

## Solid State and Structural Chemistry Unit

### Indian Institute of Science, Bengaluru

#### **Tender Notification for Procurement of a Variable Temperature Fourier Transform Infrared Spectrometer (FTIR) with Capabilities for Performing *in situ* Electrochemical Analysis of Materials for Energy Storage**

Kindly send your best quotation for a variable temperature FTIR with capabilities/provisions for performing *in situ* electrochemistry measurements (using both custom made and commercial cells) with the following technical specifications on C.I.P. Bangalore basis (by *Air Freight* only). Your quotation should clearly indicate the terms of delivery, delivery schedule, estimated delivery date, payment and warranty terms. The 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 the Institute, duly signed on or before **November 30, 2019**:

The bids should be addressed to:

*The Chair  
Solid State and Structural Chemistry Unit  
Indian Institute of Science  
Bangalore: 560012, INDIA  
chair.sscu@iisc.ac.in*

The bids should be sent to:

*Professor Aninda Jiban Bhattacharyya  
Solid State and Structural Chemistry Unit  
Indian Institute of Science  
Bangalore: 560012, INDIA  
anindajb@iisc.ac.in*

**Please enclose a compliance statement with the technical bid.**

# Technical Specifications for Spectro-Electrochemical Measurements

## 1. Broad System Requirements and Usage

We seek to procure a variable temperature FTIR having capabilities/provisions for performing electrochemistry measurements using both custom made and commercial cells typically for various types of battery studies. We work on mechanistic aspects of various rechargeable batteries such as metal-ion, metal-sulphur and metal-air batteries. The machine will find usage in studies related to oxygen evolution and reduction reactions, solar energy harvesting, biological mimics for energy devices, and sensing. We therefore seek the following technical criteria to be met by any FTIR set up being quoted under this tender notice:

- 1.1. Spectral Range: The FTIR system must have a spectral range that covers from  $350\text{ cm}^{-1}$  to  $4000\text{ cm}^{-1}$ . All necessary optical sources, beam-splitter, detectors, mirrors, windows, shutters etc. must be provided and they should all be automated and motorized. The system should be capable for extending to the Far-IR region in future.
- 1.2. Spectral Resolution: The FTIR spectral resolution should be less than  $0.5\text{ cm}^{-1}$  across the full spectral range of operation.
- 1.3. Source: Should cover entire IR range with high intensity. Source should have guaranteed lifetime of a minimum of 5 years.
- 1.4. Interferometer: Fast scanning and permanently aligned interferometer. 10 years warranty on the scanning mechanism must be included.
- 1.5. Peak to peak signal-to-noise ratio (SNR) across the full spectral range must be better than 10000:1.
- 1.6. The main chamber must come with vacuum option to remove humidity ( $\text{H}_2\text{O}$ ) and higher concentration of  $\text{CO}_2$  and other gases that influence measurements requiring high accuracy.

- 1.7. All optical components must be securely fitted within the machine chamber and should be in vacuum and sealed such that humidity (H<sub>2</sub>O) and higher concentrations of CO<sub>2</sub> and other gases do not influence the measurement. (Both points 1.5 and 1.6 to be demonstrated at the time of installation)
- 1.8. The system must have rapid scan options, 50 spectra/sec @ 8 cm<sup>-1</sup> spectral resolution or better.
- 1.9. The spectrometer must have multiple numbers of beam input/output ports that are computer controlled for future extension of various other types of measurements and for coupling with modules from the manufacturer.
- 1.10. For entire range of spectro-electrochemical experiments, the controls for both spectroscopy and electrochemical measurements should lie either with the FTIR software or should have the provision for running along with an external potentiostat software.

## **2. Specific technical requirements for the Spectrometer:**

- Spectral Range: 350 cm<sup>-1</sup> to 4000 cm<sup>-1</sup>.
- Spectral Resolution: better than 0.5 cm<sup>-1</sup>.
- Temperature range: LN<sub>2</sub> to room temperature.
- Detector: DTGS / DLaTGS detector and high sensitivity LN<sub>2</sub> cooled MCT detector. Both detectors should be permanently installed in the system.
- It should have the measurement facility in both ATR and reflectance modes.

## **3. Specific technical requirements for the software:**

- The software should have TTL triggering, and ADC, DAC based communication ports. It should be preferably Windows-based with multi PC installation facility. It should be capable of controlling the potentiostat and the spectrometer simultaneously with data

collection at desired voltage steps (voltage resolution  $5\mu\text{V}$ ) and integration times (2ms to 500s or better). The software should have the capability of running user defined macros for electrochemistry – spectroscopy combination experiments. All future upgrades to the software should be freely available for our system.

- The spectroscopy data should be interconvertible between counts / absorbance / reflectance / transmittance directly from the software.
- Standard features like smoothening, baseline correction, integration, deconvolution etc. should be available.
- The software should have facility for 3D plotting using different relevant parameters.

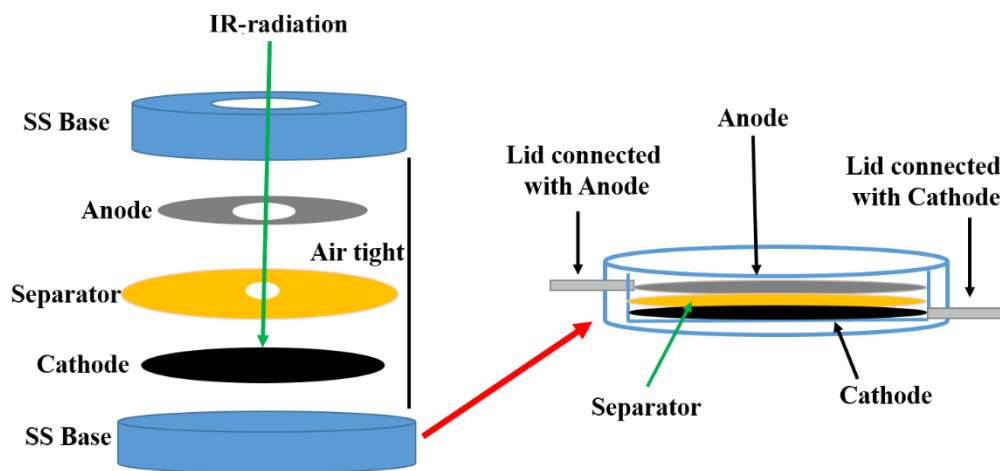
#### 4. **Specific technical requirements for the spectroelectrochemical cell:**

We will require at least **two** types of cells compatible with the potentiostat / galvanostat – spectrometer set up provided for doing spectroelectrochemical measurements.

**4.1. Thin layer spectroelectrochemical cell:** This should be a typical thin layer cell available in standard literature – with a Pt mesh (and/or conducting glass) working electrode, Pt counter electrode, and suitable reference electrodes for aqueous / non-aqueous media. The optical path length should be as low as possible (5mm or below) and there should be option for gas purging as well as flow in / flow out of electrolyte. At least two pieces of each electrode should be provided (working: two types; counter: Pt; reference: two types – aqueous and non-aqueous). Necessary provisions for drawing leads out of the spectrometer setup should be provided.

**4.2. Air tight cell for alkali metal battery measurement:** This should be a horizontally mounted, multi-purpose spectroelectrochemical cell designed to be used with standard FTIR spectrometers, for battery measurement under air tight conditions. The cell should be

designed in such a manner such that the cathode is placed on a stainless steel base, and then the separator and then the anode place over it. The anode and separator are punched at the center to allow the IR-radiation to be incident on the cathode surface. A connection from the base forms the positive connection while the connections close to the lid forms the negative connection This should be a special cell which is air-tight with an O–ring between the top and bottom portion. The lower portion of the cell should have a metal contact which will serve as the anode. The top portion should also have an electrical contact with an IR – transparent window, with appropriate path length, so that data can be collected in reflection mode. There should be facility for purging gas within the cell as well as exchanging electrolyte to / from the cell. All outlets should be valve controllable. A schematic diagram of the proposed cell is shown in in **Figure 1**.



**Figure 1.** Schematic diagram of cell for *in situ* battery measurements

The design of the cell shown here is representative. The manufacturer can also bring their own cell design, which can measure spectroelectrochemical data, as desired here, from an air tight battery system (with one end of the cell having an opaque metal anode). In addition, in-house designed cells will also be employed for the above measurements.

#### **5. PC for controlling the system:**

The set – up should come with a personal computer (desktop) capable of controlling the instrument. The system should have at least: Intel i7 processor, 500 GB SSD hard drive, 6 GB RAM (minimum), USB 2.0 or higher communication port, and Wireless LAN connection card. The system should also have a HD graphics card with 21 inch (minimum) HD LED monitor (with HDMI cable) for aesthetic display of experimental data in real time. A good set of keyboard – mouse – printer should also be provided. A genuine copy of Microsoft Windows based operating system (or whichever OS is compatible with the software used for controlling the system) should be provided.

#### **6. Requirements for the supplier:**

- The supplier / manufacturer should have been in the market for *ten years* or more with at least *fifty or more installations* related to at least the FTIR unit in leading research institutes in India. Details of such installations should be provided. The supplier / manufacturer should also produce an ISO 9001 or equivalent certificate.
- The supplier / manufacturer is responsible for the installation of the system at the institute.
- The price of quotation should include the cost of installation and training of potential users.
- The system should be provided with at least two years of warranty, on all parts and labour, from the date of installation.

- The supplier / manufacturer should have qualified technical service personnel for the equipment based in India and should assure a response time of less than 48 working hours.
- The supplier / manufacturer must provide a user list (with contact details including emails and phone numbers) of at least 5 customers from Indian Institutes/ laboratories where similar measurement systems are installed.
- The lead-time for the delivery of the equipment should not be more than two months from the date of receipt of our purchase order.
- 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.
- Wherever requested data must be supplied along with technical compliance documents. Technical bids without supporting data will be deemed as technically non-compliant.
- All guaranteed specifications may have to be demonstrated at the time of installation. Any necessary standard samples for that purpose should be brought by the service engineers.
- Printed literature and published papers in support of all compliance to the prescribed specifications may be provided.
- The supplier / manufacturer must provide compliance statement in a tabular form with respect to each technical specification in the tender document duly supported by the manufacturer's literature and published papers. Any other claim will not be accepted and may lead to rejection of the bid.

- Technical evaluation by the Institute may include demonstration to verify functionalities and capabilities of the system quoted. The Institute reserves the right to provide samples after opening the technical bids for the purpose of verification of promised specifications. Any discrepancy between the promised specifications and measurements will be deemed as technical non-compliance.
- **In the event of false claims on the compliance of the specifications as mentioned in the e-tender, the applicant will stand disqualified.**