Solid State and Structural Chemistry Unit

Indian Institute of Science

Tender Notification for Procurement of an Electrochemical Workstation coupled with RRDE, Frequency Response Analyzer and Spectroelectrochemical System for *in situ* Analysis of Materials for Energy Storage

Kindly send your best quotation for an electrochemical workstation coupled with RRDE, frequency response analyzer and spectroelectrochemical system 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 **October 2, 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 Electrochemical Measurements

1. Broad System Requirements and Usage

We seek to procure a multichannel potentiostat/galvanostat with RRDE, frequency response analyzer, and spectroelectrochemical set up. We work on various aspects of physical chemistry of energy storage systems including rechargeable batteries, solar energy harvesting, biological mimics for energy devices, and sensing. We therefore seek the following technical criteria to be met by any potentiostat/galvanostat/spectroelectrochemical set up being quoted under this tender notice:

1. The potentiostat/galvanostat being quoted should be user friendly with an easy to use software interface, modular hardware design that allows rapid user training. It should be possible to change from one measurement mode to another with relative ease. For example, the change from an electrochemical measurement mode to a spectroelectrochemical measurement option should be relatively easy so that researchers working with the set – up are able to design experiments easily and collect reliable and reproducible data.
2. The potentiostat/galvanostat being quoted should be an advanced potentiostat/galvanostat system that can go far beyond the basic electrochemical property measurements. For example, in addition to the basic electrochemical property measurements, it should be capable of simultaneously measuring spectroscopic property along with battery cycling (especially pulse based techniques: GITT/PITT). Such types of measurements should be controlled by a single software, i.e. the software should be capable of simultaneously controlling

both the works associated for the battery/electrochemistry and spectroelectrochemistry channels.

3. In addition, the instruments being quoted should have a modular design providing the flexibility to add any of the above capabilities. For example, if we want to add some channels or add some specification in spectrometer (specified in **Section 2** in detail), then that should be possible at the time of purchase or at a later date.

2. Multi channels Potantiostat/Galvanostat:

We are looking for a setup with multiple channels. At the minimum, one channel of the setup will be dedicated to RDE/RRDE, one channel for performing electrochemistry/battery studies and one for spectroelectrochemistry. It would be desirable to have at least two extra channels for doing electrochemistry/battery studies. At least two of the channels dedicated to electrochemistry/battery studies should have a frequency response analyser (FRA) facility. When RRDE or spectroelectrochemistry measurements are being done in one channel, all the other channels should be available for use. Additional slots should be provided such that these free slots can be filled up with suitable upgrades in future. The setup should also be versatile enough for connecting to a QCM, or flow cells and necessary accessories related to battery and spectroelectrochemistry research. Specific holder for mounting coin cells should be provided. Adjustable configurations are not allowed.

2.1 Specific technical requirements for the potentiostat/galvanostat:

1. Instrument should work with a 220V power supply
2. Cell connection: 2,3,4 or 5 terminal leads (+ ground)

3. Applied voltage range: -20 V to + 20 V

4. Measurable voltage range: - 20 V to + 20 V

5. Voltage resolution: 5μV

6. Current range at least: ±1nA to ±100 mA (at least in one channel) and ±1μA to ±1A in all channels

7. Current resolution: at least 0.0003% (of current range)

8. Voltage accuracy: at least 0.1%

9. Current accuracy: at least 0.1%

3. Spectroelectrochemical module:

This should come as a separate module capable of connection to any channel in the main electrochemical workstation. The data acquisition from the spectrometer should be simultaneous with that from the electrochemical workstation and controlled by a single software. The software should be available for installation over several systems for data analysis and in one master system for hardware control. There should be provision in the software for defining user macros and remote access through other PCs connected to the laboratory network.

3.1 Specific technical requirements for the spectrometer:

- The available light source should cover a wide wavelength range (200 – 1100 nm preferably) with a minimum lamp lifetime of 1000 h for D and 2000 h for halogen lamp. The light should have a software-controlled shutter.

- The spectrometer should have a high resolution (≤ 2nm) with integration time of 2 ms to 500 s.
- It should have a high resolution CCD detector (2048 pixels or higher) with a good signal to noise ratio (300:1 at full signal, or better). The dark noise should be minimum (20 counts or below, RMS)
- It should have the measurement facility in both transmittance and reflectance modes. The spectroanalytical set up should be preferably based on direct optics.

3.2 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 (at voltage resolution specified for the potentiostat/galvanostat earlier) 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 lamp control should be automatic – for dark and reference.
- 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 showing voltage – absorbance – wavelength – current – time used interchangeably.

3.3 Specific technical requirements for the spectroelectrochemical cell:

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

3.3.1 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)

3.3.2 Air tight cell for alkali metal battery measurement: This should be a horizontally mounted, multi-purpose spectroelectrochemical cell designed to be used with standard UV-vis 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 laser 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 a UV – 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**.

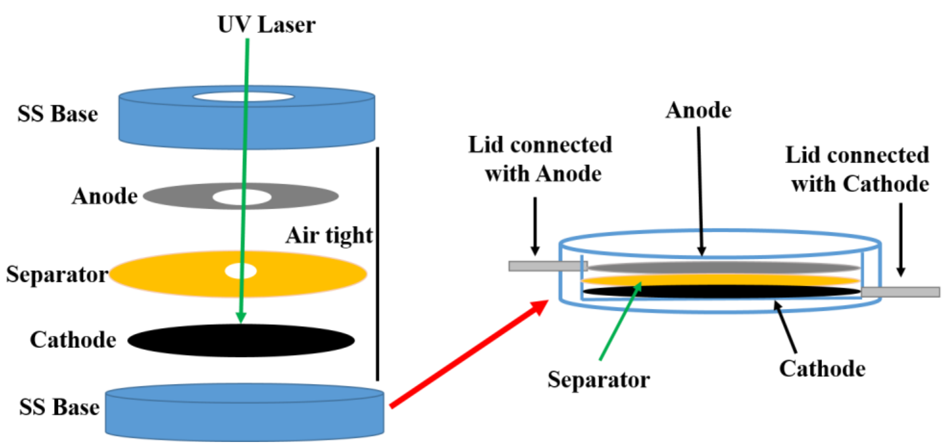

Figure 1. Schematic diagram of cell for *in situ* battery measurements

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).

4. Frequency response analyser:

At least two or more channels must have provisions to do electrochemical impedance measurements with the following specifications:

4.1 Applied Frequency Resolution: 0.005%

4.2 At high frequencies(f), log f > 4, impedance(Z) of the order of log|Z|>2 should be measurable with an accuracy of at least 0.3% with 0.3° Phase.

4.3 At 1 Hz frequency, impedance of 0.01 Ω must be determined with 0.5˚ Phase accuracy and at least 0.5 % measured impedance accuracy. i.e – Measured impedance = 0.01 ±0.00005 Ω

4.4 Frequency Range: 10 μHz to 1 MHz in the low current (1nA – 100mA) as well as in the high current (1μA – 1 A) channels

4.5 Calibration kit must be provided for routine calibration of the cables and FRA.

4.6 EIS Software must include real time fit-simulation with equivalent electrical circuit elements, live plots, and live 3D plotting.

A contour plot for the EIS space should be provided with reliable accuracies in quality control parameters up till 1 MHz

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. Future upgrades:

The system should have the following features available as upgrades in the future:

- FRA extended to other channels of the electrochemical workstation.
- Addition of further channels in the chassis (at least twelve channel required in the chassis)
- Addition of a different spectrometer (e.g. Raman spectrometry, IR) to at least one of the channels

7. Requirements for the supplier:

7.1 The supplier / manufacturer should have been in the market for *ten years* or more with at least *fifteen or more installations* 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

7.2 The supplier / manufacturer is responsible for the installation of the system at the institute.

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

7.4 The system should be provided with at least two years of warranty, on all parts and labor, from the date of installation.

7.5 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.

7.6 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.

7.7 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.

7.8 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.

7.9 Wherever requested data must be supplied along with technical compliance documents. Technical bids without supporting data will be deemed as technically non-compliant.

7.10 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.

7.11 Printed literature and published papers in support of all compliance to the prescribed specifications may be provided.

7.12 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.

7.13 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.