

Center for Dynamics and Control of Materials: *MRSEC Seminar*

Cryogenic Scanning Probe Microscope Integrated in Cryogen-Free Dilution Refrigerator for Single-Electron Sensitive Electric Force Microscopy/Spectroscopy

Friday, March 22nd, 11 am-12 pm
Innovation Center, EER 2.518

We present a cryogenic atomic force microscopy (AFM) system which is integrated in a cryogen-free dilution refrigerator with a magnetic field up to 9 T. A large internal volume of the cryostat allows the AFM unit to be installed on an efficient internal vibration isolation system, enabling the reduction of the mechanical vibration from the pulse tube cooler. The vibration isolation system consists of a massive (over 10 kg) of copper block suspended by four springs whose extensions are about 250 mm, resulting in a vertical resonant frequency as low as 1 Hz.

Combined with the rigid design of coarse positioners, the influence from the pulse tube cooler can be efficiently decoupled. The AFM is equipped with a fiber-optic interferometer which is used for both detecting the cantilever deflection and exciting the cantilever oscillation [1]. The capability of exciting cantilever oscillation by optical force enables spurious-free clean cantilever resonance, which allows for the dissipation spectra free from background signal [2]. This is crucial for single electron-sensitive electric force microscopy/spectroscopy [2,3]. In addition, the capability of tunable cantilever quality factor by cavity optomechanical effect [4] makes it possible to reduce the noise in frequency shift and dissipation signals.



Yoichi Miyahara (he/him/his) is an assistant professor in the Physics Department at Texas State University. His research group specializes in advanced scanning probe microscopy techniques for nanoscale material property characterization, his work focuses on the development and application of these techniques.

Yoichi Miyahara, Ph.D.



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