DEPARTMENT of MATERIALS ENGINEERING
Indian Institute of Science
BANGALORE

PRAVEEN C. RAMAMURTHY
Professor

Inquiry Number: MET/PCR/IOE/001/2019-20 **Dated:** 6/1/2020

Request for Quote for the procurement of Various systems for fabrication of sheet to sheet perovskite devices

Indian Institute of Science, Bangalore
(Last Date: Jan 22nd, 2020)

This is an RFQ (Request for Quote) for setting up a solar cell printing infrastructure at IISc, Bangalore. The RFQ covers seven items which are listed below. The purchase for each of the systems will be processed independently (as a separate PO). So, vendors are NOT required to quote for items. Vendors are encouraged to quote for just one or a subset of the items. To help fair comparison, vendors are required to quote the prices separately for each item.

We are seeking quotes for the following 7 items.

1. Slot die and doctor blade coater
2. Tabletop screen printer
3. Ultrasonic spray coating nozzle
4. X-Y stage with heater (to be integrated with the ultrasonic nozzle to form a spray coating system). You can assume nozzle will be supplied by the undersigned.
5. Muffle furnace
6. Precision vacuum furnace
7. UV ozone surface cleaning system

Procedure & Other conditions:

1. The decision of the purchase committee will be final.
2. Any questions can be directed to the undersigned at praveen@iisc.ac.in.
3. The quotation should address to: The Chairman, Attention: Prof. Praveen C Ramamurthy, Department of Materials Engineering, Indian Institute of Science, Bangalore – 560 012.
4. The deadline for submission of hardcopy of the quotes is **1000 hours (IST) on Jan 22nd, 2020**. The quotes should be addressed to the undersigned at the address given below.
5. Vendors will be required to submit a technical proposal and a commercial proposal in two separate sealed envelopes. Only vendors who meet the technical requirement will be considered for the commercial negotiation.
6. The technical proposal should contain a compliance table with four (4) columns. The compliance table should list out all the items in the requirements section given below, in the same order. The first column should describe your compliance in a "Yes" or "No" response. If "No", the second column should state the extent of deviation. The "third" column should state the reasons for the deviation, if any. The fourth column can be used to compare your tool with that of your competitors or provide details as requested in the technical requirements table below. Any other feature that you would like to bring to the attention of the purchase committee, can be listed at the end of the compliance table.
7. The technical specifications given below are "highly desired". However, committee reserves the right to lower technical specifications, to obtain a more competitive price.

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8. The commercial proposal should have the price of the item. All the accessories needed for the tool to function as per the technical specification, must be listed. Please provide itemized quotes for the tool and any other attachments/software.
9. The validity period of the quotation should be atleast 90 days.
10. The commercial bid must include the price of the item in Indian / Foreign currency, indicating the following separately:
    a. FOB price
    b. Freight and Insurance: If any.
    c. Shipping: The quotes should be CIF Bangalore, India. So please include cost of shipping.
    d. Total
11. Necessary training to operate the procured setup and required literature support should be provided without additional cost.
12. Your quotation should clearly indicate the terms of delivery, delivery schedule, entry tax, and payment terms.
13. Final installment will be made only after satisfactory installation and demonstration of critical capabilities.
14. Vendors should undertake to support the system with spares and software bugfixes, if any, for the next 5 years.
15. Please indicate the warranty provided with the tool. Warranty of 3 years of more is preferred. No travel claims must be made by vendor for servicing during the warrantee/guarantee period.
16. Provide itemized cost for required spares for 2 years of operation. For sake of this calculation, the vendor may assume active tool usage of 10 hours/ week. This number will be used to estimate the life cycle cost of the tool.
17. The vendor should be able to repair and maintain the equipment, once it is installed in India. Clarify if periodic (preventive) maintenance can be done by a trained on-site engineer (i.e. IISc employee) or requires a specialist from the OEM.
18. If the maintenance can be done by training a IISc employee, please specific the cost of this training, as an additional option.
19. If maintenance must be done by OEM, as an additional option, provide cost of an annual maintenance contract (AMC) for 3 years, post warranty. The AMC must cover 1 scheduled and 1 emergency visit per year. It must also indicate who will service the AMC, an Indian agent or the OEM. The AMC cost must also include an itemized list of spares that are essential for the scheduled visits.
20. The vendor should have a good track record of delivering such equipment to universities/research institutions in India and high rank institutions worldwide The RFQ must include references of 3 previous installations in the last 5 years, preferable in India. Please provide the names and contact addresses of the referees, so that the committee can contact them independently.
21. Vendors are encouraged to highlight the advantages of their tools over comparable tools from the competitors.

    If multiple systems can fulfill the requirements, vendors can submit multiple bids.

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I. Slot die and doctor blade coater

Slot-die coating and doctor-blading are two methods that can be used to deposit thin films on to surface of a substrate at large scale. The goal of the project is to demonstrate printing of electronic materials on A4 sized sheets. We are seeking equipment that can deposit uniform films even when thickness is just 100 nm (when dried). In liquid phase the printed films will be thicker, around 1 um. We understand that most equipment on the market can only print a liquid layer down to 5 μm. Vendors who are willing to work with us to design special heads to print thinner films or provide enhancements (e.g. digital gauges) to push this printing limit below 5 μm, would have an advantage in the tender. Also, accuracy and repeatability of printing thickness are more important than range of height adjustment. It is ok to submit bids even if some of the criteria cannot be satisfied.

We are seeking a thin film coater with vacuum hot plate that can do both slot-die coting and doctor blading (by switching the coating heads). The thin-film coater should have the following specs.

1. It should be a table-top system (<50 kg) that can be powered by a 220 V 50 Hz electrical output. Utilities like house vacuum and cooling water can be provided on site.
2. Minimum printing of size 200 mm X 300mm (roughly A4 sized sheets). This is the actual printing area. The stage can be larger to accommodate dead-space and uniformity constraints.
3. Hot plate with temperature control and sensor- up to 120 °C. Accuracy of ± 2 °C. Uniformity of ± 5 °C
4. Coating speeds of 0.1 cm/s to 10 cm/s.
5. Control system for automatic coating. This often includes a motor driven stage with controlled speed.
6. Need a vacuum hot stage to hold the printed sheet. The vacuum can be generated by an external pump.
7. The system will be used to print using inks that are made with solvents like DMF, chlorobenzene, chloroform, xylene, acetonitrile, DMSO, etc. The system must be compatible with these common organic solvents.

We need a collection of slot-die coating heads & accessories. All of these must be compatible with the thin-film coater. Add-ons that enhance repeatability of printing are highly encouraged. For example, height adjustment with precision digital micrometer gauges.

8. Syringe pump with solution heating up to 90 °C. The syringe pump should have flow speeds of appropriate for the coating speeds mentioned earlier. This might mean the syringe pump be compatible with different syringe sizes (1 ml, 2 ml, 5 ml, 10 ml, 20 ml and 50 ml)
9. Slot die head with 25 mm width and adjustable height (1 μm to 50 μm).
10. Slot die head with 100 mm width and adjustable height (1 μm to 50 μm).
11. Slot die head with 200 mm width and adjustable height (1 μm to 50 μm).
12. Slot die head with 4 different compartments, each of which has 25 mm width. The 4 compartments will have the same height that is adjustable (1 μm to 50 μm). This head is useful to do comparative printing studies.

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An assortment of doctor blade with the following accessories. All of these must be compatible with the thin-film coater. Add-ons that enhance repeatability of printing are highly encouraged. For example, height adjustment with precision digital micrometer gauges.

13. Doctor blading head with 25 mm width and adjustable height (1 μm to 50 μm).
14. Doctor blading head with 100 mm width and adjustable height (1 μm to 50 μm).
15. Doctor blading head with 200 mm width and adjustable height (1 μm to 50 μm).
16. Doctor blading head with 4 different compartments, each of which has 25 mm width. The 4 compartments will have the same height that is adjustable (1 μm to 50 μm). This head is useful to do comparative printing studies.
17. Doctor blading head with twin-blades of 25 mm width and adjustable height (5 μm to 50 μm). Twin-blades are often used to reduce particulates in printed films.

Finally, a list of optional accessories that can be listed and priced separately

1. Cover for the printing system so that the solvent fumes can be contained and exhausted safely.

II. Screen printer

Require a tabletop system that is small and modular. Other details:

1. Minimal footprint and weight. Prefer a system can be installed on a table.
2. It should be possible to integrate the system to a computer for automatic control.
3. Minimum printing area 200mm X 300mm. Please size the screen accordingly.
4. Maximum substrate thickness 5 mm
5. Must have an ability to align the substrate, either manually or automatically. Alignment accuracy should be ±0. 5 mm with rotational accuracy of 1°.
6. Repeat accuracy better than ±0.05 mm.
7. Printing resolution (minimum printing width) of 30 um.
8. Adjustable print pressure: 0-120 N
9. Range of squeegee speed: 20-250 mm/s
10. As an option, include cost of automatic computer controlled screen alignment
11. 220 V 50 Hz compatible

III. Spray coater

Looking for a high-quality ultrasonic spray coating nozzle that can be used to deposit thin-films of electronic materials. The coater will be used to electronic materials for printed solar cell applications. The specifications of the nozzle are:

1. Ultrasonic spray nozzle to produce a gentle spray with spray velocity of ~ 30 cm/s. The nozzle should not suffer from over-spray and macro-droplets.
2. The droplet size of the spray should be tightly controlled with a average drop diameter of ~ 20 um. Please provide data on the droplet size distribution and mention the technique used to measure this.

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3. Material flow rate of 1-100 ml/hour. The rate should be controlled by an external syringe pump, which is not part of this tender. The nozzle should come with standard fittings so that an external syringe pump can be integrated with this nozzle.
4. Air jet pressure of up to 5 psi is acceptable. The system will be used with dry nitrogen.
5. Please include detailed data on the spray pattern. At the very least we need spray pattern vs height data. This project needs spray diameter from ~5 mm to ~25 mm.
6. The nozzle should be made with high-quality SS316 or similar materials that do not corrode. Internal seals can Teflon or Kalrez. We aim to print using organic solvents like DMF, chlorobenzene, chloroform, xylene, acetonitrile, DMSO, etc. The nozzle must be compatible with these common organic solvents. The nozzle must also be compatible with water.

IV. Tech specifications for X-Y stage

This X-Y stage will be integrated with the ultrasonic nozzle mentioned above. Vendors who sell the nozzle, can bid for the X-Y stage also. Vendors who just make the X-Y stage can also submit a quote (assuming the nozzle will be supplied to them by us). The X-Y stage will allow raster of the nozzle across a substrate. Additionally, we need a substrate heater mounted on the X-Y stage so that the sample can be heated. Details:

1. 2-axis motorized gantry or table-type X-Y stage with motor. Stage remains in position when power is off. This often means that stepper motor is required not DC servo motors.
2. Prefer a closed loop control with an encoder.
3. The system must be controlled by a computer using RS232 or similar port. Full functional API to control the stage must be included.
4. Travel area must be 200mm X 300mm (both X and Y).
5. Thrust at maximum speed > 30N
6. Maximum centred load of >200N
7. Maximum cantilevered load >100N at 100 mm extension.
8. Maximum speed > 100 mm/s
9. Minimum speed < 1 mm/s
10. Repeatability < 50 um
11. Accuracy <50 um
12. Motor controller must be integrated with the stage or compact enough to not increase footprint of the stage.
13. Tabletop system powered by 220 V 50 Hz power.
14. The X-Y stage should have a substrate holder that can hold a 200mm X 300mm substrate. This often means the stage should be larger. The substrate should be mounted rigidly on the holder, either using clips or vacuum. For designing assume the substrate weight is < 1kg and substrate thickness is 0.1 mm to 5 mm.
15. The substrate holder should be integrated with a heater with closed-loop PID control. The heater should have a temperature range from room-temperature to 150°C.

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V. Tech specifications for Muffle furnace

1. Maximum temperature: 1000°C
2. Inner dimensions (minimum): 300 mm x 400mm x 100mm (l x w x h)
3. Temperature control: Programmable with PID
4. Electrical connection: Single phase 230V
5. Inlet and outlet ports for protective gas purging
6. Over temperature limiter

VI. Precision Vacuum Furnace

Need a precision vacuum furnace for annealing printed films under controlled atmosphere. Specifications are:

1. Temperature range from 50 to 200 C with accuracy and repeatability of ±1 C. Temperature control should be programmable with PID control.
2. Controls like over temperature alarm, open door alarm, must be included in the system, with appropriate interlocks.
3. Work area should be at least 300 mm x 400 mm x 100 mm (l x w x h). The temperature in this work area should be uniform within ±1 C.
4. The vacuum furnace should be connected to a pump than can pump down to 50 mTorr with a rated pumping capacity of 10 m^3/hr. The system will be used to pump solvents like DMF, chlorobenzene, chloroform, xylene, acetonitrile, DMSO, etc. The pump must be compatible with these common organic solvents. The water vapor pumping rate of the pump must be at least 0.1 kg/hour.
5. These should have a single exhaust that can be connected to house exhaust. The system must be leak-checked to ensure that it does not leak any vapors or fumes into the room.
6. Pressure gauge should be included in the system which can measure pressure down to 50 mTorr.
7. The vacuum furnace should have a needle valve to purge gas into the vacuum chamber. The flow rate should controllable in the approximate range of .1 to 1 liters/min.
8. The inside of the vacuum chamber must be constructed with polished stainless steel.

VII. UV Ozone System

Need a UV ozone system to clean substrates and prepare them for printing. Specifications are:

1. Work area should be at least 300 mm x 200 mm x 20 mm (l x w x h). The UV light and temperature must be uniform to ±5 % with this region.
2. The system must generate UV light of 185 nm or lower. Typically, this is done using Xe/Kr/Hg lamps.
3. The system should be completely sealed so that ozone or fumes from samples do not leak into the room.
4. The system should have an exhaust, that can be connected to house exhaust or an ozone destructor.
5. Irradiance at 180 nm should be at least 5 mW/cm^2. Please provide a spectrum of the lamp.
6. The substrate should be heated from 50-150 C using PID control.

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