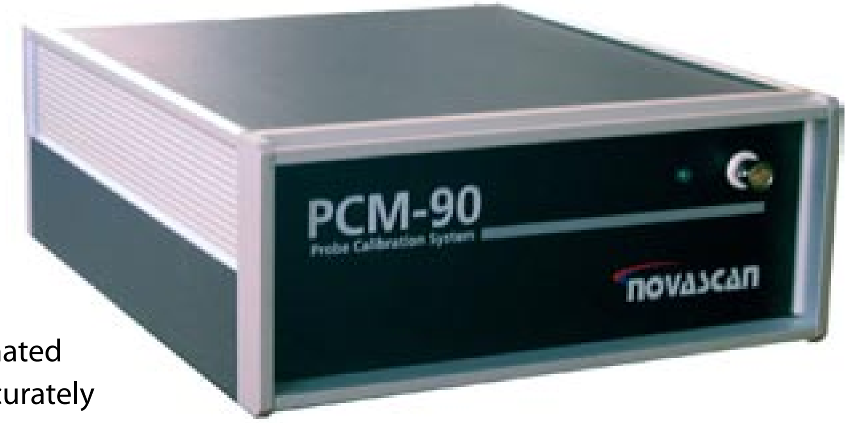
novascan

PCM-90

AFM Probe Calibration Module



Improve Force Data Accuracy

The spring constant of an AFM cantilever is dominated by its thickness. This is a difficult parameter to accurately control during manufacturing, which leads to a great deal of variability in the actual stiffness of each probe. Most AFM probe spring constants are specified as being plus or minus 50% of the nominal value.

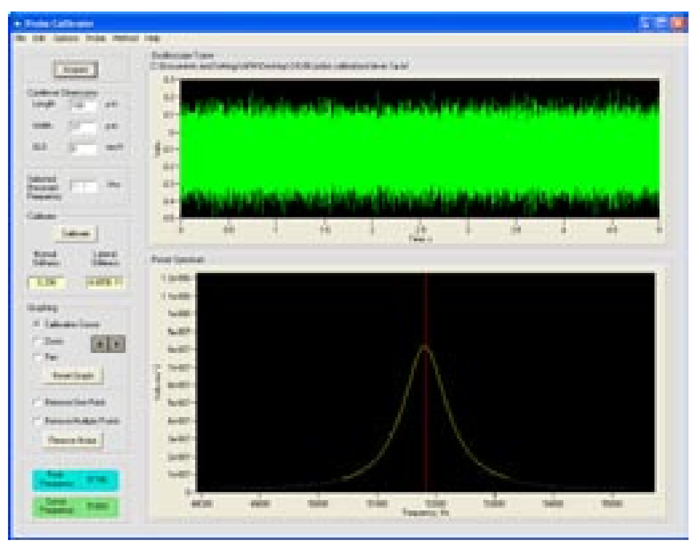
This variability can significantly affect the accuracy of the force data you collect. By using a PCM-90 to experimentally determine the spring constant of each tip you use, this uncertainty can be greatly reduced.

Fast. Simple. Universal.

The PCM-90 is a turnkey hardware/software solution that will allow you to quickly and easily determine the actual spring constant of your AFM cantilevers in a non-destructive manner. It is universally compatible with any AFM that provides access to an analog cantilever deflection signal. The self-contained amplification and acquisition unit interfaces with your PC by a USB connection.

Features

- Performs thermal (Hutter-Bechhofer) and resonance quality factor (Sader) calibrations in seconds
- High-accuracy 16 bit data acquisition
- Standard BNC signal input
- USB interface to host computer
- Compatible with rectangular and triangular levers with resonant frequencies up to 90khz
- Universal design integrates with any AFM
- Easy to use software interface



To learn more about integrating the PCM-90 with your Atomic Force Microscope, call Novascan Technologies at 515-233-5400 or email info@novascan.com.

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Overview of AFM Cantilever Calibration Methods

Resonance Quality Factor

This method uses cantilever geometry and the resonance peak freqency and quality factor (Q) to calibrate rectangular probes. It was developed by John Sader of the University of Melbourne.

To use this method it is necessary to convert time signal data to a frequency spectrum for further analysis, where it is assumed to be a simple harmonic oscillator and curve fit as such. A correction factor is implemented for use with triangular cantilevers.

Because this method depends solely on the shape and location of the resonance peak, no optical calibration is required. This can be very valuable when trying to maintain tip sharpness or preserve the surface of a chemically modified probe.

Thermal Oscillation

Developed by Hutter and Beechofer, this method models a cantilever as a simple harmonic oscillator in thermal equilibrium with its surroundings. Using the equipartition theorem, the amount of thermal energy in the cantilever can be calculated from its displacement. Because the thermal energy correlates to probe stiffness, the spring constant of the cantilever can then be determined mathematically.

In order to quantify cantilever deflection, a calibration must be performed to determine the optical sensitivity of the system--that is, to convert voltage measurements to distance values. This generally involves performing a force pull on a hard surface such as glass, which can compromise tip sharpness or chemical coatings. Because this could effect the results of some force measurements, Novascan suggests collecting voltage data and performing the optical calibration (and any thermal stiffness calibrations) at the conclusion of the experiment.

Mass-added

When a small mass is added to the end of a cantilever structure, the resonance frequency of that cantilever changes. If the mass is known, this frequency shift can be used to calculate the cantilever spring constant. This calibration method is credited to J. Cleveland, and is also referred to as the "Cleveland Method".

To use this method, the resonance frequency must be measured both with and without the added mass, which adds to the time required. The process of gluing a particle to an AFM cantilever is also quite complex in itself. The particles must be optically sized in order to accurately determine how much mass was added, and placed exactly at the end of the cantilever for the equations to be valid. In general, thermal or Sader calibrations are more accurate and much easier to perform.

References

Sader, J.E., Chon, J.W.M., Mulvaney, P. Calibration of Rectangular Atomic Force Microscope Cantilevers. *Review of Scientific Instruments*. Volume 70 Number 10. October 1999.

Hutter, J.L. and Bechhoefer, J. Calibration of Atomic-Force Microscope Tips. *Review of Scientific Instruments*. Volume 64 Number 7. July 1993.

Sader, J.E. Parallel Beam Approximation for V-shaped Atomic Force Microscope Cantilevers. *Review of Scientific Instruments*. Volume 66 Number 9. September 1995.

Clifford, C.A. and Seah, M.P. The Determination of Atomic Force Microscope Cantilever Spring Constants Via Dimensional Methods for Nanomechanical Analysis. *Nanotechnology*. Institute of Physics Publishing. Number 16. July 2005.