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FABRICATION OF Co-Cr PERPENDICULAR MAGNETIC RECORDING MEDIA BY ECR SPUTTERING

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Introduction

We have already proved that the sputtering deposition method using an electron cyclotron resonance microwave plasma (ECR sputtering) is more suitable for deposition of Co-Cr perpendicular magnetic recording media with large perpendicular magnetic anisotropy, high coercivity, fine magnetic structure, and no initial layer than conventional diode sputtering method because of its more precise controllability of ion bombardment [1-4]. In this study, we investigated the influence of magnetic field distribution in the ECR sputtering apparatus on magnetic structures and properties of the Co-Cr perpendicular media.

Experimental

In this study, beside a main coil which generated the 875G magnetic field , an auxiliary coil was installed around the deposition chamber as shown in figure 1. The magnetic field distribution in the deposition chamber could be changed from cusp magnetic field to mirror magnetic field by the electric current in the auxiliary coil. The composition of the sputtering target was Co79.5Cr20.5at%, and the substrate temperature during deposition was 170°C. The 0.1μm thick Co-Cr films were deposited on a polyimide film under the cusp, normal (auxiliary coil current = 0) and mirror magnetic field distribution.

Results and Discussion

Though the composition of the all deposited Co-Cr films measured by ICP-MS was Co79.5Cr20.5at% in spite of magnetic field distribution. The saturationmagnetization (Ms) drastically increased from 300 to 500 emu/cc when the magnetic field distribution is changed from mirror to cusp.

Figure 2 shows the NMR spectra of Co-Cr films. When magnetic field was changed from mirror to cusp, the 225.5MHz pure Co signal decreased, and the 177MHz and 130MHz satellite signals which correspond to Co nuclei with one or two Cr atoms in the nearest-neighbor sites, respectively, were increased [5]. This experimental result suggests that Co-rich and Cr-rich phase separation was enhanced in the Co-Cr films deposited in cusp magnetic field. Figure 3 shows the FE-SEM photograph of chemically etched microstructure of Co-Cr films. The white and dark regions correspond to Cr-rich and Co-rich regions, respectively. In mirror magnetic field deposition, grain size were as large as about 100nm in diameter, and separations between Co-rich and Cr-rich regions was obscure. However, in cusp magnetic field deposition, very fine size (~10nm) Co-rich regions were clearly observed.

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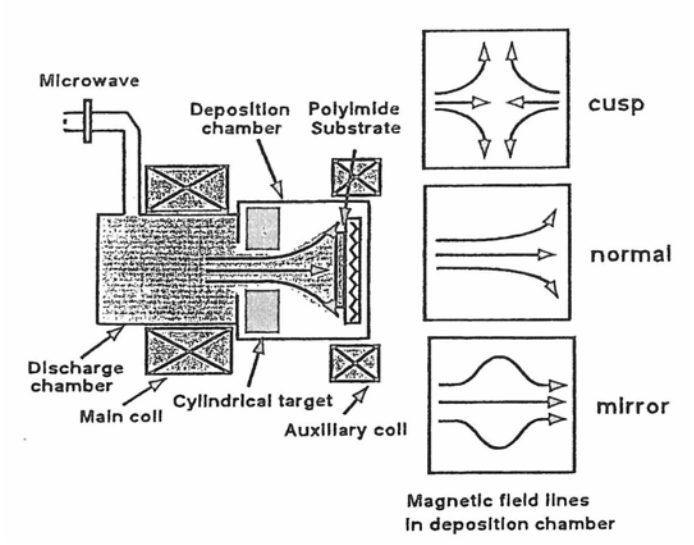

Fig.1 Schematic illustration of ECR sputtering apparatus with auxiliary coil.

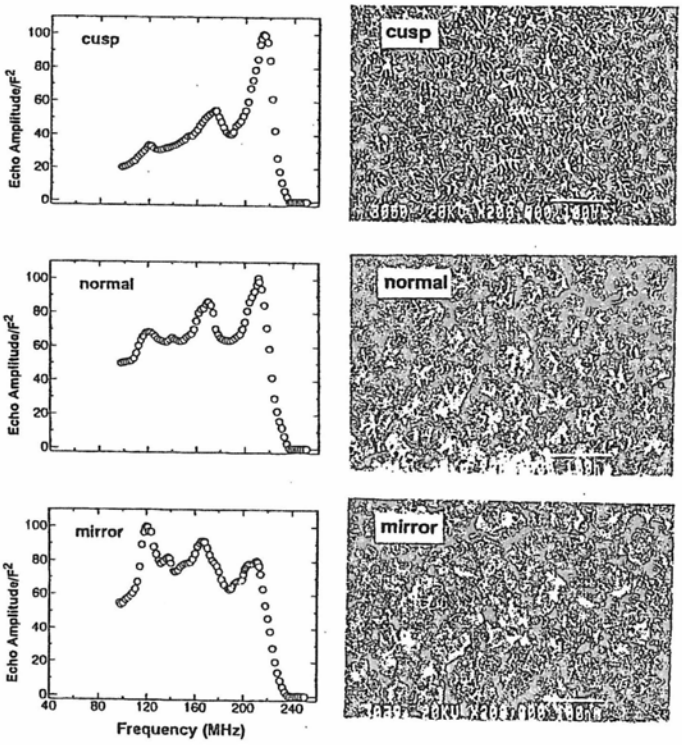

Fig.2 (left): NMR spectra of Co-Cr films
Fig.3 (right): FE-SEM photograph of chemically etched Co-Cr films.

From the plasma diagnosis using single-probe, it was found that ion accelerating voltage decreases when the magnetic field was changed from mirror to cusp. Hence, the low energy ion bombardment to substrate is essential to enhance the compositional separation in ten nm size in Co-Cr perpendicular magnetic recording media.

Conclusion

It was found that the compositional separation with nano-meter size is achieved in Co-Cr films when the cusp magnetic field distribution is realized. Such a fine magnetic structure is desirable for high density, low noise recording media.

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