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Re: Sole Source Justification Letter for the acquisition of a Bruker Multimode 8 SPM/AFM.

Date: September 13, 2024

To Whom it May Concern:

The purpose of this document is to justify the sole source procurement of the Bruker Multimode 8HR Scanning Probe Microscope (SPM) for our research facility. This advanced instrument is essential for our ongoing and future research projects, which require accurate probe-to-sample dynamics control for high-resolution imaging and surface modification capabilities. No company or distributor, other than Bruker, can provide a similar product.

The Bruker Multimode 8HR SPM offers several unique capabilities that are critical for the research needs of Dr. TJ Mullen, Dr. Greg Wurtz, and their collaborators. A selection and combination of these unique capabilities are described below.

1. The system offers a proprietary characterization mode (PeakForce), which enables high-resolution 3D correlative imaging using a sinusoidal force ramp, which must have the following features:
 - 1.1. Excellent force setpoint control during imaging which automatically compensates for drift of the deflection signal. The force setpoint can be set to less than 10 pN (pico Newtons) for high-resolution imaging, particularly of soft materials, used in Dr. Mullen's research.
 - 1.2. No cantilever tuning is required so there is no concern of cantilever resonant frequency shift caused by the experimental condition changes during the imaging process. This ensures tip-sample interaction forces are kept constant during both nanostructure imaging and writing phases in Dr. Mullen's research. In addition, no cantilever tuning makes this imaging process more consistent than tapping mode, used by competitors, particularly in liquid.
 - 1.3. Use a lock-in based feedback mechanism to control the tip-sample interaction force. This feature better preserves tips and samples, but this feature is otherwise essential in Dr. Wurtz's research to characterize the near-field optical properties of surfaces as a function of the tip-to-sample distance.
 - 1.4. Have at least 4 kHz ramp frequency to ensure a high imaging rate (effective line rates of 4 Hz at 512 pixels per line). This feature is essential when

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studying samples, which geometry is time-dependent, as used in Dr. Mullen's research.

- 1.5. Have an automated image optimization routine that adjusts the force feedback gain constantly while scanning to ensure consistent sample topography tracking to obtain high fidelity images in air and liquid. This feature is essential for both Dr. Wurtz and Dr. Mullen's research, requiring accurate tip dynamics control as the tip-sample distance is varied.
2. This instrument supports a wide range of scanning probe techniques, including Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), and more, making it highly versatile for various applications. This capability, in conjunction with the PeakForce technique described in 1., is essential to performing controlled near-field optical microscopy measurements, as implemented in Dr. Wurtz' research.
3. This instruments provides quantitative nanomechanical mapping along with a high-resolution topography image based on the fast sinusoidal force ramps up to 4kHz. With this option, the mechanical properties, such as modulus based on DMT model and Sneddon model, adhesion, indentation, and dissipation will be simultaneously collected in real time with the near-field optical measurements of Dr. Wurtz. This is essential to correlate and dissociate mechanical properties from optical properties, which otherwise lead to artifacts.
4. The Multimode 8HR provides unparalleled resolution (30 pm RMS in routine operation) due to its compact mechanical geometry and low-noise electronics, enabling the visualization of nanoscale structures with exceptional accuracy. In conjunction with point 3. this unique correlative capability is essential to distinguish height topography from force topography.

Based on these unique features, especially the PeakForce Tapping technology, as well as the correlative capabilities it enables, the Bruker Multimode 8HR SPM is the only instrument that can meet our research needs. Therefore, we request approval for the sole source procurement of this critical piece of equipment.

Best regards,



Gregory Wurtz
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