Magnetic structure of cross-shaped permalloy arrays embedded in silicon wafers

Source: Journal of Magnetism and Magnetic Materials, vol.290-291, part 1, pp.779-782, 2005
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It is critical to understand the spin structures and magnetic switching behavior of nano-scale patterned magnetic elements for their application to high-density data storage devices, nonvolatile magnetic memories, and magnetic logic gates. The spin structures of square, rectangular, and circular dots have been extensively studied. However, those for more complicated geometries with a branch have not been adequately investigated.

This paper describes the observed magnetic structures and micromagnetic simulations of cross-shaped, permalloy ($Ni_{80}Fe_{20}$) arrays embedded in silicon wafers. The cross-shaped dots of nano-scale-width were fabricated using the damascene technique, with the help of electron beam lithography. At the ends of the crossed-bars, two pairs of magnetic poles were observed as bright and dark spots using a magnetic force microscope (MFM). Bright and dark contrasts appeared in the crossing region. A three-dimensional micromagnetic calculation using the Landau-Lifshitz-Gilbert equation was done to explain the observed MFM image. The calculated spin distribution shows vortices in the depth direction on both ends of the bars. The chirality of the vortices turns around relative to the central axis of the longitudinal bars. The force gradient distribution was simulated taking into account the interaction between the cross-shaped dot and MFM probe-tip, whose stray field was calculated using the integral equation method. The calculated force gradient image successfully demonstrates the observed MFM image.

Dependence of thermal decay on the magnetic cluster size of perpendicular magnetic recording media

Journal of Magnetism and Magnetic Materials Vol. 287 pp. 96-101 (2005)
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In order to achieve higher recording density, it is necessary to decrease the grain size and to increase the perpendicular anisotropy of a magnetic recording medium. However, it becomes difficult to increase the magnetic field strength generated from a recording head because of the material limit of saturation magnetic flux density. For high density magnetic recording, a recording medium needs to have either a large perpendicular anisotropy and a small writable field or a moderate perpendicular anisotropy and small thermal fluctuation. Magnetization loops and recorded magnetizations were simulated in the micro-magnetic simulation while changing the magnitude of inter-granular interaction. This paper reports on how the inter-granular interaction relates to the magnetic parameter and recording characteristics. An individual grain behaves independently for no interaction, but grains form a magnetic cluster with the size corresponding to the interaction strength by introducing an interaction between grains. The magnetization of the medium with a small grain and small perpendicular anisotropy is thermally unstable for a small inter-granular interaction. However, it is shown that thermal stability and high density recording characteristics are improvable for such medium by controlling the inter-granular interacting strength and optimizing the magnetic cluster size.

1024-QAM Demodulator Robust to Phase Noise of Cable STB Tuners

IEEE Transactions on Consumer Electronics, Vol. 51, No. 2, p. 413-418, 2005
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In this paper, we report on a 1024-QAM demodulating method that is robust to the phase noise of a frequency-converter. The phase noise of the frequency-converter in a tuner affects the bit error rate (BER) performance of a 1024-QAM signal more than it does that of a 64/256-QAM signal. We developed a receiving method for reducing the BER degradation due to such a phase noise by modifying the symbol decision regions on the QAM constellation plane. Phase noise stretches the circular (isotropic) thermal noise distribution in the circumferential direction. To reduce the BER degradation caused by this deformation, we tune the symbol-decision regions. The optimum decision regions are analytically derived assuming that the noise distributions of the two neighboring symbols are expressed with the same Gaussian distribution. Simulations and the results of a field trial with a commercial off-the-shelf tuner show that this modification improves the required C/N by 2 dB or more. This suggests that a 1024 QAM transmission is possible in cable TV systems.