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Co-Ferrite Perpendicular Magnetic Recording Media Prepared By Spin-Spray Ferrite-Plating

F. Zhang, S. Kantake, Y. Kitamoto, and M. Abe

Department of Physical Electronics, Tokyo Institute of Technology, O-okayama, Meguro-Ku,

Tokyo 152-8552, Japan

Fax: 81-3-5734-2199, e-mail: fuchun@pe.titech.ac.jp

A read/write performance of Co ferrite perpendicular magnetic recording disks prepared by the ferrite-plating method was evaluated by using an inductive/MR head. The weak perpendicular magnetic anisotropy $(M_r/M_s)_\perp$ was considered that affected reproduced waveform. By changing concentration of a reaction solution and an oxidizing one, the content of Fe_3O_4 existed in Co ferrite films that prepared by this method decreased. This made $(M_r/M_s)_\perp$ raised effectively, and the shape of reproduced waveform got near to di-pulses, which are typical in the perpendicular recording.

Key word: ferrite-plating, Co-ferrite films, perpendicular recording media

1. INTRODUCTION

Ferrite thin film recording media have a good potential because of their low noise level [1] and large coercivity, as well as their high corrosion resistance and good mechanical durability. Conventionally, ferrite films are prepared by physical vapor deposition methods, in which high temperature above 300°C and high vacuum are necessary for the ferrite deposition. The spin-spray ferrite-plating method invented by M. Abe and Y. Tamaura [2] enables us to fabricate crystalline spinel ferrite thin films from an aqueous solution at low temperature below 100°C. The (Fe, $M)_3O_4$ films contain various transition metals, M= Ni, Zn, Co, Mn, Cr, etc.. In a previous study, we prepared Co-ferrite films with perpendicular magnetic anisotropy by this method [3]. Hysteresis loops of the Co ferrite films were similar to Co-Cr alloy films, such as perpendicular coercivity $H_{c\perp}$ above 2 kOe and saturation magnetization M_s of 400~550 emu/cc. Thus, we prepared Co ferrite perpendicular magnetic recording disks, and tried to record and reproduce by an inductive/MR (Magnetic Resistance) head. But the reproduced waveform was not ideal. In this study the method to improve the reproduced waveform will be introduced.

2. EXPERIMENTAL

Spin-spray ferrite-plating apparatus is shown in Fig.1. Co ferrite films were prepared on 2.2" glass disks, which were kept at 90°C and rotated at 150 rpm. The reaction solution (containing metal ions of Fe^{2+} and Co^{2+}) and the oxidizing solution ($NaNO_2$ and CH_3COONH_4) were sprayed simultaneously through separate nozzles onto the spinning table, at the flow rate of 60 ml/min. The mole ratio of Fe^{2+} ions and Co^{2+} ones in the reaction solution was 2:1 to obtain the maximum value of $H_{c\perp}$[3]. Thickness of the films that estimated by a scanning electron microscope (SEM) was about 100 nm.

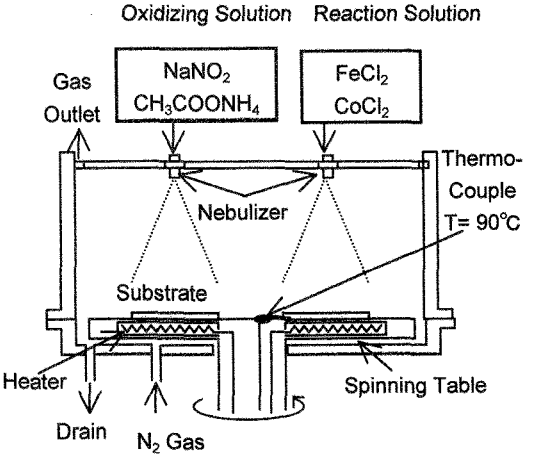

Fig.1 Apparatus of spin-spray ferrite plating

Magnetic properties of the films were evaluated using a vibrating sample magnetometer (VSM). The recording characteristics were evaluated using an inductive/MR head. Parameters of the head are listed in Table I.

Table I Inductive/MR head parameters.

Magnetic pole width	2.0 μm
Gap length	0.3 μm
Track width	1.7 μm
Shield gap length	0.2 μm

3. Results and Discussion

The concentration of the reaction solution of medium A which we prepared first is C_{FeCl2} = 7.5 m mol/l and C_{CoCl2} = 3.75 m mol/l. The oxidizing one is C_{NaNO2} = 7.2 m mol/l and $C_{CH3COONH4}$ =65 m mol/l.

Figure 2 shows the dependence of normalized reproduced output on recording density of medium A (M_S = 550 emu/cc, $(M_r/M_S)_\perp$ = 0.53 (Mr: residual magnetization), $H_{c\perp}$=2.7 kOe). D_{50} (the density at which the envelop of reproduced voltage shows half value) is about 60 kFCI.

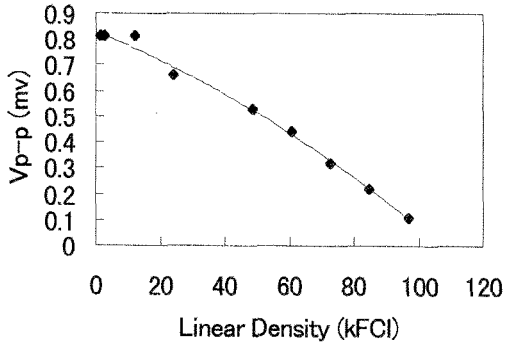

Fig.2 Dependence of normalized output on recording density of medium

Figure 3 shows the waveform of medium A at 2.2 kFCI. At the trailing edge of plus pulse and minus pulse, the waveform got a steep concavity and convexity, respectively. The waveform is closer to single pulses than to di-pulses, which are typical in perpendicular magnetic recording. That was caused mainly by weak perpendicular anisotropy, which is characterized by squareness ratio $(M_r/M_S)_\perp$, being 0.53 in medium A.

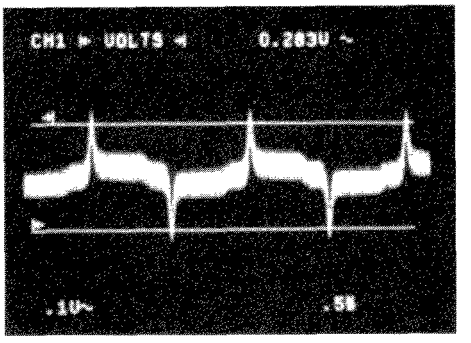

Fig.3 Reproduced waveform of Co ferrite medium A.

Co ferrite film prepared by this ferrite-plating method is composed of $CoFe_2O_4$, Fe_3O_4 ($Fe^{2+}Fe^{3+}{}_2O_4$) and γFe_2O_3. The saturation magnetization M_S of each component is 392 emu/cc, 471 emu/cc and 417 emu/cc, respectively. Fe_3O_4 has the highest M_S and strong in-plane magnetic anisotropy. We considered this strong in-plane magnetic anisotropy of Fe_3O_4 was a factor that had weakened the perpendicular magnetic anisotropy of the film. So it is effective to reduce the content of Fe_3O_4 to increase $(M_r/M_S)_\perp$ by accelerating the oxidizing reaction of Fe^{2+} ions to Fe^{3+} ones.

Consequentially, we prepared medium B by keeping C_{NaNO2} = 7.2 m mol/l and decreasing others to half of medium A. As a result, M_S decreased from 550 emu/cc (medium A) to 420 emu/cc (medium B), and $(M_r/M_S)_\perp$ increased from 0.53 (medium A) to 0.6. Figure 4 shows the reproduced waveform of medium B, at 2.2 kFCI. The baseline of pulse rose, and in the trailing edge the lower pulse appeared. The waveform shows the sign of di-pulses. These results indicate that optimizing the solution conditions increases perpendicular anisotropy, resulting in the improvements in the recording performance.

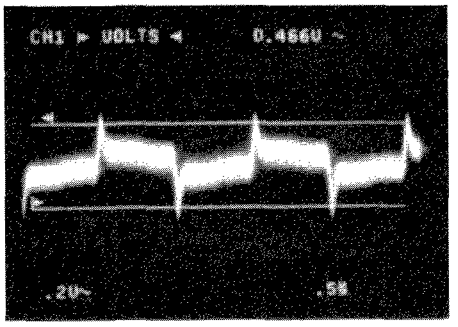

Fig.4 Reproduced waveform of Co ferrite medium B.

4. CONCLUSIONS

The influence of perpendicular magnetic anisotropy to reproduced waveform of Co ferrite perpendicular magnetic recording media prepared by spin-spray ferrite plating method have been studied. By increasing the concentration ratio of the oxidizing solution to that of the reaction solution, the oxidizing reaction of Fe^{2+} ions to Fe^{3+} ones was enhanced, the content of Fe_3O_4 decreased. As a result, perpendicular magnetic anisotropy was enhanced, the reproduced waveform became close to di-pulses, which are typical in perpendicular recording.

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