Magnetic force microscopy studies of bit erasure in particulate magnetic recording media

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Abstract:

Magnetic force microscopy (MFM) with *in situ* magnetic fields has been used to study the erasure of bit transitions in high-density particulate magnetic recording media. Specifically, bits written on a Zip disk were investigated. Qualitative analysis found the erasure to be similar to that observed by Walsh, Austvold, and Proksch [*J. Appl. Phys.* 84, 5709 (1998)] in thin film recording media. The erasure of the bit magnetization pattern was studied by imaging the bits in a sequence of applied magnetic fields, each separated by about 250 Oe. It was found that the largest change in the bit pattern between two subsequent images occurred when the field was increased to 1.4 kOe, a field value close to the measured bulk coercivity of 1.6 kOe. The reversals occurred mostly around regions that had irregular magnetic boundaries. In addition there was an observation that reversal was more likely to occur in smaller fields in those regions of the disk which exhibited a larger than average surface roughness.

Keywords: Magnetic alignment; Magnetic force microscopy; Magnetic recording media; Magnetization – field dependent

In this study, an Iomega® 100 MB Zip™ disk was used. After the disk was filled with arbitrary data, the recording media was sectioned off into small, circular pieces for imaging in a Nanoscope III Multimode magnetic force microscope [1]. The media sample was exposed to an *in situ* magnetic field, and the effects of the applied field (H) and the demagnetization fields of the magnetic transitions were imaged. The applied fields were between -4 kOe to +4 kOe [2]. From the bulk hysteresis curve in Fig. 1 [3], one can see that the measured coercivity is1.6 kOe. The region of largest magnetization reversal occurs between 1 kOe and 2 kOe, and we have concentrated the study in this region.

Fig. 2 shows MFM images made in applied fields of 1.44, 1.56, 1.68, and 1.80 kOe. From these images one can see that within the squared off sections, the "dark" region grew as the applied field increased. These growths represent large-scale penetration of aligning regions into previously established bits. As can be seen, the magnetization reversal occurred more readily at the transitions. This is consistent with previous work [4], which found that initial reversals occurred in the regions with the largest demagnetization fields.

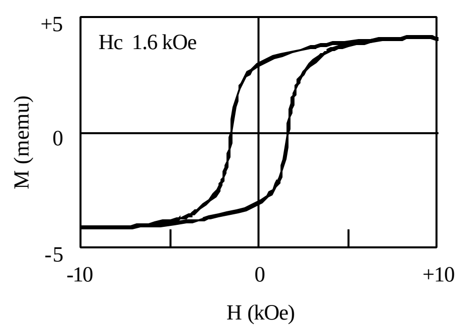

Fig. 1. Bulk hysteresis loop of Iomega® 100 MB Zip™ media.

The comparisons of the topography and the magnetic images in Fig. 3 were done to observe the possible relation between the erasure behavior of the magnetic signatures and the roughness of the recording media. Though it was found that the structure of the media did not have any visible effects on the data bits

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originally written onto the media, these images showed slight correlations between the location of the initial magnetization reversal and the surface structure of the recording media. Within the circled-off region of image a, there appeared to be a large depression in the surface. This corresponds to the squared-off regions in b, c, and d, and the initial magnetization reversal occurred at an applied field of 1.4 kOe. In the ovaled-off region, where the topography is relatively smooth, a larger external field was required to initiate the reversal process, as seen in the corresponding rectangular regions in b, c, and d.

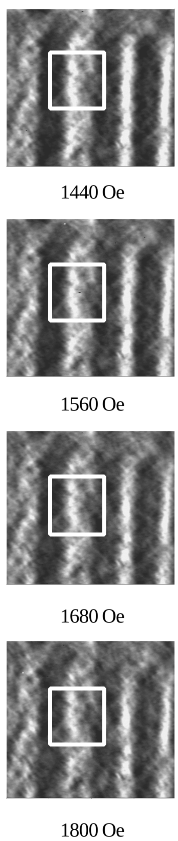

Fig. 2. Degenerating bit patterns in MFM images as the applied field increased.

In summary, erasure of bit transitions in magnetic recording media had been studied using magnetic force microscopy with *in situ* magnetic fields. The study showed that the roughness of the media surface was a contributing factor to the initial alignment of the magnetization. The applied field where the largest reversal occurred in a given field increment was 1.4 kOe, lower than the measured coercivity. However, this is most likely due to extra demagnetization fields of the adjacent media.

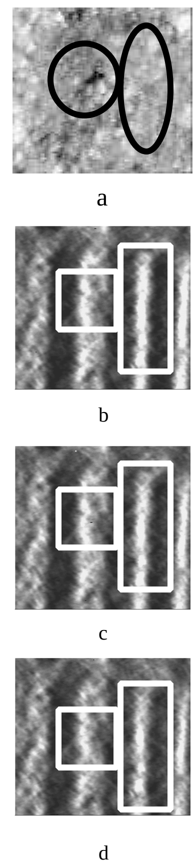

Fig. 3. Image a is the topography of the media. Images b, c, and d are MFM images made at fields of 1.44, 1.56, and 1.68 kOe, respectively.

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