

## Specifications for a "Bolt-on" Ultrahigh Vacuum High-Resolution Scanning Electron Microscope

### I. Technical Requirements

We require a high-resolution scanning ultrahigh vacuum electron microscope (SEM) that can operate compatibly with a preexisting Omicron "Nanoprobe" system and its associated chamber and sample transfer system, at an operating pressure  $< 6 \times 10^{-11}$  Torr. As a part of a nanoscale research facility, the SPM will be attached to a NRL owned multi-chamber system, which includes an Omicron UHV Nanoprobe<sup>1</sup>. During the experiments samples will be in a position to be interrogated by both the UHV Nanoprobe and the SEM. Therefore, it is essential that the SEM be compatible with the UHV Nanoprobe variable temperature sample holders and with the overall geometry of the sample in the Nanoprobe station. The SEM geometry must also be compatible with a scanning Auger microprobe hemispherical analyzer, which must also fit into the Nanoprobe station, for simultaneous SEM, SAM and STM with sample movement.

### II. Performance

Low energy performance must generate high beam currents (in the nA range at low beam energies). The beam energy must be adjustable from 100 eV to 30 keV. At a working distance of 15 mm, the SEM must be capable of  $< 6$  nm resolution at 15 keV and 0.4 nA beam current, and  $< 8$  nm resolution at 3 keV and 0.1 nA beam current. The beam currents (and magnetic fields) associated with the column elements must be sufficiently high (and low,  $< 1$  mG peak-to-peak) at low beam energies to permit scanning Auger microscopy analysis.

### III. UHV Hardware

The thermal field-emission electron source chamber must be differentially pumped by an ion getter pump, and must be protected by an integral chamber isolation valve. All materials must be UHV compatible ( $< 6 \times 10^{-11}$  Torr) and bakeable to 180 °C.

### IV. SEM Hardware as follows:

- 1) **UHV compatible electron column** with
  - a) Thermal Field Emitter (TFE),
  - b) Electrostatic condensor
  - c) Magnetic objective lenses for ultimate resolution SEM.
  - d) Electromagnetic aperture changer
- 2) **The control electronics** must comprise a high voltage power supply, a scan and deflection unit, and an SED control unit.
- 3) **The secondary electron detection system** for scanning electron microscopy must consist of:

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<sup>1</sup> The UHV Nanoprobe is a commercial product available from Omicron

- a) In-lens flange-mounted SE-detector with channeltron and bias grid for secondary electron detection from 0.1-20 keV. Must be mounted on support flange with HV-feedthroughs, NW 35 CF (2¾" OD). Must have an insertion depth 150 mm.
- b) Secondary electron detection amplifier providing video signal from channeltron collector output. The box must mount directly on channeltron support flange by HV-plug. This must include the HV and DC power supply cable.
- c) SED-control unit with front panel setting and display of channeltron high voltage (max. 2.2 kV) and bias grid voltage (-50 V – 250 V). Channeltron must be operated in analogue mode. It must include DC supply for SED-preamplifier. 19" / 3 HU rack mounting.
- d) Additional secondary electron detector (not in-lens) for high energy electrons (>20 keV).

#### **V. Sample and Probe holders**

As noted above, the sample holder must be compatible with the Omicron Nanoprobe and variable temperature AFM/STM stations and capable of temperature excursions to 50-500K.

#### **VI. Sample/Probe Viewing**

The SEM must allow visual access to the samples when in position for either SEM, SAM, or STM with the Nanoprobe.

#### **VII. Electronics and Software required**

- 1) SEM preamplifier
- 2) Control electronics hardware
- 3) Data Acquisition hardware
- 4) Computer interface hardware
- 5) Data acquisition, display, processing, and analysis software
- 6) All necessary cables and connectors

#### **VIII. Computer System Requirements**

- 1) 1.6 GHz or faster personal computer
- 2) Minimum hardware configuration: 256 Meg RAM, 40 GB hard drive, 1.44 MB floppy drive, CD-RW Drive, USB 250 Mb Zip drive or equivalent, keyboard, mouse, and Ethernet
- 3) Windows NT, Windows 2000, or Windows XP operating system and control drivers installed
- 4) 21" or larger color monitor
- 5) Windows NT-based software for operation of column and source, SEM image acquisition, image processing and data filing.

#### **IX. Miscellaneous**

- 1) User Manuals including schematics and block diagrams
- 2) 2-year software upgrade subscription
- 3) On-site installation
- 4) On-site training