Atomic Force Microscopy with Inherent Disturbance Suppression for Nanostructure Imaging

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Scanning probe imaging is often limited by disturbances, or mechanical noise, from the environment that couple into the microscope. We demonstrate on a modified commercial atomic force microscope that adding an interferometer as a secondary sensor to measure the separation between the base of the cantilever and the sample during conventional feedback scanning can result in real-time images with inherently suppressed out-of-plane disturbances (Figure 1) [1]. The modified microscope has the ability to resolve nanometer-scale features in situations where out-of-plane disturbances are comparable to or even several orders of magnitude greater than the scale of the topography. We present images of DNA in air from this microscope in tapping mode without vibration isolation, and show improved clarity using the interferometer as the imaging signal (Figure 2). The inherent disturbance suppression approach is applicable to all scanning probe imaging techniques.

We do not claim that image improvement will be comparable to these results on all SPMs and in all imaging environments. At present, this technique will be most effective in very noisy environments, such as a microfabrication facility, where Z disturbances overwhelm sample topography. However, there are two significant implications of this work: 1) vibration isolation, which is costly and consumes space, can be rendered unnecessary for noisy environments; and, 2) this technique can potentially outperform vibration isolation in any environment with further reduction of the interferometer noise floor.

REFERENCE