INTERMAG99 @Kyongju,Korea, May 18-21, 1999 (to be presented)

Preparation Method of Co-γ Fe_2O_3/NiO Thin Film Media Using ECR Plasma Oxidization

S. YAMAMOTO, T. SANTOKI, H. KURISU, M. MATSUURA,
J. KOUJIMA*, K. NAKATA*, Y. KAKIHARA*, T. DOI*, K. TAMARI*
Yamaguchi University, Ube 755-8611 JAPAN
*Toda Kogyo Corporation, Ootake, Hiroshima 739-0652 JAPAN

Introduction

We have already reported that a Co-γ Fe_2O_3 thin film deposited on a highly oriented NiO underlayer is one of the very promising candidates of ultra-high density recording media[1-3]. The merits of the Co-γ Fe_2O_3/NiO media are : (a) easy preparation using reactive sputtering and oxidization at process temperature lower than 350℃, (b) anisotropy energy as large as $1\text{-}3\times10^6$ erg/cm^3 and high coercivity which is extendable to 8kOe, (c) superior hardness tolerable for contact recording without overcoat layer, and (d) adaptability to both perpendicular and longitudinal recordings by changing orientation of the NiO underlayer.

In this paper, high speed and low temperature preparation method of Co-γ Fe_2O_3/NiO thin film recording disks is described.

Experiments

In the conventional preparation process of Co-γ Fe_2O_3/NiO thin film, at first, a CoO-Fe_3O_4 film was reactive sputter deposited on a NiO underlayer using CoFe metal target in an argon and oxygen mixture gas. The coercivity of the CoO-Fe_3O_4 film was lower than only 1000 Oe. The CoO-Fe_3O_4 film was heated up to around 300℃ and maintained for 0.5-2 hours in air to oxidized and transform to the Co-γ Fe_2O_3 film with high coercivity.

In this study, new oxidization method using oxygen ions in a plasma was introduced in the oxidization process from CoO-Fe_3O_4 film to a Co-γ Fe_2O_3 film. To perform this experiment, an electron cyclotron resonance (ECR) microwave plasma was used because ECR can generates highly active and dense plasma useful in oxidization. As a process gas, oxygen and helium mixture gas was used to promote the ionization of oxygen using Penning effect of metastable helium atoms. Total gas pressure was set to 3×10^{-4} Torr. Microwave frequency was 2.45GHz, and magnetic field strength was 875Gauss to satisfy ECR condition. Oxygen ions produced in ECR plasma generation chamber were extracted through the mesh electrode to which negative voltage of -150V was applied and irradiated to the CoO-Fe_3O_4/NiO thin film samples. Neutralizer was used to prevent charging up of the CoO-Fe_3O_4/NiO thin film samples during oxygen ions irradiation.

Results and discussions

The coercivity of irradiated samples was increased with increasing helium partial pressure because generation of ionization of oxygen was promoted. The maximum coercivity was obtained when the helium partial gas pressure was set at

1. Correspond to:
Dr. Setsuo YAMAMOTO
Faculty of Engineering, Yamaguchi University
2557 Tokiwadai, Ube city, Yamaguchi prefecture 755-8611, JAPAN
Phone: +81-836-35-9486
FAX: +81-836-35-9486
E-mail: yamamoto@po.cc.yamaguchi-u.ac.jp
2. Preferred Subject: 3. Magnetic Recording: Media, perpendicular
3. Poster presentation

50% of the total gas pressure. It was confirmed that the neutralizer increased the coercivity by 200-300 Oe by preventing static electricity of samples.

Figure 1 shows the relationships of coercivity and irradiation time of oxygen ions. The coercivity was increased from 300 Oe and exceeded 2000 Oe at the irradiation time of only 10 seconds even at the temperature as low as 150℃. No change in magnetic characteristics was observed for four month passed samples after plasma oxidization.

Figure 2 shows roll-off curves for Co-γ Fe_2O_3/NiO thin film hard disks prepared by using ECR plasma oxidization method and oxidization in air. The thickness of Co-γ Fe_2O_3 layer was 50nm, and perpendicular coercivity was 1900 Oe. The recording characteristics was measured with TFH/MR merged head. Almost same roll-off curves were obtained between these two disks.

Summary

Remarkably effective oxidization method using ECR oxygen plasma was proposed to prepare the Co-γ Fe_2O_3/NiO thin film media. This plasma oxidization method shortened the oxidization processing time to 10 seconds which is 1/100-1/700 of conventional method and lowered the process temperature to 150℃.

References

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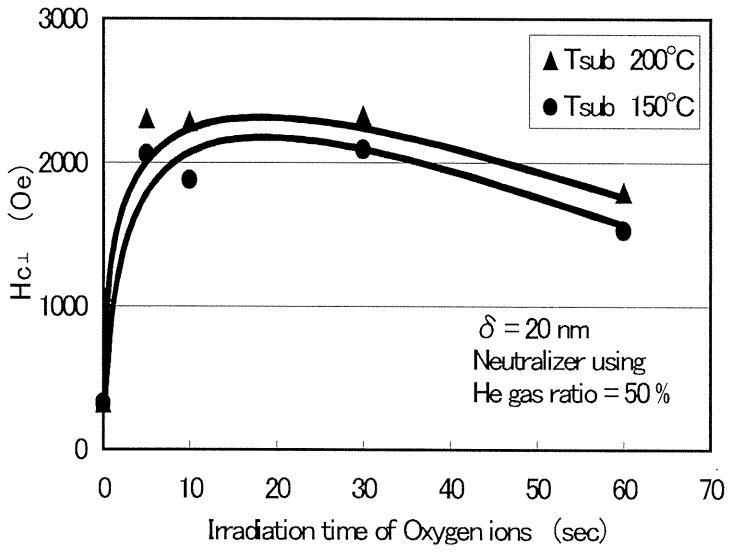

Fig.1 Perpendicular coercivity versus irradiation time of oxygen ions.

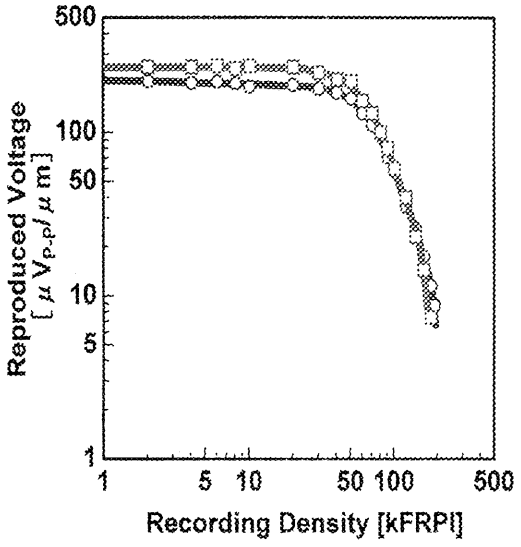

Fig.2 Roll-off curves for Co-γ Fe_2O_3 disks prepared by ECR plasma oxidization (□) and oxidization in air (○).