14 June, 2017 PH/SMI/167/2017-18

Tender Notification for the Procurement of Two Identical 'Laser Molecular Beam Epitaxy Systems'

(Last Date for submission of tenders: 3rd July, 2017)

Kindly send your best quotations for **two identical Laser Molecular Beam Epitaxy Systems** with the following technical specifications on C.I.P. Bangalore basis. Your quotations should clearly indicate the terms of delivery, delivery schedule, estimated delivery date, and payment terms. Each tender should be submitted in two separate sealed envelopes - one containing the technical bid and the other containing the commercial bid, both of which should reach us, duly signed on or before 17:00 hours on 3rd July, 2017.

The bids for both systems should be addressed to:

The Chairman,
Department of Physics
Indian Institute of Science (IISc)
Bengaluru, India - 560012

One set (technical + commercial) of sealed bids should be sent to:

Prof. P. S. Anil Kumar
Professor
Department of Physics
Indian Institute of Science (IISc)
Bengaluru, India - 560012.
Ph: +91-80-2293 2632
Email: anil@physics.iisc.ernet.in

Another set (technical + commercial) of sealed bids should be sent to:

Dr. Srimanta Middey
Assistant Professor
Department of Physics
Indian Institute of Science (IISc)
Bengaluru, India - 560012.
Ph: +91-80-2293 2861
Email: smiddey@physics.iisc.ernet.in

Please enclose a compliance statement along with the technical bid.

Technical Specifications for Laser Molecular Beam Epitaxy System

1. Main Vacuum Chamber

1.1 The main vacuum chamber should be ultrahigh vacuum (UHV) compatible. The chamber should be capable of achieving a base vacuum of $5x10^{-9}$ Torr or lower. The total time needed for achieving this base pressure after a suitable bake-out should be mentioned in the technical bid. It is required that the total pumping time to achieve a base pressure of $<5x10^{-9}$ Torr be less than 48 hours after bake-out.

1.2 The UHV chamber should preferably be a spherical chamber with a diameter of at least 18 inch. If a cylindrical chamber is being quoted, the diameter and the height of the cylindrical chamber should each be at least 18 inch.

1.3 The system should come with a Turbo pump. Turbo pumps with a drag stage such as the ones from Pfeiffer are preferred. The Turbo pump should be backed by a dry pump (preferably Edwards' dry scroll pump or Adixen ACP series pump). All electronics, controllers and cables required for the pumps should be provided.

1.4 The chamber should at the least comprise of the following ports/flanges:

1.4.1 2.75 inch conflat flange (DN40CF) for residual gas analyzer

1.4.2 6 inch conflat flange (DN100CF) for RHEED Screen

1.4.3 4.5 inch conflat flange (DN63CF) for mounting a RHEED Gun (electron source)

1.4.4 4.5 inch conflat flange (DN63CF) for Quartz Crystal Microbalance

1.4.5 1 suitable conflat flange for connecting to a loadlock chamber

1.4.6 4.5 inch conflat flange (DN63CF) to serve as a laser beam entry port. This port should have a UHV gate valve closed on the atmosphere side with a UV-grade quartz window. It should be possible to vent the space between the gate valve and the window without venting the main chamber. The gate valve should have a seat leak rate of $<10^{-9}$ mbar-l/s^{-1}.

1.4.7 4.5 inch conflat flange (DN63CF) to serve as a laser beam exit port. This port should have a UHV gate valve closed on the atmosphere side with a UV-grade quartz window. It should be possible to vent the space between the gate valve and the window without venting the main chamber. The gate valve should have a seat leak rate of $<10^{-9}$ mbar-l/s^{-1}.

1.4.8 At least two 4.5 inch conflat flanges (DN63CF) as view ports for monitoring deposition and other processes inside the vacuum chamber.

1.4.9 6 inch conflat flange (DN100CF) as a spare port

1.4.10 Suitable conflat flanges for attaching the turbo pump, target manipulator, the substrate handling assembly, pressure gauges and gas connections should be provided.

1.4.11 At least two 2.75 inch conflat flange (DN40CF) as spare ports

1.5 All flanges on the chamber should be UHV compatible and be of the ConFlat (CF) type.

1.6 The positioning and the angle of inclination of all the flanges should be such that the geometric axes of all the flanges converge at the center of the substrate. This requirement does not hold for the laser entry and exit ports. Any other flanges that do not converge at the center of the substrate should be clearly mentioned.

1.7 All gate valves (unless mentioned otherwise) should be pneumatically or electro-pneumatically controlled and UHV compatible. The gate valves should have a seat leak rate of $<10^{-9}$ mbar-l/s^{-1} and have a guaranteed actuation life of at least 50,000 cycles. The technical specifications of the gate valves being provided should be clearly mentioned. The details of the manufacturer should also be provided if the tenderer is purchasing the gate valves from a third-party vendor.

1.8 Pirani gauges, Bayard-Alpert type nude ionization gauges and baratron pressure gauges (for accurate process gas pressure measurement) should be provided.

1.9 All vacuum lines between the Turbo pump and the dry backing pump should have a Pirani gauge for foreline vacuum measurement.

1.10 Mechanical support to mount the chamber and accessories should be provided.

1.11 A rack for all the electronic components required for operating the chamber should also be included.

1.12 Bake-out tapes and necessary power sources and controllers with temperature sensors should be provided with the chamber.

2. *Substrate Handling Assembly and Heating*

2.1. Substrate holder should be capable of holding samples with sizes of 5 x 5 mm^2 and larger (e.g. 10 x 10 mm^2)

2.2. The substrate holder should enable 360° continuous rotation. The substrate holder should also have XYZ motion. The X-Y motion should be at least +/- 10 mm about the axis of the chamber and the total Z-motion should be at least 75 mm. The chamber as assembled should not have any measureable vacuum leaks (upon helium leak check) during any motion described here.

2.3. A suitable substrate heater should be provided for substrate heating. The heater should make it possible to achieve at least 850 °C on the <u>*substrate surface*</u> with a temperature uniformity of ≤1 °C over a substrate area of 10x10 mm^2. Upgrade to a SiC heater that can achieve 1000 °C on the substrate surface should be provided as an option.

2.4. The heater should be powered by a DC power source and be programmable via a temperature controller such as the Eurotherm 2400 series controllers (or the ones with similar specifications)

2.5. The substrate plane during deposition should be parallel to the ground.

2.6. A pneumatically or electropneumatically actuated (software integrated) shutter between the substrate and the targets should be provided.

2.7. Substrates (along with the substrate holder) should be transferrable to the loadlock chamber without breaking vacuum in the main chamber.

2.8. At least 4 substrate holders should be provided.

2.9. If a SiC heater is quoted as an option, at least two sets of spare heater elements and leads should be provided for the SiC heater. It should be possible to change, on-site, the heater elements or power leads, in case of heater failure. Any special tools for such repair should be provided.

3. *Loadlock Chamber*

3.1. The loadlock chamber should be connected to the main chamber via the flange mentioned in 1.4.5

3.2. A turbo pump with at least 80 l/s pumping speed should pump the loadlock. A diaphragm pump with a pumping speed of at least 0.25 m^3/h should back the turbo pump. The base pressure of the loadlock chamber should be lower than $5x10^{-5}$ Torr. The time required for achieving this base pressure should be given in the technical bid. All electronics, controllers and cables for the pumps should be provided.

3.3. A magnetic manipulator for sample transfer should be provided. The stray field at the substrate in the main chamber due to the magnetic arm should be <10 Oe with the arm fully retracted.

3.4. Pre annealing heater to obtain at least 300 °C on substrate surface should be provided in the loadlock chamber.

3.5. At least one viewport should be provided on the loadlock chamber to monitor sample transfer. The size of the viewport should at the least be 2.75 inches (DN40CF or larger)

3.6. At least one 4.5-inch diameter port (DN63CF flange) should be provided as a spare port.

3.7. The loadlock should be provided with a Bayard-Alpert type nude ionization gauge and a pirani gauge for vacuum pressure measurement. All electronics and cables for the pressure read-out should be provided.

3.8. There should be a manual gate valve between the loadlock and the main vacuum chamber. The gate valve should be UHV compatible. The gate valves should have a seat leak rate of $<10^{-9}$ mbar-l/s^{-1} and have a guaranteed actuation life of at least 50,000 cycles. The technical specifications of the gate valves being provided should be clearly mentioned. The details of the manufacturer should also be provided if the tenderer is purchasing the gate valves from a third-party vendor.

4. *Target Manipulator Stage*

4.1. A multi-target target manipulator stage, which can hold at least 6 targets, each with at least 1 inch in diameter, should be provided. The manipulator stage should contain contamination shielding allowing one target to be exposed to the laser at one time.

4.2. The target manipulator should enable rotation about the target-manipulator center to select targets for deposition (this is used for target-positioning).

4.3. The target manipulator should have the provision to rotate the targets (about the target center) continuously during deposition (this is used for target-spinning during depositions).

4.4. The rotations in 4.2 and 4.3 should be motorized so as to allow for target '*wiggling*' (using the target-positioning drive) and rotation (using the target-spinning drive) at the same time during the deposition. This composite-motion, which is necessary for target rastering, should be controllable via software. If, target 'wiggling' is not possible, target-rastering can also be accomplished by an X-Y raster (motion in the target plane). The X-Y raster, if provided, should be software-controlled.

4.5. Software control should also enable multi-layer heterostructure deposition via a user-defined macro or a script file.

4.6. All electronics, motion controllers and software required for computer controlled target positioning, target spinning and target-rastering should be provided.

4.7. The chamber as assembled should not have any measureable vacuum leaks (upon helium leak check) during any motion described in 4.2, 4.3 or 4.4.

4.8. The Z-height of the targets should be manually adjustable. This provides the manual adjustment of the distance between the substrate and the targets.

4.9. Targets should be replaceable either via a stand-alone target loadlock or using the existing substrate loadlock chamber (described in 3) without the need to break the vacuum of the main chamber.

5. *Process Gas Supply and Pressure Control*

5.1. At least two process gas lines with mass flow controllers, valves to control process gases (such as oxygen and nitrogen) inlet into the chamber should be provided. The cost of additional gas lines with mass flow controllers should be provided as an optional upgrade.

5.2. Process gas pressure in the chamber should be software controlled. A bypass valve or constriction valve to control chamber pressure during deposition is preferred. If quoting other ways of software controlled pressure setting, which can for example include changing the Turbo Speed, the advantages and disadvantages of such options should be clearly stated.

5.3. The control electronics and necessary software to programmatically control 5.1 and 5.2 should be provided.

6. *Laser Optics*

6.1. Laser optics should include mirrors for deflecting 248 nm laser beam into the chamber and lens for focusing (focal length of ca. 50 cm is preferred) the 248 nm laser beam onto the target.

6.2. An aperture for filtering out the homogenous portion of the laser beam should be provided.

6.3. The optics assembly should enable the incidence of the laser beam onto the target such that the short-axis of the rectangular excimer laser beam is elongated while the long axis remains unchanged.

6.4. The angle of incidence of the laser beam should be ≥45° when the target-substrate distance is approximately 40 mm.

6.5. All the optical components should be on an optical rail with an enclosure. The enclosure should be transparent for visible light but opaque for 248 nm laser.

7. *Automation and Software*

7.1. At a minimum the following features should be automated and be software controlled:

7.1.1. Substrate shutter opening and closing

7.1.2. Pressure measurements and monitoring

7.1.3. Process gas selection and pressure control

7.1.4. Temperature set points, ramp rate, dwell time control

7.1.5. Actuation of pneumatic or electro-pneumatic gate-valves

7.1.6. Laser start, stop, pulse number, pulse energy, total number of pulses. (Laser with an external trigger control will be provided by the user)

7.1.7. Rotation and positioning of the substrate stage

7.1.8. Possibility to write short script files or macros for automating multi-layer heterostructure deposition.

7.1.9. A simple interface for high pressure oxygen anneal

8. *RHEED and Laser Integration*

8.1. The tenderer is responsible for integrating a high pressure differentially pumped RHEED system and an Excimer Laser to the Laser MBE system.

8.2. The tenderer is responsible for the alignment of the electron beam of the RHEED on the substrate. RHEED system will be provided by the user.

8.3. The tenderer is responsible for the alignment of the laser beam onto the target.

9. Combinatorial Pulsed Laser Deposition

9.1. A software-integrated combinatorial PLD technique to deposit thin films with varying compositions on the same substrate should be provided.

9.2. The masking and substrate X-Y motion system used to achieve continuous changes in composition on the substrate should *not* interfere with RHEED when the combinatorial PLD is *not* being used.

9.3. The combinatorial PLD technique should at the least work for substrate sizes of 1 inch.

10. Spare parts

10.1. Copper gasket with all sizes necessary for the chamber should be given with at least 8 spares for each size.

10.2. Three spares of UV-grade quartz for laser entry viewport should be provided.

10.3. Two spare thermocouples with connectors should be provided.

10.4. 20 target mounts for 1-inch diameter targets should be provided.

11. Other Requirements, Options and Accessories

11.1. Power requirement ~230V, 50Hz, single phase

11.2. The cost of a laser diode heater for substrate heating should be provided as an optional upgrade.

11.3. If target '*wiggling*' and rotation is used for rastering, an alternate XY rastering system for the target manipulator should be provided as an optional upgrade. The XY rastering system and target selection should be fully computer controlled.

11.4. A list of at least 5 references, where systems with technical specifications very similar to this system have been installed in the recent 3 years, must be provided. The list and the technical specifications of those five systems must be provided inside the technical bid cover. This will be one of important criterion for the qualification of technical bid.

11.5. The tenderer can also quote total price of the laser MBE system with the following combinations

11.5.1. laser MBE system + excimer laser (400 mJ, KrF) + 40 keV high pressure RHEED

11.5.2. laser MBE system + excimer laser (400 mJ, KrF)

11.5.3. laser MBE system + 40 keV high pressure RHEED.

The technical specifications of the RHEED and excimer laser have been posted separately at http://www.iisc.ac.in/opportunities/tenders/ (Ref. number: PH/SMI/168/2017-18 and PH/SMI/169/2017-18)

11.6. The vendor should provide RHEED oscillations data for $SrTiO_3$ homoepitaxy growth (obtained in their earlier systems) with the technical bid. The tenderer should demonstrate $SrTiO_3$ homoepitaxy deposition with RHEED intensity oscillations during installation.

12. Terms and Conditions

12.1. The vendor is responsible for the installation of the system at the institute.

12.2. The price quotation should include the cost of installation and training of potential users.

12.3. The quotation should include the cost for at least two preventive maintenance visits during the first year after installation.

12.4. The system should be provided with at least two-years warranty on all parts and labor. The warranty period should start from the date of installation.

12.5. The vendor should have qualified technical service personnel for the equipment based in India.

12.6. The lead-time for the delivery of the equipment should not be more than 6 months from the date of receipt of our purchase order.

12.7. The indenter reserves the right to withhold placement of final order. The right to reject all or any of the quotations and to split up the requirements or relax any or all of the above conditions without assigning any reason is reserved.

Yours Sincerely,

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