blueDrive™ photothermal excitation for fast, reliable and quantitative AFM

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Since the advent of atomic force microscopy, cantilevers have predominantly been driven by piezo actuators for AC imaging and data acquisition. However, parasitic resonances of the AFM hardware, known as the "forest of peaks"[1], cause problems in all environments, ranging from viscous fluids[2], to water[3], air[4], and even vacuum[5].

AFM signals acquired with piezo-driven cantilevers reflect changes in the cantilever response *and* the piezo response. This reduces the accuracy of quantitative AFM studies, and may couple conservative and dissipative forces. Furthermore, it is well known that small high-frequency cantilevers enable faster AFM imaging; however, the forest of peaks prevents reliable cantilever tuning at high frequencies because piezo resonances tend to become more jagged and problematic as the drive frequency increases. The reliability of the AFM is also compromised because the forest of peaks changes with temperature and time, especially in liquids.

Photothermal excitation is a high frequency method for exciting a cantilever by heating/cooling the base of the cantilever. Photothermal excitation results in a repeatable and accurate cantilever transfer function that is time- and temperature-stable, resulting in stable imaging in liquids (see Figure) and dependable use for temperature-dependent studies. Because the driven transfer function represents the true cantilever transfer function, blueDrive ensures more accurate quantitative AFM experiments: the AFM signals stem from tip-sample interactions, rather than piezo resonances. Also, smaller cantilevers can be photothermally excited with large amplitudes for fast AFM imaging.

Our recent developments in perfecting photothermal excitation and its benefits to the AFM community will be discussed in this talk. To date, we have demonstrated reliable photothermal operation in air and fluid environments using a broad range of imaging techniques, such as AM-AFM (Tapping), FM-AFM, Contact Resonance, AMFM viscoelastic mapping.

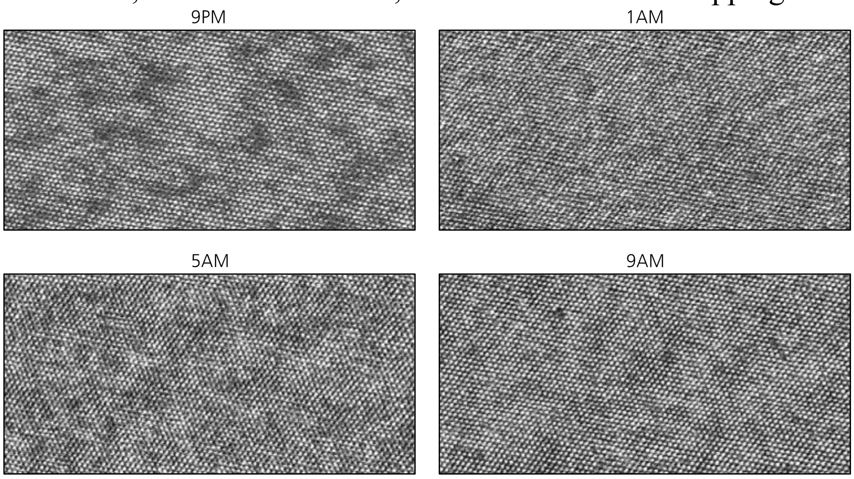

Figure: Unassisted overnight scan of the water/mica interface, measured by AM-AFM. Note the atomic resolution throughout the whole experiment, and point defect in the last image at 9AM.

References:

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