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Dissertation Announcement

Design and Characterization of Nanoscale Bit Patterned Magnetic Recording Media

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Magnetic data storage has seen rapid increases in areal bit densities over the past decade. The resultant shrinking of individual bit characteristic dimensions has led to the rapid onset of superparamagnetic instabilities due to the reduction of the magnetic thermal activation volume. Perpendicular recording, recently introduced by the magnetic data storage industry, is expected to defer the onset of the superparamagnetism to ~500Gbits/in^2. New solutions are, however, needed to extend the areal bit densities to 1Tbit/in^2 and beyond.

Bit patterned medium recording is among the main candidates for the next generation recording technologies. It is expected to enable recording densities well in excess of 1TBit/in^2 while effectively addressing the data stability issues. In this dissertation work, selected aspects of patterned medium recording technology are explored including data storage layer materials design, fabrication, and characterization, studies of magnetization reversal in bit patterned recording layers, and the recording physics of bit patterned media.

The design and magnetic properties of ultra-high anisotropy $(Co/Pd)_n$ recording layers were investigated using the combinatorial magnetron sputtering. Backpropagation neural network was used to analyze the combinatorial libraries and to model the relationship between the magnetic properties and the recording layer design. Annealing in the air and in vacuum was evaluated as a means to improve the multilayer magnetic properties. A transition of magnetization reversal mechanism was observed in the samples annealed in the air, but not in those annealed in vacuum. It is found that the formation of Co oxide plays an important role in this transition. The multilayers annealed in vacuum exhibit microstructural improvements. The multilayers were patterned into periodic arrays of magnetic islands. Switching field distribution was measured using magnetic force microscopy and magneto-optical Kerr effect. The magnetization reversal in the nanodots was found to be heavily influenced by the self-demag field while the stray fields from adjacent nanodots played only a minor role. Micromagnetic simulations were carried out to simulate selected aspects of the patterned medium recording processes. It is shown that a 25% head-to-bit misregistration substantially improves the recording efficiency for all recording configurations. The influence of misregistration is stronger for smaller ABS cross sections and greater misregistration values. The dependencies of recording efficiency on flying height and thickness are found to be linear.

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Date: April 23, 2007
Time: 10:30am