**INDIAN INSTITUTE OF TECHNOLOGY BOMBAY**

**MATERIALS MANAGEMENT DIVISION**

**Powai, Mumbai - 400076**

**PR: 1000028315**
**Rfx: 6100001291**

# Technical Specifications: X-ray photoelectron spectroscopy facility

## 1. System :

A. Fully-automated instrument should have the features to conduct X-ray photoelectron spectroscopy experiments including imaging, spectra acquisition and depth profiling at high throughput. It should be able to perform analysis on samples of semiconductors, metals, alloys, ceramics, glasses, polymers/organic compounds, magnetic materials and insulators. It should be upgradable to Ultraviolet Photoelectron spectroscopy (UPS) and Auger electron spectroscopy (AES). EELS, LEIPS and GCIS modules at a later stage.

B. The system should have integrated baking heaters along with appropriate safety interlocks. All the components should be designed to withstand the baking temperatures up to an average of 120 deg C or higher. The baking and subsequent cooling down should be completely controllable through in-built software, supplied along with the instrument.

C. The system should include a Residual gas analyzer (RGA) fitted through a DN 40 gate valve in one of the ports with differential pumping port and suitable UHV compatible valve connected to sample introduction chamber through a conveniently accessible port. In addition to this, main chamber must have few additional free ports to allow for subsequent upgradation as mentioned in point A, above.

D. The UHV system must have a two-chamber configuration, with one chamber for samples analysis and another chamber for sample exchange or introduction. The two chambers must have independent pumping stations in terms of both turbo and roughing pumps.

E. All the appropriate UHV parts should be made of μ-metal or SS with μ-metal shielding to achieve low noise XPS measurements and provide optimum magnetic field shielding and ultra-high vacuum (UHV).

F. Appropriate set of Turbo-molecular pumps backed by oil/oil-free pumps should be included to achieve a guaranteed base pressure of $5 \times 10^{-10}$ Torr or better in the analysis chamber. The sample-introduction should achieve a guaranteed base pressure of $8 \times 10^{-9}$ Torr or better. Additional pumps such as Ti-sublimation or ion-getter pumps can be included as necessary for the configuration quoted.

G. The system should include suitable gauges, pump controllers and all necessary interlocks to ensure smooth and easy operation. All the vacuum systems should be controlled through software. The software should include a vacuum-block diagram of the instrument that will display the pressures in real-time. The gate valve separating the analysis and sample-introduction chambers should be of electro-pneumatic type or equivalent.

H. Complete set of safety and interlock features for ensuring the integrity of vacuum system and associated components (electronic and non-electronic) in case of power failure/vacuum failure or faulty water supply should be provided.

## 2. X-ray source :

A. The instrument must be equipped with two standard monochromatic sources one of which must be an Al K-alpha (energy =1486.7 eV). The second source can be Ag L-alpha (energy = 2984.2 eV) or any other source of equivalent or higher energies. The switching between the two sources and subsequent alignment should be controlled completely through the software, without requiring any physical intervention from the user.
B. The monochromator should have Rowland circle quartz crystal for high resolution and high sensitivity X-ray photoelectron spectroscopy. The instrument must provide error-free positioning of the X-ray beam that allows analysis from small to large area (order of few micrometers) XPS analysis.
C. The system must have a nominal operating conditions of the X-ray source (15 kV, 30 mA or better).

## 3. Charge neutralization :

A. The system should include a robust charge-neutralization capability,that is software controlled. This should be demonstrated on PET or an equivalent sample during commissioning.

## 4. Depth profiling :

A. The system must include a Ar ion source with energy range of 0-4 keV or better for depth profiling and surface cleaning. The relevant gas admittance system, pumping system and power supplies must be included with the system. The depth capability of the Hard X-ray source, supplied as the $2^{nd}$ anode, should be specified, along with the spectral and spatial resolutions.

## 5. Electron energy analyzer and detector :

A. The system must include a hemispherical analyzer of mean radius of 125 mm or higher. Spherical analyser can be included with the system if it is required to meet the specifications and provide additional capabilities such as spatial mapping. The intrinsic energy resolution of the analyser should be $\leq$ 20 meV or better throughout the entire operational energy range.
B. The ultimate XPS energy resolution must be $\leq$ 0.50 eV (FWHM)with $\geq$ 150 Kcps and $\leq$ 1.00 eV with $\geq$ 1000 kcps, both of which to be measured and demonstrated on Ag 3d5/2 peak. This has to be established at the time of commissioning the system at IIT Bombay.
C. The ultimate XPS energy resolution must be on non-conducting samples $\leq$ 0.85 eV @ 80 kcps FWHM measured on O-C=O component on standard company-supplied PET sample). Application literature should be shared along with the technical specifications.
D. Both survey spectrum and narrow region spectra in both single-spectrum mode and imaging mode must be accessible through software.
E. It should have the ability to acquire images of the sample of interest with spatial resolution of 5 μm or better.
F. It should be able to perform angle resolved XPS capability and depth resolution. The accessible angular range with resolution must be provided.
G. The detector should consist of microchannel plate based amplification with a minimum of 128

channels.

## 6. Sample holder and manipulator :

A. The system should come with default sample stage that provides for loading of at least 10 samples of 1 x 1 $cm^2$ area at the same time. A minimum of three sample holders must be included with the system for carrying out analysis on samples as large as 20 $cm^2$ or larger. The sample transfer between the introduction and the analysis chamber should be automatic, without any human intervention, and be controlled by the vacuum in the respective chambers.
B. The sample stages should be provided with 5-axis manipulator involving x, y, z, theta and azimuthal rotational modes, all of which are driven through stepper motors. All movements of the sample stage should be automated and software controlled.
C. An imaging system to visualize the position of the sample in the analysis chamber should be included. It must be possible to click on any point of this image and direct the spectral acquisition there.
D. Angle resolved XPS should be possible for at least one sample at a time.
E. Standard calibration sample for the spectroscopy mode and grids for the imaging mode must include (but not limited to) Au and Ag in the analysis chamber. Auto-calibration through software must be provided.
F. The system must include a sample holder with 4-terminal electrical contact for in-situ electrical/electrochemical measurements. These stages should not have any effect on the spectral and spatial resolutions or other capabilities of the equipment.

## 7. Analytical capabilities :

A. The system must be capable of providing both qualitative and quantitative analysis for both single-spectrum and imaging, based on the XPS spectrum of the samples. The database for analysis should be included with the system.

## 8. Computer and software :

A. The system must include one or more dedicated computer(s) for interfacing with the instrument, collecting the data and analyzing it. In addition, at least 10 user licenses of the data analysis software should be included. All subsequent updates of these softwares should be available for lifetime. Window OS is preferred for all the computers. It must be possible to pre-program a sequence of tasks/experiments/operations using the software that will automatically run. The system must have remote access feature, through which all operations can be performed. Auto-saving and logging of data, in case of any power loss or functional stoppage, must be enabled.
B. Software must offer full control of XPS operation including X-ray source, vacuum management, charge and neutralizer, sample stage, automatic sample height alignment, automatic depth profiling and sequential angle dependent XPS as well as multi task analysis. All parameters and the sequence of tasks must be possible to be pre-defined by the user.
C. The Atomic Energy Regulatory board (AERB) registration and obtaining the procurement permission/no-objection certificate shall be in supplier's quote.
D. Complete system for ensuring Uninterrupted Power Supply (UPS) providing a backup of at least 1hour, in case of power outage along with the required batteries should be included in the quote. All accessories including gas cylinders, regulators, gas tubing, water chiller(s) and other accessories required for installing and regular operation of the equipment should be included in the quote. All power supplies should be Indian type 230+/-10% Volts, 50Hz, with Indian

standard plugs. If Indian plugs are not available, suitable converters must be provided.

E. The system should also include a **3-years comprehensive warranty**, on-site installation and a minimum of 6 training schedules spread over the three years that would be given by a fully-qualified technical person from the vendor. Details of previous installations and user-testimonials from at least five Indian laboratories and/or equivalent International installations should be provided along with the corresponding installation reports.