

Asylum Research Development Grants for New SPM Band Excitation Technique

Application Deadline: Jan. 15, 2010

Award Announcement: March 15, 2010

Description

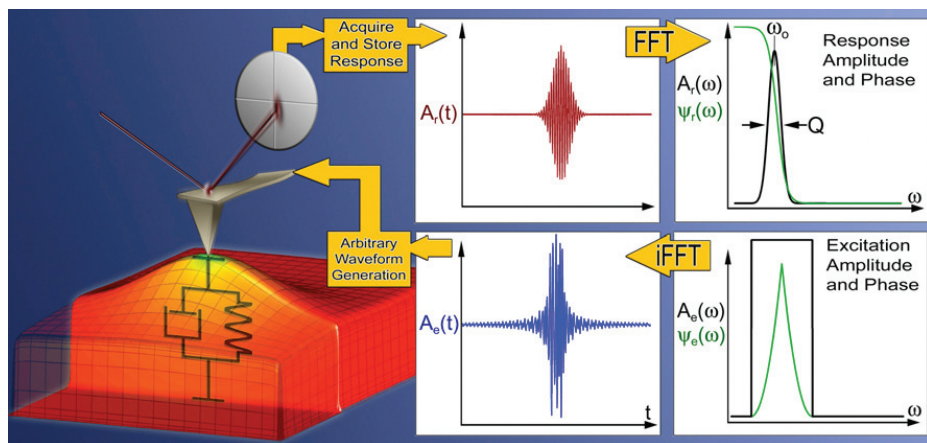
Band Excitation (BE) is a new Scanning Probe Microscopy (SPM) technique that has shown great promise in mapping the conservative interactions, nonlinearities, and energy dissipation of materials on the nanoscale.¹ The quality factor, Q , of the cantilever vibrating in the vicinity of the surface is a parameter that is inversely proportional to energy dissipation in the tip-surface junction. However, standard single-frequency SPM experiments are incapable of providing this energy transfer information quantitatively, since only two parameters (e.g. amplitude and phase) are measured experimentally, while at least three are required to describe the dynamics of the system. Frequency sweeps using standard lock-in techniques can be performed to determine Q , but the large time requirements are impractical for imaging. Stephen Jesse and Sergei Kalinin at Oak Ridge National Laboratory and their collaborators, including AFM manufacturer Asylum Research, synthesized an excitation signal programmed with a finite amplitude and phase in a

predetermined frequency range to drive the cantilever electrically, magnetically, or acoustically and probe the response at multiple frequencies at once. This method extends to energy dissipation measurements since amplitude and phase response can be determined simultaneously over a range of frequencies, even in low Q -factor environments such as liquids. The BE method is a fast and sensitive technique which may be useful for understanding and mitigating energy losses in magnetic, electrical, and electromechanical processes and technologies.

Grant Structure

Successful applicants will receive:

1. BE beta software including firmware and GUI software for their MFP-3D™ and/or ARC2™ controllers. Also compatible with the new Cypher™ AFM. Can be upgraded on systems already in the field or for new sales. A 25K USD value, provided by Asylum Research.
2. Some additional discretionary hardware and/or software support may be provided to enable application-specific BE measurements. Valued up to 25K USD. Contact Asylum Research for further information.



Operational principle of the BE method in SPM. The excitation signal is digitally synthesized to have a predefined amplitude and phase in the given frequency window. The cantilever response is detected and Fourier transformed (FFT) at each pixel in an image. The ratio of the fast FFT of response and excitation signals yields the cantilever response (transfer function). Fitting the response to the simple harmonic oscillator yields amplitude, resonance frequency, and Q -factor that are plotted to yield 2D images, or used as feedback signals.¹ Reprinted with permission (see reference 1).

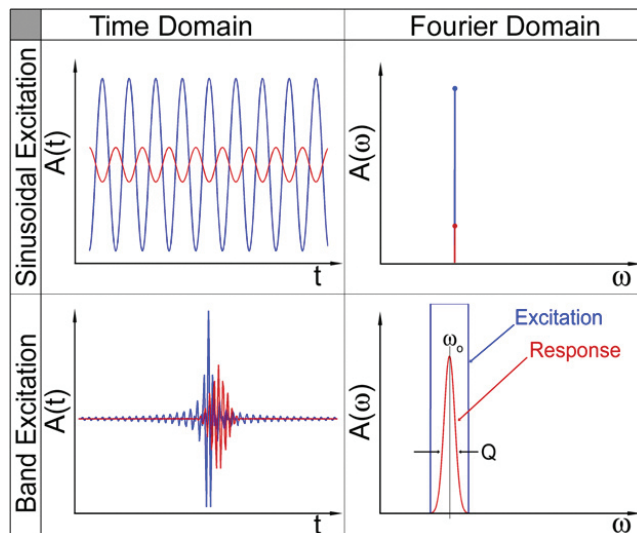
Topics

Proposals will be ranked for their originality and broad applicability to a range of current problems in nanotechnology and science. Suggested topics include:

- Energy dissipation in materials.
- Contact resonance measurements for materials properties contrast and quantification.
- Electromechanical properties of materials, including piezo- and ferroelectrics.
- Applications of BE to solar materials – photovoltaics and energetic materials.
- BE methodologies applied to other active probes, such as localized thermal analysis.
- Biological materials including mechanical properties and recognition mechanisms.
- Advanced methodologies for data reduction and analysis.
- Nonlinear in tip-sample interactions.
- Other nanoscale measurements that can benefit from rapid multiple frequency measurements.

Application Instructions

- Maximum 5 page technical description with references. Should include sufficient background for an SPM applications scientist to understand the significance of the problem. It should also elucidate where BE may provide a unique and powerful solution to an existing problem.
- CV and appropriate references for the Principle Investigator and all persons performing work
- The total length including CVs and references should be 10 pages *or less*.
- To submit your application e-mail your technical proposal and CV (Word.doc or PDF) to grants@AsylumResearch.com by January 15, 2010.



Excitation (blue) and response (red) signals in standard SPM techniques in (top left) time domain and (top right) Fourier domain. Excitation (blue) and response (red) signals in BE SPM in (bottom left) time domain and (bottom right) Fourier domain. In BE, the system response is probed in the specified frequency range (e.g. encompassing a resonance), as opposed to a single frequency in conventional SPMs. Reprinted with permission. (See reference 1).

Contact Information

Please contact Dr. Roger Proksch at Asylum Research for further information and to discuss your proposal topic.

Email: grants@AsylumResearch.com

References

1. S. Jesse, S. V. Kalinin, R. Proksch et al., "The band excitation method in scanning probe microscopy for rapid mapping of energy dissipation on the nanoscale," *Nanotechnology* 18 (43) (2007).