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SECURE BULK ERASURE OF HIGH COERCIVITY MAGNETIC MEDIA

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Introduction

Recorded magnetic patterns will remain on magnetic media surfaces until the original patterns are rendered unrecognizable via exposure to a sufficiently strong magnetic field. Bulk erasure methods, which expose entire disk drives or removable media cartridges to strong AC or DC magnetic fields, are often preferred and sometimes essential when erasure must be performed quickly. Media containing extremely sensitive data must be *secure erased*, which is defined as erasure so that the magnetic patterns cannot be recovered or reconstructed by any known means. Bulk erasure methods satisfy this criterion when the original patterns have been erased to the noise level of the magnetic medium.

As part of a program funded by the U.S. government, we have been evaluating the ability of various prototype and commercial instruments to securely erase modern high coercivity magnetic media. These studies require unique approaches for different magnetic media formats. For example, hard disk drives do not function properly even after inefficient bulk erasure operations because the factory-written magnetic servo patterns, drive motor, recording head, and head actuator mechanism are all affected by the erasure fields. The original drive assembly therefore cannot be used to recover and analyze remnant patterns on the disk surfaces. Spin stands are impractical for playback of the partially erased patterns because mechanical tolerances prevent precise alignment of the spin stand axis with the geometric center of tracks having submicron widths. However, the Scanning Magnetoresistance Microscope[1] (SMRM), also known as a "dragtester," can readily accommodate media removed from drive bodies, either as entire platters or disk fragments, and has proven to be a very useful tool in our secure erasure studies of hard disk media. We describe its use in this report.

Experimental Details and Results

CMRR sponsor companies provided both the sliders and the drives for our SMRM experiments. GMR sensors were 0.14 μm wide, and the drives contained disks having a factory-written constant frequency pattern on all tracks. The special patterns permitted Fast Fourier Transform (FFT) techniques to be used for analyzing the degraded magnetic signal after erasure. Sliders were placed in contact with disk surfaces and held stationary as the disk specimens were translated stepwise along two orthogonal directions within the plane of the disk, and the GMR voltage response was recorded after each step. All SMRM scans shown here cover 24 µm x 1.25 µm areas, and were obtained with 30nm down-track and 50 nm cross-track step sizes. Playback amplitudes were monitored before and after various erasure protocols.

Figs. 1a-c show some SMRM grayscale images obtained with 4200 Oe longitudinal media before and after exposure to erasure fields. A remnant of the original pattern is clearly visible after partial erasure with an inefficient protocol using field intensity about 20% above the medium coercivity (Fig. 1b). One problem encountered when working with the pre-written pattern shown in Fig. 1 is that proper alignment of the GMR sensor with the down-track direction becomes more difficult when the degraded magnetic pattern approaches medium noise levels. This problem can be avoided by using a pattern created by stitching together a constant frequency pattern recorded coherently on adjacent tracks, as shown in Fig. 2a for 5000 Oe longitudinal media. GMR sensor alignment is now a less critical issue and erasure to medium noise levels can be readily followed. For both types of recorded patterns, the GMR responses along lines in the down-track direction are analyzed using FFT methods. The FFT amplitudes of the line scans are used to evaluate whether the pattern has been erased to medium noise levels, as shown in Figs. 2-4.

[1] S.Y. Yamamoto and S. Schultz, *Applied Physics Letters*, **69**(21), 3263, (1996).

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(a)

(b)

(c)

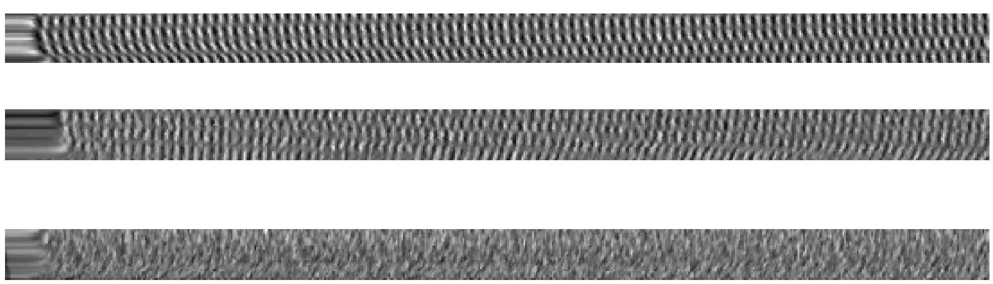


Fig.1. SMRM images of 4200 Oe hard disk media. (a) original 72.5 MHz pattern; (b) after partial erasure; (c) after complete erasure.

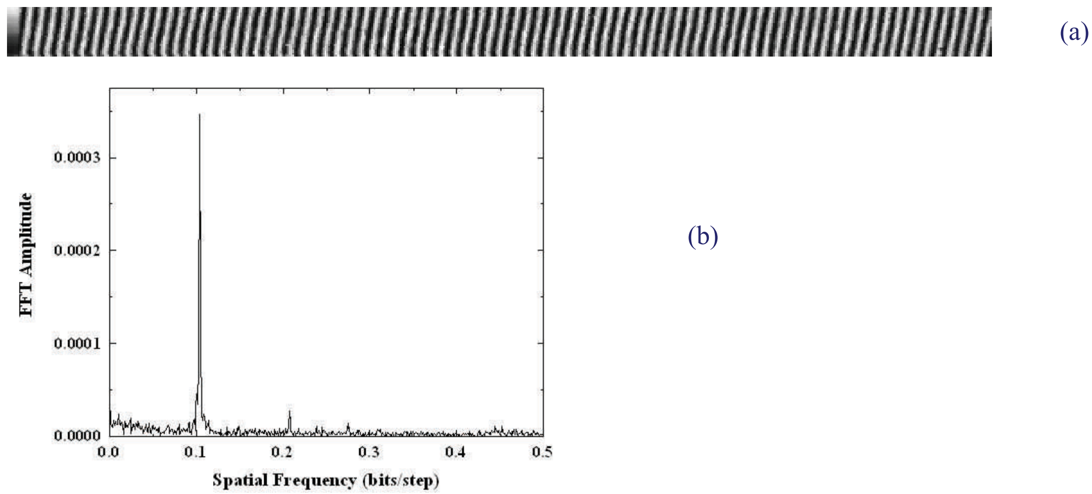


Fig. 2. Original “stitched” track 65 MHz pattern on 5000 Oe hard disk medium.
(a) SMRM image; (b) corresponding FFT of a line scan along the “down-track” direction.

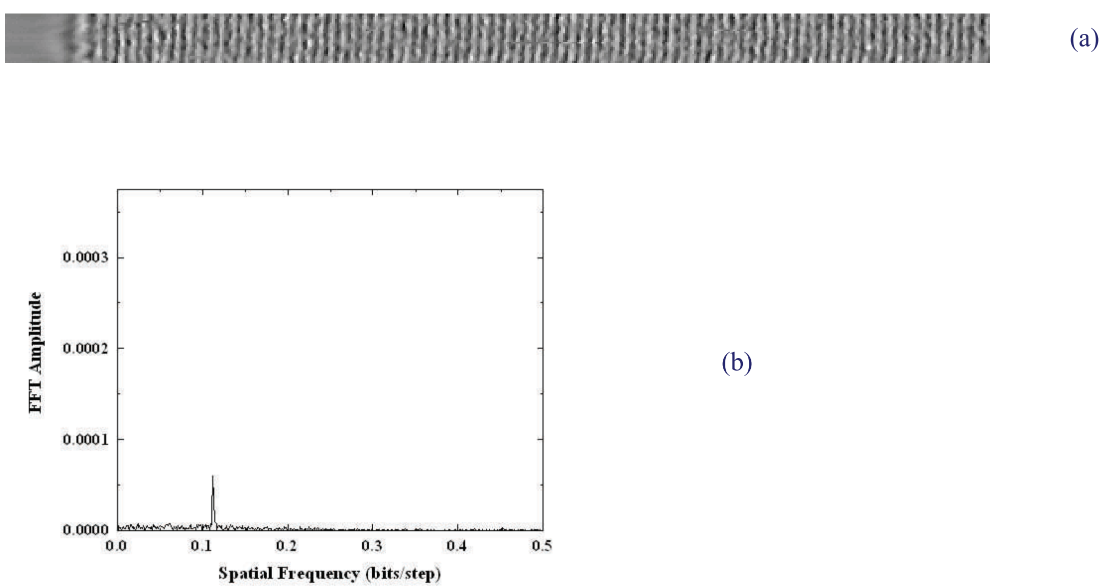
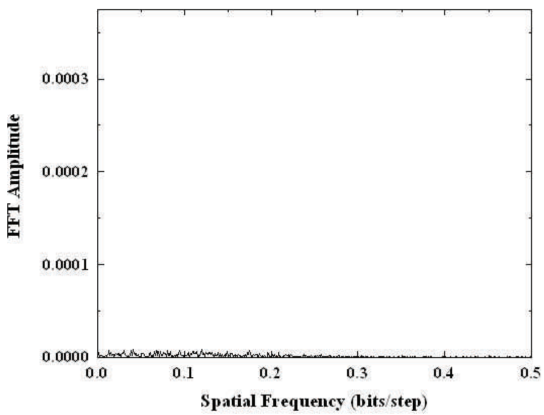


Fig. 3. “Stitched” track 65 MNz pattern on 5000 Oe hard disk medium after partial erasure. (a) SMRM image; (b) corresponding FFT of a line scan along the “down-track” direction.

(a)



(b)

Fig. 4. “Stitched” track 65 MHz pattern on 5000 Oe hard disk medium after complete erasure. (a) SMRM image; (b) corresponding FFT of a line scan along the “down-track” direction.