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Sinc or Sine? The Band Excitation Method and Energy Dissipation Measurements by SPM STEPHEN JESSE, SERGEI KALININ, Oak Ridge National Laboratory — Quantitative energy dissipation measurements in force-based SPM is the key to understanding fundamental mechanisms of energy transformations on the nanoscale, molecular, and atomic levels. To date, these measurements are invariably based on either phase and amplitude detection in constant frequency mode, or as amplitude detection in frequency-tracking mode. The analysis in both cases implicitly assumes that amplitude is inversely proportional to the Q-factor and is not applicable when the driving force is position dependent, as is the case for virtually all SPM measurements. All current SPM methods sample only a single frequency in the Fourier domain of the system. Thus, only two out of three parameters (amplitude, resonance, and Q) can be determined independently. Here, we developed and implemented a new approach for SPM detection based on the excitation and detection of a signal having a finite amplitude over a selected region in the Fourier domain and allows simultaneous determination of all three parameters. This band excitation method allows acquisition of the local spectral response at a 10ms/pixel rate, compatible with fast imaging, and is illustrated for electromechanical and mechanical imaging and force-distance spectroscopy. The BE method thus represents a new paradigm in SPM, beyond traditional single-frequency excitation.

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