Ultra-Sensitive Cantilevers with Integrated Nanometer-Scale Magnets for Magnetic Resonance Force Microscopy

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ABSTRACT:

We are fabricating and modeling mesoscopic cantilevers with integrated nanometer-scale magnetic tips as part of an effort to achieve single-proton sensitivity in magnetic resonance force microscopy. To reach this goal, the magnetic tipped cantilevers must achieve sub-attonewton force sensitivity with the magnetic tips only a few nanometers away from the surface of a sample. Thermal interactions between the silicon based cantilevers and the sample surfaces dominate the background force noise at these short distances, so the magnetic tips must be fabricated such that they extend 100 to 200 nm beyond the end of the cantilever.

Cantilevers with Ni tips have been fabricated, and their magnetic properties and force sensitivity are being characterized with promising initial results. Fabrication of cantilevers with Co tips, on the other hand, has continued to be problematic due to reactions between Co and Si during processing at moderately elevated temperatures.

With the successful fabrication of the Ni-tipped cantilevers, we have developed a model for the magnetic field in the region of the tip and calculated the expected signal for our initial experiments on 200-nm thick films of organic free radicals. Initial calculations indicate that our cantilevers will have sufficient sensitivity to detect both Boltzmann polarization and spin noise signals.

KEYWORDS: Micro-cantilever, nano-magnet, magnetic resonance imaging.

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