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Journal of Magnetism and Magnetic Materials 226–230 (2001) 2046–2047

Journal of magnetism and magnetic materials

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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. 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 patterns 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 with 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. A qualitative analysis of the erasure indicates a magnetization process similar to that observed by Walsh et al. (J. Appl. Phys. 84 (1998) 5709) in thin film recording media. © 2001 Elsevier Science B.V. All rights reserved.

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

In this study, an Iomega® 100 MB Zip™ disk was filled with arbitrary data, the recording media was sectioned-off into small, circular pieces for imaging with a Nanoscope III Multimode magnetic force microscope.[2] 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 to $+4$ kOe [1]. As shown in the bulk hysteresis curve in Fig. 1 [2], the measured coercivity is 1.6 kOe. The region of largest magnetization reversal occurs between 1 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 a magnetization parallel to the applied field into previously anti-parallel regions. As can be seen, the magnetization reversal occurred more readily at the transition region between the two magnetization directions which define the bits. This is consistent with previous work [3], which found that initial reversals occurred in the regions with the largest demagnetization fields.

The comparisons of the topography and the magnetic images in Fig. 3 show our observations of the effects of the media roughness on the erasure of the magnetic bits. In general, we did not see an effect of the surface roughness and the original bits. However, we did find some correlation between the location of the initial magnetization reversal and the surface structure of the recording media. Within the circled region of the image in Fig. 3a, there is a large depression in the surface. This corresponds to the squared-off regions in Fig. 3b–d, and the initial magnetization reversal occurred at an applied field of 1.4 kOe. In the ovaled region in Fig. 3a, the topography is relatively smooth. In this region, a larger external field was required to initiate the reversal process, as seen in the corresponding rectangular regions in Fig. 3b–d.

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PII: S0304-8853(00)00819-2

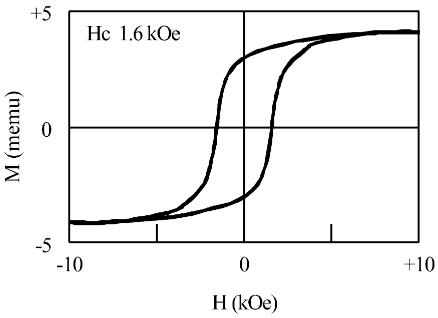

Fig. 1. Bulk hysteresis loop of Iomega® 100 MB Zip™ media.

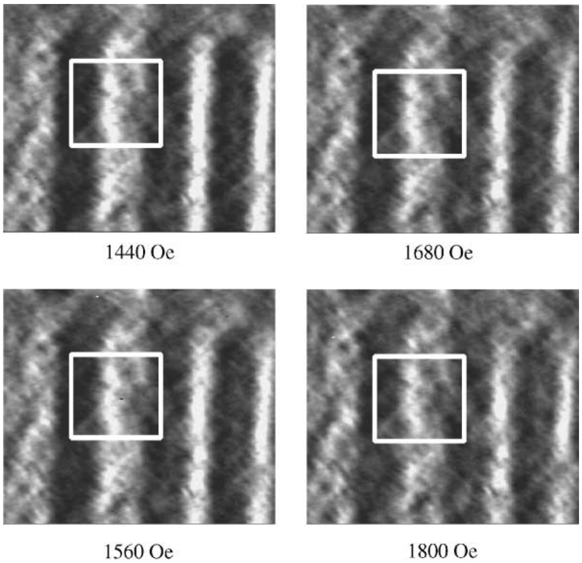

Fig. 2. Degenerating bit patterns in MFM images as the applied field increased.

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.

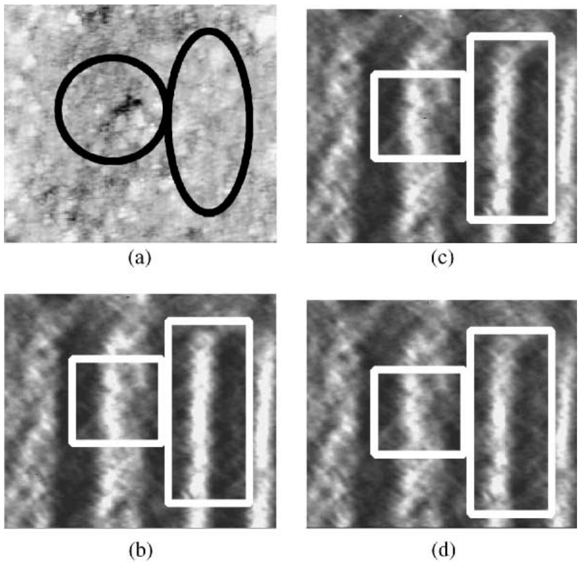

Fig. 3. Image a is the topography of the media. Images b, c, and d are MFM images made at fields of 1.44, 1.56, and 1.68 kOe, respectively.

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