

Detailed Specifications of Open Tender Notice No: 29/2013

S. N.	TENDER NO.	BRIEF DETAILS OF ITEM(S)	PAGE NOS.
1.	14-VI/SK(732)13-PB/T-116	Fully Automatic Hot Isostatic Press	2-3
2.	14-III/PK(458)13-PB/T-117	ICP-RIE system for etching of silicon	4-6
3.	14-VII/G(2414)13-PB/T-118	Low Temperature Transport Measurement System (LTTM)	7-8
4.	14-VII/CMSR(2415)13-PB/T-119	Sputtering Unit	9-12

Fully automatic Hot Isostatic Press

Broad Specifications/Special Features (essential) :

To make uniform density carbon composite materials under isostatic pressure and controlled temperature .

1. Working Pressure : 30,000 PSI (~ 200 MPa)
2. Working Temperature : Minimum upto 1200°C
3. Internal diameter of Pressing vessel : 8 to 10 inches (200 - 250 mm)
4. Length of the Pressure vessel : 25 - 30 inches (625 -750 mm)
5. Vessel Type : ASME coded vessel with suitable closure type
6. Hot Zone : 100 mm dia. X 250 mm length
7. Pressure measurement & Control : With standard transducer & auto-tuned PID controller with less than $\pm 1\%$ accuracy
8. Temperature measurement & control: should be done by fully autotuned PID controller with less than $\pm 2^\circ$ C accuracy
9. Safety Precaution : The system should be compatible to ASTM safety standards
10. CONTROLS : Fully automatic, Pentium Quad Core based computer with 19 inch LCD monitor, 4 GB RAM, 1TB HDD, latest windows operating software. User friendly on-line software to control the complete system along with graphical display and facility to save the data in user defined file in ASC II format.

11. POWER SUPPLY : Suitable power supply for controlling the temperature of furnace.
12. COMPRESSOR : Suitable electro-hydraulic compressor for maintaining the pressure up to 30,000 psi (200 MPa)
13. PIPING : Suitable high pressure valves and associated fittings to sustain maximum pressure of 30000 psi (200 MPa).
14. VACUUM SYSTEM : Suitable vacuum system with associated fittings, valves and gauges
15. FURNACE : Furnace with a minimum working temperature of 1200° C with proper insulation and external water cooling jacket.
16. COOLING : Suitable closed loop cooling system with reservoir, pump and heat exchanger along with chiller
17. SPARES : One set of spare parts (all Fuses, 20 sets of O-rings, 10 liters Lubricant, 2 sets of suitable Thermocouples & Rupture disks)
18. INSTALLATION, COMMISSIONING and TRAINING should be provided on site with full satisfaction of NPL staff so that hot iso-static moulds can be prepared independently. Complete sets of drawings and operator manuals should be provided.
19. Warranty : Two years after installation commissioning and training
20. System should operate on three phase 440V ±10%, 50 Hz ± 5% (for three phase equipment) and on single phase 230V ±10%, 50 Hz ± 5% (for single phase equipment).
21. Company should provide upgraded software for five years free of cost.
22. Company should ensure the availability of spares for ten years.
23. Company should provide the list of users along-with contact persons in India as well as abroad.

Optional

- Extended warranty for 5 years.
- AMC

Specifications for ICP-RIE system

An ICP-RIE system with Bosch Process for etching of silicon, poly silicon, SiO₂, SiN_x must consist of following features:

A. Process chamber and vacuum assembly:

- Process chamber made of corrosion resistance Aluminum with view port and plasma shield (RF safety) – preferably machined from a single block to provide the best vacuum integrity. The chamber should be compatible with corrosive gases like Cl₂ and NH₃, CF₄, C₄F₈.
- Provision for feed throughs / view port for installation of optical emission spectroscopy or end point detection system in future.
- Vacuum system -anticorrosive turbo-molecular pump with compatible backing pump (with Fomblin oil and exhaust side filter) (standard make such as Pfeiffer, Edwards, Leybold, Alcatel, VAT, Ebara) with high conductance connection to main chamber with gate valve. Base pressure equal to or better than 10⁻⁶ mbar achievable in 60 min.
- Combination gauges for vacuum measurement from atmosphere to 10⁻⁸ mbar in process and atmosphere to 10⁻³ mbar in load lock chamber
- Automatic pressure process control in process chamber.
- Load lock system (fully automatic) with suitable wafer transfer (loading and unloading of single wafer) and compatible gate valve with dedicated dry pump and pressure gauge.
- Manual override option for loading /unloading and system operation.

B. Substrate holder /electrode :

- Substrate electrode with suitable wafer clamping arrangement to handle up to 8” wafers and provision for handling 4”, 2” and smaller pieces .
- Helium back side cooling.
- Preferable temperature range of operation: 10 °C to + 60 °C with temperature stability ± 3 °C. Dynamic temperature control with necessary heating and cooling arrangements like necessary heaters/chillers/circulators.
- Proper insulation of tubing, and other involved components should be provided to prevent condensation for low temperature operation.

C. Plasma sources:

- Inductively coupled plasma (ICP) source with integrated automatic matching network, Power variation from 100 W up to 1kW or more, suitable frequency for Si-etching. Proper cooling arrangements (air cooled preferred) for the source.
- Necessary RF biasing for substrate (Power 300W or more and 13.56 MHz frequency) with cooling and automatic matching network.

D. Gas manifold and scrubber:

- Provision for 6 lines for CF₄, C₄F₈, SF₆, Ar, O₂, CHF₃ gases.
- Provision for future expansion to two more gas lines (maximum of 8 gas lines).
- Each gas line with mass flow controllers (MFCs), particle filters, bypass for corrosive gas and cut-off valves and all necessary gas manifolds with VCR compatible.
- Suitable dry scrubber for gases used in silicon etching

E. Process demonstration

Silicon etching process should be demonstrated to show the following

- Uniformity (tolerance $\pm 5\%$) across 8" silicon wafer on a given pattern.
- Reproducibility: $\pm 4\%$ (run to run).
- Vertical side walls smoothness: ≤ 75 nm, vertical alignment/profile: $90^\circ \pm 2^\circ$
- Selectivity (using resist and SiO₂ etch mask) : 3:1 (PR) in continuous process and 20:1 (PR) in Bosch process.
- Aspect ratio for a defined mask: 10:1 (silicon structure), open area: $\sim 50 \pm 10\%$.
- Participating vendors should also submit silicon samples etched on the ICP-RIE system offered by them to validate the above mentioned process capabilities along with process details (PR make, mask layer thickness, coating parameters and ICP process parameter along with profile pictures before and after processing). The mask geometry should be capable of making $2 \mu\text{m} \times 2 \mu\text{m}$ etched silicon pillars at a distance of $0.5 \mu\text{m}$ of $10 \mu\text{m}$ height.

F. Controls systems:

Compact control system operable through PC/touch panel units with all operating systems, systems monitors and parameter displays, Recipes and recipe editors, Automatic and manual control, Password protected system access. All basic safety interlocks and extended error diagnostics.

G. Mains supply specifications:

The system should have compact power-supply distribution box for different parts of the system with electrical interface between ICP etcher and user power supply. Power inputs should be compatible with Indian electrical standard (3-phase 380-415 V; 50Hz $\pm 5\%$ power supply)

H. Training and Installations:

Pre-shipment User Training Charges at supplier's overseas facility/site for NPL personnel(s) must be offered separately.

However, cost of to & fro Travel and boarding/lodging expenses shall be borne by NPL, if so desired by NPL.

Installation, Commissioning and on-site Training at NPL must be done free of charge including all process requirements to be demonstrated as per details given in "E" above during installation for process acceptance at NPL

I. General:

- Site preparation and various infrastructural requirements and essential utilities such as power, cooling water, gases, etc. must be explicitly mentioned in the Technical Bid.
- Comprehensive warranty for one year or more after Installation, Commissioning, Training & Acceptability Test must be offered.
- List of users having similar systems installed and operational in India and abroad in R&D or Academic Institutes/ Universities/ Semiconductor Industry with contact details must be given in the Technical Bid.
- Guarantee for after sales support for minimum of 5 years must be provided.
- The technical bid should include relevant technical notes as well as published papers based on this machine for etching the materials stated in item D.
- Foot print and added space requirement must be given in the technical documents.
- Availability of local customer support and service, engineering support for on-site maintenance and repairs in India is mandatory.
- Detailed service, operation and maintenance manuals with drawings should be provided in soft and hard format. One set of printed manuals compatible to clean room should also be given.
- All items should be sourced from the Original Equipment Manufacturer(s).
- System and sub-systems should be CE certified and should be clean room compatible.

J. Optional items as under should be quoted separately:

- Optical emission spectroscopy for process control
- End point detection system/LSR
- Optical fiber wafer temperature sensor (-100 °C to +300 °C)
- LN2 Tank, 120 litre with liquid gas supply, connection accessories.
- AMC Charges after expiry of Warranty Period with details & scope.
- Consumables for 3 years.
- List of recommended Spares for one year along with qty. & unit rates.

Technical Specifications of “Low Temperature Transport Measurement System”

A Cryogen Free Magnet System with Integrated Variable Temperature Insert with Optical Windows.

A. Magnet System

1. Superconducting split magnet (cryogen free) + 7 Tesla to -7 Tesla with compatible power supply.
2. The field homogeneity should be 1% (or better) over 1cm diameter
3. Magnet cool down time should be ≤ 24 hrs.
4. Magnet should be fully protected against the power failures and the accidental quench.
5. Provision for persistent mode of magnet operation.

B. Variable Temperature Insert

6. Cryogen free variable temperature insert (VTI) with 25mm diameter sample space having following specifications:
 - Temperature range 2K to 400K (or wider at both ends)
 - Temperature stability of 25mK (or better) for temperature below 10K, 50mK (or better) for temperature range 10-50K and 100mK for temperature range 50K to 300K
7. VTI should allow continuous measurement in presence of field at any fixed temperature in the entire temperature range.
8. Heat exchanger based control of temperature employing a suitable temperature controller with auto tune, closed loop digital PID (0.1 setting resolution), ramp control mode (0.1K per min to 10K per min or more) and magnetic field compatible (0-7T) thermometer at appropriate places.
9. Sample cool down time from 325K to 2K should be ≤ 2 hrs.

C. Cryo cooler & cryostat

10. Pulse tube based Cryo cooler - cryostat system compatible to cool the superconducting magnet to liquid Helium temperature and VTI down to 2K with following feature
11. System should have an anti-vibration support.
12. Suitable pumping system, safety valves, gauges and associated accessory should be included.
13. Cooling capacity ≥ 1 W at 4.2K.

D. Optical Access to Sample in VTI

14. VTI should be fitted with Optical windows - 4 in nos, diameter ≥ 15 mm providing line of sight to the sample both parallel and perpendicular to the magnetic field.
15. Windows should be made of compatible material to perform photoluminescence measurements with He-Cd laser.

E. Measurement module

16. DC resistance and Hall-effect measurements in entire temperature & field range with following features:
 - Option for dynamical reversal of voltage in order to subtract thermal potentials and
 - Hall measurement of the sample having resistance in the range of $\mu\Omega$ to $M\Omega$ resistance (or better).
 - Hardware interface circuitry which can enable to change configuration of sample current and voltage terminals via software control to alternate between resistivity & Hall measurements on a single sample during a measurement sequence.

- Multi sample scanning for simultaneous measurements of DC Resistance or Hall Voltage on up to five samples or more.
17. AC resistance measurement system (frequency range 1mHz to 100kHz or wider) with suitable probe for real and imaginary parts of impedance in the entire temperature and magnetic field range, complete with Current source (2pA -100mA or better) and appropriate lock in amplifier.
 18. Suitable optical fiber arrangement for detection of photoluminescence spectra (quote for various wavelengths).
 19. Suitable electronic equipments for all the above measurements.
 20. Standard plug-in platform for resistivity, Hall effect, multi sample (quantity – 10)
 21. Computer, interface and software requirement:
 - The offer must include a desktop PC with minimum 4 GB RAM, 500 GB (or more) HDD, RW-DVD with 21 inches or higher flat LCD color monitor, latest version of windows operating system.
 - Necessary data acquisition and automated measurement software compatible with latest windows operating environment be provided, in respect of all above measurements.
 - Offline software for data analysis with graphics and display.
 22. Quoted system should be compatible as per Indian standards electrical power requirements.
 23. Installation, operation and training at customer's site of the system.
 24. Two years of comprehensive warranty after successful installation, commissioning and training.

F. Optional

(i) Magnetic measurement module:

25. AC magnetic susceptibility measurements.
26. Option of sample movement between the centers of the coils to eliminate parasitic signal.

(ii) Sample rotation:

27. Provision for sample rotation (0-330°, accuracy of $\leq 0.1^\circ$) with rotation axis perpendicular to the field direction.

(iii) System Upgradation in respect of:

28. Future upgradability for He-3 insert to carry out the electrical/ magnetic measurements at 300mK.

(iv) AMC

29. Annual Maintenance Contract for 2 years after standard warranty period of two years is over.

G. General conditions

1. Provide information on after sales service centers in India.
2. Provide e-mails, addresses and telephone nos. and order copies from customers of same systems with similar specifications in India/abroad.
3. At least five years of free upgradation of the system software.
4. Ten years of system support after installation and operation.
5. Provide hard and soft copies of all the operation, control and various data handling software, and relevant system manuals.
6. Site preparation documents at customer site should be provided.

TECHNICAL SPECIFICATIONS OF THE SPUTTERING UNIT

1. Scope of the System

The high vacuum sputter deposition system, configured in sputter down configuration, should include all necessary controls, pumps, valves, power supplies, instrumentation, gas system, pulsed DC & RF sources, magnetrons, targets, shutters, capable of one button automatic control with manual over rides. It should have reactive, sequential and confocal co-sputtering deposition on 75 to 550 μm thick substrate/wafer of size 50, 100, 125, 150 mm diameter and 156 mm \times 156 mm. System should be able to adapt an ion source for ion-assisted deposition.

2. Vacuum Chamber

- 2.1 Double walled water cooled vacuum chamber of SS 304 or better grade material with removable liner to protect walls against deposition. The chamber should be in box or cylindrical geometry of size equivalent to approximately 60 cm in diameter and 50 cm height or more (approximate volume \sim 125-185 liters).
- 2.2 The chamber should have one circular view port of window size of 100 mm in diameter with a moveable SS 304 shutter.
- 2.3 Provision for suitable sized feed-through port for adapting ion beam source at the center of targets to achieve uniform ion bombardment on the substrate.
- 2.4 One number of gas inlet feed-through for four electronically controlled gas injection lines to be connected to Ar, O₂, and N₂ gases through MFC's. A tubular stainless steel ring should be provided for uniform distribution of gas.
- 2.5 Feed-through ports for adapting Pirani and ion gauge heads, gas inlet, shutters, air admittance, and multiple pin feed-through.
- 2.6 Additional 4 number of blank ports (KF40 – 2 Nos. & KF25 – 2Nos.).
- 2.7 Easily removable SS 304 shutter between the targets and the substrate.
- 2.8 All rotary feed-through in the system should be Ferro fluidics
- 2.9 The base vacuum should be $\sim 2 \times 10^{-7}$ torr.
- 2.10 Individual components as well as entire system should be helium mass spectrometer leak tested to sensitivity better than 5×10^{-9} torr.litre/s.
- 2.11 All parts of both the chambers and gas lines should be electro-polished.

3. Load Lock

- 3.1 System should have load lock facility to hold single substrate of 75-550 μm or more thickness of 50, 100, 150 mm diameter and 156 \times 156 mm² size. The load lock will be evacuated to a vacuum 2×10^{-6} torr or better using primary dry pump and turbo-molecular pumps.
- 3.2 Provision of UV / plasma cleaning of substrates.

4. Pumps

- 4.1 A combination of dry scroll / rotary pump (30 m³/h or more) and cryo / turbo-molecular pump (1500 l/s or more of N₂ capacity) to achieve base vacuum $\sim 2 \times 10^{-7}$ torr in the main chamber.
- 4.2 A combination of dry scroll / rotary pump (6 m³/h or more) and turbo-molecular pump (\sim 250 l/s or more of N₂ capacity) to achieve a vacuum $\sim 2 \times 10^{-6}$ torr in the load lock chamber.

- 4.3 Sputter chamber and load lock will have the primary pumps of Kashiyama / Edward / Varian/ Alcatel / Anesta-iwata / Oerlikon make; turbo-molecular pump of Varian /Alcatel / Edwards / Pfeiffer / Leybold / Osaka / Elettrorava make and cryo-pump of Oxford / CTI / Austin make.
- 4.4 Total pump down time should be less than 1 hour to achieve the vacuum of 5×10^{-7} torr or better in main chamber and less than 10 minutes to attain a vacuum better than 5×10^{-6} torr in load lock chamber.
- 4.5 The typical process pressure ~ 100 m torr will be maintained with pressure stability of ± 0.25 m torr under sputter conditions with appropriate controllers.
- 4.6 Complete set of ionization / pirani / capacitance gauges will be from Oerlikon / Leybold / Varian / Edwards / MKS / Pfeiffer to monitor vacuum from 1 atm to 10^{-9} torr (with built-in dual gauge type for entire pressure range)

5. Gas Control System

- 5.1 Gas manifold for four electronically controlled gas injection to be connected to gas lines for Ar, O₂, and N₂ gases through MFC's (MKS / Alborg /Advanced Energy / Tylan make) with filters for both chemical and humid constituents, for the given input gas purity of 4N-5N at the input pressure 2 to 5Kg/cm² to give 6N output purity at flow from 0 to 50 sccm.

6. Power Sources

- 6.1 The system should have two 600 watts, 13.56 MHz RF generators with two automatic matching networks (Alcatel, MKS, SEREN, Advance Energy, Huttinger make) with switch over connectivity to all the targets.
- 6.2 The system should have one 2 KW normal DC supply along with arc suppressor and one 5 KW pulsed DC power supply (Advance Energy or Huttinger make) with connectivity to all the four targets.
- 6.3 RF / DC switching and blocking filters, and suitable decoupling network when both RF and DC are superimposed
- 6.4 The system should have the capability of co-sputtering with either DC or RF or DC and RF.

7. Magnetron and Targets

- 7.1 Four magnetrons (Gencoa, Mievac, Angstrom Science make) with SEMI standards to hold 100 mm diameter targets. The targets utilization should be $> 35\%$.
- 7.2 Targets of Ti, Ag, Pd, SiO₂ and Si₃N₄ of 100 mm diameter and 3 mm thickness each with appropriate backing plates. The targets should have purity of better than 99.99%.
- 7.3 Facility of angular tilt ($\pm 5^\circ$) and height adjustment of the targets (maximum 30 mm)
- 7.4 The distance between the substrate and the target should be adjustable (maximum separation 150 mm and movement 40 mm).
- 7.5 Cross contamination shield for magnetron sputtering sources and shutter for the substrates.

8. Substrate Holder

- 8.1 Substrate holders for 50mm, 100mm, 150 mm diameter & 156 mm \times 156 mm substrates.
- 8.2 PID controlled substrate heating facility up to 300C with stability of $\pm 1C$. The temperature sensor should read the substrate temperature with accuracy of $\pm 1C$.
- 8.3 Circular movement of the substrate holder from 2 rpm to 20 rpm with an increment of 1 rpm.
- 8.4 Provision for vertical motion of the substrate holder during process.

9. Control and Safety

- 9.1 All the international safety features should be available. The control system should have dedicated and independent interlock features. Automatic shut-off the process in case of any short circuit or any defect in the system or any accident.
- 9.2 System should be automatic PLC / PC window operating system along with complete control interface and 24" size TFT monitor.
- 9.3 The sputtering process should be done automatically once recipe is fixed.
- 9.4 Interlocks for water flow, minimum pressure requirement in turbo molecular/ rotary pumps, backing/roughing/ RF/DC power supply with proper sequence.
- 9.5 The utility (electric power, chilled water temperature and pressure, process gases) deviation alarms and interlocks should be provided with audio and visual display
- 9.6 All safety interlocks and different level of logins with password security protection.
- 9.7 Remote assistance features to access the system monitor for trouble shooting.

10. Process

- 10.1 Sequential and co-sputter deposition of metals (Ti, Ag and Pd) and dielectric layers (SiO_2 and Si_3N_4) on 100 mm diameter substrates with the thickness uniformity $\pm 3\%$.
- 10.2 Minimum Rate of deposition for Pd, Ti & Ag should be > 1.0 nm/s at a target-substrate separation of 10 cm.

11. Documentation and Control Software

- 11.1 Installation, operation and maintenance manuals along with schematics and circuit diagrams in hard copy (compatible to clean rooms) as well as soft copy.
- 11.2 Original installable CD/DVD of OS and drives installed in PC and also the system and process control software installed in PC

12. System Mains Power Requirement (to meet Indian standard)

- 12.1 $3-\phi : 415 \pm 10\% \text{ V}, 50 \pm 5\% \text{ Hz}$, and / or $1-\phi : 230 \pm 10\% \text{ V}, 50 \pm 5\% \text{ Hz}$,
- 12.2 Phase reversal protection should be provided to all pump and electronics connected to $3-\phi$ mains power.

13. Other essential items

- 13.1 Water control switches should be provided
- 13.2 All auto control valves (for backing and roughing etc.) should be electro pneumatic and operable at $230 \pm 10\% \text{ V}, 50 \pm 5\% \text{ Hz}$, AC and the all necessary accessories like push type sockets and gas tubes for the valves should be provided as per Indian conditions.
- 13.3 Water chiller with accessories.
- 13.4 Essential tool kit should be provided with the system.

14. Process Demonstration for System Acceptance

- 14.1 Demonstration of magnetron sputtering deposition of metals and dielectrics in sequential and co-sputter mode for
 - Basic system operation with all four magnetrons.
 - Uniformity of across the wafer (along radial as well as circumferential) and run to run for 50 nm film with the thickness uniformity better than $\pm 3\%$.

15. Training & Installation

- 15.1 Pre-shipment User Training Charges at supplier's overseas facility/site for NPL personnel(s) must be offered separately. However, cost of to & fro Travel and boarding/lodging expenses shall be borne by NPL, if so desired by NPL.

15.2 Installation, Commissioning and on-site Training at NPL must be done free of charge including process demonstration as per details given at point # 14 above during installation for process acceptance at NPL

16. Other Mandatory Requirements

- 16.1 The system and sub-systems should be compatible to class 1000 clean rooms and meet SEMI standards ISO certificate for design, fabrication and testing.
- 16.2 All items should be sourced from the Original Equipment Manufacturer(s).
- 16.3 The system fabrication assembly at vendor's site should be in class 10,000 or better. If necessary, experts committee has the right to visit the fabrication and assembly site of the vendors during technical evaluation.
- 16.4 The vendor must provide details of infrastructure requirement for the system.
- 16.5 List of two users having similar systems installed and operational in India and abroad in R & D or Academic Institutes / Universities / Semiconductor Industry with contact details must be given in the Technical Bid.
- 16.6 Availability of local customer support and post-sale service, engineering support for on-site maintenance and repairs in India is mandatory.
- 16.7 The vendors submitting the quotes are required to deposit 100 nm thick film (Ag : 30 nm) / Pd : 30 nm) / Ti : 40 nm) on 150 mm diameter Si-wafers on a similar system and should ensure uniformity of $\pm 3\%$ to demonstrate their expertise and competence on system performance. Vendors can collect the Si-wafers from NPL and the deposited wafer should be given back to NPL within 20 days from the last date of submission of quotes along with third party validation certificate for thickness and uniformity from an accredited agency.
- 16.8 Pricing for the item at Point # 3.1 should be mentioned separately.
- 16.9 Detailed technical literature should be provided.
- 16.10 Vendors may be asked to make a technical presentation for the technical evaluation of their quotes before the expert committee.

17. Warranty

- 17.1 Comprehensive warranty for two years or more after Installation, Commissioning, Training and Acceptability Test of the system must be offered.
- 17.2 Guarantee for after sales support for minimum of 5 years including availability of Spares & Accessories and up gradation of control & process software must be provided.

18. Optional Items (Price should be quoted separately)

- 18.1 List of recommended basic set of critical Spares for three year along with qty. & unit rates.
- 18.2 Details of the ion gun (Veeco / Advance Energy / Oxford / Kauffman & Robinson / Kurt J Lesker make) to be used for ion-assisted deposition (on 150 mm diameter substrate). The vendor should provide specifications along with thickness uniformity and area, deposition rate vis-a-vis non-assisted rate of a suitable ion source.
- 18.3 Load lock facility to hold 5 wafers as per details given in Point # 3.1.
- 18.4 Substrate heater up to 550C with an accuracy of $\pm 2C$.
- 18.5 Thickness monitor of 1 nm resolution with RF/DC plasma protection and accessories.
- 18.6 AMC Charges after expiry of Warranty Period with details & scope.
- 18.7 Any other item not included above.

