

Attachment 1:
RFP Number: N00173-12-R-RS03
Specifications for Scanning Electron Microscope System

The Naval Research Laboratory, Washington, DC (NRL-DC) requires a computer-controlled Schottky-field-emission scanning electron microscope type system for use by researchers to image and measure nanometer size features. The instrument shall be capable of imaging a wide variety of structures and materials composed of both conductive and insulating substrates. It shall provide automated control of primary beam parameters, stage motion, image acquisition and archiving. The system will be installed at NRL-DC in a class 100 cleanroom and be used by a variety of scientists, engineers and technicians.

Abbreviations

EDS	Energy Dispersive Spectroscopy
eV	electron Volts
keV	Kilo-electron Volts
kV	KiloVolts
kX	Magnification, in units of 1000
WD	Working Distance
nA	nanoAmp
nm	nanometer
mm	millimeter
pA	picoAmp
SEM	Scanning Electron Microscope

1.0 Scanning Electron Microscope (SEM)

The Scanning Electron Microscope shall meet or exceed the following specifications:

1.1 Primary beam acceleration.

1.1.1 Accelerating voltage range. 0.1 – 30 kV, minimum.

1.1.2 Beam voltage resolution: 100 V steps (max) between 0.1 kV and 30 kV.

1.2 Resolution.

1.2.1 1.0 nm or smaller resolution in both x and y directions at 15 kV.

1.2.2 1.5 nm or smaller resolution in both x and y directions at 1 kV.

1.2.3 Resolution shall be demonstrated to meet or exceed these specifications after installation at the NRL site using a vendor-supplied standard resolution sample (e.g. gold on carbon).

1.3 Magnification

- 1.3.1 25X – 1,000,000X, minimum. The magnification indicators shall automatically correct for changes in operating voltage and/or working distance. Magnifications shall be able to be preset and recalled through the graphical user interface.
- 1.3.2 Length scale: An automated length scale indicator shall be provided and overlaid to the user's image at user's option.

1.4 Beam current

- 1.4.1 Minimum range of probe current: 1 pA – 200 nA
- 1.4.2 Software controlled adjustment of probe current.

1.5 General Source and Column Requirements

- 1.5.1 The system shall have a Schottky type field emission gun for high stability.
- 1.5.2 Automatic run-up of electron source required.
- 1.5.3 Electromagnetic, computer-controlled beam alignment.
- 1.5.4 Electromagnetic, computer-controlled aperture alignment.
- 1.5.5 Automatic gun isolation valve with interlock to prevent source burn-out under conditions of high chamber pressure.
- 1.5.6 Fully automated aperture angle control lens to maintain a minimum probe size versus probe current.
- 1.5.7 Display of beam voltage, emission current, filament current and column vacuum on the graphical user interface.
- 1.5.8 Computer control of stigmation, working distance (focus), focus wobble, and magnification required.

1.6 Required Chamber Detectors

- 1.6.1 Solid state low-angle backscatter electron detector.
- 1.6.2 Everhart-Thornley secondary electron detector (E-T SED) capable of imaging at minimum of 1kV.
- 1.6.3 A below-the-lens detector that shall be retractable and allow operation at working distances as short as 6mm.

1.7 Imaging

- 1.7.1 The system shall have a digital scan generator capable of at least 5000 x 3500 pixel resolution.
- 1.7.2 The system shall have full frame, full screen, sizeable and moveable reduced field, spot mode, line scan, live dual display, and signal mixing capabilities.
- 1.7.3 The system shall have a minimum of 15 user selectable scan speeds.
- 1.7.4 The system shall have a live image display resolution of at least 800x600 pixels.
- 1.7.5 The system shall be capable of frame averaging. A minimum of 1 to 1000 frames.
- 1.7.6 Image storage in the TIFF (tagged image file format) format, BMP (bit map) format, and JPEG (joint photographic experts group) format.
- 1.7.7 The image acquisition shall be capable of 16 bit resolution TIFF files.
- 1.7.8 Image processing shall contain such features as sharpen, smooth, and edge enhancement.
- 1.7.9 Shall contain a searchable image storage database with thumbnail view.

- 1.7.10 External control. The system shall allow external control of electron beam raster and video capture for third-party applications, including EDS.
- 1.7.11 The system shall have on screen scalar measurement and annotation capabilities. Including: point to point, angular, circle, and square at a minimum.

1.8 Specimen Chamber and Stage

- 1.8.1 The system shall have a load lock capable of loading a 4 inch silicon wafer.
- 1.8.2 The system shall be capable of moving at a minimum 50 mm in X, 50 mm in Y, 1 to 30 mm in Z, -5° to $+70^{\circ}$ tilt (T), and 360 degree rotation (R). The stage shall be computer eccentric at all working distances and tilts.
- 1.8.3 The tilt axis shall be perpendicular to the axis of a dedicated EBSD port.
- 1.8.4 X,Y, tilt, Z and rotation shall be PC controlled.
- 1.8.5 The stage shall be capable of meeting all resolution specifications without using a stage lock or clamp.
- 1.8.6 The stage shall include a vibration dampener that does not restrict stage axis movement.
- 1.8.7 An active vibration cancellation system shall be built into the system.
- 1.8.8 Automatic stage homing for sample exchange.
- 1.8.9 User selectable safety limits in Z for tall samples.
- 1.8.10 Sample grounding alarm and stage halt for conditions contact of the sample and/or stage with the electron column.
- 1.8.11 Storage and recall of stage points.
- 1.8.12 The chamber shall have entry ports for: wavelength dispersive x-ray detector, electron backscatter diffraction system, energy dispersive x-ray spectrometer system, cathodoluminescence detector at a minimum.

1.9 Vacuum System

- 1.9.1 The main chamber vacuum system shall have a turbo molecular pump with an oil free backing pump to provide an oil-free specimen chamber.
- 1.9.2 There shall be a gun column isolation valve that is interlocked with the airlock and the accelerating voltage control.
- 1.9.3 The electron gun chamber vacuum shall be capable of operation at 10^{-9} Torr or less. A gauge for measurement of the vacuum in the specimen chamber shall be provided. Base vacuum of the chamber shall be 2×10^{-6} Torr or less after overnight pump down.
- 1.9.4 The gun chamber shall be ion pumped.
- 1.9.5 The evacuation and up-to-air procedures shall be automatic and equipped with fail-safe interlocks to prevent catastrophic failure and venting of the electron gun column.
- 1.9.6 The microscope design shall include an airlock for the introduction of specimens to the chamber. The dimensions of the introduction port and the airlock shall be large enough to accommodate at least 4 inch diameter silicon wafer samples. Introduction of samples from the airlock into the chamber should be guided to ensure proper positioning.
- 1.9.7 The load lock pumping system shall use an oil free pump or turbo molecular pump.
- 1.9.8 The vacuum system shall have a Penning gauge with a read out on the graphical user interface.

1.10 Computer System

- 1.10.1 Operating system: Windows XP or Windows 7.
- 1.10.2 Processor: at least 2.5 GHz.
- 1.10.3 4 Gbyte RAM, minimum
- 1.10.4 Network capability: Shall have 10/100/1000 Base T network card.
- 1.10.5 Hard drive, 250 Gbyte, minimum
- 1.10.6 Minimum one 19" or larger flat panel display. (All displays shall be flat panel type.)
- 1.10.7 Mouse and keyboard.
- 1.10.8 The computer shall allow for multiple user accounts
- 1.10.9 The SEM control software shall allow for multiple user accounts and customized recipe recall.

1.11 Health/Safety Requirements

- 1.11.1 The system shall include radiation leak shielding consistent with U.S. Navy Radiological Affairs Support Program Manual (RAD-010), Item 9.5.1-15. Electrical systems shall comply with 29CFR Part 1910, Subpart S, Occupational Safety and Health Standards for General Industry. Safety interlocks shall be provided to prevent system damage or personal injury.

1.12 Training.

- 1.12.1 The vendor shall include on-site (NRL-DC) operator training for at least 5 NRL employees. Operator training shall include SEM operation and routine maintenance procedures following installation of the instrument. Training shall be done within four weeks of completion testing and acceptance of the instrument.

1.13 Documentation:

- 1.13.1 The SEM System should be shipped with one (1) complete set of operation and maintenance manuals printed on CD-ROM and one copy printed on clean-room paper.

Documentation should contain:

- a) Full operational instructions suitable for use in teaching new users.
- b) Gas, water, air, and vacuum schematics.
- c) Electrical wiring schematics.
- d) Complete mechanical schematics suitable to guide future modifications and repairs.
- e) Troubleshooting manual for common servicing and repairs of electrical, mechanical, and computer software problems.

1.14 Warranty

- 1.14.1 The vendor shall have a warranty that lasts for 12 months on parts and labor and 36 months on the emitter which commences after the system is installed at NRL and tested by an engineer.
- 1.14.2 The electron source must include full replacement while under warranty and service contract.

CONTRACT DATA REQUIREMENTS LIST
(2 Data Items)

Form Approved
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 220 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Department of Defense, Executive Service and Communications Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. Please do not return your form to the above organization. Send completed form to the Government Issuing Contracting Officer for the Contract/PR No. listed in Block E.

A. CONTRACT LINE ITEM NO. 0002				B. EXHIBIT A		C. CATEGORY: TDP _____ TM _____ OTHER _____				
D. SYSTEM/ITEM				E. CONTRACT/PR NO. N00173-12-R-RS03		F. CONTRACTOR TO BE PROVIDED AT AWARD				
1. DATA ITEM NO. A001	2. TITLE OF DATA ITEM Commercial Operation & Maintenance Manuals					3. SUBTITLE				
4. AUTHORITY (Data Acquisition Document No.)			5. CONTRACT REFERENCE RFP Attachment 1, Paragraph 1.13			6. REQUIRING OFFICE NRL CODE ****				
7. DD 250 REQ LT	9. DIST STATEMENT REQUIRED	10. FREQUENCY OTIME		12. DATE OF FIRST SUBMISSION		14. DISTRIBUTION				
8. APP CODE		11. AS OF DATE See Blk. 16		13. DATE OF SUBSEQUENT SUBMISSION		a. ADDRESSEE		b. COPIES		
16. REMARKS In accordance with Paragraph 1.13 of Attachment 1, the Contractor shall deliver one (1) set of operation and maintenance manuals both on CD-ROM and printed on clean-room paper. The required documentation shall be delivered with the SEM System. As a minimum, the documentation shall contain: a. Full operational instructions suitable for use in teaching new users; b. Gas, water, air, and vacuum schematics; c. Electrical wiring schematics; d. Complete mechanical schematics suitable to guide future modifications and repairs; and e. Troubleshooting manual for common servicing and repair of electrical, mechanical, and computer software problems						COR/TM		Draft	Final	Repro
								1		
						15. TOTAL →	0	1	0	
1. DATA ITEM NO. A002	2. TITLE OF DATA ITEM SEM Control Software					3. SUBTITLE				
4. AUTHORITY (Data Acquisition Document No.)			5. CONTRACT REFERENCE RFP Attachment 1, Paragraph 1.10			6. REQUIRING OFFICE NRL CODE ****				
7. DD 250 REQ LT	9. DIST STATEMENT REQUIRED	10. FREQUENCY OTIME		12. DATE OF FIRST SUBMISSION		14. DISTRIBUTION				
8. APP CODE		11. AS OF DATE See Blk. 16		13. DATE OF SUBSEQUENT SUBMISSION		a. ADDRESSEE		b. COPIES		
16. REMARKS The Contractor shall provide the software necessary to provide a fully functional, fully operational SEM system in accordance with Attachment 1 to the RFP. The SEM control software shall allow for multiple user accounts and customized recipe recall, in accordance with Attachment 1, paragraph 1.10.						COR/TM		Draft	Final	Repro
								1		
						15. TOTAL →	0	1	0	
G. PREPARED BY NRL CODE 3235			H. DATE 13 JAN 2012		I. APPROVED BY		J. DATE			

17. PRICE GROUP
18. ESTIMATED TOTAL PRICE

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