Pacific Northwest
NATIONAL LABORATORY
Tel: (509) 372-6212
Fax: (509) 375-3818
kathy.whelan@pnl.gov

July 29, 2009

Dear Prospective Offeror:

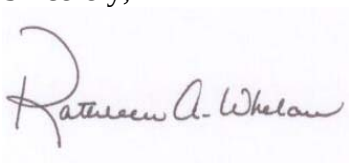
REQUEST FOR PROPOSAL (RFP) NO. 103960, AMENDMENT 1
HIGH-SENSITIVITY XPS SYSTEM

This letter serves as Amendment No. 1 to the subject RFP that was issued on July 14, 2009. The purpose of this Amendment is to incorporate the attached, revised Technical Specification dated July 27, 2009. All references to the Technical Specification contained in the subject RFP are construed to mean the Technical Specification dated July 27, 2009.

Except as provided herein, all terms and conditions of the referenced RFP remain unchanged and in full force and effect.

Offerors shall acknowledge receipt of this Addendum in accordance with the RFP section entitled "Amendments to RFP."

Sincerely,



Kathleen A. Whelan
Sr. Contracts Specialist

Attachment: Technical Specification dated July 27, 2009

Request for Proposal 103960
High-Sensitivity XPS System
July 27, 2009

Battelle requires a high-sensitivity and high-throughput XPS imaging and spectroscopy instrumentation that includes:

- a monochromatic Al Kα x-ray sources,
- an electron energy analyzer with high-sensitivity and high-energy and spatial resolution, and
- argon ion sputtering capability.

Sample transfer under control environment is required for most of the work; an introduction chamber with a glove box for sample transfer under anaerobic conditions is required. The system shall have controlled cooling and heating capabilities both at the introduction chamber and the analysis position for carrying out measurements on biological and wet samples (we must be able to load sample on pre-cooled stage in the sample introduction chamber through the glove box). The UHV system shall be maintained by combination of ion pump, Ti sublimation pump and turbo molecular pumps backed by dry roughing pumps.

Overall System

- A computer controlled UHV system is required. The main system shall be pumped by the combination of ion pump, Ti sublimation pump and turbo-molecular pumps backed by dry roughing pumps (no oil pumps). Appropriate pumping systems for Ar ion gun and introduction chamber are required. All the turbo molecular pumps on the system shall be isolated with gate valves which are interlocked to ion gauges to avoid venting the chambers when power fails. The base pressure in the main chamber and the introduction chamber shall be $5x10^{-10}$ Torr and $1x10^{-7}$ Torr, respectively.
- The instrument shall have an automatic baking function.
- The system shall have digital camera capability to visualize enlarging micron-scale features on the sample and carry out micro-area spectroscopy (separate monitor).
- Contractor shall install the system at the EMSL facility and perform acceptance testing in accordance with the requirements outlined herein.

Al Kα Monochromatic X-ray Source

- The x-ray source shall provide high-flux Al Kα monochromatic x-ray beam.
- A minimum analysis area of 20 μm diameter shall be obtained**;** Offeror shall specify the size of possible analysis areas and the corresponding count rates for Ag $3d_{5/2}$ peak at 0^o emission (sample normal to the analyzer) with ≤ 0.6eV energy resolution.
- X-ray source shall be capable of providing secondary electron or other imaging of the sample surface; Offeror shall specify the spatial resolution of the imaging with the

minimum size of the feature that can be identified on the surface and the time required for the imaging.

Argon Ion Gun System

- Ion gun system shall provide surface cleaning capability, and chemical depth profiling. Offeror shall specify the resolution for depth-profiling.
- Ion gun system shall provide high current densities with low ion energies, minimizing surface damage.
- The ion energies shall be in the range of 0.25-4.0 keV; Offeror shall specify the current and the beam size as a function of energy and Ar pressure in the chamber.
- The chamber Ar pressure shall be at most $5x10^{-8}$ Torr for the normal operation of ion gun; Offeror shall specify the Ar pressure range for normal operation.
- The ion gun system shall provide a continuous long-term stability and sputter rate reproducibility.
- The ion gun shall have neutral suppressor or be designed to minimize production of neutrals.
- The gas pressure in the ion gun shall be monitored and controlled.
- The ion gun shall be digitally controlled to provide different effective beam sizes and the corresponding beam currents. Offeror shall specify the currents on a clean Ag surface with varying ion impact energies.
- Digital control of gas pressure in the ion gun shall be provided.
- Offeror shall specify "standard" and "optimum" operating conditions and the corresponding beam size, beam current on a clean Ag surface, ion impact energy and the chamber pressure.

Sample Stage

- The system shall have at least four axes (x, y, z and tilt) computer driven sample stage providing a stable analytical platform with high degrees of accuracy and reproducibility.
- In addition, the sample stage shall be equipped with azimuthal rotation for high resolution sputter depth profiling; Offeror shall specify the angular range and the repeatability.
- x, y and z directions shall have translations of ±25 mm, ±7.5 mm and ±7.5 mm, respectively, with the repeatability of ≤ 5 μm .
- The tilt angle range shall be $\pm 45^{o}$ with the repeatability of $\leq 0.2^{o}$.
- Various sample mounts shall be provided with the system. These mounts shall have a capability of mounting multiple samples, powder samples, and can be used for angle resolved measurements.
- The temperature range shall be between -120^{o}C to 250^{o}C. Offeror shall specify the cooling and heating rate and the time required to reach the specified temperatures.
- When the sample stage at ≥ 250°C in the absence of sample, the base pressure in the analyses chamber shall be $\leq 1.0x10^{-8}$ Torr.

- The system shall have an automated sample handling and analysis area identification tools.

Sample Introduction Chamber and Glove Box

- The sample introduction chamber (load-lock) shall be attached to a glove box for an anaerobic sample transfer.
- The sample introduction chamber shall have a quick sample entry doors for mounting samples on to the stage from air as well as from the glove box.
- The stage in the introduction chamber shall have controlled cooling and heating capabilities between -120^{o}C to 250^{o}C. Offeror shall specify the cooling and heating rate and the time required to reach the specified temperatures.
- Samples shall be loaded on pre-cooled stage in the sample introduction chamber through the glove box.
- The introduction chamber shall be pumped down to $1.0x10^{-7}$ Torr in ≤10 minutes in the absence of any sample.
- The sample transfer (after the chamber reached the desired vacuum) shall be completed in ≤5 minutes.
- Offeror shall provide with its proposal the conceptual design with detail descriptions. The glove box shall be a complete system with integrated purifier, controls, display and stand. The glove box system shall be capable of achieving <1 ppm O2 and & H_2O equilibrium. This system shall provide at least on antechamber for transfer of samples to and from the glove box while maintaining <1ppm O_2 levels. Glove box pumping shall be performed using a 120 VAC, BOC Edwards style scroll pump. The system shall include a pre-calibrated oxygen monitor with display with a range from 0.1 ppm to 25% O_2 and a moisture monitor with that displays the glove box levels to 0.5 ppm moisture (-80 degrees C dew point)

Charge Compensation System

- The system shall have a charge compensation for carrying out measurements on insulators. The system must be capable of making measurements on PET (polyethylene terephthalate) with O-C=O peak resolution of ≤0.85 eV within 60 seconds of turning on the neutralization system after system as been set up for routine operation. Offeror shall describe the details of charge compensation system for insulators.
- The difference between the binding energies of the corresponding C 1s peaks from PET collected at 0^{o} and 45^{o} emission angles using monochromatic x-ray beam with an energy resolution of ester (O-C=O) peak at ≤0.85 eV shall be ≤ 0.5 eV .
- The count rate of C 1s scan from PET collected at an emission angle of 0^{o} using monochromatic x-ray beam with an energy resolution of ester (O-C=O) peak at ≤0.85 shall be ≥ 30,000 cps using large area x-ray beam (≥ 20,000 μm^2).
- The difference in the background counts from the survey scans collected in 5 minutes each (monochromatic x-rays operating at maximum power that is recommended for

routine operation of the instrument, FWHM of Ag $3d_{5/2} \leq 0.6$ eV) recorded on a lightly etched Ag surface with and without neutralizer shall be ≤ 500 counts.;

Electron Energy Analyzer

- The energy analyzer shall provide a full-featured XPS imaging and spectroscopy, line / area scans and angle-resolved analyses.
- The detection system shall be efficient enough to provide high sensitivity and high dynamic range.
- The divergence from linearity of count rates obtained from $M_H(E_J)/ M_L(E_J)$ vs $N_H(E_J)$ (ISO/DIS 21270) shall be within ± 2.5% at 5 million CPS.
- The instrument must have imaging capabilities that provide a spatial resolution of ≤ 6 μm spatially resolved chemical state information.
- Offeror shall specify the size of possible analysis areas and the corresponding count rates for Ag $3d_{5/2}$ peak at 0^o emission (sample normal to the analyzer) with ≤ 0.6eV energy resolution using monochromatic x-ray source operating at maximum power that is recommended for routine operation of the instrument.
- In a large area (≥ 20,000 μm^2), the count rate for Ag $3d_{5/2}$ peak at 0^o emission (sample normal to the analyzer) with ≤ 0.6eV energy resolution using monochromatic x-ray source shall be ≥ 900,000 cps. If this count rate involves magnetic lenses, the count rate without the magnetic lenses shall be at least one third of this count rate.
- The degradation rate (atom% Cl per minute) from PVC (using the same analysis parameters used above in measuring FWHM of C 1s peak and monochromatic x-rays operating at maximum power that is recommended for routine operation of the instrument) shall be reported.

Computer and Software Requirements

- The data acquisition computer shall have provisions to network. Offeror shall provide detailed computer feature specifications.
- The software for instrument control, data acquisition, and, data analyses shall be provided with the system. This shall include (but not be limited to) the ability for peak quantification (with defined sensitivity factors), the ability to test and alter the instrument transmission function, the ability to transfer data files for other types of analysis in a batch mode, the ability to repeat or batch analyze similar spectra without repeated entry of all analysis parameters, the ability to export data in the ISO format, the ability to curve fit and the ability to do multi-layer analysis.
- The software shall be user-friendly and easy to navigate the system for diagnostics purposes.
- Data acquisition for multiple samples shall be automated with different tasks for a period of 24 hrs. or more.
- Multiple depth profiling followed by data acquisitions and their analyses shall be automated for an easy extraction of the results.
- Software shall have provisions to navigate sample positions.

- Minimum two copies (licenses) of the data analyses software shall be provided with the system and this software shall run on personal computers in order to process the data in the office. A digital operations manual shall be provided.

Spares

Contractor shall provide a complete set of spare filaments, detectors, and gaskets.

Warranty and Maintenance Services

A standard one-year onsite warranty, including all parts, labor, travel, lodging and expenses, shall be provided for the system. In addition, a minimum of one maintenance service call, including all parts, labor, travel, lodging and expenses, per year shall be provided. Contractor shall provide guaranteed on-site response and spare parts available within 72 hours of the service call.

Training

Basic operator training shall be provided at EMSL following installation and acceptance testing of the system. Within six months following installation or by November 15, 2010, whichever comes first, Contractor shall provide advanced operator training for up to three employees at the EMSL facility.

Installation and Acceptance Test Procedures

Offeror shall provide its standard procedures for installation and acceptance testing of the system at the EMSL facility. In addition to applying its standard procedures to installation and acceptance testing activities, Contractor shall collaborate with PNNL scientists to develop and perform additional onsite testing procedures that may be required to ensure the system meets the requirements specified herein.

References

Offeror shall demonstrate that it has previously installed systems similar to the one proposed by providing the respective client contact information for three to six firms. Contact information shall include name of firm, contact and contact's telephone number and email address.

OPTIONAL CAPABILITIES

Data Analyses Software (1)

Three (3) additional copies (licenses) of the data analyses software.

Data Analyses Software (2)

Site license for the data analyses software, such license to allow remote access by multiple EMSL users (non-Battelle staff members).

Extended Warranty and Maintenance

- Year 2 warranty and maintenance (consistent with Year 1 as described above);
- Year 3 warranty and maintenance (consistent with Year 1 as described above); and
- Year 4 warranty and maintenance (consistent with Year 1 as described above).

Al/Mg Dual-anode Non-Monochromatic X-ray Source

- Dual-anode shall be operated independently and/or simultaneously.
- The Offeror shall provide availability and pricing of a Zr/Mg anode as a replacement for an Al/Mg dual anode.
- The non-monochromatic dual anode x-ray source shall operate at ≥ 350 Watts**;** and the Offeror shall specify the count rate as a function of the power indicating the optimum power conditions and the spot size.

Ultra-Violet Light Source

- The light source shall provide very stable and highly collimated beam. The Offeror shall provide information confirming the stability and collimation of the light source.
- The ratio of He I/He II shall be ≥ 3/1.
- The chamber pressure shall be ≤ $5x10^{-8}$ Torr when UV light source is operating.
- The discharge current on a clean Ag surface shall be ≥ 75 mA; Offeror shall specify the maximum discharge current on a clean Ag surface that can be obtained and the corresponding beam size and the chamber pressure.
- The Offeror shall provide the optimum operating conditions and the corresponding discharge current on a clean Ag surface, beam size and the chamber pressure.
- The Offeror shall provide details of how the gas pressure in the UV source is monitored and how the UV light from the source to the sample is collimated.
- The sensitivity of ≥ 2 Mcps shall be obtained for Ag 4d peak with an energy resolution of ≤140 meV using He I ultra-violet light source.

C_{60} or other Cluster Ion Gun System

- Ion gun system shall provide surface cleaning capability and chemical depth profiling at normal or low ion impact energies with a high resolution**;** Offeror shall specify the resolution.

- Ion gun system shall provide high current densities with low ion impact energies, minimizing surface damage.
- The ion gun shall have the beam energy: at least 1KeV to 10 KeV.
- The ion current (mass filtered) shall be ≥ 20 nA; Offeror shall specify the maximum current and the beam size as a function of ion energy (at least at 1 KeV, 5 KeV and 10 KeV).
- The ion gun system shall provide a continuous long-term stability and sputter rate reproducibility; Offeror shall specify the chamber pressure range during the normal operation of the ion gun
- Provide the optimum operating conditions and the corresponding beam size, beam current on a suitable surface (either a clean Ag surface or organic material or both); Offeror shall specify the impact energy, the chamber pressure and carbon deposition on the sample after certain amount of time of operation for this optimum condition.