IIT Madras proposed to procure two state-of-the-art scanning electrochemical microscopes (SECMs), one for biological studies and another for studying basic catalytic properties. Detailed technical specifications are given in the following sections. Any qualified vendor/manufacturer/distributor who complies with all the technical requirements shall submit their bids along with a compliance certificate for both the SECM systems together. Along with detailed justification, a compliance certificate should list the quoted instrument/component/accessories and their part/model numbers that meet the requirements of each of the technical requirements given below. Any compliance statement that does not meet this requirement will not be considered.

TECHNICAL SPECIFICATIONS

I. Scanning Electrochemical Microscope – Setup 1:

Set up 1 should be a modular and fully expandable Scanning Electrochemical Microscope fitted with an Inverted Optical Microscope that is suitable for studying biological systems.

I.1. Potentiostat / Galvanostat: A high-end bipotentiostat / galvanostat is required with a low current resolution of 1 fA or better.

- **Maximum scan rate**: 1000 V/s with at least 15 to 20 mV steps for fast enzymatic kinetics / biological studies
- **Output voltage range**: ± 10 V or better
- **Maximum output Current:** ± 800 mA or better
- **Compliance voltage**: ± 12 V or better – Adjustable compliance voltage configurations will not be considered. Compliance voltage add-ons or modules have to be quoted separately.
- **Input bias current of electrometer**: < 1 pA
- **Input impedance of electrometer**: > 1 TOhm
- **Measured current resolution**: at least 0.0003% at entire current range (e.g. 30 fA resolution at 10 nA current range). Must be a default hardware configuration without any additional amplification
- **Measured Potential Resolution**: 0.5 µV or better
- **Potentiostat Rise/fall Time**: < 300 ns or lower
- **Interface**: USB interface for connection with computing system

I.1.1. Bipotentiostat configuration in one of the channels: The system must be equipped with an 'internal' dual mode bi-potentiostat option that can be worked in two independent modes explained below. Configurations combining two separate channels will not be allowed: Parallel measurements should be possible on two working electrodes sharing the same counter and reference electrode. In the first mode, a fixed potential is required to be applied to the second Working Electrode while applying a potential step or a sweep to the first Working Electrode. In the second mode, a potential offset with respect to the first working electrode is required to be applied to the second working electrode.

I.1.2. Low Current Amplification: Our research requires measurement of extremely low currents at the best possible accuracy and resolution. The system quoted should have an option that provides additional low current ranges such as 1 nA or 100 pA to immediately trigger and allow a minimum current resolution of 0.5 fA or better.

I.2 An advanced SECM Workstation with capabilities for high resolution analysis (1 nm or better), shear stress option (structure size < 1µm), video imaging and an immediate plug and play analysis on an inverted optical microscope is required.

I.2.1. Inverted Microscope Configuration: The SECM stage should be mounted on an inverted microscope.

(a) 5x, 10x, 20x and 40x Objective lenses should be provided. .
(b) Must also include adapting plates to reversibly mount the SECM positioning system on the inverted optical microscope and for using the standard SECM measuring cell
(c) Must also include a dedicated electrode holder to adjust the horizontal distance between the positioning system and the optical pathway of the microscope.

I.2.2. Scale Range and Resolution: Must include a stepper motor drive based positioning system (or better) with xyz positioning system that provides a scale range of at least 25 mm/axis in normal mode with 20 nm resolution (minimum step width). The system must be supplied with an additional capability of a piezoelectric positioning system that is mounted in tip holder for high-resolution movements:

(a) Travel / Scale Range (xyz): 100 µm/ Axis
(b) Resolution: 1 nm

I.2.3. Shear force attachment to deconvolute electrochemical activity and topography of sample: To precisely separate topographic and electrochemical information, we need an option that provides the ability to control the tip-to-sample separation. This option should allow us to hold the tip in a constant distance of 50 to 300 nm above the sample surface via a feedback mechanism. We would prefer to carry out constant-distance mode imaging of electrodes in the sub-micrometer range and rough samples. The set-up must allow us to study the deconvolution of topography and activity effects.

I.2.4. SECM Software & computing system: An easy to use SECM software must be provided with a suitable computing system along with the following options:

- Current-independent constant-distance mode for high-resolution measurements (Shear force analysis)
- Different modes of tip movement during array scans.
- Online preview of experimental results, 3D visualization of array scan data including graphics export, topography image for constant-distance mode, automatic approach curve and option for tilt compensation.
- Options to perform complete electrochemical analysis at each grid point.
- Future expandability for electrochemical impedance spectra for AC-SECM (Nyquist, Bode Plots, 3D images for Array Scans on Real & Imaginary parts)

I.2.5. Video camera add-on: Vendor must provide an option that provides a monochrome USB CCD camera with macro objective, manual zoom, and a corresponding stand, to view the movement of SECM tip on the substrate. The live-view image of the camera must be integrated into the SECM software.

I.2.6. The manufacturer should have prior experience in integrating Scanning Electrochemical Microscope with Inverted Optical Microscope. Evidence of such installation should be provided.

I.2.7. Electrodes (3 numbers each):

(a) Miniaturized Ag/AgCl reference electrode
(b) Miniaturized Pt counter electrode
(c) 10 µm Pt-microelectrode
(d) 25 µm Pt-microelectrode
(e) 1 µm Pt-microelectrode
(f) 5 to 10 µm carbon microelectrode
(g) 10 µm Au-microelectrode
(h) 25 µm Au-microelectrode

I.2.8. The manufacturer should have the capability to provide nanoelectrodes less than 1 µm. A list of available nanoelectrodes shall be provided as optional.

I.2.9. Other Mandatory accessories: The system must be supplied with a beginner's kit consisting of two Pt-microelectrodes (25 and 10 µm), reference and counter electrodes, and a test sample for training purposes. A measuring cell with distance pieces to adapt to different sample heights and adjustable base plate for manual tilt compensation must be provided.

I.2.10. Future upgradation: Future upgradation of the system to Scanning Photoelectrochemical Microscopy should be possible.

II. Scanning Electrochemical Microscope – Setup 2:

Setup 2 should be a modular SECM with a potentiostat/galvanostat and a basic SECM stage for basic electrochemical imaging. Setup should have options, including Shear Force and photoelectrochemical SECMs, for future upgrade.

II.1. Potentiostat / Galvanostat:

A Potentiostat / Galvanostat is required with a low current resolution of 30 fA or better.

- **Output Voltage Range**: ± 10 V or better; Maximum output current: ± 400 mA or better
- **Compliance voltage**: ± 20 V or better – Adjustable compliance voltage configurations will not be considered. Compliance voltage add-ons or modules have to be quoted separately.
- **Input bias current of electrometer**: < 1 pA
- **Input impedance of electrometer**: > 100 GOhm
- **Measured current resolution**: At least 0.0003% at entire current range (e.g. 30 fA resolution at 10 nA current range). Must be a default hardware configuration without any additional amplification
- **Measured Potential Resolution**: 3 µV or better
- **Potentiostat Rise/Fall Time**: < 300 ns or lower
- **Bipotentiostat add-on** should be provided to use two working electrodes with a common reference and counter electrode in SECM.
- **Interface**: USB interface for connection with the computing system.
- **Independent EIS Configuration** should be provided as an optional add-on.

II.2 A basic SECM Workstation with future capabilities for high resolution analysis (1 nm or better), shear stress option (structure size < 1 µm) is required.

- **Scale Range and Resolution:** Must include a stepper motor drive based positioning system (or better) with xyz positioning system that provides a scale range of at least 25 mm/axis in normal mode with 20 nm resolution (minimum step width).

Future upgrade options for SECM stage

- **SECM positioning system:** System must be expandable anytime in the future with an additional capability of a piezoelectric positioning system that is mounted in tip holder for high-resolution movements:
  (a) Travel / Scale Range (xyz): 100 µm/ Axis
  (b) Resolution: 1 nm
- **Shear force attachment to deconvolute electrochemical activity and topography of sample:** To precisely separate topographic and electrochemical information, we need an option in the future that provides the ability to control the tip-to-sample separation. The option should allow us to hold the tip at a constant distance of 50 to 300 nm above the sample surface via a feedback mechanism. We would prefer a constant-distance mode imaging of electrodes in the sub-micrometer range and rough samples. The set-up must allow us to study the deconvolution of topography and activity effects.

II.3. SECM Software & computing system: An easy to use SECM must be provided with suitable computing system along with the following options:

- Current-independent constant-distance mode for high-resolution measurements (Shear force analysis)
- Different modes of tip movement during array scans.
- Online preview of experimental results, 3D visualization of array scan data including graphics export, topography image for constant-distance mode, automatic approach curve and option for tilt compensation.
- Options to perform complete electrochemical analysis at each grid point.
- Future expandability for electrochemical impedance spectra for AC-SECM (Nyquist, Bode Plots, 3D images for Array Scans on Real & Imaginary parts)

II.4. Other Mandatory accessories: System must be supplied with a beginner's kit consisting of two Pt-microelectrodes (25 und 10 µm), reference and counter electrodes and a test sample for training purposes. A measuring cell with distance pieces to adapt to different sample heights and adjustable base plate for manual tilt compensation must be provided.

II.5. Future upgradation: Future upgradation of the system to Scanning Photoelectrochemical Microscopy should be possible.

III. Warranty

Should provide a minimum of 3 Years manufacturer's warranty for both the SECM systems, from the date of installation. Any AMC shall be quoted separately after the warranty period.

IV. Additional requirements

The vendor should be an authorized provider of sophisticated high-precision potentiostat/galvanostat systems for a minimum of 10 years with at least 10+ electrochemical system installations in India.