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Feasibility of FePt Longitudinal Recording Media for Ultra High Density Magnetic Recording

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INTRODUCTION

Scaling areal density of magnetic recording media has driven reducing grain size of media to achieve acceptable SNR, as well as lowering Mrt (remanance×thickness) to adequately exploit highly sensitive GMR head by suppressing non-linear signal distortion such as hard transition shift, partial erasure and NLTS. This causes a serious concern about the thermal stability of Co alloy based media which faces looming superparamagnetic limit[1].

Chemically ordered $Fe_{1-x}Pt_x$ ($x \simeq 0.5$) with $L1_0$ (CuAu-I) structure possesses one of the highest K_u ($\simeq 10^8$ erg/cm^3), large thermal switching volume ($K_uV/kT \geq 100$), moderate magnetic moment and good corrosion resistance, thus, has been regarded as an attractive successor of Co alloy media[2]. Fully ordered FePt thin film treated at high enough temperature ($\geq 500°$C) exhibits H_c exceeding 10,000 Oe, thus may need to be spared for literally future recording media until a proper writer or new recording scheme, such as temperature assisted recording, are available. Alternatively, partially ordered FePt film processed at moderate temperature is of technological interest of current or in near future.

It is the primary objective of the present research to speculate from the basic magnetic and structural properties of partially ordered FePt thin film whether FePt media has a potential to be *a priori* over Co alloy media in the roadmap to 100 Gb/in^2. We particularly focus on ultra thin ($d \ll 10$ nm) film with extremely low Mrt ($\ll 0.3$ memu/cm^2) where the performance of Co alloy media is suspiciously challenged.

EXPERIMENTAL

$Fe_{1-x}Pt_x$ ($x \simeq 0.5$) thin films were fabricated by 6 inch DC magnetron sputter system on Corning 7059 glass substrate. Deposition was put forward at 50 W under the base pressure of 3×10^{-7} Torr or better and working Ar pressure of 1 mTorr. Films were deposited at 300°C, then annealed *in-situ* by a quartz lamp in vacuum (2×10^{-6} Torr) in a separated load-lock chamber at 375 $\sim$ 500°C for 1 hours. The composition of the film was characterized by Rutherford backscattering spectroscopy, which confirmed the excellent equiatomic stoichiometry.

High resolution X-ray diffractometer employing specular, rocking and assymetric scans were used to characterized the films. Magnetic properties were characterized by commercial vibrating sample magnetometer (VSM). Media noise characteristics of FePt media was characterized by Guzik RWA2550++/1701MP spin stand.

RESULTS AND DISCUSSION

Figure 1 displays H_c versus Mrt plots of ultra thin FePt thin films ($d = 4 \sim 6$ nm) as a function of annealing temperature. H_c and Mrt values attractive for current recording technology ($H_c = 3,000 \sim 4,000$ Oe, Mrt=0.3 ~ 0.4 memu/cm^2) can be obtained at 400 ~ 425°C, which can be accommodated for rapid thermal processing in current media manufacturing system.

The grain size media is the strongest determining factor of media noise characteristics. In this regards, FePt has an intrinsic advantage over Co alloy media, i.e., the grains of FePt film are inherently small due to its intermetallic compound nature. Typical grain size of our films at $d = 4 \sim 6$ nm is about 5 nm, and was not changed much from as-deposited film, which is an important advantage of partially ordered FePt thin film processed at relatively low temperature.

In contrast to Co alloy media whose grain boundaries are effectively "engineered" by additives (Ta, P, Nb) or by underlayers (Cr, CrV, CrTi), bare FePt is susceptible to intergranular exchange coupling induced transition noise. Nevertheless, we point out that the extremely small grains of FePt thin films, combined with high K_u, instabilize the large domain coalescence. Figure 2 shows the spectrum analysis of the output signal of FePt media (d=4 nm, H_c=3,600 Oe, Mrt=0.3 memu/cm^2) recorded at 63 MHz. Compared with commercial 3.2 Gbit/in^2 CoCrPtTa media (H_c=3,000 Oe and Mrt=0.47 memu/cm^2), the noise level of FePt media is certainly higher. However, the difference is not very significant, and moreover, the noise level of FePt media is largely affected by wide band low frequency noise from dc-erased track, which is due to large switching field distribution and insufficient erasing field from the writer. Tentatively, the transition noise of FePt may not be a critical problem.

[1] S. H. Charap, P.L. Lu and Y. He, *IEEE Trans. Magn.* **33**, 978 (1997)

[2] K. R. Coffey, M. A. Parker and J. K. Howard, *IEEE Trans. Magn.* **31** 2737 (1995)

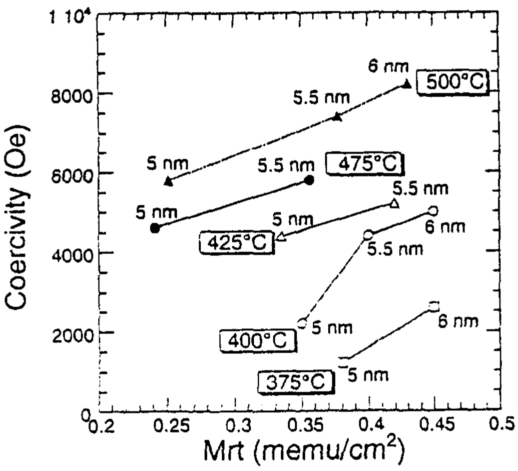

Fig.1 H_c versus Mrt curves of FePt.

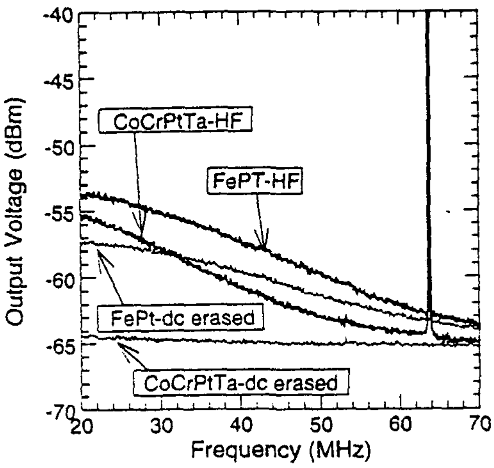

Fig.2 Spectrum analysis of media noise.