Ultrasmall Higher-Frequency Cantilevers For Nanoscale MRI

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We investigated the potential for ultrasmall, higher-frequency cantilevers to reduce noise and improve resolution in magnetic resonance force microscopy. The most recent MRFM results used ultrasoft, mass-loaded silicon cantilevers with resonant frequencies of 1 - 10 kHz. Low frequency noise processes such as tip-surface interactions were suspected to be limiting the force resolution of these cantilevers. To explore this theory, ultrasmall silicon cantilevers with higher resonant frequency were designed, fabricated and characterized. Additionally, we explored new methods of spin detection in MRFM suitable for these higher frequency cantilevers. Previous MRFM experiments utilized adiabatic rapid passage to synchronously flip spins at the cantilever resonant frequency and thereby detect the z-component of spins. However this method is not scalable to higher frequencies. We conducted numerous experiments in an attempt to sense the transverse component of spins in our MRFM apparatus, as these experiments should scale more readily to higher cantilever frequencies.

SEM image of a fabricated ultrasmall cantilever to improve achievable resolution in nanoscale magnetic resonance imaging using magnetic resonance force microscopy.