ANTI-FERROMAGNETICALLY COUPLED MEDIA FOR MICROWAVE ASSISTED MAGNETIC RECORDING

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I. INTRODUCTION

Microwave-assisted magnetic recording (MAMR) technology can increase the effective head field gradient and reduce the switching field of a recording medium [1]. It may also allow selective recording on multiple-layer media [2]. In a MAMR system a high frequency (HF) field is generated by a spin-torque oscillator (STO). One issue is the dependence of the optimum HF field frequency on the magnetic state of the medium, e.g. the optimum HF field frequency may differ depending on whether the medium is AC-demagnetised or saturated. This behaviour originates in the magnetostatic field interactions between media grains. In this talk we present the results of simulations of anti-ferromagnetically coupled (AFC) media, in which such interactions can be reduced.

II. RESULTS

AFC and single layer (SL) perpendicular media were compared. Both media had an 11 nm thick recording layer; in the AFC media the recording layer had a 4 nm hard / 1 nm Ru / 6 nm soft structure. The non-magnetic Ru layer provided anti-ferromagnetic exchange coupling of -1 erg/cm^2 between the hard and soft layers [3]. The soft layer had M_s of 400 emu/cm^3 whilst the hard layer and SL media M_s was 600 emu/cm^3. The soft layer K_u was 2×10^6 erg/cm^3 whilst the hard layer K_u and SL media K_u was varied. Fig. 1 shows an example of MH loops for SL and AFC media with an average grain size of 8 nm and an average grain pitch of 9 nm. In zero field the remanence of the AFC medium was almost zero due to the anti-parallel alignment of the magnetisation in the hard and soft layers. The remanence was not exactly zero due to distributions of M_s among grains. The coercivity of the SL medium and the average switching field of the hard layer of the AFC medium was about 20 kOe in both media.

Fig. 2 shows the SNR of 635 kfci tracks written on media with various K_u using a range of HF field frequencies. Peaks in the SNR were clear in some cases but, particularly in the case of high K_u AFC media, the optimum HF field frequency extended over a wide range. As K_u increased the peak SNR decreased and the optimum HF field frequency increased. The maximum SNR gain over a non-MAMR system ranged from 8-10 dB when recording on AFC media to 9-16 dB when using SL media.

Fig. 3 shows the SNR versus linear density for two SL and two AFC media. Significant differences between the two media can be seen. The SNR of SL media decreased linearly with increasing linear density, dropping below zero dB at around 1450 kfci. The SNR of AFC media was much less sensitive to linear density and although the SNR was lower at 635 kfci, for linear densities exceeding 1200 kfci the AFC media had higher SNR. The AFC media had a small output signal at low linear density, about 1/7th that of the SL media at 635 kfci. However, the AFC output signal (and noise) were almost independent of linear density, whereas the SL media output signal decreased rapidly with linear density. Head output waveforms at 1693 kfci are shown in fig. 4. The waveforms are the average of five tracks, with the average output signals of the AFC and SL media indicated by the horizontal lines. The SL media output signal was about 1.7 times that of the AFC media, but the noise was much higher. Fluctuations in the AFC media waveform were much smaller than in the SL waveform, resulting in higher SNR for the AFC media.

Although the remanence of the AFC media was close to zero the read head was still able to detect a small signal from the written tracks. The higher M_s hard layer was nearest to the read head and spacing loss reduced the contribution to the signal from the soft layer. By reducing the thickness of the AFC media it may be possible to introduce a second recording layer and this will be explored in the talk,

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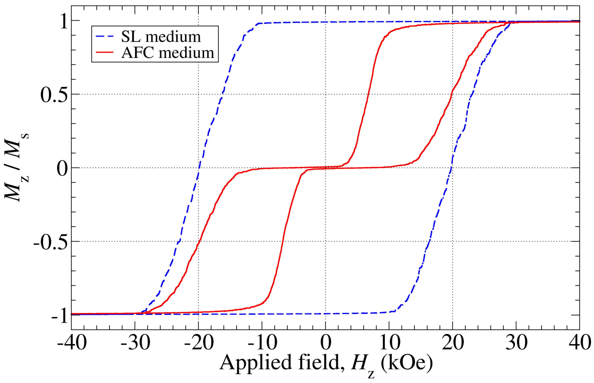

Fig. 1 Hysteresis loops of single layer (SL) and AFC media. K_u hard / SL = 8×10^6 erg/cm^3.

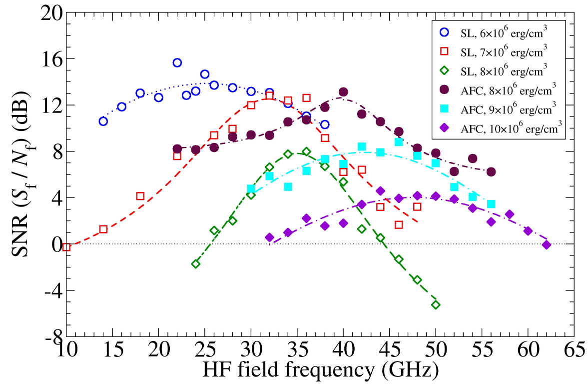

Fig. 2 SNR of 635 kfci tracks vs. HF field frequency and media K_u.

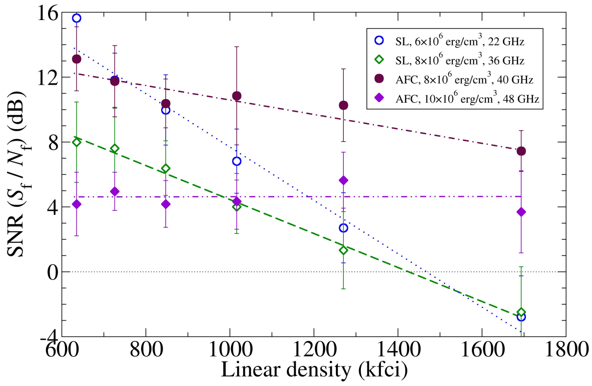

Fig. 3 SNR vs. linear density for SL and AFC media with various K_u.

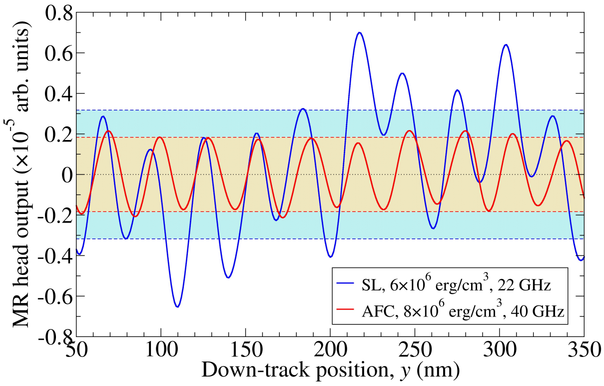

Fig. 4 MR head output signal for 1693 kfci tracks written on SL and AFC media.

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