Thermal ALD	● The system shall be supplied with a ventilated precursor delivery cabinet suitable for accommodating at least six independent precursor ports and six independent delivery lines (one line dedicated to each port) extending up to the ALD chamber with dedicated dosing valves for each line. ● Precursor Delivery system shall be configured with necessary dosing hardware & controls systems on four ports and four lines and two spare ports & line spaces should be left empty for future upgrades. ● Each precursor delivery line shall be equipped with a dedicated fast-acting precursor dosing valve and a second fast-acting purge/divert valve, both valves shall be with ultra-fast actuation capability to allow dosing pulsing of a few tens of milliseconds. ● Each Precursor delivery line shall have multiple (2 or more) heating zones to provide a positive temperature gradient along each precursor delivery path up to the chamber. ● All precursor delivery lines, valves and dosing manifold shall be heated up to 200°C temperatures using heater jackets or equivalent arrangements, with independent temperature controls for each line and each heating zone. ● The cabinet precursor ports shall be configured as follows: ○ **Two Ar-bubbling precursor ports**: Each port shall accommodate a precursor container with a capacity of at least 150 mL, and configured with controlled heating for up to 150°C or higher and bubbling arrangement. The bubbling arrangement shall support rapid bubbling through an argon diversion system without requiring pressurization of the precursor containers. ○ **One heated vapour-draw precursor port:** The port shall accommodate a vapour-draw precursor container with a capacity of at least 150 mL and configured with controlled heating for up to 150°C or higher. Necessary control valves, MFCs/MFMs as may be required for controlled vapour draw shall be provided.		

		○ **One cooled vapour-draw precursor port:** The port shall accommodate a vapour-draw precursor container with a capacity of at least 150 mL and configured with Peltier or equivalent cooling capable of achieving a temperature of 15°C or lower. Necessary control valves, MFCs/MFMs as may be required for controlled vapour draw shall be provided. ○ **Two spare ports:** Two port spaces shall remain available for future upgrades. ● The system shall include a dedicated H_2O vapour source port with suitable size H_2O Pot and heated pulsed vapour delivery system for thermal ALD processes. ● A glove panel shall be provided for the precursor cabinet to enable safe handling and changing of the precursor pots.		
9.	Vacuum Load-Lock and Wafer Transfer	● The system shall include a vacuum load-lock, suitable for loading of 4", 6" and 8" wafers, and wafer pieces of arbitrary shape and size, no less than 3 mm x 3 mm. ● The load-lock shall be connected to the process chamber through an isolation gate valve. ● An independent dry pump with a minimum pumping capacity of 14 m^3/h shall be supplied for the load-lock. ● On initiation of a process request through the control computer, the system shall automatically transfer the wafer from the load-lock to the process chamber, execute the recipe, and return the wafer to the load-lock. ● A soft-pumping and soft-venting mechanism shall be provided to enable gradual evacuation and venting, thereby reducing unwanted wafer movement and particle generation. ● A wafer-tracking sensor shall be provided to monitor wafer presence in load lock. ● The wafer-tracking sensor shall include a software-controlled disable function for authorised users. ● The loading and unloading sequence shall be controlled through the system software, with appropriate interlocks to prevent unsafe transfer operations, and shall allow manual transfer as well.		
10.	Through-the-Wall Installation and Cleanroom Interface	● The system shall be supplied with a cleanroom-compatible interface panel for through-the-wall installation. ● The arrangement shall permit operation of the single-wafer load-lock from an ISO Class 6 cleanroom or substantially equivalent while the remaining equipment is installed in the service chase. ● The cleanroom-side interface shall include: • A display screen and cleanroom-compatible keyboard. • A system PC interface for equipment monitoring and control. • An emergency machine-off (EMO) switch accessible from the cleanroom side. • A cleanroom-compatible status light tower. ● The status light tower shall provide the following indications: • Red: Alarm or fault. • Amber: Idle or standby. • Green: System running or busy. ● All mounting hardware, cabling, feedthroughs, and accessories necessary for through-the-wall installation shall be included. ● The wall interface panel shall be sealed and designed to maintain the integrity of the ISO Class 6 or substantially equivalent cleanroom. ● The supplier shall provide installation drawings and define the required wall opening, service clearances, and facility interfaces along with bid.		

11.	Control System and Process Software	● The equipment shall be controlled by a programmable logic controller (PLC)-based system with suitable control software. ● The software shall provide recipe-based and manual operation of the complete system. ● Recipes shall support programmable control of gas flows, power, Ultra-fast dosing of few tens of milliseconds, chamber pressure, electrode temperature, and other available process parameters. ● The software shall include automatic leak-checking and automatic MFC-checking functions. ● The system shall support storage of at least 200 recipes. ● Advanced users shall be able to configure system tolerances through the graphical user interface, subject to the applicable access permissions and safety limits. ● Multiple level password-protected user access levels shall be provided. ● The software shall provide channel-by-channel input/output diagnostics, including operational states such as ON/OFF and fault states such as OK, short circuit, or open circuit, wherever supported by the installed I/O hardware. ● Software & Control system shall support to define dosing time in few tens of milliseconds (ms) time intervals. ● Software shall support a configurable sampling interval of few tens of milliseconds (ms) for process & system data logging. ● All relevant setpoints, measured values, alarms, and equipment status information shall be available for monitoring and logging.		
12.	Data Logging and Graphical Analysis	● The software shall provide graphical visualisation of logged process parameters. ● Users shall be able to load and analyse data from multiple process steps and plot selected parameters. ● The graphical analysis tools shall support the following representations: • Measured values & setpoints. • Measured values together with setpoints. ● The software shall allow multiple Process runs to be loaded and their process parameters to be compared graphically Online and Offline. ● Alarms and alerts associated with the loaded recipe steps shall be displayed alongside the corresponding process data. ● Data shall be exportable in a suitable format for offline analysis and process verification. ● The system shall support a configurable sampling interval in few tens of milliseconds (ms) for process & system data log data.		
13.	Communications and Regulatory Compliance	● System The shall be SECS/GEM compliant for semiconductor equipment communication and integration. ● The equipment shall comply with applicable electrical, electromagnetic compatibility (EMC), process gas, and machinery safety standards. Bidders must submit valid **CE conformity** (covering LVD, EMC, and Machinery Directives) **OR** equivalent global/national compliance certifications/test reports from an **ILAC / NABL-accredited** laboratory or recognized third-party evaluator, specifically: 1. **Equipment, Electrical & Machinery Safety:** Third-party evaluation/certification to **SEMI S2**, **UL / ETL (NRTL)**, or **IEC 61010-1** along with **IEC 60204-1 / ISO 12100** (or equivalent **IS/IEC** standards). 2. **Electromagnetic Compatibility (EMC):** Compliance with **IEC 61326-1**, **CISPR 11** (mandatory for RF plasma systems), or **FCC Part 15/18** ● OEM must comply with ISO quality management certification.		

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<td>14.</td>
<td>Documentation</td>
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The following documents shall be submitted with the technical bid:
• Valid ISO certificates for ISO 14001, ISO 45001, ISO 9001 etc. for quality management certification of the manufacturer.
• Installation and facility requirement documentation.
• CE Conformity Declaration or as specified above, refer item no. 12
• System footprint Drawings along with subsystems
• Through-the-Wall cleanroom Interface panel drawing
• Utility requirements, including but not limited to, electrical power, cooling water, compressed air, process gases, and exhaust gas abetment requirements.
The following documents shall be supplied with the equipment:
• Complete system operation and maintenance manuals in electronic format.
• Original equipment manufacturer (OEM) manuals for the major subsystems and components.
• Electrical, gas, vacuum, and control schematics.
• Installation, commissioning, and preventive maintenance instructions.
• Utility requirements, including electrical power, cooling water or coolant, compressed air, process gases, and exhaust requirements.
• A signed compliance certificate or written undertakings verifying adherence to all material, component, and process requirements must be provided as requested.

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<td>15.</td>
<td>ALD deposited Nitrides Performance and Acceptance Criteria</td>
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The supplier shall demonstrate the performance of the proposed system as below. Also the supplier shall provide starting-point recipes and process trends for other materials.

<table>
<tr><th>Material</th><th>NbN</th><th>NbTiN</th><th>TiN</th><th>AlN</th></tr>
<tr><td>Precursor</td><td>TBTDEN</td><td>TBTDEN & TDMAT</td><td>TiCl4</td><td>TMA</td></tr>
<tr><td>Process Gas</td><td>N2, H2, Ar</td><td>N2, H2, Ar</td><td>NH3, H2, Ar</td><td>NH3 or N2, H2, Ar</td></tr>
<tr><td>Precursor Delivery Method</td><td>Heated, Bubbled</td><td>Heated, Bubbled</td><td>Heated-Vapour Draw</td><td>Cooled, Vapour Draw</td></tr>
<tr><td>Substrate</td><td>Si</td><td>Si</td><td>Si</td><td>Si</td></tr>
<tr><td>Wafer Size</td><td>200mm</td><td>200mm</td><td>200mm</td><td>200mm</td></tr>
<tr><td>Dep rate (nm/hr)</td><td>> 25</td><td>Tunable from bulk NbN to TiN via Nb:Ti ratio</td><td>> 19 nm</td><td>> 35</td></tr>
<tr><td>RI @632.8 nm</td><td>2.1 ± 0.1</td><td>Tunable from bulk NbN to TiN via Nb:Ti ratio</td><td>1.4 ± 0.1</td><td>> 1.95</td></tr>
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			Resistivity (μΩ.cm)	< 250 @ 50 nm	Tunable from bulk NbN to TiN via Nb:Ti ratio	< 120 @ 50 nm	-
			Tc	> 10 K	Tunable from bulk NbN to TiN via Nb:Ti ratio	> 4.2 K	-
			Within-Wafer Uniformity	±5%	±5%	±5 %	±3.0%
			Run-to-Run Uniformity	±3.0%	±3.0%	±3 %	±2.0%
16.	Supplier Qualification Criteria	● The manufacturer should have experience of operating its own cleanroom facility with at least one installed system of the same type as the system being quoted. ● The manufacturer's application laboratory shall have at least 5 plasma processing systems and at least 1 process engineer, fully trained to operate the system being quoted. ● The manufacturer shall demonstrate its through-the-wall installation capability by providing a functional demonstration of a fully integrated installation either at its own facility or at an operational customer site where a comparable system has previously been installed. ● The manufacturer should include the provision for a visit by the client or client's representative to the factory premises during factory testing, quality assurance review. ● The bidder shall provide at least three references for comparable systems supplied to research institutions, universities, or industrial semiconductor facilities that are operational 5 years post installation. ● Spare parts for the quoted system shall be available ex-stock in India for at least seven years from the date of supply. ● The supplier shall confirm that a free-of-charge service hotline has been operational for at least ten years. ● The supplier shall provide the service hotline telephone number, email address, and contact details of the responsible service personnel. ● The guaranteed maximum telephone response time from the OEM (Not by Local Agent/Distributor) shall be 30 minutes or less. ● The guaranteed onsite service response time by an OEM engineer (Not by Local Agent/Distributor), shall be no more than five working days from notification of a service issue.					
17.	Installation, Commissioning, and Acceptance	● Installation and commissioning shall be performed by OEM personnel only. ● The supplier shall coordinate with the purchaser to confirm the installation layout, service-chase requirements, cleanroom interface, and utility connections before delivery. ● The supplier shall provide the required installation drawings, facility specifications, and utility consumption details in advance. ● The supplier shall demonstrate at least three of the requested					

		Deposition processes during commissioning. ● Process acceptance shall include demonstration ALD Nitrides Deposition in accordance with the acceptance criteria specified above. ● The supplier shall provide starting-point recipes and process trend information for all requested processes.		
18.	Training	● The OEM Engineer shall provide five days of onsite training after installation and commissioning. ● Training shall be provided for up to three personnel, nominated by IIT Bombay. ● The training shall include: • System operation and recipe execution. • Recipe creation, parameter adjustment, and process optimisation. • Plasma source and substrate bias operation. • Vacuum system operation and basic leak checking & troubleshooting. • Gas safety • System interlocks, emergency shutdown, and safe operating procedures. • Process data logging, graphical analysis, and interpretation of process trends. • Training shall include practical operation of the equipment and execution of representative Deposition processes. • Training materials and relevant operating instructions shall be provided to the trainees.		
19.	Warranty	● The complete system along with subsystems supplied with the system should have a warranty period of minimum one year.		
20.	Electrical Supply	● The electrical supplies available at the Institute are as follows: • Three-phase supply: 400 V (±5%), 50 Hz (±1%). • Single-phase supply: 230 V (±5%), 50 Hz (±1%). ● If any power-conditioning equipment, such as a step down or step up voltage transformer, is required to ensure that the equipment supplied by the Vendor operates properly with the electrical supplies available at the Institute, the Vendor shall supply such power-conditioning equipment.		

Item Description: 8. Plasma_Enhanced Chemical Vapour Deposition (PECVD)-Dielectric SiN/SiO2 – [Qty - 2]

Sr. No	Item Description	Detailed Technical Specification	Technical Compliance (Yes / No)	Additional Information (if any)
1.	Process chamber	● The process chamber shall be manufactured from a single solid block of aluminium or other plasma compatible metals/materials with suitable provisions for mounting the plasma source, vacuum pumping system, load-lock, viewport, and process monitoring accessories. ● The chamber construction shall be free from additional sealing joints or welds. ● The chamber shall be provided with a viewport having a flange size of at least KF40 together, with a suitable RF shielded plasma viewing arrangement.		

		● Optical emission spectroscopy (OES) endpoint or equivalent end point monitoring shall be provided for in-situ plasma cleaning. ● The chamber shall have an electrical heating arrangement capable of maintaining the chamber temperature up to 60 °C or higher using external heating pads, heating jackets etc. ● The plasma source and chamber pumping arrangement shall be designed with radial symmetry to provide uniform plasma distribution and wafer-scale deposition over a wide range of process parameters. ● The chamber design shall facilitate easy routine cleaning, maintenance, and replacement of internal consumable components without breaking any process gas line joints to open the chamber.		
2.	System Console	● The system console shall accommodate the vacuum valves, and associated control components as required by the equipment design. ● The system shall incorporate comprehensive hardware and software interlocks to protect the equipment against service failures, including loss of cooling water, inadequate compressed air, abnormal vacuum conditions, and any other critical faults. ● Appropriate safety provisions shall be incorporated to protect personnel from electrical hazards during operation and maintenance. ● In the event of a system or utility failure, the equipment shall transition to a safe state and maintain vacuum in chamber. ● The console shall provide convenient access for routine inspection, servicing, and preventive maintenance.		
3.	Substrate Electrode	● The substrate electrode shall be of diameter of at least 225 mm and shall be suitable for processing wafers up to 200 mm (8 inches) in diameter. ● The electrode shall support direct mounting and processing of complete wafers, without requiring carrier wafers or change of full electrode, for wafers of size 4”, 6’’ and 8’’. ● The chamber should also allow small irregular wafer pieces to be loaded, using carrier wafers. ● The permissible substrate thickness shall be 5 mm or higher. ● The electrode shall be designed without seals or O-rings in the wafer heating interface.		
4.	Electrode Heating	● The system shall provide substrate electrode temperature control over the range of +100 °C to +400 °C with ±2 °C temperature uniformity. ● Electrode temperature shall be measured using a thermocouple embedded in the electrode. ● Suitable heater control shall be provided with temperature range of +100°C to + 400 °C. ● The complete temperature range shall be controlled automatically through the process recipe, without requiring manual intervention, when changing between heating setpoints. ● Temperature setpoints, measured values, and relevant alarms shall be accessible through the system control software.		
5.	Plasma Source	● RF generator powers and all matching parameters shall be programmable and monitored through the system software. ● The RF system shall include appropriate interlocks to prevent operation under unsafe or out-of-range conditions.		

		● The system shall be equipped with dual frequency plasma source suitable for wafer processing up to 200 mm (8 inches) with active stress control. ● The plasma source shall provide capacitively coupled plasma RF generators connected showerhead electrode and grounded table electrode. ● The system shall support independent adjustment of High Frequency (HF) and Low frequency (LF) generators power. ● System shall allow to run HF and LF generators to work in alternating pulsing with user selectable plus timings in recipes.		
5.1	High Frequency Plasma Source (HF Generator)	● The High Frequency RF generator shall have a rated power of at least 600W or higher and shall operate at 13.56 MHz frequency connected to upper showerhead electrode. ● An automatic impedance-matching network shall be provided, with vacuum capacitors. ● The matching network shall support the following operating modes: • Automatic impedance matching. • Automatic matching with pre-set capacitor positions, programmable for individual recipe steps. • Fixed capacitor positions, programmable for individual recipe steps.		
5.2	Low Frequency Plasma Source (LF Generator)	● The Upper electrode shall also be connected to a 2^{nd} Low Frequency RF generator rated at 300 W or higher and operating at lower frequency in KHz range for stress control via a suitable impedance matching network.		
6.	Vacuum System	● A multistage dry pump with a pumping capacity of at least 450 m^3/h shall be supplied for the main chamber roughing and vacuum or an equivalent capacity pumping arrangement via suitable Turbo pumping station may be supplied. ● The pumping arrangement shall be designed to provide adequate effective pumping speed, and stable pressure control to achieve ultimate chamber pressure of ~10^{-5} Torr, or lower. ● A 100 mm automatic throttle valve shall be supplied for process pressure control. The throttle valve shall be suitably sized to avoid unnecessary restriction of the pumping conductance. ● The vacuum system shall include a heated capacitance manometer suitable for pressure measurement of up to 2 Torr. ● Internal vacuum pipework shall be provided with electrical heating to 60 °C or higher. ● The system shall provide suitable monitoring of chamber pressure, pump operation, and vacuum-system status through the control software.		
7.	Process Gas Delivery Gas Box	● The system shall be supplied with a ventilated gas box accommodating at least eight MFC-controlled gas lines, fitted with 6 Mass flow controllers (MFCs) as listed below: • 4 non-hazardous gas lines, with Viton-sealed MFCs (for Ar, N_2, N_2O, CF_4) • 2 hazardous gas lines with Metal sealed MFC and with bypass line (for SiH_4, NH_3) ● Each gas line shall be provided with an electropneumatic isolation valve, and an in-line filter with a nominal filtration rating of 2 µm or better.		

		● All Lines should only be made of SS316L electropolished tubes and only Vacuum Coupling Radiation (VCR) fittings to be used on process gas lines. ● The gas box shall be designed to permit the addition of up to four further gas lines in future. ● The system shall include automatic MFC checking and gas-line leak-checking provisions through the control software.		
8.	Vacuum Load-Lock and Wafer Transfer	● The system shall include a vacuum load-lock, suitable for loading of 4", 6" and 8" wafers, and wafer pieces of arbitrary shape and size, no less than 3 mm x 3 mm. ● The load-lock shall be connected to the process chamber through an isolation gate valve. ● An independent dry pump with a minimum pumping capacity of 14 m^3/h shall be supplied for the load-lock. ● On initiation of a process request through the control computer, the system shall automatically transfer the wafer from the load-lock to the process chamber, execute the recipe, and return the wafer to the load-lock. ● A soft-pumping and soft-venting mechanism shall be provided to enable gradual evacuation and venting, thereby reducing unwanted wafer movement and particle generation. ● A wafer-tracking sensor shall be provided to monitor wafer presence in load lock. ● The wafer-tracking sensor shall include a software-controlled disable function for authorised users. ● The loading and unloading sequence shall be controlled through the system software, with appropriate interlocks to prevent unsafe transfer operations, and shall allow manual transfer as well.		
9.	Through-the-Wall Installation and Cleanroom Interface	● The system shall be supplied with a cleanroom-compatible interface panel for through-the-wall installation. ● The arrangement shall permit operation of the single-wafer load-lock from an ISO Class 6 cleanroom or substantially equivalent while the remaining equipment is installed in the service chase. ● The cleanroom-side interface shall include: • A display screen and cleanroom-compatible keyboard. • A system PC interface for equipment monitoring and control. • An emergency machine-off (EMO) switch accessible from the cleanroom side. • A cleanroom-compatible status light tower. ● The status light tower shall provide the following indications: • Red: Alarm or fault. • Amber: Idle or standby. • Green: System running or busy. ● All mounting hardware, cabling, feedthroughs, and accessories necessary for through-the-wall installation shall be included. ● The wall interface panel shall be sealed and designed to maintain the integrity of the ISO Class 6 or substantially equivalent cleanroom. ● The supplier shall provide installation drawings and define the required wall opening, service clearances, and facility interfaces along with bid.		
10.	Control System and Process Software	● The equipment shall be controlled by a programmable logic controller (PLC)-based system with suitable control software.		

		● The software shall provide recipe-based and manual operation of the complete system. ● Recipes shall support programmable control of gas flows, HF power & LF power pulsing, chamber pressure, electrode temperature, and other available process parameters. ● The software shall include automatic leak-checking and automatic MFC-checking functions. ● The system shall support storage of at least 200 recipes. ● Advanced users shall be able to configure system tolerances through the graphical user interface, subject to the applicable access permissions and safety limits. ● Multiple level password-protected user access levels shall be provided. ● The software shall provide channel-by-channel input/output diagnostics, including operational states such as ON/OFF and fault states such as OK, short circuit, or open circuit, wherever supported by the installed I/O hardware. ● Software shall support a configurable sampling interval of few tens of milliseconds (ms) for process & system data logging. ● All relevant setpoints, measured values, alarms, and equipment status information shall be available for monitoring and logging.		
11.	Data Logging and Graphical Analysis	● The software shall provide graphical visualisation of logged process parameters. ● Users shall be able to load and analyse data from multiple process steps and plot selected parameters. ● The graphical analysis tools shall support the following representations: • Measured values & setpoints. • Measured values together with setpoints. ● The software shall allow multiple Process runs to be loaded and their process parameters to be compared graphically Online and Offline. ● Alarms and alerts associated with the loaded recipe steps shall be displayed alongside the corresponding process data. ● Data shall be exportable in a suitable format for offline analysis and process verification. ● The system shall support a configurable sampling interval in few tens of milliseconds (ms) for process & system data log data.		
12.	Communications and Regulatory Compliance	● System The shall be SECS/GEM compliant for semiconductor equipment communication and integration. ● The equipment shall comply with applicable electrical, electromagnetic compatibility (EMC), process gas, and machinery safety standards. Bidders must submit valid **CE conformity** (covering LVD, EMC, and Machinery Directives) **OR** equivalent global/national compliance certifications/test reports from an **ILAC / NABL-accredited** laboratory or recognized third-party evaluator, specifically: 1. **Equipment, Electrical & Machinery Safety:** Third-party evaluation/certification to **SEMI S2**, **UL / ETL (NRTL)**, or **IEC 61010-1** along with **IEC 60204-1 / ISO 12100** (or equivalent **IS/IEC** standards). 2. **Electromagnetic Compatibility (EMC):** Compliance with **IEC 61326-1**, **CISPR 11** (mandatory for RF plasma systems), or **FCC Part 15/18** ● OEM must comply with ISO quality management certification.		

13.	Documentation	● The following documents shall be submitted with the technical bid: • Valid ISO certificates for ISO 14001, ISO 45001, ISO 9001 etc. for quality management certification of the manufacturer. • Installation and facility requirement documentation. • CE Conformity Declaration or as specified above, refer item no. 12 • System footprint Drawings along with subsystems • Through-the-Wall cleanroom Interface panel drawing • Utility requirements, including but not limited to, electrical power, cooling water, compressed air, process gases, and exhaust gas abetment requirements. ● The following documents shall be supplied with the equipment: • Complete system operation and maintenance manuals in electronic format. • Original equipment manufacturer (OEM) manuals for the major subsystems and components. • Electrical, gas, vacuum, and control schematics. • Installation, commissioning, and preventive maintenance instructions. • Utility requirements, including electrical power, cooling water or coolant, compressed air, process gases, and exhaust requirements. • A signed compliance certificate or written undertakings verifying adherence to all material, component, and process requirements must be provided as requested.		

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<td>14.</td>
<td>Thin films deposition of SiN & SiO2 Performance and Acceptance Criteria</td>
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The supplier shall demonstrate the performance of the proposed system as below. Also the supplier shall provide starting-point recipes and process trends for other materials.
<table>
<tr><th>Process Reference</th><th>SiO_2 Deposition</th><th>SiN Deposition</th></tr>
<tr><td>Wafer Size (mm)</td><td>Up to 200 mm</td><td>Up to 200 mm</td></tr>
<tr><td>Deposition Rate (nm/min)</td><td>> 40 nm/min</td><td>> 10 nm/min</td></tr>
<tr><td>Within-Wafer Thickness Uniformity</td><td>< ±4% for 200 mm</td><td>< ±4% for 200 mm</td></tr>
<tr><td>Run-to-Run Thickness Repeatability</td><td>< ±3%</td><td>< ±3%</td></tr>
<tr><td>Refractive Index</td><td>1.46 (controllable: 1.46–1.50)</td><td>1.98 (controllable 1.96 - 2.10)</td></tr>
<tr><td>Within Wafer Refractive Index Uniformity</td><td>< ± 0.01</td><td>< ± 0.01</td></tr>
<tr><td>Run-to-Run Refractive Index Repeatability</td><td>< ± 0.01</td><td>< ± 0.01</td></tr>
<tr><td>Film Stress (MPa)</td><td>< −300 MPa compressive</td><td>< 300 MPa tensile (high-frequency-only process); & < ±50 MPa (dual-frequency process)</td></tr>
<tr><td>Wet Etch Rate Using 7:1 BHF at 20 °C</td><td>< 350 nm/min at 300 °C (high-frequency processes)</td><td>100–150 nm/min at 300 °C (high-frequency processes); < 30 nm/min at > 350 °C</td></tr>
<tr><td>Breakdown Voltage (MV/cm)</td><td>> 5 MV/cm at ≥ 300 °C</td><td>> 5 MV/cm at ≥ 300 °C</td></tr>
<tr><td>Step Coverage (1:1 Aspect Ratio)</td><td>> 50% for a straight, smooth, vertical feature</td><td>> 50% for a straight, smooth, vertical feature</td></tr>
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<td>15.</td>
<td>Supplier Qualification Criteria</td>
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The manufacturer should have experience of operating its own cleanroom facility with at least one installed system of
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		the same type as the system being quoted. ● The manufacturer's application laboratory shall have at least 5 plasma processing systems and at least 1 process engineer, fully trained to operate the system being quoted. ● The manufacturer shall demonstrate its through-the-wall installation capability by providing a functional demonstration of a fully integrated installation either at its own facility or at an operational customer site where a comparable system has previously been installed. ● The manufacturer should include the provision for a visit by the client or client's representative to the factory premises during factory testing, quality assurance review. ● The bidder shall provide at least seven references for comparable systems supplied to research institutions, universities, or industrial semiconductor facilities that are operational 5 years post installation. ● Spare parts for the quoted system shall be available ex-stock in India for at least seven years from the date of supply. ● The supplier shall confirm that a free-of-charge service hotline has been operational for at least ten years. ● The supplier shall provide the service hotline telephone number, email address, and contact details of the responsible service personnel. ● The guaranteed maximum telephone response time from the OEM (Not by Local Agent/Distributor) shall be 30 minutes or less. ● The guaranteed onsite service response time by an OEM engineer (Not by Local Agent/Distributor), shall be no more than five working days from notification of a service issue.		
16.	Installation, Commissioning, and Acceptance	● Installation and commissioning shall be performed by OEM personnel only. ● The supplier shall coordinate with the purchaser to confirm the installation layout, service-chase requirements, cleanroom interface, and utility connections before delivery. ● The supplier shall provide the required installation drawings, facility specifications, and utility consumption details in advance. ● The supplier shall demonstrate at least three of the requested Deposition processes during commissioning. ● Process acceptance shall include demonstration of SiO_2 and SiN_x Deposition in accordance with the acceptance criteria specified above. ● The supplier shall provide starting-point recipes and process trend information for all requested processes.		
17.	Training	● The OEM Engineer shall provide five days of onsite training after installation and commissioning. ● Training shall be provided for up to three personnel, nominated by IIT Bombay. ● The training shall include: • System operation and recipe execution. • Recipe creation, parameter adjustment, and process optimisation. • Plasma source and substrate bias operation. • Vacuum system operation and basic leak checking & troubleshooting. • Gas safety • System interlocks, emergency shutdown, and safe operating procedures.		

		• Process data logging, graphical analysis, and interpretation of process trends. ● Training shall include practical operation of the equipment and execution of representative Deposition processes. ● Training materials and relevant operating instructions shall be provided to the trainees.		
18.	Warranty	● The complete system along with subsystems supplied with the system should have a warranty period of minimum one year.		
19.	Electrical Supply	● The electrical supplies available at the Institute are as follows: • Three-phase supply: 400 V (±5%), 50 Hz (±1%). • Single-phase supply: 230 V (±5%), 50 Hz (±1%). ● If any power-conditioning equipment, such as a step down or step up voltage transformer, is required to ensure that the equipment supplied by the Vendor operates properly with the electrical supplies available at the Institute, the Vendor shall supply such power-conditioning equipment.		