1.0 SUMMARY EQUIPMENT SPECIFICATION:

1.1 DEPOSITION CHAMBER:

- 304L stainless steel chamber, electro-polished, measuring approximately 20" (wide) x 26" (deep) x 28" (high); incorporating a full-width front door mounted to chamber with articulating hinges (2 spare door o-rings provided with system).
- Chamber removable from baseplate (2 spare lower o-rings provided with system).
- 304 stainless steel internal studs for foil attachment.
- Bottom-mounted pumping plenum.
- Single rack control cabinet and integrated frame with removable access covers.
- The following chamber penetrations will be provided:
  - Baseplate:
    a) (1) 8.0" diameter penetration (pumping plenum)
    b) (22) 1.0" diameter penetration
  - Sidewall:
    a) (6) 2.75" CF
  - Top-plate:
    a) (1) 12.0" diameter penetration (substrate rotation)
    b) (2) 1.0" diameter penetration
  - Door:
    a) (2) 4.0" diameter viewport (shuttered)
  - Pumping Plenum:
    a) (1) 6" ASA (high vacuum pump)
    b) (2) 0.75" compression seals (vacuum gauge)
    c) (1) NW40 (roughing valve)
    d) (1) 3.50" (high vacuum bellows valve actuator)
1.2 CHAMBER PUMPING SYSTEM:

- APD Cryogenics AP-8S cryogenic pump, APD HC-4 Displex water-cooled compressor, and 10' hose assembly.
- Alcatel UT2021 two-stage, rotary vane pump.
- High conductance, bellows-sealed poppet valve:
  - welded to the chamber's baseplate,
  - all 304SS construction,
  - removable seal plate, and
  - flange mounted bellows and linear actuator.
- Foreline-mounted absorption trap.
- 25 mm SS bellows-sealed, electro-pneumatic roughing valve.
- 25 mm bellows-sealed, electro-pneumatic regen valve.
- 0.25" (VCR-4) bellows-sealed, electro-pneumatic vent valve.
- 0.25" (VCR-4) bellows-sealed, electro-pneumatic cryogenic pump purge valve with adjustable needle valve.
- 0.25" electric, mechanical pump purge valve (independent operation to facilitate chamber pumping and cryopump regeneration).
- 0.25" electric, mechanical pump vent valve (slaved to mechanical pump status).
- 0.5" NPT manual ball valve (leak checking), mounted on system foreline; KF40 termination.

1.3 VACUUM GAUGING/PROCESS GAS AND PRESSURE CONTROL:

- MKS Instruments 290C-07 ionization/thermocouple gauge controller, supporting 2 Bayard-Alpert ionization gauges (adjustable sensitivity) and 2 thermocouple gauges, each with 2 user-programmable setpoints.
  - TC1A, TC1B, TC2A, TC2B, IG1, and IG2 setpoints interfaced to discrete PLC digital inputs, and
  - IG1 setpoint interfaced to TT-3 electron beam gun power supply "VAC" interlock.
- Denton Vacuum DV-23, two-position thermocouple controller (redundant measurement of foreline pressure and mechanical pump stack performance).

1.4 ELECTRON BEAM EVAPORATION SOURCE:

- (1) Telemark TFI 241-02 (4 x 7 cm³ crucibles; side drive) compact electron beam gun:
  - manual crucible selection,
  - single-piece baseplate plenum (removable) and
  - dedicated cooling water circuit with integral flowrate sensor; hardwired interlock to corresponding TT-3 electron beam gun power supply.
1.4 **ELECTRON BEAM EVAPORATION SOURCE (cont.):**

- (1) Telemark TT-3 (3.0 kW) electron beam gun power supply and Telemark X/Y sweep:
  - front panel and remote input control of voltage and filament emission current,
  - visual status/interlock indication,
  - interfaced to a XTC/2 deposition rate controller (for remote layer termination and rate control), and
  - hardwired safety interlocks.
- Rectangular HV feedthrough covers with full access flange.
- Filament transformer located in NEMA 4 enclosure.

1.5 **EVAPORATION SOURCE SHUTTER:**

- (1) Electro-pneumatic deposition source shutter:
  - interfaced to system PLC for remote open and close operation, and
  - interfaced to XTC/2 deposition rate controller (via system PLC) for automatic layer termination.

1.6 **EVAPORATION DEPOSITION CONTROL:**

- (1) Leybold Inficon XTC/2 quartz crystal rate controller:
  - interfaced to the TT-3 e-beam power supply, and
  - manual film program edit (via front panel).
- PLC-enabled, XTC/2 manual-mode, shutter over-ride.
- (1) water-cooled, single, standard crystal sensor with shutter.

1.7 **SUBSTRATE FIXTURING/ROTATION CONTROL:**

- Single rotation, bearing supported feedthrough terminated with a removable (18" diameter) flat substrate rack.
- High torque, reversible DC, gearmotor and controller:
  - direct drive coupling to rotation feedthrough, and
  - variable speed 0-27 RPM (potentiometer adjust), and
  - interfaced to system PLC for on/off operation.
1.8 SUBSTRATE HEAT:

- (1) 3.0 kW quartz heater array with backside reflector and deposition shield; mounted to baseplate plenum.
- 208/110 VAC step-down/isolation transformer to minimize glow discharges and feedback from sputter power supply.
- 3.0 kW PI temperature control system (Omega CN76000 series temperature controller, manual setpoint input).
- (1) sheathed thermocouple positioned internally in chamber.

1.9 SYSTEM CONTROL AND AUTOMATION:

- GE-Fanuc 90-30 programmable logic controller (PLC).
- EEPROM memory backup.
- Membrane-type operator interface with integral LED status annunciation.
- Valve control/sequencing, pump operation, and "soft" system interlocks (i.e., non-safety related) controlled by the PLC.
- The following operating modes provided:
  - AUTOPUMP (automatic loadlock and chamber pumpdown to high vacuum conditions),
  - AUTOVENT (automatic loadlock and chamber venting to atmospheric pressure),
  - MANUAL (permits manual (front panel) system operation and interruption of in-process automatic system sequences), and
  - MAINTENANCE MODE (key-switch selectable from MANUAL mode; permits all MANUAL MODE functionality, "soft" system valve interlocks disabled. All "hard" safety interlocks remain operational).

1.10 UTILITIES:

- Electrical: 208 VAC, 60 Hz, 3 phase, 5 wire (75 A).
- Cooling water: 15-20 l/min, 15-25 degrees Centigrade, 3-4 bar differential between supply/return (6 bar max. inlet pressure):
  - foreign particles, size: maximum of 100 microns
  - foreign particles, concentration: maximum of 10/cm^3
- Four circuit water manifold; visual flow indication and temperature indication (return side) on all circuits. Circuits requiring flow "sense" (required for hard-wired safety interlocks) will be equipped with a proximity switch keyed to the integral brass float in specific circuit’s sightglass.
1.10 UTILITIES (cont.):

Cooling water circuit designations follow:

1: E-beam gun (flow sense/interlock);
2: XTC Crystal Sensor;
3: Cryopump compressor;
4: Spare.

- Compressed air: 10-20 l/hr, normal dry shop air, 6-7 bar:
  - dew point: maximum of 2 degrees Centigrade
  - oil content: 1-5 mg/m³
  - foreign particles, size: maximum of 5 microns
  - foreign particles, concentration: maximum of 5 mg/m³

- Nitrogen: (preferentially evaporated from liquid N₂)
  - 0.5 bar (chamber venting, 300 l/cycle, optional)
  - 2.0 bar (cryopump regeneration, 500 l/regeneration)

1.11 SYSTEM DOCUMENTATION:

- Three complete sets of operating instruction manuals; to include preventive maintenance procedures/timetable, troubleshooting guides, and fully-costed spare parts listing.
- One complete set of sub-assembly vendor manuals.
- Three complete sets of electrical schematics (B-size).
- One complete set of electrical schematics (AUTOCAD.DWG format).

1.12 MECHANICAL REQUIREMENTS:

- Equipment will be designed to industrial machine tool standards and where applicable to Delco Electronics Specifications for Industrial and Clean Room Equipment (WEMA-8403, 4/15/87).
- Commercially purchased components must be new, of industrial quality and demonstrated "best in class" availability.
- All ferrous or aluminum metals are to have proper finishes to prevent corrosion or oxidation.
- All pneumatic lines, valves, cylinders and flow controls are to operate at a minimum pressure of 70 psi and a maximum pressure of 110 psi.

1.13 ELECTRICAL STANDARDS:

- All electrical equipment will be in compliance with JIC Electrical Standards, National Electric Code, and where applicable General Motors ES1 Basic electrical standard.
- All signal power will be isolated from system power; proper shielding and routing practices will be followed.
1.13 ELECTRICAL STANDARDS (cont.):

- All electrical, electronic, and optical sensors will be adequately protected from process contamination.
- Three phase distribution is 208 VAC, 60 cycle (all equipment with three phase inputs must be supplied for this voltage); single phase inputs shall be 110 VAC.
- All equipment will have panelized control; single entrance protection by a heavy duty disconnect switch. The disconnect switch will have a "lockout" provision to ensure that no electrical power can be delivered to the system during maintenance operations.

1.14 SAFETY STANDARDS:

1.14.1 SAFETY INTERLOCKS:

- The system will be equipped with a hardwired safety interlock system which fully protects operators and maintenance personnel from personnel injury. The following hardwired interlocks will be provided:
  - Electron Beam Gun High Voltage: TT-3 key switch, vacuum safety bellows switch, frame lower-skin switch and chamber door.
  - Electron Beam Gun Filament Emission: TT-3 key switch, ionization gauge (chamber) emission, chamber thermocouple gauge setpoint, and water flow switch.
  - Heater Power: Vacuum safety bellows switch and chamber door.
- The status of all hardwired safety interlocks will be displayed to the system operator(s) at all times.
- All hardwired safety interlocks will be duplicated by PLC "software" interlocks.

1.14.2 MOVING PARTS:

- Sliding surfaces and pinch points must be fully guarded to prevent injury to operators and maintenance personnel.
- In the event of a power failure, all moving parts are to come to a complete stop. Upon initiating a restart cycle, all moving parts will proceed to their home position without damage to the equipment or injury to operations and/or maintenance personnel.
1.14.3 POWER SYSTEMS:

- In the event of an interlock dropout or power failure, all power to internal sources of energy (heat and e-beam power supply) will be interrupted. When power is restored, or an interlock is satisfied, a hard, manual reset of the affected subsystem will be required.
- High voltage transformers, vacuum feedthroughs and inter-connecting cabling will be enclosed in water-tight enclosures (NEMA 4 rating or better).
CRYOPUMP COMPRESSOR

MECHANICAL PUMP

CONTROL CABINET

DOUBLE ACTION HINGES

TOP VIEW

TOP PLATE REMOVED

72.00" APPROX.

31.00"

56.50"