21 Sept. 2023

Domestic Tender

Development of a molecular beam epitaxy unit for deposition of epitaxial thin films of semiconductors.

This is an RFQ (Request for Quote) to **develop and build a molecular beam epitaxy (MBE) unit for the deposition of epitaxial ultra-thin film semiconducting materials** including **installation and commissioning of the system** at CeNSE (IISc), as part of a limited tender for the Centre for Nano Science and Engineering (CeNSE) at Indian Institute of science (IISc) Bengaluru.

CeNSE is a multidisciplinary research department at IISc that houses a 14,000 sq. ft. cleanroom and characterization facility used by 200 faculty members from various disciplines at IISc. CeNSE also runs a nationwide program which has allowed 4200 participants from more than 700 universities and institutes all over India to use the facilities at CeNSE. Consequently, any utility/facility at CeNSE receives significant exposure to scientific community at IISc and beyond. The vendors are kindly requested to factor in the value of this exposure in their quotes.

Procedure

I. Quote should come only from Indian Original Equipment Manufacturer (OEM) or their Indian authorized distributor.

II. The quotations should be on FOR-IISc Bangalore basis in INR only.

III. Vendors will be required to submit their technical proposal and their commercial proposal in **two separate sealed envelopes**. Any violation of this will lead to cancellation of the proposal.

IV. **The deadline for submission of proposals is the 3 weeks from the date of release of this tender, which is 13 Oct 2023, 5:30 pm Indian Standard Time.** Proposals should arrive at the Main office, GF-20, Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore 560012, India, by the above deadline.

V. The decision of purchase committee will be final. The purchase committee can rescind, amend, cancel the tender without any explanation.

VI. The technical proposal should contain a compliance information in detail. The technical configuration of the equipment and its procurement are listed below. Against each item and sub-item listed below, the vendor must provide the response in terms of 'Yes' or 'No'. If "yes" the details should provide the make and type of system, followed by the advantages of the system. If "No" the fourth column should provide the extent of the deviation (please provide quantitative responses), and state the reasons for the deviation.

VII. Vendors are encouraged to highlight the advantages of their tools over comparable tools from the competitors.

VIII. Only vendors who are compliant with the technical requirements will be considered for commercial comparison. The bid is awarded to the lowest cost vendors (referred as L1)

IX. The commercial comparison is done as per Government of India rules, specifically GFR 2017. Note that GFR has recently been amended. We shall follow the GFR rules as they stand on the date the tender has been released.

X. As per recent edits to the GFR, there are three classes of vendors distinguished by their "local content". **In the cover letter, vendors must mention the "Class" that applies to them**:

   a. Class 1 supplier: Goods and services have a local content of equal to or more than 50%
   b. Class 2 supplier: Goods and services have a local content more than 20% but less than 50%
   c. Non-local supplier: Goods and services have a local content of equal to or less than 20%

XI. **This is domestic tender, in which only Class 1 and Class 2 suppliers can participate.**

XII. In the commercial bid, please provide itemized cost of the items in the bill of material (BOM) required to develop the MBE unit.

XIII. Bidders offering imported products will fall under the category of non-local suppliers. They cannot claim themselves as Class-1 local suppliers/Class-2 local suppliers by claiming the services such as transportation, insurance, installation, commissioning, training, and other sales service support like AMC/CMC, etc., as local value addition.

XIV. Purchase preference as defined by the recent edits to GFR (within the "margin of purchase preference") will be given to the Class-1 supplier.

XV. MSMEs can seek an exemption to some qualification criteria. IISc follows GFR2017 for such details.

XVI. As an option, please provide itemized cost for any *suggested* accessories/add-ons that may enhance the usability, capability, accuracy or reliability of the system.

XVII. Please indicate the warranty provided with the Equipment. Warranty of 3 year is required.

XVIII. Payment will be within 30 days, against a tax invoice after work is completed successfully/ complete supply, installation and commissioning is done to the satisfaction of the IISc user department.

XIX. For any question, please contact Prof. Dhavala Suri, Centre for Nano Science and Engineering, Indian Institute of Science, Bangalore 560012, India. (dsuri@iisc.ac.in)

Technical configuration of the MBE equipment and its procurement is appended below.

Main Chamber:

1. MBE main chamber should be cylindrical with inner diameter 330 mm. The precise drawings of the main chamber have to be approved with the client before fabrication.
2. The main chamber should have following ports as per requirements approved by the client prior to fabrication.
    a. Two CF-150 flanges.
    b. Four CF-60 flanges.
    c. Eight CF-40 flanges in radial manner.
    d. Six CF-40 flanges in addition to (c).
    e. One CF-16 port.
    f. The ports that are not used initially should be fitted with ultra-high vacuum (UHV) compatible blank flanges.
3. All the flanges in the entire chamber should strictly use oxygen free copper gaskets only.
4. The main chamber should host an inner stainless steel shroud capable of continuous liquid nitrogen (LN2) circulation; the inner diameter of the shroud should be 270 mm.
5. The LN2 shroud should host an inlet and outlet port with a CF-16 flange.
6. The shroud should be easily detachable from the chamber for service/maintenance due to aging.
7. The chamber with all the accessories plugged in should be bake-able up to 150 deg. C. for two weeks continuously.
8. A CF-16 port has to be fitted with UHV compatible gas line for Ar gas. This port should be fitted with a UHV leak proof valve.
9. Three CF-40 ports should be plugged with UHV compatible view ports with UHV shutters.
10. All the bellows used for connection between pumps and the chambers should be UHV compatible and tested with helium leak detectors.
11. The base pressure of the main chamber with all the accessories plugged in should be less than 5 e-10 mbar.
12. A helium leak test report of the UHV chamber is mandatory after before and after chamber baking to 120 deg. C for one week.
13. UHV compatible CF 150 gate valve should be fitted between the turbo pump and the main chamber, and CF 40 gate valve main chamber and transfer port.
14. The system frame should be made of aluminum profiles.
15. The drawing of the entire system with accessories plugged in shall be shared with the client prior to fabrication.

Manipulator:

16. Manipulator plugged via the top flange should host a sample holder of size 20 mm x 20 mm, made of tantalum.
17. The sample holder must be positioned at the center of the main chamber.
18. The sample holder should have a z axis motion of 25 mm vertical stride.
19. The sample holder should have capability to rotate in the x-y plane at < 20 rpm.
20. The temperature of the sample holder shall reach up to 800 deg. C with PID temperature controller and tolerance less than +/- 1 deg. C, when the substrate is heated up to 600 deg. C the chamber pressure should strictly not exceed 1 e-9 mbar.
21. There should be a manipulator controller that controls the substrate temperature, the z-axis position of the sample holder, the angular position of the sample holder for transfer.
22. The manipulator should have an integrated manual rotary shutter for sample holder.

Growth Monitoring:

23. Two quartz crystal monitor (QCM) should be plugged for continuous reading of the material thickness that is being evaporated.
24. The QCM should be water cooled.
25. One QCM sensor should be mounted on a bellow with linear drive with a stride of 15 cm so that the QCM sensor head can be driven to the sample position and retracted back.
26. The QCM sensor linear drive trajectory should not coincide with the manipulator/shutter of the manipulator.
27. Second QCM should be fixed for regular monitoring.
28. The QCM sensors should be connected to oscillators calibrated for sensitivities of different materials.
29. One set (6-8) QCM sensor crystals should be provided as spare.

Effusion cells and Electron gun:

Standard effusion cells (Qty: 2):

30. The crucible size should be of 25 cc to suit standard PBN crucibles.
31. The effusion cells should have a water cooling shroud.
32. Effusion cells should have temperature controllers with tolerance of +/- 1 deg. C.
33. One of the effusion cells should be standard effusion cell and the other should be hot lip effusion cell.
34. The effusion cells should have a rotary soft shutter.
35. The effusion cells should accompany all the necessary accessories such as thermocouple to read temperature of the cell, power supply to control the cell temperature all of which can be operated remotely.
36. The effusion cell manufacturer must be from a reputed company with few decades of experience in manufacturing them.

Pumping Station and pressure gauges:

37. A turbo pump should be plugged to the bottom of the main chamber.
38. A backing pump should be provided by a scroll pump.
39. A diaphragm pump should be attached to entry chamber.
40. Three pressure gauges should be installed in the system.
    (i) Ultra high vacuum gauge with pressure range from e-3 mbar to e-11 mbar.
    (ii) High pressure range with pressure range from atmosphere to e-6 mbar.
    (iii) One pressure gauge should be plugged to the entry chamber in the range from atmosphere to e-6 mbar.

Bake-out Control:

41. The main chamber, the transfer arm and the entry chamber should be bake-able to 150 deg. C, continuously up to two weeks.
42. The heating can be achieved via bake-able tents fitted with hot air fans or via silicone heating pads.
43. The power supply, PID temperature controller, the electrical wiring for bake-out should ensure safety features to avoid any possible short circuits during bake out.
44. The temperature control of baking should be automated to monitor the temperature and the pressure of the chamber continuously real time while baking.

Entry Chamber:

45. The entry chamber should be a small cylindrical chamber (design as approved by the client).
46. The top part should have a CF 40 flange with view port.
47. The chamber should hold a pressure gauge.
48. The chamber should be plugged to an oil free diaphragm pump.
49. The entry chamber should be plugged to a linear magnetically coupled transfer rod that can hold a 20 mm^2 sample holder.
50. The entry chamber should host a port plugged to a Ar gas line. Venting of the entry chamber should occur only with Argon gas.
51. The entry chamber should hold an open-close door set-up where the door is plugged inside a compact glove box with argon over pressure.
52. The compact glove box dimension should have two arms of length 1 m and an inner space of approximately 100 cm x 50 cm x 50 cm. The inner space should have an argon over pressure subject to purity as supplied by the argon gas.

Safety Features and Interlock:

53. Safety features should cover the emergency situation for the operation of pumps, effusion cells and electron gun.
54. The electron gun hosts high voltage lines. Back-up UPS power should be incorporated to power the e-gun. In case of power outage during its operation, the user should have the control to either continue the operation using UPS or ramp down the current.

55. The gate valves should be shut immediately to protect the turbo pump in case of power outage.
56. Specifics of emergency situations are below
    a. There should be an alarm indicator in the control system and in case of power fluctuations in the electric lines.
    b. In case pressure in the chamber is above a set threshold value, there must be an indicator for this and should not allow turning on the effusion cell or e-gun.
    c. In case pressure in chamber is above a set threshold value, the gate valve must be closed.

Computer Control and Automation:

57. The MBE control system software should include the interfacing control of:
    a. Main chamber and entry chamber pressure: Continuous monitoring of pressure.
    b. Turbo pump and Diaphragm pump: Continuous monitoring of turbo pump temperature, pump status and other parameters to check the healthy operation of pumps.
    c. Sample holder temperature: Continuous monitoring of substrate temperature and control of substrate temperature through PID protocol.
    d. Effusion cells: Control of effusion cell operation with the feedback from quartz crystal monitor for thickness of the material deposited.
    e. The control system should also incorporate easy add on of additional effusion cells.
    f. Electron gun control: Control of the current through the electron gun evaporator through feedback from flux control of the electron gun.
    g. Control system should incorporate easy add-on of additional e-guns.
    h. Gate valves: Manual switches as well as digital control of gate valve states.
    i. Soft shutters: In case soft shutter is designed to have automated control, these have to be controlled using the software.
    j. Thickness monitoring via QCM sensor: Continuous read out of the material being deposited and the rate read by the QCM sensor.

58. The software and hardware shall provide necessary recipe data storage facility for each run along with tables to enter the results achieved in the run for easy collaboration of data. A control system platform should be set up to run the entire recipe in an automated fashion and all the relevant data of each session should be saved.

Installation and Commissioning:

59. Vendor shall install and commission the system at CeNSE, IISc, which will include

a) Demonstration of base pressure < 5e-10 mbar with all accessories plugged in within time frames agreed upon.

b) Demonstration of epitaxial growth and characterized by the client within time frames agreed upon.

c) Training of a certain number of personnel agreed upon between the client and vendor. Trained personnel will run the reactor independently and be certified by vendor representatives that they are satisfied with the level of training.

d) Vendor will provide at the time of installation a detailed manual that includes all drawings - electrical, mechanical, pneumatic, installation, design, operational details and software details.

e) Quote should include as an option the cost of shipping the system and locating it AT THE SITE specified by the client. This includes the final mile transfer from the airport or dock to the site. IISc will provide documents for customs clearance.

f) The technical bid should include details of utilities required – power, water, gases and vacuum- for the stable operation of the equipment.

g) Tool footprint and utilities: A floor plan should be part of the technical bid. A list of utility requirements should be part of the technical bid. The system should be compatible with 240±10V, 50 Hz single phase or 415±20V, 50 Hz 3 phase supplies. The MINIMUM set of utility requirements needed are provided in Table 1. If there are additional utility requirements, please include them in the technical bid. Please list connector types for all utilities.

h) Cost of Ownership and supply of spares: The quote should include a listing of spares that need to be replaced periodically to ensure that the system is in operation in a stable fashion – the stability parameters being defined by the vendor and agreed to by the client – the cost of such items, the ability to guarantee their availability at this cost for a period of 5 years from the time of procurement.

i) Maintenance:

   i. The cost of an annual maintenance contract and cost of emergency technical support that may involve an engineer being on site should be quoted for in the commercial bid and addressed in the technical bid. The availability of trained engineers in India for servicing the system will be preferred. If more than one type of maintenance contract is available, they should be listed as separate line items in the commercial bid.
   ii. On all systems a set of basic tools required: non-standard screw or spanner head that is required for routine tool maintenance should be mentioned- for performing routine maintenance should be included.
   iii. System operation, process and troubleshooting manuals and detailed drawings are a must. Their inclusion must be indicated in the technical bid.

j) Online support: System should have the capability for online diagnostics from a remote location in case of tool problems.

60. Payment Terms and Conditions: On all systems the payment terms should be specified in the technical and commercial proposal and is subject to negotiation.
61. Bidder shall have to submit audited accounts of financial year 2017-18, 2018-19 and 2019-20. Audited statement must be signed and stamped by qualified chartered accounted. Income Tax return for assessment year – 2017-18, 2018-19 and 2019-20.
62. Shipping: On all systems the cost of shipping up to IISc should be included. IISc will help with customs clearance at Bangalore Airport. Please include your payment option. IISc would prefer to retain at least 20% of payment till instruments have been commissioned and successfully demonstrated.
63. Company financials: Bidder shall have to submit audited accounts of financial year 2017-18, 2018-19 and 2019-20. Audited statement must be signed and stamped by qualified chartered accounted. Income Tax return for assessment year – 2017-18, 2018-19 and 2019-20.
64. The following documentation should be provided: ISO9001 quality certification, CE marking confirmation.

Pre-requisites for vendor qualification:

i. Vendor should make presentation of their design and capabilities to build the above equipment and explain the design rationale to achieve the objectives along with Fail Safe considerations of equipment design, within one month of approval of the tender.

ii. Vendor should also present the results of simulations and details of the simulations for the base pressure along with the material properties to be used for chamber fabrication.

iii. Vendor should present an animated version of the 3D CAD model of the entire system that includes the main chamber, entry chamber, system frame, pumps, sample transfer, sample rotation, effusion cells, e-gun evaporator, QCM sensor etc., as given by the specifications above.

iv. Vendor must be a registered enterprise for the last 5 years and provide account statements. Vendor must have turn-over of 5 crore INR or more.

v. Vendor should preferably have a fully functional service office in Bangalore, Karnataka for after-sales support.

vi. Vendor should demonstrate the experience of installation of similar complete equipment that are functional in reputed academic institutions in India, preferably in the Indian Institute of Science.