High Vacuum Electron Beam Deposition System (CLIN 0001)

1.0 Scope This specification describes the minimum technical requirements and the minimum acceptable performance standards for a high vacuum electron beam deposition system. This system will be used by NRL personnel to fabricate thin film coatings on wafers or substrates under high vacuum conditions. The electron beam deposition system will be placed in a multiple user facility and must provide ease of operation and safety to those in the facility.

2.0 Installation The contractor shall install the system at the Naval Research Laboratory, Washington DC. The Government will provide the necessary facilities for installation such as air, water and drainage, electrical power and grounding. The contractor must install the system in a manner consistent with typical clean-room operating procedures.

3.0 Description and Primary System Components The electron beam deposition system will be used to deposit films of high melting temperature materials, in high vacuum, upon conducting, insulating and semiconducting substrates. These films are to be subsequently lithographically patterned into various electronic devices. In order to reduce pump down time per cycle and minimize source and substrate heater contamination, the vacuum chamber must consist of two separate sections. The lower source chamber must be separated from the upper product chamber by a high vacuum isolation valve. It is intended for use by multiple users and therefore must be computer controlled via menu-driven software.

The system must have the following:

3.1 A batch loading vacuum chamber designed to minimize material buildup and cleaning requirements.

3.2 A stainless steel hinged Bell jar of at least 20-inch-diameter.

3.3 An electric hoist actuation of source flange for easy gun and shield removal and cleaning.

3.4 At least one clear viewport mounted in the vacuum chamber protected from deposition coating.

3.5 Wide–angle viewport mounted in the source chamber. Viewport must have method of maintaining clear view of source while under vacuum (clear tape advance or similar method must be provided to accomplish this feature).

3.6 Installed set of stainless steel easily removable evaporation shields for ease of cleaning system.

3.7 Spare set of above mentioned evaporation shields (two sets total).

3.8 Must provide easy access to the electron gun and feedthroughs, such as a drop down swing out source tray.

3.9 The substrate holder must include fixturing that can support five 6-inch SEMI-Standard wafers as well as reducer inserts to hold 2-in., 3-in. and 4-in. wafers and blank inserts to hold wafer pieces. The fixturing must permit normal angle-of incidence deposition in order to facilitate lift-off processing. Holder must provide for rotation of substrates. Rotation must be variable and from 0 to at least 40 rpm. Quartz lamps for infrared

heating of substrates must be provided and include a thermocouple for closed loop temperature control by the system computer. The lamps must be capable of heating the substrates to at least 500°C.

3.10 A port must be provided for installation of a residual gas analyzer.

3.11 The chamber and the bell jar must be water-cooled.

3.12 The source to substrate distance must be at least 49.5 centimeters (cm).

Section 4. E-gun Source and Power Supply

4.1 The E-gun source tray must include a turret electron beam gun with at least six 15 cc pockets and designed to prevent cross-contamination between pockets. Complete isolation of the active source must be achieved. The preferred method of accomplishing this is by a plate, which contacts the top of the gun crucibles during deposition and can be raised when crucibles are rotated. A turret index controller for rotation of the crucibles must be provided. The electron beam gun must have at least a 10 kW rating.

4.2 A 6 kilowatt (kW) constant voltage power supply must be provided for operation of one electron beam source in the chamber, operated at 208 VAC.

4.3 All controls must be mounted in an electronics cabinet.

4.4 At least one gun control must be provided.

4.5 A transformer kit must be provided with at least 20 foot of long lines.

4.6 A variable frequency and range x-y e-beam sweep control must be provided.

Section 5. Control System

5.1 The control system must control the pumps, valves, drives, deposition sources, shutters, power supplies, the gas system, gauges, substrate heating and ion gun source. Multiple layer deposition control must utilize a quartz crystal rate controller. Data logging capabilities must be available. The gauges must be Edwards High Vacuum Active Inverted Magnetron gauges and Pirani controllers for high and low vacuum applications or equivalent.

5.2 The system must be provided with a Process controller based upon quartz crystal sensors and have an RS232 computer interface, video display programming panel, dual sensor head and shutter and single source capability, as well as a hand-held power controller and interface connectors. The performance must be equivalent to or better than an Inficon Model XTC/2 controller.

5.3 The contractor must provide a control system that has full automatic, manual and service modes of operation. The contractor must provide a personal computer running InTouch Software by Wonderware or similar software for the operator interface. The computer must be mounted in a standard 19" electronics rack that is least 6' high and equipped with casters.

Section 6. High Vacuum Pump Stack

6.1 The system must be provided with heavy duty 6" cryogenic pump with integral regeneration capability, such as a CTI Model CT-8, or equivalent. The pump must be mounted on the source chamber plenum below the load lock gate valve. The base unit must include a first and second stage with RS232 interface and two set point relays, microprocessor regeneration control and a remote keyboard display. The system must also include the following features:

- Automatic regeneration
- Water-cooled compressor
- Silicon diode temperature indicator
- Configuration kit, 20ft. water cooled

6.2 The system must have a roughing pump (mechanical two stage direct drive - Edwards model E2M80 or equivalent) with throughput of at least 57 cubic feet/min (cfm). The pump must include a flexline connector at least 20-inches long with at least a 1.5 inch outside diameter (o.d.), an angle trap and fomblin oil charge.

Section 7. Ion Pre-Clean

7.1 The system must have a 3-centimeter ion gun for pre-cleaning mounted substrates with power supply and integrated with gas control to the computer control systems for ion-pre-clean process steps. The ion source must be Ion Tech or equivalent.

Section 8. Residual Gas Analyzer (RGA) System

8.1 The contractor must provide a quadrupole-based RGA attached to the vacuum system, integrated into the computer-based control system with range of 1-100 atomic mass units (AMU) and programmable set-points for up to six different gases. An RGA analysis step must be provided to enter into the process recipe to ensure that background gas conditions are realized prior to proceeding with the deposition.

8.2 The system must have software that permits spectral analysis of background gases to be displayed on a PC.

Section 9. Training

9.1 The contractor must provide at least two days of basic system operation training.

Section 10. Warranty

10.1 The contractor must provide at least a twelve (12) month commercial warranty from date of installation and acceptance at the NRL.

Section 11. Documentation

11.1 The contractor must provide commercial documentation such as drawings, schematics, troubleshooting tactics, servicing and repair of the system and components.

Section 12. Optional Items

(CLIN 0002): The contractor must provide an additional 2 ¾ inch port to the bell jar.

(CLIN 0003): The contractor must provide an upgrade source extension, via simple field retrofit. The source-to-substrate distance must be at least 8 inches.

(CLIN 0004): The contractor must provide an extended commercial warranty for maintenance.