

# **“Bolt-on” Ultrahigh Vacuum Variable Temperature Scanning Probe Microscope**

## **Technical Requirements**

The Naval Research Laboratory (NRL) requires a scanning probe microscope (SPM) that can operate at variable temperature as a scanning tunneling microscope (STM) and as an atomic force microscope (AFM). The SPM must be contained on its own bolt-on an ultrahigh vacuum (UHV) chamber with an operating pressure  $< 6 \times 10^{-11}$  Torr. A means to manipulate samples and probes in and out of the SPM must be provided. As a part of a nanoscale research facility, the SPM will be attached to an existing multi-chamber system, which includes an Omicron UHV Nanoprobe. During the experiments samples will be transferred between the UHV Nanoprobe and the SPM. Therefore, the SPM sample holders must be compatible with the Omicron UHV Nanoprobe variable temperature sample holders. The SPM must meet or exceed the following minimum specifications:

### **1. Performance**

- a. The SPM must be capable of at least the four following operation modes: (1) AFM contact mode with lateral force detection, (2) AFM non-contact mode, (3) STM mode, and (4) STM/AFM dual mode where STM and AFM data will be collected simultaneously.
- b. The non-contact AFM mode must be capable of atomic resolution on Si (111).
- c. The STM mode must be capable of atomic resolution on Si (001) and Au (111).

### **2. UHV Hardware**

- a. Stainless steel bolt-on UHV chamber with view ports, blanks, assembly hardware and gaskets
- b. Sample and probe storage
- c. Sample and probe handling wobble stick or similar mechanism
- d. Continuous flow liquid helium cryostat with heater and temperature sensor

### **3. SPM Hardware**

- a. Internal spring suspension stage with eddy current damping
- b. Variable temperature stage (minimal temperature range of 30 K – 750K)
- c. AFM using beam deflection technique
- d. STM tube scanner resolution: (0.05 nm in X and Y, and 0.005 nm in Z) or better.
- e. At least 8 mm × 8 mm × 8 mm probe coarse positioning range
- f. In-UHV I/V-converter for STM mode

### **4. Sample and Probe holders**

- a. At least 4 variable temperature sample holders for resistive sample heating
- b. At least 4 variable temperature sample holders for direct current sample heating

- c. A minimum of 10 Cantilever/Probe holder

## **5. Sample/Probe Viewing**

- a. CCD camera
- b. Macro zoom lens
- c. 9" or larger monitor
- d. Light source

## **6. Electronics and Software**

- a. STM preamplifier
- b. AFM preamplifier for four-quadrant detector
- c. Control electronics hardware
- d. Data Acquisition hardware
- e. Computer interface hardware
- f. Data acquisition, display, processing, and analysis software
- g. Capability for I/V spectroscopy and force-distance spectroscopy
- h. All necessary cables and connectors

## **7. Computer System**

- a. Minimum of 850 MHz personal computer
- b. Minimum hardware configuration: 128 Meg RAM, 8 GB hard drive, 1.44 MB floppy drive, CD-RW Drive, keyboard, mouse, and Ethernet
- c. Windows NT, Windows 2000, or Windows XP operating system and control drivers installed
- d. Minimum of 21" color monitor

## **8. Miscellaneous**

- a. One set of user Manuals including schematics and block diagrams
- b. 2-year software upgrade subscription
- c. On-site installation at the NRL, Washington, D.C.
- d. On-site training at NRL for 2 people for one day.