EFFECT OF Al UNDERLAYER ON THE MICROSTRUCTURES OF CoCrTa/Cr FILMS

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Abstract —— Thin CoCrTa/Cr films were deposited on glass substrates at 280℃ with or without Al underlayer. The coercivity of CoCrTa increased considerably by introducing an Al underlayer. The grain size of Cr thin film deposited on Al underlayer became smaller than that of Cr thin film deposited on glass substrate. The grain size of CoCrTa thin film was determined by Cr grain size. The cause of the coercivity increase seems to be associated with the refinement and uniform distribution of CoCrTa grains.

I. INTRODUCTION

The most important issue in a rigid disk type magnetic recording medium is to increase recording density. To meet low flying requirements for glass substrate, sputter texturing methods have been developed [1]. Many different sputter texture underlayer materials for longitudinal media, such as Al, In and Ga have been studied in the view of tribological performance [2]. However, the effects of underlayer on the magnetic properties are not studied well. In the present work, we investigated the effect of Al underlayer which is used as micro-bump former on the magnetic properties and microstructures of CoCrTa/Cr thin films.

II. EXPERIMENTAL

The metal films were deposited by using a dc magnetron sputtering unit. The substrates used were 1.5cm×1.5cm squares of glass substrate. Co-13at%Cr-2at%Ta alloy target was used for depositing a magnetic layer and highly pure Al and Cr targets were used. The base pressure was 6×10^{-7} torr and the sputtering pressure was 10 mtorr. The magnetic properties were measured by a vibrating sample magnetometer (VSM). The surface morphologies and microstructures were studied by atomic force microscopy (AFM) and transmission electron microscopy (TEM), respectively.

III. RESULTS AND DISCUSSIONS

Fig.1 shows the variation of the coercivity with substrate temperature in CoCrTa/Cr/Al and CoCrTa/Cr films. The coercivities of both films were almost the same when the substrate temperature was lower than 100℃. At the higher substrate temperature than 100℃, however, the coercivity of CoCrTa/Cr films formed on Al bumps shows higher value than that of the CoCrTa/Cr films without Al bumps and the increase is around 300 Oe at 280℃.

Fig.2 is the coercivity changes of CoCrTa/Cr/Al thin films with increasing Cr intermediate layer. The coercivity of CoCrTa was increased with increasing Cr intermediate

layer and showed maximum value at 700 Å Cr thickness. Further increasing Cr layer thickness decreased the coercivity of CoCrTa/Cr/Al thin films.

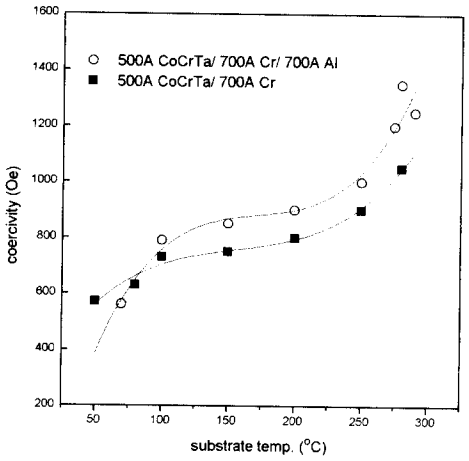

Fig.1 Coercivity of CoCrTa/Cr with or without Al bumps as a function of substrate temperature

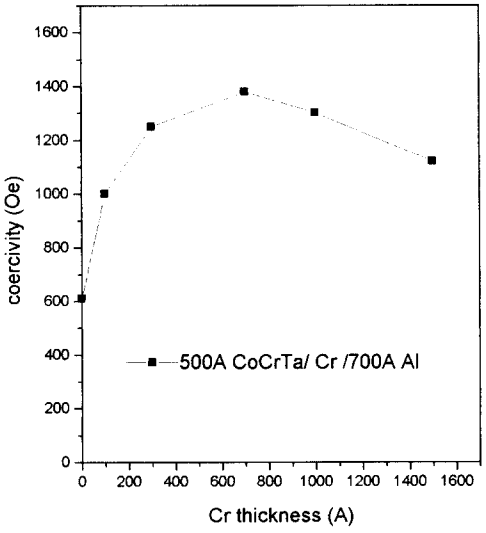

Fig.2 Coercivity changes of CoCrTa/Cr/Al thin films with increasing Cr thickness

To examine the mechanism of the coercivity enhancement of the CoCrTa/Cr film with an Al layer at the higher temperatures, the microstructures were investigated by AFM and TEM..

Fig.3 is the AFM images of Cr thin film deposited on different substrate conditions. Fig.3 (a) shows surface image of Cr thin film deposited on glass substrate. Fig.3 (b) is the AFM image of Cr thin film deposited on Al/glass substrate. By comparing with (a) and (b), it is observed that the grain sizes of Cr deposited on Al/glass is smaller than those of Cr deposited on glass substrate. The average grain size of Cr on different substrate condition were summarized in table. I .

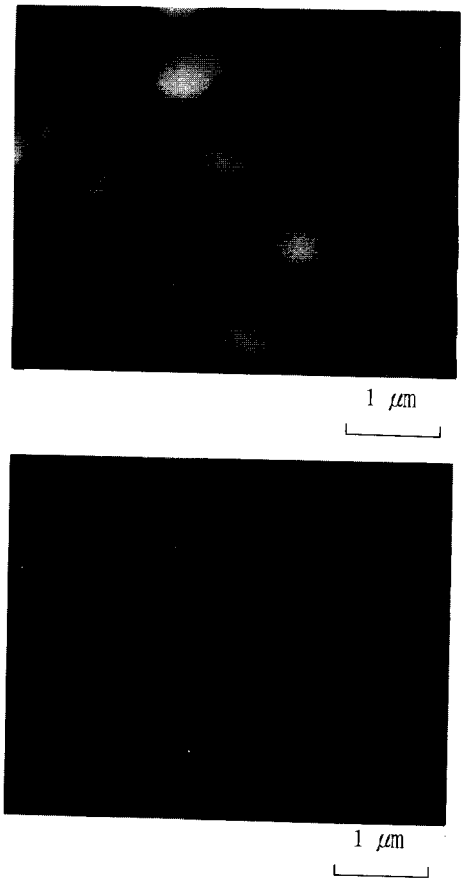

Fig.3 AFM images of Cr thin film deposited on different substrate conditions.
(a) Cr thin film on glass
(b) Cr thin film on Al/glass

Table. I. Average grain size (A) of Cr thin films. Ts=280℃

substrate	Cr grain size
glass	520
Al/glass	410

Fig.4 shows the planar view TEM images of CoCrTa thin films deposited on Cr/glass and Cr/Al/glass substrate. In CoCrTa/Cr thin films, CoCrTa grains are composed of a few large grains and many small grains. In the other hand, the grains of CoCrTa deposited on Cr/Al thin films were uniformly distributed than those of CoCrTa deposited on Cr thin film. As grain size is larger than that needed to form a single domain, magnetic domains can be formed in the grains. Therefore, the coercivity increase of CoCrTa/Cr/Al thin films can be explained by the uniform distribution of CoCrTa film with a smaller grain.

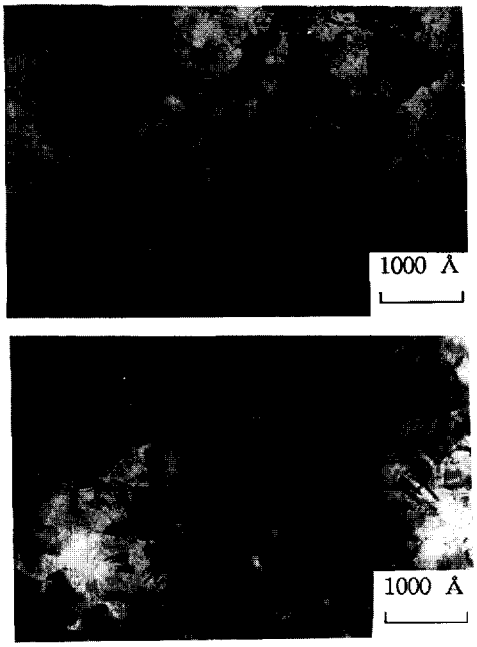

Fig.4 TEM images of CoCrTa thin film deposited on different substrate conditions
(a) CoCrTa thin film on Cr/glass
(b) CoCrTa thin film on Cr/Al/glass

From Fig. 3 and 4, it is observed that the grain size of CoCrTa was controlled by that of Cr underlayer due to grain-to-grain epitaxial growth between bcc Cr and hcp CoCrTa. To clarify the effect of Cr grain size on the CoCrTa grain size, the morphology of CoCrTa thin film deposited on Cr/Al/glass was observed by increasing Cr layer thickness (Fig.5).

The column size of Cr at the surface is strongly dependent on the thickness of the Cr layer. The column size of Cr thin film at the surface becomes larger by increasing film thickness resulting from the difference in grain growth rate among Cr grains. The grain size of a CoCrTa film increased from 350Å to 600Å with increasing Cr thickness. The coercivity of CoCrTa/Cr/Al thin films showed its maximum value at a grain size of 430Å. From this result, it was considered that transition from single domain to multi-domain occurred at a grain size of about 400 Å.

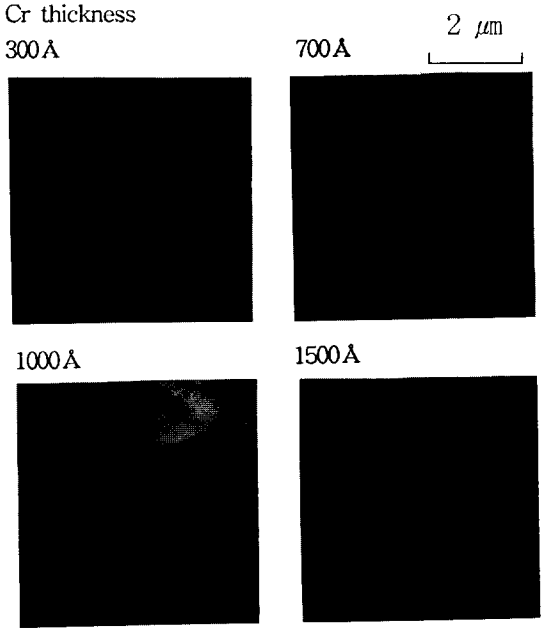

Fig.5 AFM surface images of 500Å CoCrTa/ Cr /700Å Al thin films with increasing Cr thickness

Ⅳ. CONCLUSION

The coercivity of CoCrTa/Cr thin films increased by introducing Al underlayer. Cr grain size on Al bump are smaller than that on glass substrates. CoCrTa grain size which is closely related to Cr grain size have small value when deposited on Cr/Al layers. The coercivity increase of CoCrTa/Cr/Al thin films may be associated with the uniform distribution of CoCrTa grains with a small size.

REFERENCES

[1] Mohammad Mirzamanni, Christopher V. Jahnes, and Michael A. Russak, " thin film disks with transient metal underlayers", IEEE Trans. Magn. vol. 28, pp 3090-3092, 1992

[2] Toshihiro Kokure, Yoshihiro Matsuno, Toshiya Itoh and Chiemi Shima, " Isotropic thin film texture for alternative substrates", IEEE Trans. Magn. vol. 30, pp 4116-4118, 1994