SIMS Technical Specifications
Statement of Work

Provide the high sensitivity magnetic sector secondary ion mass spectrometry instrumentation and materials specified below and complete installation, post installation validation/acceptance testing and onsite familiarization training for one to three Pacific Northwest National Laboratory (PNNL) staff for three weeks for that instrumentation.

SPECIFICATIONS

A)General

1)The contractor shall furnish and install a high sensitivity magnetic sector secondary ion mass spectrometer (SIMS). The contractor shall provide a complete SIMS system in accordance with the specifications outlined below as well as those published by the manufacturer that might not appear below.

2)Acceptance test procedures shall be performed by mutually agreed methods when contractual specifications differ from or are in addition to standard vendor specifications.

3)The contractor shall understand that in some instances this system provides critical, time-sensitive analytical services thus the contractor shall have available documentation, spare components, and other specialized tools to facilitate immediate repair by the user. In the case where the contractor must provide proprietary information to PNNL for the purpose of fulfilling a requirement of documentation, PNNL will sign a non-disclosure agreement concerning that information.

B)<u>Ion sources and primary ion column</u>

1)There shall be at least two ion sources available at all times on the primary column. The accelerating voltages of each ion source shall be continuously adjustable within their specified ranges.

2)The primary ion sources shall have isolation valves so that they can be vented and cleaned without venting the entire primary column.

3)There shall be a high brightness Cs+ ion source capable of operating at accelerating voltages up to 13 kV. It shall have a minimum spot size on the sample of 0.2 micrometers, and a maximum of at least 200 micrometers. It shall be capable of achieving a beam current density of 50 mA/cm2 with a beam diameter of <50 micrometers.

4)There shall be a duoplasmatron ion source capable of producing both positive and negative ions at accelerating voltages up to 17.5 kV positive ions and at least 13 kV for negative ions. It shall have a minimum spot size of 0.3 micrometers for O2+ and 1 micrometer for an O- beam.

5)The primary ion beam shall be mass-filtered.

6)All lens and deflector voltages shall be adjustable under computer control.

7)The deflectors that control the position of the primary ion beam on the sample shall have sufficient range to cover a 250x250 square micrometer imaged area at the highest available beam energy and at all allowable sample extraction distances while maintaining the secondary ion beam centered on the immersion lens axis.

8)The primary ion beam intensities shall vary <1% over 10 minutes and shall vary by < 0.1% over 10 seconds.

C) <u>Mass spectrometer and ion detectors.</u>

1)The instrument shall be capable of operating as a stigmatic ion microscope as well as an ion microprobe.
2)The mass spectrometer shall be a double-focusing type and shall have the ability to measures species up to 300 amu at 10 kV.
3)The secondary ion column shall be capable of operating at accelerating voltages up to 10 kV (both positive and negative) and shall be continuously variable within that range.
4)The mass spectrometer shall be capable of a mass resolving power (m/Dm, where Dm is the 10% peak width) of up to 40,000.
5)The abundance sensitivity shall be such that contributions of a mass M on a mass M-M/250 shall be less than 40 ppb in the collector of the mono-collection system as measured for uranium on NIST SRM 960 (provided by PNNL) on the low-mass side of a selected peak of uranium with an energy band pass of at least 50 eV.
6)The magnetic field of the mass spectrometer shall be controllable with the computer to at least +-1 bit in 21 bits, and the field shall be stable to +- 1 bit (i.e. 1 part in 2097152) as measured by the position of the peak of 48Ti+ for at least 100 seconds.
7)The mass spectrometer shall be equipped with a single electron-multiplier pulse-counting system (EM). The background of this detector shall be < 5 counts/minute with all high voltages, ions sources and pumps on. This shall be checked for both positive and negative secondary voltages prior to acceptance of the instrument.
8)The dead time of the EM shall be 25 nanoseconds or less and be independent of count rate. This shall be demonstrated by the measurement of Ti isotopes, at several count rates of the major isotope from 100,000 to 1,000,000 counts/second, on Ti metal.
9)The system shall be equipped with a single collection faraday cup detector (FC). The FC shall have a background noise, integrated over 5 seconds, of less than 0.001 pico-amps.
10)The SIMS shall have a multi-collector system for at least 5 masses. The system shall be capable of at least measuring all of the isotopes of Pb at an accelerating voltage of 10 kV. The system shall be equipped with electron multipliers and Faraday cups. It shall be demonstrated that all 4 uranium isotopes (U-234, U-235, U-236, U-238) and uranium-238 hydride can be measured on the multi-collector as part of the acceptance tests.
11)Crosstalk between adjacent electron multiplier detectors on the multicollector system shall be less than 1 ppm.
12)Crosstalk between an electron multiplier and an adjacent Faraday cup detector on the multicollector system shall be less than 100 ppb.
13)Background noise on individual electron multipliers in the multicollector system shall be less than 5 counts/minute for both positive and negative ion settings.
14)The secondary ion system shall be designed such that the transmission shall not decrease by more than 10% when the mass resolution increases from 2000 up to 6000.
15)The sensitivity for Pb+ measurements shall be demonstrated to be at least 24 cps/ppm/nA with an O2- primary ion beam and mass resolution of at least 5700.
16)The instrument shall have a resistive anode encoder installed as a secondary ion detector.

D) <u>Optical sample viewing, stage, and sample chamber.</u>
1)The sample surface shall be viewable through a high-quality color CCD camera and a high-quality color monitor.
2)The sample and sample chamber shall be illuminated with a fiber optic illuminator.
3)The video image of the sample shall be able to be captured via computer as a popular image-file-format such as TIFF.

4)The stage shall have X, Y, and Z adjustments. The X and Y position shall be under computer control, and shall have a reproducibility of 5 micrometers after motions of 10 mm. The total range of motion of X and Y shall be at least 20 mm for each axis. The Z-motion shall have a range of at least 3 mm.
5)There shall be multiple access ports on the sample chamber vacuum system to allow the future addition of a RIMS or SNMS laser system. The final drawing of the sample chamber with access ports shall be approved by PNNL before delivery.
6)The sample chamber shall be pumped by a turbomolecular pump.

E) Charge compensation
1)A system to provide charge compensation for insulating sample shall be provided.

F) Spare parts
1)One set of spare electronic components of common items in the system and items known to be susceptible to failure shall be provided. Additional spare parts shall be available for purchase thereafter.
2)One set of spare parts kits for apertures, vacuum system seals and other consumable items shall be provided on delivery. Additional spare parts shall be available for purchase thereafter.

G) Software, software documentation and computer control.
1)The instrument shall be fully automated and capable of unattended operation.
2)A National Instruments LabView™ interface to the instrument as well as control-programs that allow at least the following operations and measurements shall be provided: primary and secondary column tuning, stage control, detector tuning (both multicollector and monocollector), mass spectral acquisition, energy spectrum acquisition, depth profiling (both multicollector and monocollector), isotope and elemental ratio measurements (both multicollector and monocollector), ion image acquisition, and any other operations that have become a de-facto standard for SIMS operation.
3)A program or set of programs shall be provided to perform off-line analysis of data.
4)Software upgrades for all computer systems and subsystems shall be provided free of charge for three years after acceptance.

H) Vacuum
1)The detector-end of the secondary ion column shall be isolated from the rest of the instrument by a high-vacuum gate valve.
2)Turbomolecular pumps shall be supplied on the detector-end of the secondary ion column to facilitate quick pump-down after repairs.
3)A liquid-nitrogen-cooled cold-finger shall be provided in the sample chamber.

I)Experience
1)The performance of the mass spectrometer and the primary ion column shall have been demonstrated on previously delivered systems.
2)The software functionality and interfaces to the hardware shall have been demonstrated on previously delivered systems.
3)The delivered SIMS system shall not be a prototype system. The delivered system shall be largely similar to systems previously delivered to other customers of the contractor.

4)The contractor shall demonstrate prior experience in manufacture of such SIMS systems by providing a current customer list, with the phone numbers of customers, so that PNNL can verify the prior experience with the current customers.

INSTALLATION

During the installation of the instrumentation, the offeror shall:
A) The onsite installation technicians/engineers shall take PNNL web-based safety training (approximately two hours per person)
B) Oversee, assist, and/or perform the unpacking and movement of the instrumentation to its final location. The instrumentation shall be installed in 3430 building. The laboratory will be configured (by PNNL) for the laboratory service requirements (to be provided by the offeror) of the instrumentation.
C) Check conformity of laboratory and laboratory services requirements for proper instrument operations as outlined in the manufacturer-provided site preparation guide.
D) Oversee, assist, and/or perform the installation and connection of instrument peripherals.
E) Oversee, assist, and/or perform the connection of all services to the instrumentation.
F) Perform instrumentation start-up.
G) Perform tuning and calibration of the instrumentation to meet specifications.

POST INSTALLATION

During the post installation validation/acceptance testing, the offeror shall:
A) Perform instrument qualification testing to validate the instrument meets the manufacture's published performance specifications.
B) Demonstrate or illustrate that the instrumentation provided meets the specifications identified below. The validation/acceptance testing documentation shall be transmitted to the contracting specialist.

TRAINING

During the familiarization training, the offeror shall:
Familiarize one to three PNNL staff for three weeks in the 3430 building on the instrument operation, maintenance and software for all equipment and materials supplied.

SUBMITTALS

Included in the proposal, the offeror shall:
A) Provide PNNL the installation service (power, environmental, gas services, cooling, exhaust, etc.) requirements.
B) Provide a listing of any required equipment (uninterruptible power supplies, chillers, vacuum pumps, safety equipment, etc.) that PNNL will need to acquire elsewhere.

Please provide information on the following items for informational purposes only and these will not be part selection criteria:

- NMR control of the magnetic sector field.
- Scanning ion image acquisition with the multicollector system.
- Oxygen flooding attachment for the sample chamber.
- Computerized duoplasmatron source.
- A Faraday cup extension for the multicollection system.

- Providing editable source code shall be provided for the LabView™ control software so that custom/proprietary user-programs can be written.
- Providing schematics and board layouts of all electronics used in the systems. This includes electronics built by the contractor and purchased subsystems (excluding computer systems, but including computer interfaces built by the contractor).