SOLICITATION/CONTRACT/ORDER FOR COMMERCIAL ITEMS
OFFEROR TO COMPLETE BLOCKS 12, 17, 23, 24, & 30

1. REQUISITION NUMBER	PAGE 1 OF
11-4800-04	12

2. CONTRACT NO.	3. AWARD/EFFECTIVE DATE	4. ORDER NUMBER	5. SOLICITATION NUMBER	6. SOLICITATION ISSUE DATE
			N00173-04-R-JS02	4/20/04

7. FOR SOLICITATION INFORMATION CALL:	a. NAME	b. TELEPHONE NUMBER *(No collect calls)*	8. OFFER DUE DATE/ LOCAL TIME
	Jamie Simpson	(202) 767-4597	Blk 20

9. ISSUED BY CODE N00173

CONTRACTING OFFICER
NAVAL RESEARCH LABORATORY
ATTN: CODE 3220.JS
WASHINGTON DC 20375-5326

10. THIS ACQUISITION IS
- [X] UNRESTRICTED
- [ ] SET ASIDE: % FOR
  - [ ] SMALL BUSINESS
  - [ ] SMALL DISAV. BUSINESS
  - [ ] 8(A)

SIC: 334516
SIZE STANDARD: 500

11. DELIVERY FOR FOB DESTINATION UNLESS BLOCK IS MARKED
- [X] SEE SCHEDULE

12. DISCOUNT TERMS

- [ ] **13a. THIS CONTRACT IS A RATED ORDER UNDER DPAS (15 CFR 700)**

13b. RATING D0-C9

14. METHOD OF SOLICITATION
- [ ] RFQ
- [ ] IFB
- [X] RFP

15. DELIVER TO CODE

16. ADMINISTERED BY CODE

17a. CONTRACTOR/ OFFEROR CODE FACILITY CODE

TELEPHONE NO.

18a. PAYMENT WILL BE MADE BY CODE

- [ ] **17b. CHECK IF REMITTANCE IS DIFFERENT AND PUT SUCH ADDRESS IN OFFER**

18b. SUBMIT INVOICES TO ADDRESS SHOWN IN BLOCK 18a UNLESS BLOCK BELOW IS CHECKED [ ] SEE ADDENDUM

19. ITEM NO.	20. SCHEDULE OF SUPPLIES/SERVICES	21. QUANTITY	22. UNIT	23. UNIT PRICE	24. AMOUNT
	Offer Due Date: June 1, 2004 Local Time: 4:00 PM Est. *(Attach Additional Sheets as Necessary)*				

25. ACCOUNTING AND APPROPRIATION DATA
To be completed at time of award

26. TOTAL AWARD AMOUNT *(For Govt. Use Only)*

- [ ] 27a. SOLICITATION INCORPORATES BY REFERENCE FAR 52.212-1, FAR 52.212-4. FAR 52.212-3 AND 52.212-5 ARE ATTACHED. ADDENDA [ ] ARE [ ] ARE NOT ATTACHED
- [ ] 27b. CONTRACT/PURCHASE ORDER INCORPORATES BY REFERENCE FAR 52.212-4. FAR 52.212-5 IS ATTACHED. ADDENDA [X] ARE [ ] ARE NOT ATTACHED

28. CONTRACTOR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN _____ COPIES
- [ ] TO ISSUING OFFICE. CONTRACTOR AGREES TO FURNISH AND DELIVER ALL ITEMS SET FORTH OR OTHERWISE IDENTIFIED ABOVE AND ON ANY ADDITIONAL SHEETS SUBJECT TO THE TERMS AND CONDITIONS SPECIFIED HEREIN.

29. AWARD OF CONTRACT: REFERENCE _____ **OFFER**
- [ ] DATED _____. YOUR OFFER ON SOLICITATION (BLOCK 5), INCLUDING ANY ADDITIONS OR CHANGES WHICH ARE SET FORTH

30a. SIGNATURE OF OFFEROR/CONTRACTOR

31a. UNITED STATES OF AMERICA *(SIGNATURE OF CONTRACTING OFFICER)*

30b. NAME AND TITLE OF SIGNER	30c. DATE SIGNED	31b. NAME OF CONTRACTING OFFICER	31c. DATE SIGNED

32a. QUANTITY IN COLUMN 21 HAS BEEN
- [ ] RECEIVED
- [ ] INSPECTED
- [ ] ACCEPTED, AND CONFORMS TO THE CONTRACT, EXCEPT AS NOTED

32b. SIGNATURE OF AUTHORIZED GOVT. REPRESENTATIVE	32c. DATE

41a. I CERTIFY THIS ACCOUNT IS CORRECT AND PROPER FOR PAYMENT

41b. SIGNATURE AND TITLE OF CERTIFYING OFFICER	41c. DATE

33. SHIP NUMBER [ ] PARTIAL [ ] FINAL

34. VOUCHER NUMBER

35. AMOUNT VERIFIED CORRECT FOR

36. PAYMENT
- [ ] COMPLETE
- [ ] PARTIAL
- [ ] FINAL

37. CHECK NUMBER

38. S/R ACCOUNT NUMBER	39. S/R VOUCHER NUMBER	40. PAID BY

42a. RECEIVED BY *(Print)*

42b. RECEIVED AT *(Location)*

42c. DATE REC'D *(YY/MM/DD)*	42b. TOTAL CONTAINERS

1. CONTINUATION OF THE SF 1449 - SOLICITATION/CONTRACT/ORDER FOR COMMERCIAL ITEMS

A. Blocks 19 - 24 are completed as follows:

Item No.	Schedule of Supplies/Services	Quantity	Unit	Unit Price	Amount
0001	Dual-Beam FIB System (DB-FIB) In accordance with Attachment 1, Section 1	1	Ea		
0002	Training In accordance with Attachment 1, Section 1.10	1	Lo		
Option 1 0003	Spare Gallium Ion source In accordance with Attachment 1, Section 1.2.14	1	Ea		
Option 2 0004	Direct Ion Detector (CDEM) type In accordance with Attachment 1, Section 1.3.4	1	Ea		
Option 3 0005	STEM Detector In accordance with Attachment 1, Section 1.3.6	1	Ea		
Option 4 0006	Spare Ion Detector In accordance with Attachment 1, Section 1.3.7	1	Ea		
Option 5 0007	Carbon Deposition Capability In accordance with Attachment 1, Section 1.7.6	1	Ea		
Option 6 0008	Spare GIS Unit In accordance with Attachment 1, Section 1.7.7	1	Ea		
Option 7 0009	Airlock/Specimen Introduction In accordance with Attachment 1, Section 1.8.6	1	Ea		
Option 8 0010	SEM Options In accordance with Attachment 1, Section 1.11	1	Ea		

0011	Energy Dispersive Spectrometer (EDS) and Electron Backscatter Diffraction (EBSD) analysis system with Phase ID Capability and 3D Compatibility In accordance with Attachment 1, Section 2	1	Ea		
0012	Training In accordance with Attachment 1, Section 2.4	1	Lo		
Option 9 0013	Service Contract In accordance with Attachment 1, Section 2.5	1	Lo		
Option 10 0014	Ebeam Writing Attachment In accordance with Attachment 1, Section 3	1	Ea		
Option 11 0015	Training In accordance with Attachment 1, Section 3.4	1	Lo		
Option 12 0016	Service Contract In accordance with Attachment 1, Section 3.5	1	Lo		
Option 13 0017	Optical Microscope In accordance with Attachment 1, Section 4	1	Ea		
Option 14 0018	SIMS Analysis capability In accordance with Attachment 1, Section 5	1	Ea		
Option 15 0019	Internal micromanipulator system In accordance with Attachment 1, Section 6	1	Ea		
Option 16 0020	Metal/Insulator Deposition Chamber In accordance with Attachment 1, Section 7	1	Ea		

Option 17 0021	Temperature Variable Cryo Stage with Deposition Capability In accordance with Attachment 1, Section 8	1	Ea		

B. Block 25 is completed as shown on Page 1

2. ADDENDA TO FAR 52.212-4 CONTRACT TERMS AND CONDITIONS--COMMERCIAL ITEMS (OCT 2003)

A. REQUIRED DELIVERY OR PERIOD OF PERFORMANCE

The required delivery is as follows:

ITEM NO.	QUANTITY	WITHIN DAYS AFTER DATE OF CONTRACT AWARD
CLINS		
0001-0002	ALL	Estimated 120 days
0011-0012	ALL	Estimated 120 days
0003-0010	ALL	Estimated 120 days
0013-0021	ALL	Estimated 120 days

The government reserves the right to award under either the required delivery schedule or the proposed delivery schedule, when an offeror offers an earlier delivery schedule than required above. If the offeror proposes no other delivery schedule, the required delivery schedule above will apply.

OFFEROR'S PROPOSED DELIVERY SCHEDULE		
Item No.	Quantity	Within Days After Date Of Contract

B. OPTION(S)

The Government may require delivery of the optional items by the contracting officer giving written notice any time prior to contract completion.

C. AUTHORIZED GOVERNMENT REPRESENTATIVES

Authorized Government Representative (AGR) for Inspection and Acceptance- * ,Code * ,Telephone number * .

Security Matters- Contracting Officer for Security, Code 1221, (202) 767-2240, DSN 297-2240, email security-group@nrl.navy.mil

Safety Matters- Head Safety Branch, Code 3540, (202) 767-2232, DSN 297-2232, email safety@nrl.navy.mil

*(To be filled in at time of award)

D. ELECTRONIC AND INFORMATION TECHNOLOGY (EIT)

In accordance with Section 508 of the Rehabilitation Act of 1973 (29 U.S.C. 794d), all EIT supplies and services provided under this contract must comply with the applicable accessibility standards issued by the Architectural and Transportation Barriers Compliance Board at 36 CFR part 1194 (see FAR Subpart 39.2). Electronic and information technology (EIT) is defined at FAR 2.101.

E. REQUIREMENTS FOR ON-SITE CONTRACTORS

For those portions of the work under this contract performed at any NRL site, the contractor shall comply with the Requirements for On-Site Contractors dated 08 October 2002, which are hereby incorporated by reference. The full text is available at http://heron.nrl.navy.mil/contracts/home.htm.

F. OPTIONAL TRADE-IN OF NRL-FIB SYSTEM

NRL has an operational FIB system manufactured by FEI, Inc. The system is a Model FIB-200 (Serial Number 6384) running FEI xP software under Windows NT 4.0-Service Pack 3 and with a Service Date of November, 1997. It is equipped with three GIS units for enhanced etch, Pt metal deposition, and insulator deposition. This option allows for NRL to trade this system to the prime contractor for value applied to the purchase of the dual-beam system. Further information, if required, may be obtained through the NRL Contracting Officer and should be requested in writing (email is acceptable at simpson@contracts.nrl.navy.mil). The system is available for offeror inspection. Shipment of the system to the offeror's destination will be the responsibility of the offeror.

3. FAR 52.212-5 CONTRACT TERMS AND CONDITIONS REQUIRED TO IMPLEMENT STATUTES OR EXECUTIVE ORDERS--COMMERCIAL ITEMS (JAN 2004)

(a) The Contractor shall comply with the following Federal Acquisition Regulation (FAR) clause, which is incorporated in this contract by reference, to implement provisions of law or Executive orders applicable to acquisitions of commercial items: 52.233-3, Protest after Award (AUG 1996) (31 U.S.C 3553).

(b) The Contractor shall comply with the FAR clauses in this paragraph (b) that the Contracting Officer has indicated as being incorporated in this contract by reference to implement provisions of law or Executive orders applicable to acquisitions of commercial items :

(Contracting Officer check as appropriate.)

- ☒ (1) 52.203-6, Restrictions on Subcontractor Sales to the Government (JUL 1995), with Alternate I (OCT 1995)(41 U.S.C.253g and 10 U.S.C.2402).
- ☐ (2) 52.219-3, Notice of Total HUBZone Set-Aside (Jan 1999) (15 U.S.C. 657a).
- ☒ (3) 52.219-4, Notice of Price Evaluation Preference for HUBZone Small Business Concerns (Jan 1999) (*if the offeror elects to waive the preference, it shall so indicate in its offer*) (15 U.S.C. 657a).
- ☐ (4) (i) 52.219-5, Very Small Business Set-Aside (JUN 2003) (Pub. L. 103-403, section 304, Small Business Reauthorization and Amendments Act of 1994)
- ☐ (ii) Alternate I (MAR 1999) to 52.219-5
- ☐ (iii) Alternate II (JUN 2003) to 52.219-5
- ☐ (5) (i) 52.219-6, Notice of Total Small Business Set-Aside (JUN 2003) (15 U.S.C. 644).
- ☐ (6) (i) 52.219-7, Notice of Partial Small Business Set-Aside (JUN 2003) (15 U.S.C. 644).
- ☒ (7) 52.219-8, Utilization of Small Business Concerns (OCT 2000) (15 U.S.C.637 (d)(2) and (3)).
- ☐ (8) (i) 52.219-9, Small Business Subcontracting Plan (JAN 2002)(15 U.S.C.637 (d)(4)).
- ☐ (ii) Alternate I (OCT 2001) of 52.219-9.
- ☐ (iii) Alternate II (OCT 2001) of 52.219-9.
- ☐ (9) 52.219-14, Limitations on Subcontracting (DEC 1996) (15 U.S.C.637(a)(14)).
- ☐ (10) (i) 52.219-23, Notice of Price Evaluation Adjustment for Small Disadvantaged Business Concerns (JUN 2003) (Pub. L. 103-355, section 7102, and 10 U.S.C. 2323) (if the offeror elects to waive the adjustment, it shall so indicate in its offer)
- ☐ (ii) Alternate I (JUN 2003) of 52.219-23.
- ☐ (11) 52.219-25, Small Disadvantaged Business Participation Program - Disadvantaged Status and Reporting (OCT 1999) (Pub L. 103-355, section 7102, and 10 U.S.C. 2323).
- ☐ (12) 52.219-26, Small Disadvantaged Business Participation Program - Incentive Subcontracting (OCT 2000) (Pub. L. 103-355, section 7102, and 10 U.S.C. 2323).

☐ (13) 52.222-3, Convict Labor (JUN 2003) (E.O. 11755).

☐ (14) 52.222-19, Child Labor –Cooperation with Authorities and Remedies (JAN 2004) (E.O. 13126).

☒ (15) 52.222-21, Prohibition of Segregated Facilities (Feb 1999)

☒ (16) 52.222-26, Equal Opportunity (APR 2002)(E.O.11246).

☒ (17) 52.222-35, Equal Opportunity for Special Disabled Veterans, Veterans of the Vietnam Era, and Other Eligible Veterans (DEC 2001) (38 U.S.C.4212).

☒ (18) 52.222-36, Affirmative Action for Workers with Disabilities (JUN 1998) (29 U.S.C.793).

☒ (19) 52.222-37, Employment Reports on Special Disabled Veterans, Veterans of the Vietnam Era, and Other Eligible Veterans (DEC 2001) (38 U.S.C.4212).

☐ (20) (i) 52.223-9, Estimate of Percentage of Recovered Material Content for EPA-Designated Products (AUG 2000) (42 U.S.C. 6962(c)(3)(A)(ii)).

☐ (ii) Alternate I (AUG 2000 of 52.223-9 (42 U.S.C. 6962(i)(2)(c)).

☒ (21) 52.225-1, Buy American Act – -Supplies (JUN 2003) (41 U.S.C.10a – 10d).

☐ (22) (i) 52.225-3, Buy American Act –Free Trade Agreements—Israeli Trade Act (41 U.S.C.10a –10d, 19 U.S.C.3301 note, 19 U.S.C. 2112 note).

☐ (ii) Alternate I (JAN 2004) of 52.225-3.

☐ (iii) Alternate II (JAN 2004) of 52.225-3.

☐ (23) 52.225-5, Trade Agreements (OCT 2003) (19 U.S.C. 2501, *et seq.*, 19 U.S.C. 3301 note).

☐ (24) 52.225-13,Restrictions on Certain Foreign Purchases (OCT 2003) (E.o.s. proclamations, and statutes administered by the Office of Foreign Assets Control of the Department of the Tresury).

☐ (25) 52.225-15,Sanctioned European Union Country End Products (FEB 2000) (E.O.12849).

☐ (26) 52.225-16,Sanctioned European Union Country Services (FEB 2000) (E.O.12849).

☐ (27) 52.232-29,Terms for Financing of Purchases of Commercial Items (FEB 2002) (41 U.S.C. 255(f), 10 U.S.C. 2307(f)).

☐ (28) 52.232-30,Installment Payments for Commercial Items (OCT 1995) (41 U.S.C. 255(f), 10 U.S.C. 2307(f)).

☒ (29) 52.232-33, Payment by Electronic Funds Transfer -- Central Contractor Registration (OCT 2003) (31 U.S.C. 3332).

☐ (30) 52.232-34, Payment by Electronic Funds Transfer --Other than Central Contractor Registration (MAY 1999) (31 U.S.C. 3332).

☐ (31) 52.232-36, Payment by Third Party (MAY 1999) (31 U.S.C. 3332).

☐ (32) 52.239-1, Privacy or Security Safeguards (AUG 1996) (5 U.S.C.552a).

☐ (33) (i) 52.247-64, Preference for Privately Owned U.S.-Flag Commercial Vessels (APR 2003) (46 U.S.C. Appx 1241and 10 U.S.C. 2631).).

☐ (ii) Alternate I (APR 1984) of 52.247-64.

(c) The Contractor shall comply with the FAR clauses in this paragraph (c), applicable to commercial services, that the Contracting Officer has indicated as being incorporated in this contract by reference to implement provisions of law or Executive orders applicable to acquisitions of commercial items :

(Contracting Officer check as appropriate.)

☐ (1) 52.222-41, Service Contract Act of 1965, As Amended (MAY 1989) (41 U.S.C.351, *et seq.*).

☐ (2) 52.222-42, Statement of Equivalent Rates for Federal Hires (MAY 1989) (29 U.S.C.206 and 41 U.S.C.351, *et seq.*).

☐ (3) 52.222-43, Fair Labor Standards Act and Service Contract Act -- Price Adjustment (Multiple Year and Option Contracts) (MAY 1989) (29 U.S.C.206 and 41 U.S.C.351, *et seq.*).

☐ (4) 52.222-44, Fair Labor Standards Act and Service Contract Act - Price Adjustment (FEB 2002) (29 U.S.C.206 and 41 U.S.C.351, *et seq.*).

☐ (5) 52.222-47, SCA Minimum Wages and Fringe Benefits Applicable to Successor Contract Pursuant to Predecessor Contractor Collective Bargaining Agreement (CBA) (MAY 1989) (41 U.S.C.351, *et seq.*).

(d) *Comptroller General Examination of Record.* The Contractor shall comply with the provisions of this paragraph (d) if this contract was awarded using other than sealed bid, is in excess of the simplified acquisition threshold, and does not contain the clause at 52.215-2, Audit and Records -- Negotiation.

(1) The Comptroller General of the United States, or an authorized representative of the Comptroller General, shall have access to and right to examine any of the Contractor's directly pertinent records involving transactions related to this contract.

(2) The Contractor shall make available at its offices at all reasonable times the records, materials, and other evidence for examination, audit, or reproduction, until 3 years after final payment under this contract or for any shorter period specified in FAR Subpart 4.7, Contractor Records Retention, of the other clauses of this contract. If this contract is completely or partially terminated, the records relating to the work terminated shall be made available for 3 years after any resulting final termination settlement. Records relating to appeals under the

disputes clause or to litigation or the settlement of claims arising under or relating to this contract shall be made available until such appeals, litigation, or claims are finally resolved.

(3) As used in this clause, records include books, documents, accounting procedures and practices, and other data, regardless of type and regardless of form. This does not require the Contractor to create or maintain any record that the Contractor does not maintain in the ordinary course of business or pursuant to a provision of law.

(e) (1) Notwithstanding the requirements of the clauses in paragraphs (a), (b), (c) or (d) of this clause, the Contractor is not required to flow down any FAR clause, other than those listed in paragraphs (i) through (vi) of this paragraph in a subcontract for commercial items. Unless otherwise indicated below, the extent of the flow down shall be as required by the clause –

(i) 52.219-8, Utilization of Small Business Concerns (OCT 2000) (15 U.S.C. 637 (d)(2) and (3)), in all subcontracts that offer further subcontracting opportunities. If the subcontract (except subcontracts to small business concerns) exceeds $5000,000 ($1,000,000 for construction of any public facility), the subcontractor must include 52.219-8 in lower tier subcontracts that offer subcontracting opportunities.

(ii) 52.222-26, Equal Opportunity (APR 2002) (E.O.11246).

(iii) 52.222-35, Equal Opportunity for Special Disabled Veterans, Veterans of the Vietnam Era, and Other Eligible Veterans (DEC 2001) (38 U.S.C.4212).

Vietnam Era (38 U.S.C.4212).

4. 252.212-7001 -- CONTRACT TERMS AND CONDITIONS REQUIRED TO IMPLEMENT STATUTES OR EXECUTIVE ORDERS APPLICABLE TO DEFENSE ACQUISITIONS OF COMMERCIAL ITEMS. (JAN 2004)

(a) The Contractor agrees to comply with the following Federal Acquisition Regulation (FAR) clause which, if checked, is included in this contract by reference to implement a provision of law applicable to acquisitions of commercial items or components.

☒ 52.203-3 Gratuities (APR 1984) (10 U.S.C. 2207).

(b) The Contractor agrees to comply with any clause that is checked on the following list of Defense FAR Supplement clauses, which, if checked, is included in this contract by reference to implement provisions of law or Executive orders applicable to acquisitions of commercial items or components.

☐ 252.205-7000 Provision of Information to Cooperative Agreement Holders (DEC 1991) (10 U.S.C. 2416).

☐ 252.219-7003 Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan (DoD Contracts) (APR 1996) (15 U.S.C. 637).

☐ 252.219-7004 Small, Small Disadvantaged and Women-Owned Small Business Subcontracting Plan (Test Program) (JUN 1997) (15 U.S.C. 637 note).

☒ 252.225-7001 Buy American Act and Balance of Payments Program (APR 2003) (41 U.S.C. 10a-10d, E.O. 10582).

☐ 252.225-7012 Preference for Certain Domestic Commodities (FEB 2003) (10 U.S.C. 2533a).

☐ 252.225-7014 Preference for Domestic Specialty Metals (APR 2003) (10 U.S.C. 2533a).

☐ 252.225-7015 Preference for Domestic Hand or Measuring Tools (APR 2003) (10 U.S.C. 2533a).

☐ 252.225-7016 Restriction on Acquisition of Ball and Roller Bearings (APR 2003)
☐ (Alternate I) (APR 2003) (10 U.S.C. 2534 and Section 8099 of Public Law 104-61 and similar sections in subsequent DoD appropriations acts).

☐ 252.225-7021 Trade Agreements (APR 2003) (19 U.S.C. 2501-2518 and 19 U.S.C. 3301 note).

☐ 252.225-7027 Restriction on Contingent Fees for Foreign Military Sales (APR 2003) (22 U.S.C. 2779).

☐ 252.225-7028 Exclusionary Policies and Practices of Foreign Governments (APR 2003) (22 U.S.C. 2755).

☐ 252.225-7036 Buy American Act--Free Trade Agreements--Balance of Payments Program(JAN 2004)
☐ (Alternate I) (JAN 2004) (41 U.S.C. 10a-10d and 19 U.S.C. 3301 note).

☐ 252.225-7038 Restriction on Acquisition of Air Circuit Breakers (APR 2003) (10 U.S.C. 2534 (a)(3)).

☐ 252.227-7015 Technical Data--Commercial Items (NOV 1995) (10 U.S.C. 2320).

☐ 252.227-7037 Validation of Restrictive Markings on Technical Data (SEP 1999) (10 U.S.C. 2321).

☒ 252.232-7003 Electronic Submission of Payment Requests (DEC 2003) (10 U.S.C. 2227)

☐ 252.243-7002 Requests for Equitable Adjustment (MAR 1998)(10 U.S.C. 2410).

☐ 252.247-7023 Transportation of Supplies by Sea (MAY 2002)
☐ (Alternate I) (MAR 2000)
☐ (Alternate II) (MAR 2000)
☐ (Alternate III (MAY 2002) (10 U.S.C. 2631)

☐ 252.247-7024 Notification of Transportation of Supplies by Sea (MAR 2000) (10 U.S.C. 2631).

(c) In addition to the clauses listed in paragraph (e) of the Contract Terms and Conditions Required to Implement Statutes or Executive Orders--Commercial Items clause of this contract (FAR 52.212-5), the Contractor shall include the terms of the following clauses, if applicable, in subcontracts for commercial items or commercial components, awarded at any tier under this contract:

252.225-7014 Preference for Domestic Specialty Metals, Alternate I (MAR 1998) (10 U.S.C. 2241 note).

252.247-7023 Transportation of Supplies by Sea (MAY 2002) (10 U.S.C. 2631).

252.247-7024 Notification of Transportation of Supplies by Sea (MAR 2000) (10 U.S.C. 2631).

DFARS:

252.204-7004 Required Central Contractor Registration (NOV 2001)

5. CONTRACT DOCUMENTS, EXHIBITS OR ATTACHMENTS:

Attachment (1) - Statement of Work/Specifications – 16 Pages

Attachment (2) - Test and Evaluation Procedures – 1 Page

Attachment (3) - Accounting and Appropriation Data – 1 Page*
(To be included at time of award)*

6. ADDENDUM TO FAR 52.212-1 INSTRUCTIONS TO OFFERORS- COMMERCIAL ITEMS (JAN 2004)

The Government intends to award a contract resulting from this solicitation to that responsible offeror proposing the lowest price for the Supplies or Services that has been determined to comply with the requirements of the solicitation.

7. OFFEROR REPRESENTATIONS AND CERTIFICATIONS

Offeror must complete and submit with its proposal *Offeror Representations and Certifications--Commercial Items* ., which are available electronically in full text at : http://heron.nrl.navy.mil/contracts/reps&certs.htm

Use Commercial Item Representations and Certifications: B

Offerers are requested to respond to each itemized specification.

1.0 Dual-beam FIB System (DB-FIB)

The dual-beam focused ion beam milling system must meet or exceed the following specifications. Note for optional items within Section 1 the offeror is requested to quote the option separately from the main system cost.

1.1 Scanning Electron Column Requirements

The scanning electron column provides a source of focused primary beam electrons that are rastered across a sample to generate secondary electrons used for imaging. The source must be of the Schottky thermal field emitter type with the following capabilities.

1.1.1 Minimum electron beam accelerating voltage range. 0.2 – 30 kV

1.1.2 Automatic run-up and turn-off of electron gun to establish emission.

1.1.3 Automatic run-up and turn-off of electron beam accelerating voltage.

1.1.4 Resolution. Less than or equal to 1.1 nm at primary electron beam voltage of 30 kV
Less than or equal to 1.5 nm at primary electron beam voltage of 15 kV
Less than or equal to 2.0 nm at primary electron beam voltage of 5 kV
Electron beam resolution measurements are to be determined at the coincidence point of the electron and ion beams using a gold-on-carbon sample.

1.1.5 Horizontal field width range at beam coincidence point (20 kV): 2 micrometer – 2 millimeters, minimum.

1.1.6 A calibrated beam current ammeter and interface cable must be supplied with the instrument. The ammeter must have 10 fA current resolution, 5 ½ digit readout (minimum), GPIB interface capability and appropriate cabling for connection to the DB-FIB system.

1.1.7 A stage-mountable Faraday cup must be supplied to allow accurate beam current measurement.

1.1.8 Display of beam voltage, emission current, filament current and column vacuum.

1.1.9 Computer or interface panel control of stigmation, magnification, working distance (focus), beam shift, and aperture alignment required.

1.1.10 Dynamic focus/automatic tilt compensation required.

1.1.11 The electron column must be configured with high-speed, electrostatic beam blanking capability and interface electronics allowing a minimum ON:OFF ratio of 1000:1 with the application of a digital TTL signal. The beam blanking system must be capable of turning on or turning off the primary beam in 100 nsec or less. (A TTL signal is to operate between 0 - 5V, maximum, at a drive current of 10 mA or less).

1.1.12 Coincidence position of the electron and ion beams must be 7 mm or less as measured from the electron column.

1.1.13 Minimal electromagnetic field interaction with the sample is required to allow stable imaging of MEMs-type structures. The offeror shall provide DC and frequency dependent electric and magnetic field characteristics of the quoted system at the coincidence point under low-magnification and high-magnification conditions.

1.2 **Scanning Ion Column Requirements.**

1.2.1 Type: Gallium liquid-metal ion source (LMIS) type.

1.2.2 Source lifetime: 1500 microAmp-hours, minimum.

1.2.3 Automatic run-up and turn-off of emission current.

1.2.4 Automatic run-up and turn-off of accelerating voltage.

1.2.5 Accelerating Voltage Range: 5 kV to 30 kV, inclusive

1.2.6 Resolution: Less than 7 nm during operation at 30 kV at beam coincidence point.

1.2.7 Horizontal field width range at coincidence point (5kV): 2 micrometer – 2.5 millimeter, minimum.

1.2.8 Ion beam current range measured at stage (Faraday cup): 2 pA – 20 nA, minimum.

1.2.9 Aperture: The system must be configured with an aperture strip assembly to allow variation of the beam current delivered to the stage. The system should provide at least 15 apertures allowing beam current measured at the stage to vary from 2 pA – 20 nA.

1.2.10 Beam blanker. The column must be configured with a high-speed beam blanker with a turn-on and turn-off time of less than 100 nanoseconds.

1.2.11 Computerized control of aperture alignment required.

1.2.12 Beam shift following aperture change must be less than 1 micrometer.

1.2.13 Coincidence position of the electron and ion beams must be 7 mm or less as measured from the ion column.

1.2.14 (Option) A spare gallium ion source and a descriptive procedure and hardware to allow user-replacement of the gallium source.

1.3 Chamber Detectors

The chamber detectors perform the secondary electron and ion detection for imaging and provide for video monitoring of motion within the main system chamber.

1.3.1 The system must include an 'in-lens' secondary electron detector.

1.3.2 The system must include an 'in-lens' back-scattered electron detector.

1.3.3 The system must include a chamber-mounted secondary electron detector of the Everhardt Thornley type.

1.3.4 (Option) The system must provide a direct ion detector (CDEM) type.

1.3.5 The system must provide an interal IR-CCD video image of the stage.

1.3.6 (Option) The system must provide a STEM detector.

1.3.7 (Option) A spare ion detector is required.

1.4 Digital Image Processor

The digital image processor is the interface between the detection system and image display system.

1.4.1 Image resolution range: 1024 x 768 - 3072 x 2394 pixel resolution, minimum.

1.4.2 Pixel dwell time range: 50 ns – 1 ms

1.4.3 The system must be capable of displaying both single and dual–frame images to allow the user to comparatively evaluate the milling process. A second monitor may be used to display the second image.

1.4.4 Partial field raster/image capability must be provided. The x and y dimensions of the partial field image must be independently adjustable up to the entire screen size. Partial field position must be adjustable over the entire range of the screen. There must be a movable cursor available in both full and partial field images.

1.4.5 Must have spot mode capability, with spot position capable of being placed at any position within the field of view.

1.4.6 Image averaging display mode, allowing noise reduction by averaging successive frames of an image raster. The system must be capable of averaging up to 256 (minimum) successive frames.

1.4.7 The image processing system must be capable of importing and displaying TIFF (8 or 16 bit), BMP and JPEG formatted images files. The system must be capable of archiving image data in TIFF (16 bit) and JPEG file formats.

1.5 Digital Pattern Generator

1.5.1 Resolution: 4k x 4k minimum

1.5.2 Dwell time: programmable from 100 ns – 4 ms per pixel, minimum.

1.6 Specimen Chamber and Stage

1.6.1 The specimen chamber must be large enough to accommodate specimens of at least 6 inch diameter and 0.1 inch height. The specimen chamber must be mounted in such a way as to be vibration-isolated from the workstation.

1.6.2 The system specimen stage must allow motorized travel in each of the five axes x, y, z, tilt and rotation. Each axis must meet the requirements as listed below:

a. x, y travel range: 150 mm, minimum.
b. z travel range: 10 mm, minimum
c. Continuous rotation
d. Tilt: -10 - +60 degrees, minimum
e. Repeatability of (x,y) position for 0 Degree tilt: 1 micrometer or less.
f. Repeatability of (x,y) position at normal incidence to ion beam: 2 micrometer or less.
g. Minimum stage position resolution: 100 nm or less.
h. Stage drift must be less than 1 micrometer within a 15 minute interval.

1.6.3 Achievable clearance below eucentric point: 30 mm, minimum.

1.6.4 External interface control. The system must provide a digital or software-based interface to allow the stage to be programmed to coordinates defined in third party applications. Third party application must be capable of reading stage coordinates via digital or software interface.

1.6.5 Sample mounts: the offeror shall supply sample mounts capable of supporting 1 cm pieces, 75, 100, and 150 mm diameter silicon wafers and a TEM specimen holder kit.

1.6.6 In addition to the ion gun, the electron gun, and chamber detectors, the chamber must be capable of supporting the following add-on units:

a. Third-party EDS and EBSD systems (PGT, EDAX, Oxford, hkl System) with allowance for 60-70 degree angle between electron gun and CCD camera axis (see Section 2 below).
b. 3 GIS units for metal deposition, enhanced etch, and insulator deposition
c. A SIMS analysis capability (see Section 5 below.)
d. A minimum of two micromanipulators (ie, Kleindiek, Omniprobe) (see Section 7 below.)
e. Sample prep chamber (see Sections 7 and 8 below).

The offeror shall identify chamber mounting limitations if all add-on units can not be concurrently supported.

1.6.7 The stage and/or chamber must supply electrical isolation and a feed-through to allow measurement of electron and/or ion column beam current.

1.6.8 The stage must be capable of supporting lateral sample transfer to and from a side-mounted sample prep chamber without breaking vacuum.

1.7 GIS (Gas Insertion System) Capability

The GIS requirements allow injection of chemically active gases that interact with the primary and secondary electrons to produce patterns of metal, insulator, or to allow enhanced etch rates. Gases are to be injected from temperature controlled cells through needles that can be positioned to close proximity to the sample surface (sample at coincidence position.) All GIS units are to be computer activated and controlled.

1.7.1 Pt metal deposition capability required.

1.7.2 SiO2 insulator deposition capability required. The system must be capable of putting down an insulator material having resisitivity 100 Ohm-cm or greater.

1.7.3 Enhanced etch capability required: iodine or xenon diflouride based.

1.7.4 A selective carbon mill capability is required.

1.7.5 Injected gases should not cause degradation of performance of electron or ion columns or any chamber detectors. Known chemical influences of injected gases must be made known to the NRL's Technical Representative to allow appropriate use and maintenance of the system.

1.7.6 (Option) A carbon deposition capability is required.

1.7.7 (Option) A spare GIS unit and empty crucibles for offeror-approved user supplied materials. An appropriate storage container is also required.

1.8 Vacuum system requirements

1.8.1 The vacuum system must provide an oil-free specimen chamber capable of achieving main chamber pressure of 3.0×10^{-6} mbar or less.

1.8.2 Pumpdown time of main chamber from atmospheric pressure to operational (imaging) vacuum: 6 minutes or less.

1.8.3 The evacuation and up-to-air procedures must be automatic and equipped with fail-safe interlocks to prevent catastrophic failure.

1.8.4 Column isolation valves are required to allow operation of both electron and ion sources (emission only) with main chamber at atmospheric pressure.

1.8.5 The offeror shall supply necessary vacuum tubing and electrical cabling for the primary rough-pumping system to be placed in a utilities chase. The length of tubing/wiring required will not be more than 30 feet.

1.8.6 (Option) Airlock/Specimen Introduction. The microscope design must include an airlock for the introduction of specimens to the chamber. The dimensions of the introduction port and the airlock must 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. The pumpdown time for the airlock must be less than or equal to 1 minute in order to allow rapid specimen exchange.

1.9 Computer System and Software Programmability Requirements.

1.9.1 Operating system: Windows OS required; Windows 2000, or later version.

1.9.2 Processor: Intel Pentium III or higher, 550 MHz or higher

1.9.3 512 Mbyte RAM, minimum.

1.9.4 Network capability: Must have 10 – 100BaseT hardware and support Ethernet TCP/IP protocol.
1.9.5 Internal hard drive, 40 Gbyte, minimum.
1.9.6 RW CD-ROM, 250Meg ZIP-drive, an external IEEE 1394 (Firewire) hard-drive (80 GB minimum) and provision for IEEE 1394-based (Firewire) portable storage devices.
1.9.7 Minimum one 18" or larger flat panel display capable of minimum 1280 x 1024 resolution. (All displays must be flat panel type.)
1.9.8 A backup hard drive containing all software and control parameters necessary to operate the instrument is required.
1.9.9 Capability to execute macros or user-defined programs that position the stage and execute a FIB mill process at multiple locations on a sample.
1.9.10 Capability to automatically prepare TEM samples.
1.9.11 Automated milling of lines, circles, rings, rectangles, cross-sectional wedge cuts and cross-sectional cleaning cuts.
1.9.12 Automated (unattended) slicing at a user defined section depth between sections – of at least 100 sections
1.9.13 Automated capture of either secondary electron or ion beam images (whichever the user chooses) for each section, without manual interaction from the user between slices
1.9.14 Automated alignment and/registry and storage of each of the 2D images in the stack
1.9.15 Computer and software for making 3D reconstructions from the 2D slices
1.9.16 Material-dependent calibration of etch-rate vs. time required. An ability to define and save new material properties files associating mill-rate to FIB time.
1.9.17 The system must be capable of milling from images imported as BMP files.
1.9.18 The system must be capable of simultaneous patterning and imaging.
1.9.19 An endpoint detection capability by use of stage current graph (minimum).

1.10 Training.

1.10.1 The offeror shall include on-site (NRL-DC) operator training for at least 8 NRL employees for a minimum of three days. Operator training must include DB-FIB operation and routine maintenance procedures following installation of the instrument. Training must be done within four weeks of completion of testing and acceptance of the instrument.
1.10.2 Two operator manuals must be provided

1.11 SEM Options. Items in section 1.11 are OPTIONAL.

1.11.1 The offeror shall supply a three year extended service contract to cover travel, parts, and labor. The service contract must include replacement of the electron source, the ion source, and the CDEM detector. (Total coverage: 1 yr + 3 yrs).
1.11.2 The offeror shall provide a water-water cooling system having sufficient cooling power to maintain operation of the DB-FIB system and items listed in Sections 1.1 – 1.8. NRL will provide sufficient primary chilled water through the site's process water system. The water-chiller will be placed in a utility chase and cooling water directed through offeror-supplied tubing to the DB-FIB system.
1.11.3 The offeror shall provide an uninterruptible power supply to provide conversion and filtration of NRL base power (208 VAC) and battery lifetime to support the DB-FIB system under full operational load conditions for at least five minutes.

1.11.4 The offeror shall provide a vibration isolation platform for support of the chamber column in a raised floor cleanroom environment. The platform must be able to extend 24 – 28" to the cleanroom base floor.

1.11.5 The offeror shall provide two gold-on-carbon samples for use in resolution testing.

1.11.6 The offeror shall provide one stub-mounted SEM calibration standard traceable to the National Institute of Standards and Technology (NIST). The sample must have certified pitch values of 100 nm, 200 nm, 400 nm, 800 nm, and 1000 nm with uncertainty of the 100 nm pitch metrology less than 1 nm. The material composition of the calibration standard is to be silicon.

2.0 Energy Dispersive Spectrometer (EDS) and Electron Backscatter Diffraction (EBSD) analysis system with Phase ID Capability and 3D Compatibility

The EDS/EBSD system components shall include:

a) an EDS subsystem composed of a Si/Li x-ray detector with pulse processing electronics, a multichannel analyzer and computer and software for data acquisition, storage, and quantitative composition analysis

b) an EBSD subsystem composed of a CCD camera system with image processor to image scattered and diffracted electrons, forward and backscatter electron detectors, SEM interface, computer, and software for acquisition, indexing, display, and storage of crystallographic data, and a video monitor.

c) have appropriate safety interlocks to prevent exposure to x-rays, machine failure, and system training.

2.1 EDS Subsystem

2.1.1 The detector crystal must have an active area of 30 square millimeters.

2.1.2 The energy resolution of the detector (full-width at half maximum) must be less than or equal to 136 eV at 5.898 keV (Mn K-alpha) at a count rate of 1000 counts per second.

2.1.3 The system must be configured with an atmospheric window and be able to withstand 1 Atmosphere or more of pressure.

2.1.4 The detector and window must have enhanced "light element" capabilities for elements having low atomic mass. The system must be capable of detecting elements having atomic number 5 (boron) or greater.

2.1.5 The detector and electronics must be capable of spectral resolution of x-ray energies up to 40 keV, minimum.

2.1.6 The atmospheric thin window must be opaque to ambient levels of visible light to eliminate excitation of the detector by cathodoluminescence of specimens.

2.1.7 If the detector is cooled, it must be equipped with a temperature or liquid-level monitor to shut down the high-voltage detector power to prevent damage in the event of detector warm-up and sound an alarm in time to allow maintenance prior to warm up. It must be possible, without damage to the detector, to allow it to warm to room temperature when not in use. Cool-down to operating temperature must be automatically monitored to allow start-up only after sufficient detector cooling.

2.1.8 The EDS detector must be equipped with a magnetic electron trap to prevent backscattered electrons of energies up to 30 keV from reaching the detector crystal or

producing spurious x-ray peaks by exciting elements in the detector window. The performance of the electron trap must be sufficient to give a spectrum from a pure Cu specimen with a Cu K-alpha peak-to-background ratio of at least 4000 to 1 taken with a 30 keV electron beam energy and a 45 degree x-ray take-off angle from the specimen surface. Furthermore, the spectra from a pure Cu specimen taken at a 45 degree x-ray take-off angle and electron beam energies of both 30 and 3 keV must be free from spurious x-ray peaks from elements in the detector window for integrated x-ray spectra of at least 50,000 total counts.

2.1.9 EDS software must include capability for obtaining SEM images, elemental mapping, and control of the DB-FIB stage system of (x,y, z) coordinates.

2.1.10 Automatic and manual peak identification and labeling

2.1.11 High-performance quantitative analysis for both standardless analysis and analysis with standards

2.1.12 Automatic and manual spectrum calibration.

2.1.13 A computer capable of performing the required spectral, graphics, and mapping operations described herein having minimum processor speed of 550 MHz. Flat panel monitors must be provided for all computers. The offeror may utilize the same computer used to control the DB-FIB for this subsystem with concurrence of the DB-FIB offeror.

2.1.14 Capability for user to go between slicing mode (with FIB) and EDS analysis elemental x-ray map generation and storage, without breaking the vacuum, i.e. with sample remaining in the chamber.

2.1.15 Ability to register/align all of the EDS elemental maps from multiple sections and store them as a stack of 2D images, to be subsequently reconstructed in 3D.

2.1.16 The computer must support Transport Control Protocol / Internet Protocol (tcp/ip) protocols over 10-100 Base-T ethernet.

2.1.17 The system must have a detector interface and the necessary electrical connections to the digital field emission SEM.

2.1.18 The system must be interfaced to operate on a digital field emission SEM such that the vacuum integrity of the microscope is maintained in the presence of the necessary electronic and mechanical connections.

2.1.19 NIST composition standards SRM 895 (Cr-Mn SAE 201) and SRM 482 or similar. One standard reference material must include minimum 10% copper.

2.2 EBSD Subsystem

2.2.1 The EBSD camera shall be a high speed CCD camera with at least a 1300 X 1000 pixel resolution capable of resolving diffracted electrons from the surface of the sample.

2.2.2 The camera control unit and image processor shall have adjustable brightness and contrast controls and shall perform background correction functions to enable the display of real-time background-corrected images.

2.2.3 The camera and computer interface must be capable of a readout rate of 65 frames/sec, minimum.

2.2.4 Provision for multiple forward scatter detector diodes to be placed around the phosphor screen.

2.2.5 The forward scatter and backscatter electron detector system shall consist of integrated detector crystals with built-in electrical feedthroughs (must not require additional chamber ports).

2.2.6 The system must provide all necessary cables and feedthroughs.

2.2.7 The system shall include EBSD acquisition and indexing software having the following capabilities:

a) capture frame-averaged EBSD patterns from the image processor.
b) perform automatic indexing of the EBSD patterns.
c) allow manual indexing of the EBSD patterns for user-selected Kikuchi bands or zone axes.
d) perform automatic or manual indexing for any crystal type.
e) generate data sets of x-y coordinates, orientation parameters, EBSD pattern quality, and confidence index.
f) perform the indexing with a total cycle time of 65 patterns/sec. in appropriate specimens.
g) allow unattended acquisition of EBSD patterns.
h) Multiple-user software host licenses (minimum of 4) for post-processing data analysis.
i) It should work with flexible EBSP geometry (e.g. working distance, port geometry and sample to detector distance).
j) Fully integrated stage and beam mapping with the ability to stitch multiple beam maps into one complete project.
k) Simultaneous EDX and EBSP data acquisition from each point in a map.
l) High accuracy orientation measurements at low mag (~50X), as well as at the typical higher magnifications.
m) Full EBSP image storage (not only Hough space storage) with adjustable compression for off-line reanalysis.
n) Data exchange links to other programs.

2.2.8 Capability for user to go between slicing mode (with FIB) and EBSD analysis and grain orientation map (GOM) generation and storage, without breaking the vacuum, i.e. with sample remaining in the chamber

2.2.9 Ability to register/align all of the EBSD/GOM maps from multiple sections and store them as a stack of 2D images, to be subsequently reconstructed in 3D

2.2.10 The post-processing software capabilities must include pole figure, grain orientation mapping, and ODF capabilities:

a) generation of pole figures and inverse pole figures
b) full user control of display parameters (e.g. projection type, hemisphere, crystal direction, contour levels etc.) during pole figure plotting
c) generation of plots of the orientation and misorientation distributions in Euler space and/or Rodrigues space
d) generation of grain size histograms and charts, and advanced grain size analyses (e.g., linear intercepts, equivalent circle diameter, twin exclusion etc.)
e) generating misorientation angle distributions and histograms
f) reconstruction of grain maps from orientation data sets
g) software to display EBSD orientation data in Euler space, as orientation distribution functions (ODF's)
h) misorientations can be displayed as misorientation distribution functions (MODF)
i) providing a direct linkage between all points on pole figures, orientation distribution functions, and grain maps
j) highlighting the following microstructural features:
grains of user-specified sizes

grains of user-specified orientations
grain boundaries within user-specified misorientation ranges

k) providing "point-and-click" analysis of orientations and grain boundaries
l) performing coincidence site lattice boundary and special boundary analysis and mapping
m) generating grain maps and plots based on "average" grain misorientations (i.e. misorientations averaged across individual grains)
n) Sophisticated data cleaning / noise reduction algorithms
o) Automatic separation of deformed and recrystallized fractions
p) Subset creation by multiple terms (size, shape, orientation etc.)
q) output of the 3X3 misorientation matrix for each pattern

2.2.11 In addition to the features mentioned above, the system shall provide for the following standard map components:
a) Diffraction Pattern Quality Maps (also referred to by some as "image quality maps")
b) Diffraction Pattern Quality histograms and charts
c) Orientation coloring (Euler angles, unit triangle, RF vectors)
d) Any user-defined texture component
e) Phase coloring
f) Grain and sub-grain boundaries
g) Phase boundaries (wherever possible)
h) Grain shape characteristics
i) Deformed / recrystallized fractions
j) Strain contouring
k) Schmid and/or Taylor factors
l) Multiple graphics formats for storing maps and exporting to standard word processor and presentation programs (e.g. .tiff, .jpeg, and/or .pct formats)
m) interactive numerical data exported to text files

2.2.12 The system shall be capable of the following Phase ID capabilities:
a) Fully integrated, fast and accurate automatic phase identification software.
b) Phase mapping by combining/integrating EBSD and EDS analysis.
c) Ability to combine EBSD grain orientation maps and EDS elemental maps.
d) Simple and rapid input of elemental data (*e.g.* periodic table display or similar.)
e) Point and click mode where the EDS spectrum acquisition is initiated and subsequent elemental peaks are read automatically in as the phase search criteria
f) Highly optimized for rapid searching of phase databases by composition, name or space group
g) Ranked list of phase identification solutions
h) Multiple phase databases to be activated at the same time
i) Full phase information reviewed and maintained by the International Centre for Diffraction Data (ICDD) (but not limited to this data base only)
j) Wide coverage of metal, intermetallic, ceramic and geological phases
k) Licensed without time limit: periodic updates within the terms of distribution agreement with ICDD
l) Provisions for user-created searchable data bases.
m) Electron bream positioning by mouse clicking on the electron image.

2.2.13 The offeror shall supply two EBSD standard samples composed of a) silicon and b) aluminum for use in system testing.

2.2.14 File compatibility: files should be either stored in standard file formats so that both images and data can be subsequently accessed using programs on PC, Macintosh and unix workstations, or there must be some provision for exporting the data and images in file formats generally accessible to these platforms. In particular, graphics files should be exportable in .tiff and/or .jpg format.

2.3. EBSD — DB-FIB Interface

2.3.1 The system shall be interfaced to operate on a DB-FIB system such that the vacuum integrity of the microscope is maintained in the presence of the necessary electronic and mechanical connections.

2.3.2 It shall be possible to obtain SEM images and EBSD patterns without breaking vacuum.

2.3.3 The interface shall retract the camera-screen assembly to prevent interference with normal SEM operation when not in use.

2.4 Training.

2.4.1 The offeror shall include on-site (NRL-DC) operator training for at least 5 NRL employees for a minimum of three days for EDS and EBSD. Operator training is to include EDS and EBSD operation and routine maintenance procedures following installation of the instrument. Training must be done within four weeks of completion of testing and acceptance of the instrument.

2.4.2 Two operator manuals must be provided.

2.5 Service Contract

2.5.1 The offeror shall supply a three year extended service contract to cover travel, parts and labor. (Total coverage: 1 yr + 3 yrs)

2.6 DB-FIB, EDS and EBSD Compatibility

2.6.1 The DB-FIB offeror is to ensure compatibility of the EDS , EBSD, and 3D slicing attachments, whose specifications are attached to this document (see above). In particular, there should be geometrical compatibility in the chamber and the column such that all of the EDS and EBSD sub-systems can exist simultaneously, and the user can go back and forth between the modes, without removing the specimen from the chamber or making any hardware changes.

3.0 (Option) Ebeam Writing Attachment

The ebeam writing attachment will allow an external system to control the x-y raster and beam blanking electronics of either the ion column or the electron column of the DB-FIB for writing of computer-designed features. The system must provide computer aided design (CAD), drive electronics and support software. The following are requirements for such a system.

3.1 CAD Requirements.

3.1.1 The CAD software must allow for easy creation of lines, filled squares, filled rectangles, filled circles and filled polygons of arbitrary side length and up to 200 vertices. The software must also allow easy creation of unfilled circles and polygons.

3.1.2 The software must allow for user placement of coordinate system origin and have the capability to provide distance measurements between any two points in an (x,y) format.

3.1.3 The software must be capable of reading and storing pattern information using industry standard Calma GDS-II stream file format files.

3.1.4 The CAD must allow for definition of the beam scan axis along an axis chosen by the user. For circular structures, the CAD must execute beam scan tangential to the circumference.

3.1.5 Automatic fracturing of large patterns is required to allow the scan axis to automatically orient to the longest side of a fractured sector of a feature.

3.1.6 Each unique feature must have an associated dose control that specifies the dwell at each exposed pixel.

3.1.7 The CAD system must have minimum position resolution capability of 1 part in 65,536 in each of the x and y directions, or better, over the full file image.

3.1.8 The CAD must be capable of manipulating at least 16 separate layers identified with unique colors or fill styles.

3.1.9 The CAD must allow easy construction of array structures from the definition of a single element of the array and copy/move commands.

3.1.10 The CAD software license must allow concurrent operation for up to 2 copies running on different computers.

3.2 Physical Interface.

3.2.1 The system must provide x, y (scan) and z (blanking) signals as outputs and be capable of monitoring the SEM video image. External cables to interface to the SEM must be provided. The system must be capable of programmable control of the (x,y,z) coordinates of the stage through hardware and/or software interface to the DB-FIB system.

3.2.2 The system must be capable of scanning between full scale x and y voltage limits with a settling time not to exceed 10 microseconds when connected to the microscope.

3.2.3 The system must be capable of providing a TTL blanking signal at a rate equivalent to 100 kHz, or higher.

3.2.4 The x and y output voltages must be deglitched.

3.2.5 The e-beam writing system must be capable of a minimum of 16 bit resolution (1 part in 65536) of the x and y voltage range.

3.3 General.

3.3.1 The system computer must support TCP/IP protocol access to the internet via 10-100 Base-T hardware interface.

3.3.2 Operating system requirements: Microsoft Windows 2000 or later.

3.3.3 The system computer must be equipped with an 18 inch flat panel monitor having minimum 1280 x 1024 resolution.

3.3.1 Alignment markers: The system must allow screen capture of at least three independently configurable subfields of the full scan area to allow for overlay of the CAD image to sample alignment features.

3.3.2 The system must allow for placement of alignment markers and implement an automatic alignment algorithm to establish a coordinate system on the sample relative to the CAD coordinate system. The system must have and easily implement combined rotation, shift, and magnification adjustments to establish the CAD to sample coordinate system transformation.

3.3.3 The system must allow for capture and averaging of the secondary electron image. The image must be capable of being stored to a TIFF or JPEG graphical format file.

3.3.4 The system must allow easy annotation of the SEM image by overlay of text.

3.3.5 The system must be equipped with a pico-ammeter that is integrated to the system to allow direct measurements of SEM ebeam current in a offeror supplied Faraday cup. Current readings must be integrated to allow for active dose correction during exposure.

3.3.6 The software must be capable of interfacing to the SEM stage driver to execute relative or absolute stage shift.

3.3.7 This system must not be a 'beta' version and the supplier must have a demonstrated record of successful installation and operation.

3.4 Training.

3.4.1 The offeror shall include on-site operator training for at least 5 NRL employees. Operator training is to include CAD training and ebeam writing of features to a PMMA-coated silicon wafer and routine maintenance procedures. Training must be done within four weeks of completion of testing and acceptance of the ebeam writing option.

3.5 Service Contract

3.5.1 The offeror shall supply a three year extended service contract to cover travel, parts and labor. (Total coverage: 1 yr + 3 yr)

4.0 (Option) Optical Microscope

4.1.1 The microscope is to be equipped with the following features:

a. top and bottom directed visible light illumination of non-transparent samples (minimum).

b. four-turret objective (minimum) that provides, in combination with the eyepiece lens, a minimum range of optical magnification of 50X – 1000X.

c. microscope and objectives must be capable of bright field, dark field, differential interference contrast (DIC), and fluorescence imaging.

d. trinocular observation tube.

e. a length reticle must be supplied to the eyepiece light-path.

f. manual wafer stage having x-y-z position control. A minimum x and y stage travel of 2 inches in each direction is required.

g. computerized color digital image capture capability to TIFF or JPEG format, having minimum 1024x768 resolution and color monitor live display of samples.

h. a computer having internet connectivity, flat panel display, 20 Gigabyte hard-drive, R/W CD-drive, 250M ZIP disk storage, Microsoft Windows 2000 or later operating system.

i. fluorescence imaging capability required having minimum 75Watt Xe source.

j. optical imaging capability having minimum 100W halogen lamp source.

k. 5 spare bulbs halogen bulbs and 5 spare Xe bulbs.

5.0 (Option) SIMS Analysis capability

5.1.1 The system must include a quadrupole mass spectrometer capable of detecting FIB-sputtered elements having atomic mass in the range 1 – 200, inclusive.

5.1.2 Software to support automated mapping of a user-defined region and for selected chemical elements.

5.1.3 A depth profile capability is required that produces a line graph showing relative concentration of user-selected elements as a function of mill time or depth.

5.1.4 The software must be capable of implementing end-point detection deriving from threshold detection or loss of a user defined chemical element.

5.1.5 The offeror shall supply appropriate hardware and containers to allow removal and storage of the SIMS detector for extended periods of time.

5.1.6 The general system software must be capable of operation with or without the presence of the SIMS hardware on the main chamber. (Not to include SIMS support software modules.)

6.0 (Option) Internal micromanipulator system.

A micromanipulator is to be provided that allows for in-situ sample translation over small distances. The micromanipulator can be equipped either to fit an existing chamber port or be configured fully within the chamber with electrical feedthrough to a standard chamber port for external electronic control.

6.1.1 Automated in-situ micromanipulator system having the following capabilities:

a. The micromanipulator may be either flange-mounted, stage mounted, or chamber wall mounted to the focused ion beam instrument and will provide capability for in-situ lift-out, electrical measurements and nano-mechanical testing.

b. The system must include a 3-axis micromanipulator, motion control interface, a computer and flat-panel monitor, and software for automated operation for lift-out, electrical measurements and mechanical testing. The main control computer for the DB-FIB system may be used with consent of the DB-FIB manufacturer.

c. The system should be compatible with both needle and gripper style probes; a sufficient supply of the consumable probes should be provided with the system to enable specifications testing of the installed micromanipulator.

d. The micromanipulator translation range must be at least +/- 0.5 mm in the x and y axes, and 4 mm in the z axis.

e. The system must include physical limit switches and failsafe electrical limits.

f. The minimum user-actuated incremental motion must be 100 nm or smaller.

g. The micromanipulator must be compatible with all standard FIB operations, and the simultaneous installation in the FIB of two (minimum) GIS units and the optional EDS/EBSD system.

h. The system must be compatible with main chamber vacuum requirements.

7.0 (Option) Metal/Insulator Deposition Chamber

This optional item provides for the capability to transfer the sample on an appropriate sample mount to a vacuum isolated deposition chamber allowing for large area surface ion milling and sputter deposition of both insulator and metallic films.

7.1.1 The attachment must fit to a standard chamber port via an adapter tube. A bellows adapter and independent support stand may be used to provide vibration isolation to the main chamber. The system must be capable of transferring, ion milling and deposition to samples having 2.5 cm diameter, minimum, with preference given to systems capable of supporting up to 150 mm diameter silicon wafers. Transfer is made between the attachment chamber and main DB-FIB stage via a transfer rod and sample mount. The transfer rod establishes the z-direction of motion for this system.

7.1.2 The attachment chamber must allow for vacuum isolation of the main system chamber by a manually or automatically operated gate valve.

7.1.3 The attachment is to be configured with an ion mill, a magnetron sputter gun for metal deposition, a magnetron sputter gun for silicon nitride deposition, and a turbo-molecular pump with a manual or electronically controlled throttle valve. The ion mill and sputter gun attachments should be mounted to cause minimal cross-contamination of sputter targets and ion mill accelerator grids.

7.1.4 The pumping system must be capable of achieving a base pressure of 3×10^{-6} Torr or less with the gate valve to the main system closed and throttle valve to the attachment chamber turbo-molecular pump open.

7.1.5 The ion mill and sputter deposition units must be capable of milling/deposition to uniformity of 10% or less over the maximum sample size area.

7.1.6 A electronic gas mass-flow control system composed of two mass-flow controllers capable of ratio mixing between a 1:1 – 20:1 ratio (inclusive) of argon:nitrogen gas and to separately allow only argon flow. The mass flow controller must allow for establishment of sputtering pressures from 5 – 15 milliTorr in conjuction with the throttle valve.

7.1.7 The chamber must be equipped with a capacitance manometer to measure sputtering pressure.

7.1.8 It must be possible to remove the attachment and the offeror must supply blanking ports for both the main DB-FIB chamber and the sputter chamber.

7.1.9 One DC and one RF power supply with matching network and appropriate cabling must be supplied to generate sputter plasma to the metal and silicon targets, respectively. The power rating of each supply must be within the range of 50 – 1000 Watts. Each supply must be interlocked to cooling water flow sensors to prevent operation under low water-flow conditions. The ion mill requires a supporting power supply.

7.1.10 Sputter targets: One copper target, two aluminum targets, and two silicon targets with backing plates are to be provided.

8.0 (Option) Temperature Variable Cryo Stage with Deposition Capability

This option allows for a temperature-controlled cryo stage assembly and sputter and/or thermal evaporation capability of carbon, gold-palladium, chromium and tungsten with integrated thickness monitor.

8.1.1 Cryo-stage capable of programmable control of sample temperature of 100K – 300K.
8.1.2 Carbon evaporation or sputtering source required with control electronics.
8.1.3 A film thickness monitor including control unit, crystal sensors (10 minimum), and oscillator.
8.1.4 A precision cold fracturing device/cold shield.
8.1.5 Electron-beam shadowing facility.
8.1.6 Specimen holders appropriate for DB-FIB system. Minimum 5 required.
8.1.7 Magnetron sputter-deposition capability with target set including platinum, chromium, gold-palladium, and tungsten.
8.1.8 Spare carbon rods

Abbreviations

BMP	Bit-MaP image storage protocol
CCD	Charge-Coupled Device
CDEM	Continuous Dynode Electron Multiplier
DB-FIB	Dual Beam-Focused Ion Beam
EBSD	Electron Back-Scattered Diffraction
EDS	Energy Dispersive Spectroscopy
eV	electron Volts
FIB	Focused Ion Beam
GIS	Gas Insertion System
GOM	Grain orientation map
GPIB	General Purpose Interface Bus (IEEE-488 standard)
IEEE	Institute of Electrical and Electronic Engineers
IR-CCD	Infra-Red-Charge Coupled Device
JPEG	Joint Photographic Experts Group
keV	Kilo-electron Volts
kV	KiloVolts
kX	Magnification, in units of 1000
LMIS	Liquid Metal Ion Source
mm	millimeter
MODF	MisOrientation Distribution Function
nA	nanoAmp
NIST	National Institute of Standards and Technology
NRL-DC	Naval Research Laboratory-Washington DC
nm	nanometer
ns	nanosecond
ODF	Orientation Distribution Function
OS	Operating System
pA	picoAmp
SEM	Scanning Electron Microscope
SIMS	Secondary ion mass spectroscopy
STEM	Scanning Transmission Electron Microscopy
TEM	Transmission Electron Microscopy
TIFF	Tagged Image File Format
TTL	Transistor-transistor logic

Test and Evaluation Procedures

In addition to demonstration of all elements listed in the specification, the following must be demonstrated for acceptance of the instrument.

1.1 FIB demonstration

1.1.1 Minimum etched line width using ion column (Si): 20 nm or less.
1.1.2 Minimum deposited ion beam metal linewidth (Pt): 75 nm or less
1.1.3 Minimum deposited electron beam metal linewidth (Pt): 30 nm or less
1.1.4 Maximum hole aspect ratio using ion beam (Si): 10:1 depth:diameter minimum
1.1.5 Maximum hole aspect ratio using ion beam and enhanced etch GIS (Si): 20:1 depth:diameter minimum.
1.1.6 TEM sample prep membrane thickness (Si): 75 nm or less
1.1.7 Insulator material resistivity must be 100 Ohm-cm or greater, demonstrated by the orthogonal overlay of two Pt metal lines having interface area of 10 x 10 micrometers.
1.1.8 Pt metal deposition resistivity must be 3 Ohm-cm or less determined from Hall-bar structures. NRL will provide AFM to determine areal cross-section of test structures.

1.2 Chemical Standards Measurements

1.2.1 Evaluation of NIST composition standards by EDS techniques. Compositional analysis must be with +/- 5% of the documented value.