National Centre for Nanoscience & Nanotechnology
University of Mumbai
(NCNNUM)

National Center for Nanoscience and Nanotechnology, Ramkrishna Bajaj Sanskrut Bhavan,
University of Mumbai, Vidyanagari, Santacruz (E), Mumbai 400 098, India.
Tel: (022) 2654 3495, Fax (022) 26530299 Email: director@nano.mu.ac.in

Tender Document for

LASER MOLECULAR BEAM EPITAXY SYSTEM

No: NCNNUM/Tender/380/2012

Date: 14th May 2012

Part A - Terms and Conditions

Part B – Specifications

Price: Rs. 500/- (non refundable)

Important Dates:

Last date of Sale of Tender Document	28th May , 2012, 4.00 pm
Last Date of Receiving sealed Bids/Tenders:	29th May , 2012, 1.00 pm
Tender opening (if minimum three bids is received)	30th May , 2012, 11.00 am

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Part A - Terms and Conditions

Tender Notice

National Center for Nanoscience and Nanotechnology
University of Mumbai, Vidyanagari, Santacruz (E),
Mumbai 400 098, India
Tel: (022) 2654 3495, Fax (022) 26530299
NCNNUM/380/ of 2012
Date: 14th May 2012

Sealed Tender bids for the purchase of **LASER Molecular Beam Epitaxy System,** for National Center for Nanoscience and Nanotechnology, University of Mumbai are invited for and on behalf of University of Mumbai by the Director, NCNNUM. Following schedule shall be maintained for various processes.

Last date of Sale of Tender Document	28th May , 2012, 4.00 pm
Last Date of Receiving sealed Bids/Tenders:	29th May , 2012, 1.00 pm
Tender opening (if minimum three bids is received)	30th May , 2012, 11.00 am

Tender Document containing terms and conditions and technical specifications are available in the Office of the National Center for Nanoscience and Nanotechnology, University of Mumbai, Vidyanagari, Santacruz (E), Mumbai 400 098, on all working days between 11.00 a.m. & 4.00 p.m. from 14th May 2012 to till 04 pm of 28th May 2012. In case, the tender document is downloaded from the website, the Tender Document fee of Rs. 500/- should be enclosed in the Technical Bid Envelop, in the form of a Demand Draft drawn in favour of **"Finance and Accounts officer, University of Mumbai".** The tender bids duly complete in all respects, along with the necessary documents should be submitted to The Director, National Center for Nanoscience and Nanotechnology, University of Mumbai.

The technical bids so received, shall be opened on 30th May, 2012, at 11.00 am in the office of The Director, National Center for Nanoscience and Nanotechnology, University of Mumbai in the presence of the representatives of the suppliers. The Financial bids of the tenderers shall be opened on the same day or on the following day. The names of shortlisted tenderers shall be announced on the website after scrutinizing the Technical bids and evaluating their suitability to meet the University requirements. **Right to reject any or all tenders, without assigning any reason thereof is reserved by the University of Mumbai.**

Sd/-
Director,
NCNNUM,
University of Mumbai

Terms and Conditions of Supply

1. The last date and time for the acceptance of the bids is **29th May, 2012, 1.00 pm**
2. Suppliers shall submit the following documents along with their quotations **(which should be placed in the Technical Bid Envelope, i.e Envelope No. 1)**.
   (a) Income-Tax clearance certificate from the Income-Tax Officer concerned, certifying that the tenderer has cleared all the Income-Tax dues. Copies of Income Tax returns shall be applicable.
   (b) Suppliers should be either manufacturer or authorized dealer of the said equipment and should submit the proof for the same. Also, the suppliers should state whether they are a Proprietary Firm, Partnership Firm or a Private/Public Limited Company and furnish the proof of the same.
   (c) The names of the organizations and laboratories for which similar work carried out.
   (d) Earnest Money Deposit in the form of a Demand Draft drawn in favour of **"Finance and Accounts officer, University of Mumbai"** on any Nationalized Bank, payable at Mumbai. Alternately, BG from a Nationalised Bank only may be acceptable. The amount of Earnest Money Deposit shall be Rs. 2,00,000/- (Rs Two Lacs only).
   (e) In case, the tender document is downloaded from the website, the Tender Document fee of Rs. 500/- should be enclosed in the form of a Demand Draft drawn in favour of **"Finance and Accounts officer, University of Mumbai"**
   (f) VAT Registration No.
   (g) Technical specifications offered by the Supplier.
   (h) Technical compliance table
   (i) Proprietary certificate, if any, should be included in the Technical bid

3. The rates should be mentioned in the **Schedule** attached with the Tender Document.Each page of the tender shall be signed in full and stamped with the seal by the supplier. The supplier must clearly state in what capacity he or she is signing the tender. **(which should be placed in the Financial Bid Envelope, i.e Envelope No. 2)**

4. The supplier shall submit the tender in two envelopes. The first envelope (Technical Bid) shall contain all the documents referred to in **para two above** and sealed. The second envelope (Commercial Bid) shall contain the **Schedule,** in which the supplier shall register the rates of supply. The second envelope shall also, likewise, be sealed. Both the envelope then should be put together, and shall be sealed in an envelope, and shall prescribe time and date. The Technical Bid shall be opened first to ensure that supplier have submitted all the requisite documents. If the Technical Bids are not in order or are deficient in some respect, the commercial bids in respect of such tenders shall not be opened. The date and time of opening the Financial bids shall be announced immediately after opening all the Technical bids.

5. Tender bids not accompanied by the requisite amount of Earnest Money Deposit are liable to be rejected

6. The Earnest Money Deposit paid by the supplier shall be forfeited, if the supplier fails to pay the necessary security deposit in the event of his tender being accepted.

7. The amount of Security Deposit/Performance Guarantee shall be 5 % of the cost. In case of successful tenderer the amount of Earnest Money Deposit shall be converted in Security Deposit / Performance Guarantee. Security Deposit / Performance Guarantee shall be refunded after the warranty period is over. The Security Deposit / Performance Guarantee can be paid in the form of a Bank Guarantee from a scheduled bank will be deducted from the payments being made to the supplier against every bill.

8. Supplier should read carefully all the instructions and terms and conditions, etc before registering rates in prescribed schedule of the tender. Taxes and duties etc, should be shown separately.

9. The offers made by the suppliers shall be open for acceptance within 120 days after the last date of submission of tender.

10. **The Technical Documents shall be opened** by The Director, National Center for Nanoscience and Nanotechnology, **at 11.00 am. on 30th May 2012, for** those bids for which minimum three Vendors have participated. The tenderers or their authorized representatives shall be allowed to be present at the time of opening of the tenders. Financial bids of only qualified tenderers shall be opened. The date and time of opening the financial bids shall be announced immediately after opening all the Technical bids.

11. In case of imported items/equipments, the rates should be quoted in the light of exemptions enjoyed by educational institutions. University is exempted from the payment of Octroi and the necessary certificate/form can be issued by the University. The customs duty applicable to the University of Mumbai is maximum 5% of the invoice.

12. Technical specifications of the instruments/equipments/articles are given in Annexure to these papers (Part B).

13. The delivery, installation of the works should be completed within 4 months from date of design review and acceptance placing of the order. No extension shall be granted to the contractors/suppliers for the period of delivery, under any circumstances. All drawings to be approved by NCNNUM. No change is allowed without written permission.

14. In case of delayed supplies / installation of the equipments at NCNNUM, liquidated damages at the rate of 1 percent per week of delay with a maximum of 5 percent will be levied.

15. If the supplier fails to deliver the article as per the delivery schedule, the University of Mumbai shall be free to procure the balance/undelivered supply, at the risk and cost of the supplier, from other such suppliers

16. The goods, articles, materials supplied by the supplier shall be accepted after inspection by an officer authorized by the competent authority. No articles/materials which

do not conform to the specifications laid down in the terms and conditions or damaged in transit accepted

17. Before tendering, the tenderer shall inspect the site to fully acquaint himself with the condition in regard to accessibility of site, working condition of site and locality including unloading of materials, installation of tools and plants, etc., required for the satisfactory execution of the work contract. No separate claim whatsoever on these accounts shall be entertained by the University of Mumbai. No claim for expenses incurred in the site visit will be entertained by the University of Mumbai

18. The bills of suppliers shall be paid by the University only after the complete installation of system as per the stated specification in the tender documents and certified test reports are submitted

19. Only those contractors who can execute the complete project shall submit their bids. Bids received for part work shall not be considered. Tenderers of the LASER Molecular Beam Epitaxy system should provide the entire equipments as described in part B, and will be responsible for the design, development and installation of the complete instrument.

20. The vendor must assume responsibility for any damage to equipment during the shipping process or unloading to NCNNUM

21. Vendor must submit Compliance statement in tabular form comparing each specification of the quoted item with that given in the Tender Document part B. The Vendor also must supply a soft copy of the Table only in Microsoft word format.

22. If the equipment is imported and requires PC, printer other peripherals, they can be bought from India and should be of International brand such as HP. The monitor should be LCD/TFT screen. The printer should be LaserJet printer. The processor should be Intel latest processor. The amount quoted for the items bought in India, installation; servicing etc. can be in Indian Rupees and the imported items can be quoted in foreign currency.

23. The warranty period shall be of 2 year from the date of complete and satisfactory installation of the system.

24. As the suppliers shall be responsible for the supply and installation of equipment at Mumbai, the cost towards insurance until destination in the University, shall be borne by suppliers.

25. In the event of any breach of the terms and conditions of the supply, the University of Mumbai may terminate the contract placed with the supplier and forfeit the security deposit or the supplier.

26. Right to reject any or all tenders without assigning any reason there for is reserved by the University of Mumbai

Prequalification Criteria

A. Qualification Criteria for the System Vendor.

a) The vendor must be a well established company with a large market share in the field of research MBE systems and research LASER MBE systems. The vendor must have a long track record of at least 10 years (preferably 15 years) in development of MBE systems

b) They vendor must have an Indian agent who will assist in the procurement process as well as provide after-sales service

c) The vendor must have MBE applications lab with Laser MBE system – lab scientists available for consultation on MBE processes.

B. Qualification Criteria for the Product Brand (MBE system).

a) The brand of MBE system (Make) being quoted must have a record of being in use for at least 10 years in well known production or research establishments. The vendor must provide references to that effect. Documents citing technological / research breakthroughs achieved by users of the brand will be given weight during the selection process.

b) The MBE system should be customizable, so as to be suitable for use under conditions, and as per specifications provided by the end user (NCNNUM)

c) The MBE system should be flexible enough to work with individual components (effusion cells, vacuum pumps, etc) provided by major providers not affiliated with the system provider.

d) The MBE system should be robust and contain adequate mechanisms to withstand short disruptions of the facilities (power, water, liquid nitrogen, compressed air, etc) without catastrophic failure

e) All UHV gate valves shall be VAT series 10 (CH) or equivalent.

f) All UHV ionization gauges shall be Granville Phillips or equivalent.

g) All ion pumps shall be Gamma brand or equivalent.

Schedule to Tender

Note:

1. Tenderers are advised to read carefully the Terms and Conditions of supply and "the Instructions to the Tenderers" before recording the rates in this schedule.
2. No erasures or overwriting shall be allowed, unless they are authenticated under the full signature and the seal of the tenderer.
3. The Rates shall be FOR, at destinations/godowns/places indicated in the delivery

Item no	Description of goods with details of specifications	Number / quantity	Price / Rate per Unit	Taxes	Duties	etc

Signature of the Tenderer

Date:

Seal of the Firm

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Tender Document for

LASER MOLECULAR BEAM EPITAXY SYSTEM

No: NCNNUM/Tender/380/2012

Date: 14th March 2012

Part B – Specifications

Specifications for LASER – Molecular Beam Epitaxy System

1. System Description

Supply, installation and performance demonstration of LASER – Molecular Beam Epitaxy system with necessary hardware and software at National Centre for Nanoscience & Nanotechnology, University of Mumbai. The thrust area using this system will be to produce metal thin film epitaxy, metal oxide materials and silicon epitaxy with or without in-situ doping. The vendor must provide detailed specifications of the infrastructural requirements for the MBE system with the bid. Also the tender should provide the clear timeline by which the system will be built, inspected, shipped and installed.

1.1 **Four-inch system:** The system shall be able to process and appropriate for the growth of wafers up to four inches in diameter with 5mm edge exclusion for ±1% uniformity in thickness (verified by profileometer provided by NCNNUM) and temperature up to 1000^0C. This will be four chamber systems consisting of Growth Chamber, Organic Chamber, Buffer/Preparation chamber (compatible for RF-Oxygen Plasma Source) and load lock chamber with linear transfer arms. Laser MBE system configured to be stand-alone or connected to form a multiple module system such as the cluster configuration at a later stage.

1.2 **Design Compatibility:** The system should be designed in a way that one can add surface analysis techniques (such as XPS, UPS, AES, Depth Profiling, SEM) and STM or AFM without compromising in performance. The design should able to support simultaneous STM and MBE operations. Tenderer should provide the proof that they have realized a solution like this before.

1.3 **Buffer (Preparation Chamber):** The system will have a preparation chamber for the outgassing of substrates prior to the growth.

1.4 **Organic Chamber:** The system will have an effusion cell based organic chamber for the deposition of organic materials.

1.5 **Entry / Exit Chamber:** The system should have a separate load lock chamber. This chamber will preferably have the ability of heating the substrate up to 150^o C to remove water and other volatile products.

1.6 **LASER Module:** The system should have a automated target stage for four rotatable 2" PLD targets. The Laser source itself and its integration will be provided by the university

1.7 **Accessories / Modules:** E-beam evaporator source, and Effusion cells should be integrated with the MBE system

1.8 **Diagnostic Instruments:** The system should be integrated with in-situ diagnostic modules of a) Ellipsometry, b) Reflection High-Energy Electron Diffraction (RHEED), c) Quartz Crystal Microbalance and d) Residual Gas Analyzer / Mass Spectrometer.

1.9 **Expandable:** The system must be capable of easily incorporating additional growth chambers, or chambers for materials characterization

1.10 **Cooling:** The system should be capable of being cooled by chilled water or by Liquid Nitrogen, or by both

1.11 **Easy Access:** The system should be designed with ease of maintenance and service in mind. Every vacuum port should be easily accessible without extensive dismantling of panels, instrument controls, etc.,

1.12 **Cleanroom Compatibility:** The system should be clean room compatible to Class 1000 and pump exhausts should be properly handled.

2. Load Lock Chamber Module

2.1. Load lock base pressure shall be 5 x 10^{-8} Torr
2.2. Load lock pump down from atmospheric pressure to 5 x 10^{-7} Torr in less than 30 minute
2.3. Upper load lock chamber and quick hatch door
2.4. Cassette Assembly with 6 positions
2.5. Six inch electro pneumatic gate valve – VAT Series 10 or equivalent
2.6. Pumping system for Load lock chamber should contain following
   a) Turbo pump capable of pumping speed of at least 250 l/s and controller
   b) Dry scroll roughing pump having minimum capacity of 5 m^3/hr
   c) Electronic pressure gauges and control system
2.7. Eight inch manual gate valve to buffer chamber
2.8. Minimum Two view ports with 2.75" flange
2.9. Load lock docking mechanism
2.10. Load lock outgassing heater to heat ≥ 150^0C
2.11. Power supply and controller

3. UHV buffer or Preparation chamber

3.1. UHV buffer chamber base pressure shall be 2 x 10^{-10} Torr
3.2. Pumping system for UHV buffer should contain following
   a) An ion pump capable of standard pumping speed of at least 230 l/s.
   b) Ion pump controller
3.3. Minimum two quantity of view ports having 4.5 inch flange
3.4. Minimum three quantity of view ports with 2.75 inch flange
3.5. Elevator stage assembly
3.6. Port with RF-Oxygen Plasma Source (auto-tune) and gas inlet valve / system
3.7. Magnetic Transfer rod having length ≥ 36 inch
3.8. Console for Loadlock – buffer module
3.9. Cassette Assembly with 4 positions
3.10. Minimum Six quantities of 4 inch Mo Wafer Blocks
3.11. It should have a heater for pre-degassing (achievable temperature >200°C) and a port for H-passivation of pre-degassed samples.

4. Growth Chamber

4.1. The system shall be appropriate for the growth of wafers up to four inches in diameter with the uniformity better than ± 1% excluding 5 mm edges.
4.2. The growth chamber base pressure shall be 5 x 10^{-11} Torr
4.3. Minimum four quantities of 4.5 inch ports for installation of effusion sources
4.4. All source ports on growth chamber shall have corresponding complete shutter systems, including computer controlled electro or electro-pneumatic actuators etc.
4.5. All viewports on the growth chamber will have shutters.
4.6. The growth chamber should have additional ports for following accessories
   a) Electron beam evaporator

b) Port for Laser target assembly
c) Laser entrance view port
d) Sample manipulator
e) Beam Flux Monitor
f) Four View port
g) Ion Gauge Port
h) Residual Gas Analyzer Port
i) Pyrometer port (normal to wafer)
j) Two corresponding Ellipsometry ports

4.7. There shall be extra few ports of different size with blanks for future additions of sources and tools

4.8. This will further have upper and lower cryo panel with Mo partitions (cell dividers) or single cryopanel

4.9. Laser Target to Substrate Distance: typically adjustable from 75 to 110 mm.

4.10. Substrate Manipulators
a) Manipulator with master shutter for 4inch diameter wafer handling
b) Travel Length in vertical axis ≥ 25 mm, Rotation : 360 degree, continuous and PC based control (/ feedback) system for R movement
c) Continuous magnetically coupled azimuthally rotation with motor for ≥ 50 rpm
d) Hand held pendant to control rotation - motor controller. Motor controller (/encoder) cable
e) Substrate heater (Tungsten) and controller to the temperature up to 1100^0C

4.11. Growth chamber vacuum hardware shall consists of following
a) Two quantity of 4.5 inch view port,
b) Two quantity of 4.5" view port shutter – full open
c) Three quantity of 2.75 inch viewport shutter – full open
d) All viewports on the growth chamber will be equipped with shutters
e) Eight inch manual gate valve to preparation/buffer chamber
f) Blank flange kit

4.12. Growth chamber pumping system should contain following
a) A Cryogenic pumping system capable of pumping speed of at least 1500l/s for LN2
b) Cryopump compressor
c) Cryopump installation kit (conduits, Si diode)
d) Ten inch pneumatic gate valve
e) Pumping bypass incl. all metal manual valve to roughing pump for initial pump down after re-generation
f) Titanium Sublimation Pump (3 filaments) including controller and cable

4.13. Growth Console Assembly
a) Controller for multiple shutters
b) Baking Assembly suitable for class 1000 cleanroom (no fiber glass should be coming out of the bakeout assembly) including automatic temperature controller and heaters for up to 200°C

c) Pneumatic distribution assembly (for shutters - if pneumatic)
d) This should consist of: Racks for Electronics,, Power Distribution, Cable Kits, and all Controllers -
e) PLC based system and interlock controller including the bake out control (temperature, slope, hold time)
f) Water Cooling manifold incl. valves for each source and flow controllers
g) Spare kit (e.g. filaments, gaskets, toolbox)

4.14. Separate Organic Deposition Chamber

a) sample holder (at room temperature)
b) port for upgrade with sample heater
c) ports with QCM and viewport(s)
d) port with gas inlet for argon/hydrogen with one mass flow controller
e) four ports for organic source
f) linear transfer arm to/from and a manual gate valve the main deposition chamber
g) port for pumping

4.15. **Sources:** The design of the growth chamber should able to support up to ≥5 effusion cells plus e-beam evaporator plus PLD target stage (with 4 targets). The Tenderer should attach four effusion cells on the growth chamber and one effuiosn cell on the organic chamber. One each Ga, In, B, P – valved cracker or decomposition source.. All the effusion cells shutter shall be electrically driven and the shutter should able to close < 250 ms. The specification of effusion cells are as follows. The tender may also offer better options for the effusion cells mentioned below

a) Effusion Cell for Gallium (quantity : one) and Indium (quantity: one):
The hot-lip type effusion cell to be quoted. The source to have full primary full length dual filament that maintains uniform temperature over the entire length of the crucible and should provide higher temperature at the lip, preventing condensation of materials from forming on crucible lip during evaporation.

Temperature: 0-1400 Deg C
Power: 1000W
Temperature stability: +/- 0.1 DegC
Thermocouple type: Type C
Crucible Size: ≥ 60cc with tapered wall for best uniformity
Crucible material: PBN
Eurotherm or equivalent PID Controller for dual filament
Temperature reproducibility: 0.1°C.

b) Effusion cell for Boron: High temperature effusion cell suitable for Boron should be offered.
Temperature: >1900° C

Power: 1000W
Temperature stability: +/- 0.1°C
Thermocouple type: Type C
Crucible Size: ≥ 25 cc
Crucible material: Pyrolytic Graphite
Eurotherm or equivalent PID Controller
Temperature reproducibility: 0.1°C

c) Valved Cracker Source For P:
The Phosphorus valved Cracker should provide efficient, reliable, and ultrapure phosphorus flux in a UHV environment. The source must have 3 independently controlled thermal zones with thermal isolation for optimum in-situ conversion as well as reproducible evaporation. Heaters to be provided to ensure proper out-gassing, while water cooling is to be provided to promote condensation in the reservoir region. Cracker should ensure Conversion from red to white Phosphorus to ensure reproducible and safe low temperature evaporation from the reservoir. An all-metal needle valve is to be provided for rapid flux adjustment during operation.

Crucible Size: ≥ 200cc
Typical Temperatures in Deg C:
Cracking Head: 1000°C
Bulk: 200°C
Reservoir: < 100°C
Temperature Stability:.+/-0.1 C
In Vacuum Length:.12“
In Vacuum Diameter:1.4“
Mounting Flange: 4.5“ CF
Valve Speed (Full Open/Close): < 3s

Phosphorous recovery System: Phosphorous removal pumping package including Liquid Nitrogen cold trap for condensing phosphorous, Isolation gate valve, Bakeout system, pressure gauge, turbo pump with backing pump, isolation and vent valve to be included.

The supplier shall also propose better phosphorous source so that in-situ doping of phosphorus to the level of > 10^{20} cm^3 can be done during the growth of 2μm thick silicon on the 4 inch substrate.

Or as an alternative:

GaP Decomposition Source (Phosphorous recovery system is not nescessarily needed in this case) – please quote for the Valved P-Cracker plus the recovery system as optional items

- Allows 10E20/cm^3 n-type doping in Si/SiGe MBE
- P-doping through GaP decomposition
- High P incorporation rate
- Minimum memory effects, Easy to install and to operate
- Sharp doping profile;
- high operating temperatures 900-1200°C for growth applications
- precise P2 control in GaAsP, GaInAsP etc. compounds
- P2/P4 ratio about 150
- very low parasitic Ga flux (P : Ga > 103)
- high efficiency: about 10 g P in GaP for 100 µm film thickness
- scarcely any white P accumulation in MBE system
- no additional safety facilities needed in contrast to PH3, AsH3 or valved elemental Phosporus crackers
- no bakeout necessary before opening the system
- requires no additional pump
- simple but effective design

d) Organic Molecule Effusion Cell

Crucible material: Quartz or Alumina
Crucible sizes: ≥ 10 cc
Temperature range from 15° C up to ≥300° C
Temperature stability: +/- 0.1°C
Eurotherm or equivalent PID Controller
Temperature reproducibility: 0.1°C

e) RF Source for Atomic Oxygen:

This Plasma Source is for disassociating oxygen, without producing high energy ions. This high flux should allow for high quality growths as well as cleaning of substrates for thin film deposition without damaging the surface. This should be able to produce high quality growth rates greater than 1.5 um/hr.
RF Power Level: 600 Watts
Gas Flow Rate: 0.1-5 SCCM
Flange: 4.50 ''CF
Source Diameter: 2.35''
RF Matching Network: Auto tuning
Plasma Chamber: Alumina or appropriate for atomic oxygen

4.16. **UHV Electron beam evaporator:** It should have following features:
Linear motion hearth should be easily removable for easy cleaning or changing of crucible. This should provide for efficient water cooling for longer crucible life and more consistent evaporation

of materials. Permanent magnet should be provided for beam positioning to facilitate improved control of evaporation process. Plug in type emitter assembly should be provided for easy filament replacement. Emitter assembly design should provide for increased filament life. This should include Water cooled hearth, electronic scanning of electron beam.

a) Number of pocket ≥ 6
b) Volume of each pocket ≥ 15 cc
c) Minimum 5kW electron beam power supply
d) Ebeam deflection: 270°
e) Maximum High Voltage: -10kV
f) High Voltage range: –6kV to – 10 kV
g) Lateral Coil Resistance: 3 – 10 Ohm
h) Long Coil Resistance: 3 – 10 Ohm

4.17. Special Facility: Linear mask assembly with stepper for growing wedge structures over a 4" wafer. This is important feature and must be offered.

4.18. Pulsed Laser Deposition Target Assembly with motorized indexing of a minimum of four selectable 2" diameter targets under process recipe control and motorized rotation of the target.

5. LASER Module

5.1. Laser source with following specifications will be supplied by University of Mumbai. Type of LASER: High Power Excimer Laser. Coherent Model COMPexPro 210 of 700mJ. Laser beam splitter will also be provided by Mumbai University. This distance between laser source beam splitter to LASER MBE tool would be about 10 feet.

5.2 Retraction (horizontal movement) of target stage assembly from the deposition position

5.3 Target introduction system.

6. Linear Molecular beam Flux Monitor

6.1. Linear flux monitor – Based on Bayard Alpert ionization gauge, moveable with Four inch travel length

6.2. Ion gauge controller with 3 digit resolution, sensitive to $5x10^{-11}$ Torr Beam equivalent pressure.

6.3. The flux can be measured continuously and regardless if the shutter of the electron-beam evaporator is opened or closed.

7. Residual Gas Analyzer

7.1. Quadruple Mass spectrometer type residual gas analyzer shall be integrated with the MBE system

7.2. Residual Gas Analyzer should be capable of detecting atomic mass number (amu) from 1 to ≥200

7.3. PC based software for data acquisition as well as online monitoring of residual gas shall be provided.

8. Reflection High-Energy Electron Diffraction (RHEED)

8.1. The system should be equipped with RHEED and corresponding viewport lead glasses for x-ray protection.

8.2. Electron gun : Electron gun capable of accelerating voltages ≥ 30kV, Means for focusing and positioning the beam
8.3. RHEED gun controller to control all relevant electron gun parameters.
8.4. Beam blanking shall be incorporated in the RHEED system
8.5. Screen Size: Six inch RHEED screen port with mounting hardware, Phosphorus Screen with Aluminum Mounting Frame mounted on deposition chamber
8.6. Power supply and control unit
8.7. RHEED analysis system:
   a) Camera, lens, cables, framergrabber and video monitor
   b) Fully integrated multitasking RHEED acquisition and RHEED video analysis software (k-space kSA400 (lite) or equivalent). RHEED analysis software shall be capable of Lattice Constant Measurement, 2D and 3D Charts for Documentation. Pre-installed computer with ≥17" flat color monitor.
   c) Analysis package must provide for measurement of the intensity of a given area of the diffraction pattern as a function of time to monitor RHEED intensity oscillations for growth rate monitoring
   d) Images exported as standard bitmaps and JPEG as well as Movies exported as AVI format

9. Quartz Crystal Flux Monitor

9.1. Two channel (or more) QCM inputs
9.2. Frequency ≥ 6 MHz
9.3. Frequency Resolution : ≤ ± 0.05 Hz
9.4. Frequency Stability : ≤ ± 2 ppm
9.5. Measurement Rate : ≥ 10 Hz
9.6. Deposition rate display resolution : 0.01 Å/sec
9.7. Display Unit: ≥ 320 x 240 active matrix LCD, capable of displaying graphs for rate of deposition, deviation, power or full screen numeric
9.8. Sensor Kit, 10-pack of gold crystals
9.9. Command set for interfacing (data acquisition and control) the QCM through RS232 or USB or Ethernet for PC Connectivity
9.10. Water cooled sensor head mounted to CF flange on growth and on organic chamber

10. Data Acquisition and Instrumentation

10.1. Major equipment should be controllable through a computer interface.
10.2. Computer control with real time data acquisition. Software to define and save recipes, including recipes for multilayer structures. Logging of process parameters (temperatures, pressures) during deposition
10.3. All system parameters should be recorded in the computer and ready for easy retrieval when needed
10.4. Computer control of instruments should include
   a) Cell shutter controls
   b) Cell temperature controls
   c) PID control values
   d) Substrate temperature and rotation
   e) PLD target controls (selection of target and rotation)

f) Controls for growing wedge structures
g) Vacuum gauge indicators
h) Mass flow controller for the organic chamber
i) Pyrometer

11. Deliverable Documents, Tool-kits and Spare Parts

11.1. All documentation shall be in English language. In addition to the hard copies, soft copies of the manuals shall be submitted vide – CD.
a) System Operational Manual in print and CD
b) System Maintenance Manual in print and CD
c) Calibration Procedure Manual in print and CD
d) Complete set of Service Manuals for all OEM products
e) Complete set of Engineering Drawings
f) Test Reports

11.2. Complete set of tool-kits for maintenance of LASER-MBE system

11.3. Complete set of took-kits for Cryo-pumps and Compressors

11.4. Complete sets of spare parts including (if appropriate)
a) Gaskets for every port
b) Turbo pump lubricant

12. Optional Accessories

The following accessories (Optical Pyrometer, Ellipsometer, Source Materials and Liquid Nitrogen Dewars) should be quoted optionally and separately

12.1 Optical Pyrometer

12.1.1. Complete optical pyrometer, including temperature sensor, panel mounting indicator unit, interconnecting cable and pyrometer support needs to be provided and installed.

12.1.2. Emissivity corrected dual wavelength pyrometery system for measurement of true temperature and thickness growth of wafer or substrate. This should provide for:
a) Real-time measurement of temperature and film thickness on a single view-port
b) Dual wavelength for window coating and substrate transparency compensation
c) Emissivity compensation for “True” Temperature

12.1.3. The optical pyrometer should measure the reflectance at least two different wave lengths (e.g 950 nm and 470 nm)

12.1.4. The optical pyrometer should allow the temperature measurement of the sample in the range of 450 – 1300 degree Celsius.

12.1.5. Data acquisition software and RS 232 or Ethernet or equivalent link should be provided with optical pyrometer for connectivity with PC.

12.2 Ellipsometer

12.2.1. Rotation compensator Ellipsometer should be offered on LASER MBE for in-situ optical properties measurements

12.2.2. UV/VIS spectroscopic ellipsometer for *in situ* application, 280 nm - 850 nm including, compensator, controlled polarizer, Spectraray, Windows XP

12.2.3. x-y -adjustment of ellipsometer receiver

12.2.4. UHV windows backable

12.2.5. PC based software for data acquisition and all necessary hardware need to be supplied.

12.3 Source Materials

Following source materials shall be quoted as optional

12.3.1 Effusion cell source materials for (a) Phosphorus/GaP, (b) Boron, (c) Gallium and (d) Indium – 6N to 7N grade

12.3.2 E-beam evaporator source material – Silicon

12.3.3 LASER Targets – 2inch (a) Iron, (b) Cobalt, (c) Chromium and (d) Permalloy

12.4. Liquid Nitrogen Dewars

12.4.1. Different capacities like 100l, 200L, 350L Liquid Nitrogen dewars with castor wheel mounted should be quoted optionally and separately.

12.4.2. These are self pressurizing vessels for liquid nitrogen storage/transportation. These vessels have to be designed to automatically maintain pressure at a pre-set level using the Pressure Building regulator. This should have features like:

- Dual liquid fill/decant valves for maximum versatility.
- Automatic pressure building circuit.
- High quality castor, 2 with brakes.
- Trilock to prevent overfilling.

13. Installation and Training

13.1 The complete system along with accessories specified in Part B of this tender documents must be installed at National Center for Nanoscience and Nanotechnology within 4 months from purchase order.

13.2 The supplier / manufacturer must provide qualified instructor(s) to train NCNNUM research staff on the use of LASER MBE system and its accessories

13.3 The supplier / manufacturer must provide training for the operation, trouble-shooting and maintenance complete system.

13.4 Vendor should provide for pre-shipment inspection training for one working week for one person. All costs like airfare boarding and lodging should paid by the vendor

13.5 Warranty: Two year from installation and acceptance.

14. Acceptance and Completion

14.1 The supplier shall install and commission all the accessories covered under the Part B of this tender and demonstrate performance and quality parameters of the complete system as per design. NCNNUM Personnel shall witness the performance tests.

14.2 The supplier shall demonstrate the growth of 2μm thick silicon on the 4 inch substrate with in-situ doping of phosphorus to the level of $> 10^{20}$ cm^3.

14.3 The supplier shall demonstrate the deposition of organic molecules related to OLED application using organic molecule effusion cells

14.4 The supplier shall demonstrate the growth of 100 nm thicknesses of Fe / Co / Cr Permalloy on the 4 inch substrate using LASER targets.

14.5 The supplier should demonstrate <1% thickness homogeneity for 4 inch substrate, excluding 3 to5 mm edges for the effusion cells / ebeam evaporator.

Sd/-
Director,
NCNNUM,
University of Mumbai

Annexure ‘A’ – Format for submitting un-priced BOQ along with technical bid

S No.	Description	Qty	Make / Model

Signature of the Tenderer

Date:

Seal of the Firm

Annexure ‘B’ – Format for submitting compliance/response of bidder

With reference to the technical details described in different sections of Part B, the bidder shall provide their compliance/response as below format.

Section Number	Nomenclature	Bidder’s Compliance / Response
1	System Description	
2	Load Lock Chamber Module	
3	UHV buffer chamber	
4	Growth Chamber	
5	LASER Module	
6	Linear Molecular beam Flux Monitor	
7	Residual Gas Analyzer	
8	Reflection High-Energy Electron Diffraction (RHEED)	
9	Quartz Crystal Flux Monitor	
10	Data Acquisition and Instrumentation	
11	Deliverable Documents, Tool-kits and Spare Parts	
12	Optional Accessories	
13	Installation and Training	
14	Acceptance and Completion	
15	Annexure ‘A’ –Un-priced BOQ along with technical bid	

If the tenderer specification has **any deviations** from the specifications or details provided in any of the sections described in Part B needs to be clearly specified in the above table.

Signature of the Tenderer

Date:

Seal of the Firm