Magnetic resonant force microscopy

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We present the methods for diagnostics of magnetic nanostructures based on magnetic force probe microscopy.

A magnetic force microscope (MFM) registers the force interaction of a magnetic probe with a non-uniform stray magnetic field of the sample. As a result, the spatial distributions of the MFM contrast correlate with the domain structure of the sample. The MFM method is especially effective in analyzing the magnetization distributions of patterned magnetic nanostructures, such as arrays of nanoparticles and nanowires [1]. On the other side, the MFM probe affects the sample magnetization causing effects of local magnetization reversal, which opens up great opportunities for selectively controlling the magnetic state of nano-dimensional objects [2].

In addition, the oscillations of magnetic probe leads to the formation of eddy currents in the conducting samples, which create magnetic fields damping the cantilever oscillations. This effect is used in microscopy of eddy currents when a change in the amplitude and quality factor of the resonant oscillations of the cantilever over areas with different conductivities is recorded as the data signal. The spatial resolution of this method reaches 20 nm [3].

In recent years, a new method for diagnosing resonant properties of ferromagnetic structures has been developed – magnetic resonance force microscopy based on the phenomenon of ferromagnetic resonance. In magnetic resonance force microscope (MRFM), a sample is placed in a microwave field modulated in amplitude at the frequency of the mechanical resonance of a cantilever. As a result, the oscillation amplitude of the cantilever becomes proportional to the amplitude of the ferromagnetic resonance in the sample. This method can detect the local spin-wave spectra in magnetic nanostructures and study the spatial distributions of the resonant oscillations of the magnetization in the samples [4].

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