

Effect of Zn Ferrite Underlayers on Magnetic Properties and Recording Characteristics for Co-Ni Ferrite Media

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

Department of Physical Electronics, Tokyo Institute of Technology,

O-okayama, Meguro-ku, Tokyo 152-8552, Japan

Fax: 81-3-5734-2906, e-mail: fuchun@pe.titech.ac.jp

Effects of Zn ferrite underlayers on the magnetic properties of Co-Ni ferrite perpendicular magnetic recording media prepared by spin-spray ferrite-plating method is described. Though a thinner recording layer for a Co-Ni perpendicular magnetic recording medium is required to reduce medium noise level, perpendicular anisotropy of the Co-Ni ferrite films deteriorated with decreasing the film thickness $t_{\text{Co-Ni}}$, due to worse crystallinity in the initial growth zone. To improve the crystallinity of the Co-Ni ferrite films, Zn ferrite layers with M_s about 40 emu/cc and thickness t_{Zn} in the range of 25~100nm were prepared as underlayers. Consequently, perpendicular coercivity $H_{c\perp}$ of the Co-Ni ferrite films increased with increasing t_{Zn} , and reached 3800 Oe even for the 50 nm-thick Co-Ni ferrite layer on the 100 nm-thick Zn ferrite underlayer. The reproduced waveform exhibited di-pulses, which are typical in perpendicular magnetic recording.

Key words: ferrite-plating, perpendicular magnetic recording, double-layer, Co-Ni ferrite

1. Introduction

Spin-spray ferrite-plating method enables us to fabricate crystalline ferrite thin films of spinel structure from aqueous solution below 100°C [1]. Co ferrite thin films prepared by this method exhibited excellent perpendicular anisotropy [2]. Read/write characteristics of Co ferrite perpendicular magnetic recording media has been investigated by an inductive/MR head. Single to noise ratio (SNR), an important parameter for high-density magnetic recording, decreased with increasing the film thickness. Though thinner films are required to increase SNR, perpendicular coercivity and remanence ratio deteriorated with decreasing film thickness, due to worse crystallinity of initial growth zone in the film. Co-Ni ferrite medium of 50 nm in thickness exhibited a single pulse reproduced waveform, as observed in longitudinal recording.

We introduced Zn ferrite underlayers to improve the crystallinity and the perpendicular magnetic properties of Co-Ni ferrite recording layers. The same spinel structure and lattice parameter between the Co-Ni ferrite recording layer and the Zn ferrite underlayer confirm us that the introduction of Zn ferrite underlayer will improve the crystallinity of the initial growth zone in the Co-Ni ferrite recording layer. The present study describes the effect of Zn ferrite underlayers on the improvement of magnetic properties of Co-Ni recording films.

2. EXPERIMENTAL

The spin-spray ferrite-plating apparatus is shown in Fig. 1. Both CoNi ferrite single layers and CoNi ferrite/Zn ferrite double layers were prepared on Corning 7059 glass substrates (and/or 2.5" glass disks)

at 90°C on a spinning table at 150 rpm. A reaction solution ($\text{FeCl}_2 + \text{CoCl}_2 + \text{NiCl}_2$ for Co-Ni ferrite layers and $\text{FeCl}_2 + \text{ZnCl}_2$ for Zn ferrite layers) and an oxidizing solution ($\text{CH}_3\text{COONH}_4 + \text{NaNO}_2$) were sprayed simultaneously through separate nozzles onto the spinning table at a flow rate of $85 \text{ cm}^3/\text{min}$. Between the deposition of Zn ferrite underlayer and Co-Ni recording layer, distilled water was sprayed for 20 second to prevent the formation of Co-Ni-Zn ferrite layer with low coercivity.

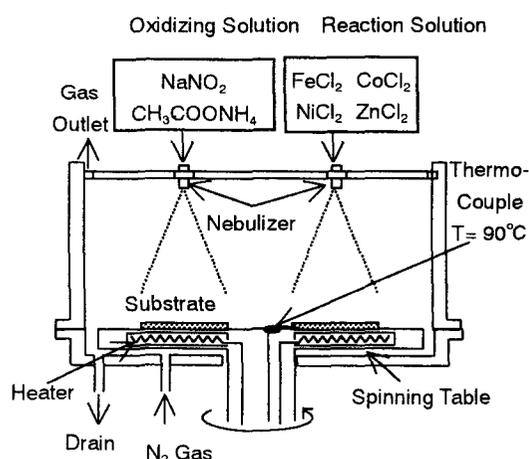


Fig. 1. Apparatus for spin-spray ferrite-plating

Solution conditions are listed in Table I. Addition of Ni^{2+} ions is to decrease the surface roughness of Co-Ni ferrite recording layer [3]. Ion mole ratio of Ni:Co in reaction solution was 1:9.

Table I. Solution conditions to prepare Co-Ni and Zn ferrite films

		Chemicals	Concentration (mol/m^3)
Co-Ni Ferrite	Reaction Solution	FeCl_2	3.78
		CoCl_2	1.70
		NiCl_2	0.19
	Oxidizing Solution	NaNO_2	1.45
		$\text{CH}_3\text{COONH}_4$	32.5
Zn Ferrite	Reaction Solution	FeCl_2	15.1
		ZnCl_2	1.47
	Oxidizing Solution	NaNO_2	7.2
		$\text{CH}_3\text{COONH}_4$	65

Thickness of the films was estimated by a scanning electron microscope (SEM). Magnetic properties of the films were evaluated using a vibrating sample magnetometer (VSM). A flying height of the inductive/MR head with a write track width $2.0 \mu\text{m}$ and a read track width $1.7 \mu\text{m}$ was 40 nm.

3. Results and Discussion

The dependence of perpendicular magnetic properties (perpendicular coercivity and remanence ratio) of Co-Ni ferrite magnetic recording films on film thickness $t_{\text{Co-Ni}}$ is shown in Fig. 2. With decreasing $t_{\text{Co-Ni}}$, perpendicular coercivity and remanence ratio decreased, especially in the case of $t_{\text{Co-Ni}}$ below 50 nm. This is thought to be caused by the existence of initial growth zone with worse crystallinity such as amorphous phase in the films.

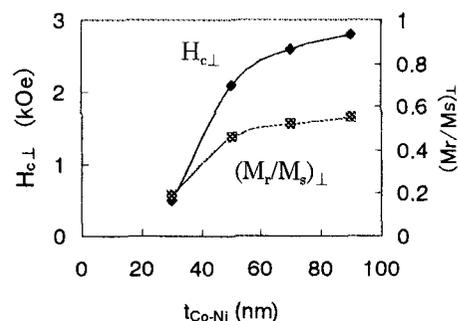


Fig. 2. Dependence of perpendicular anisotropy of Co-Ni ferrite films on the film thickness.

To suppress the formation of the initial growth zone in recording layer, Zn ferrite plated thin films were introduced as underlayers. Same spinel structure and lattice parameter will unite the two layers perfectly, and the crystallinity of Co-Ni ferrite recording layer is thought to be get better than growing on glass substrate. Moreover, because the Zn ferrite magnetic films have weak saturation magnetization about $40 \text{ emu}/\text{cc}$, degradation of magnetic properties in Co-Ni recording

films due to the magnetic interaction between the two layers can be disregarded.

Fig. 3 shows the increase of perpendicular anisotropy of Co-Ni ferrite films by introducing the Zn ferrite underlayers. The underlayer thickness was 100 nm. The perpendicular coercivity of Co-Ni ferrite recording films increased remarkably, for example, from 2000 Oe to 3500 Oe, in the case of $t_{\text{Co-Ni}}=50$ nm.

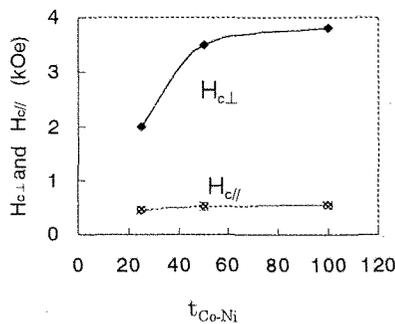


Fig.3 Dependence of coercivity on Co-Ni film thickness in double-layer films. Zn ferrite underlayer is 100 nm in thickness.

With increasing the thickness of Zn ferrite underlayer, the quality of the crystallinity of the surface in Zn ferrite underlayer was improved. Consequently, perpendicular coercivity of Co-Ni ferrite recording layer increased by the improvement of the crystallinity in the Co-Ni ferrite layers. This can be seen in Fig. 4. $t_{\text{Co-Ni}}$ was 50 nm.

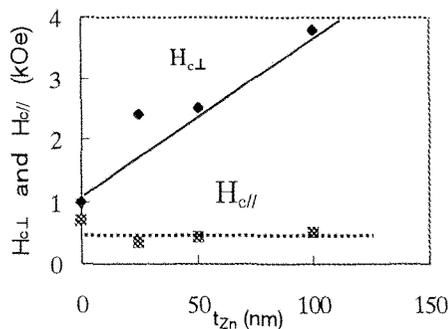
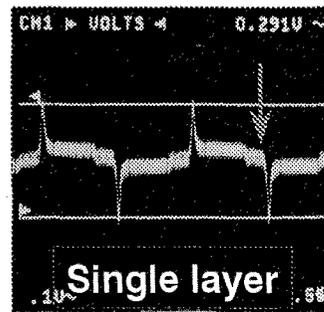


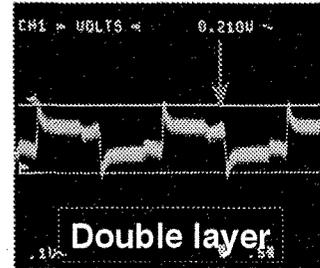
Fig. 4 Dependence of coercivity of Co-Ni recording layers on the thickness of Zn ferrite underlayers.

The enhancement of perpendicular coercivity by

introducing Zn ferrite underlayers also improved read/write performance. Fig. 5 shows the reproduced waveforms of Co-Ni ferrite single-layer and Co-Ni ferrite/Zn ferrite double-layer media. Co-Ni ferrite recording layers of both media were 50 nm in thickness, and Zn ferrite underlayer was 100 nm. In the case of single-layer, due to the weak perpendicular anisotropy, the reproduced waveform exhibited single-pluses. While, the double-layer one exhibited di-pluses, that are typical in perpendicular magnetic recording media



(a)



(b)

Fig. 5 Reproduced waveforms of CoNi ferrite single-layer medium and CoNi/Zn ferrite double-layer medium. Thickness of recording layer and underlayer is 50nm and 100nm, respectively.

4. CONCLUSION

Co-Ni ferrite/Zn ferrite double-layers were prepared by spin-spray ferrite-plating method. By introducing Zn ferrite underlayers, degradation of perpendicular anisotropy caused by worse crystallinity of initial growth zone in thinner Co-Ni ferrite films was

impressed. $H_{c\perp}$ increased with increasing the underlayer thickness, even got to 3500 Oe at $t_{zn}=100$ nm. In contrast with the single-pulse reproduced waveform exhibited by Co-Ni single-layer medium, the double-layer one showed the sign of di-pluses, in spite of same recording film thickness, being 50 nm.

ACKNOWLEDGEMENTS

This study has been financially supported by the "Research for the Future" program, #JSPS-RFTF96R06901, from the Japan Society for the Promotion of Science.

REFERENCES

- [1] M. Abe and Y. Tamaura, *Jpn. J. Appl. Phys.*, **22** (1983). 511-514.
- [2] Y. Kitamoto, S. Kantake and M. Abe, *J. Magn. Soc. Jpn.*, **21** [S2] (1997). 81-84.
- [3] F. Zhang, Y. Kitamoto and M. Abe, *J. Jpn. Soc. Powd. Metallurgy*, **47**, No. 2 (2000). 171-174.

(Received February 15, 2000; Accepted May 27, 2000)