# Structure Analysis of Co-based Alloy Thin Film Magnetic Media

The recording density of hard disk drives (HDD) used in personal computers is increasing by about 60% a year. The key components of HDDs are magnetic heads and magnetic recording media. A magnetic recording medium consists of layered thin films such as a Co-based alloy polycrystalline magnetic thin film on an Al or a glass substrate, and it is produced by a sputtering deposition system. With increasing recording density, the thickness of the magnetic film has decreased to about 10 nm.

The two most important factors for high density recording media are small grain size for small recording bits and excellent magnetic properties including high coercivity for thermal stability of small recording bits. Magnetic coercivity depends on the magnetic materials used, the strain in the magnetic layer and the preferred orientation of c-axes in Co micro-crystals [1,2]. Because the c-axis of a *hcp*-Co crystal is the easiest axis to magnetize, the preferred orientation of the c-axis to the surface plane is important in longitudinal magnetic recording media. The preferred c-axis orientation and the strain in the magnetic layer depend on both deposition conditions and layered structures including underlayers. Conventionally, CoCr alloy is used as the magnetic layer, and *bcc* -Cr or a Cr-based alloy is used as an underlayer. They are deposited on a heated substrate disk.

Grazing incidence X-ray diffraction, especially in-plane diffraction, by synchrotron radiation is useful for the crystallographic analysis of such thin films in recording media, because the highly brilliant X-rays of synchrotron radiation causes high sensitivity and high accuracy [1,2].

XAFS is also expected to be a useful method for the local structure analysis of Co atoms and additional atoms, because magnetic properties depend on the composition and atomic arrangement of the magnetic layer.

Recently we have studied a new type of recording media prepared with non-heating process. Figure 1 shows the layered structure. This type of medium has a CoPt alloy magnetic layer and an intermediate layer of Ru and shows high magnetic coercivity [3]. To clarify the role of the Ru intermediate layer, we investigated the crystallographic structure of each layer and the dependence of the structure on the deposition conditions and on Pt content of the magnetic layer [4]. We have also studied the local structure of Co atoms in the CoCrPt magnetic layer.

We conducted 2θ scan measurements of in-plane diffraction with an X-ray energy of 10 keV (λ = 0.124 nm) or 12.4 keV (λ = 0.1 nm) at beamline **BL16XU**. The grazing incidence angle was 0.25° or 0.2° in the total reflection condition. The incidence

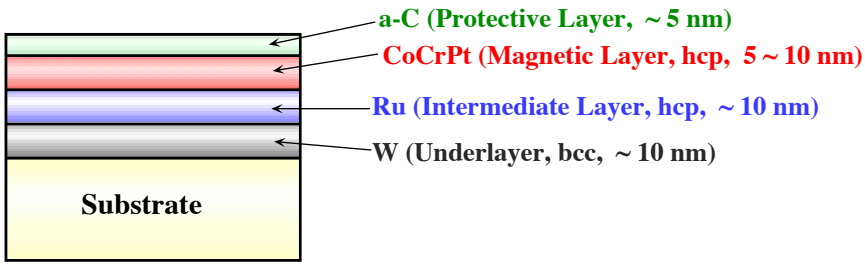


*Fig. 1. The layered structure of magnetic recording media prepared with the non-heating process.*

slit was 1 mm(V) × 0.1 mm(H).

Figures 2(a) and 2(b) show the in-plane 2θ scan diffraction profiles of magnetic layers and Ru layers respectively. Preferred in-plane c-axis orientation of *hcp* -Ru increases largely with a changing Ru deposition condition, from A to C, and that of *hcp* -Co in the magnetic layer also increases depending on the crystallographic orientation of Ru. The coercivity Hc also increases with the changing Ru deposition condition, from A to C, as a result of increasing preferred c-axis orientation of Co.

The Ru crystal has the same *hcp* structure as Co; but it has lattice constants several % larger than those of Co. Therefore, the Ru intermediate layer is considered to play an important role in controlling the preferred c-axis orientation of the CoPt alloy magnetic layer in the case of using non-heating process.

Figure 3 shows the in-plane 2θ scan diffraction profiles of three CoCrPt-alloy magnetic thin films with different Pt contents. With increasing Pt content, magnetic coercivity increases and the preferred in-plane c-axis orientation of Co crystals also increases suggesting a correlation between them. Diffraction peaks of Co also shift to lower diffraction angles with increasing Pt content, indicating that lattice spacing of Co crystals increases through CoPt alloying. This result suggests that the increase in preferred c-axis orientation is caused by a decrease in the lattice misfit between the CoCr alloy and Ru.

We also measured Co *K*-edge XAFS spectra of these three CoCrPt alloy magnetic films. XAFS measurements are performed in the fluorescence

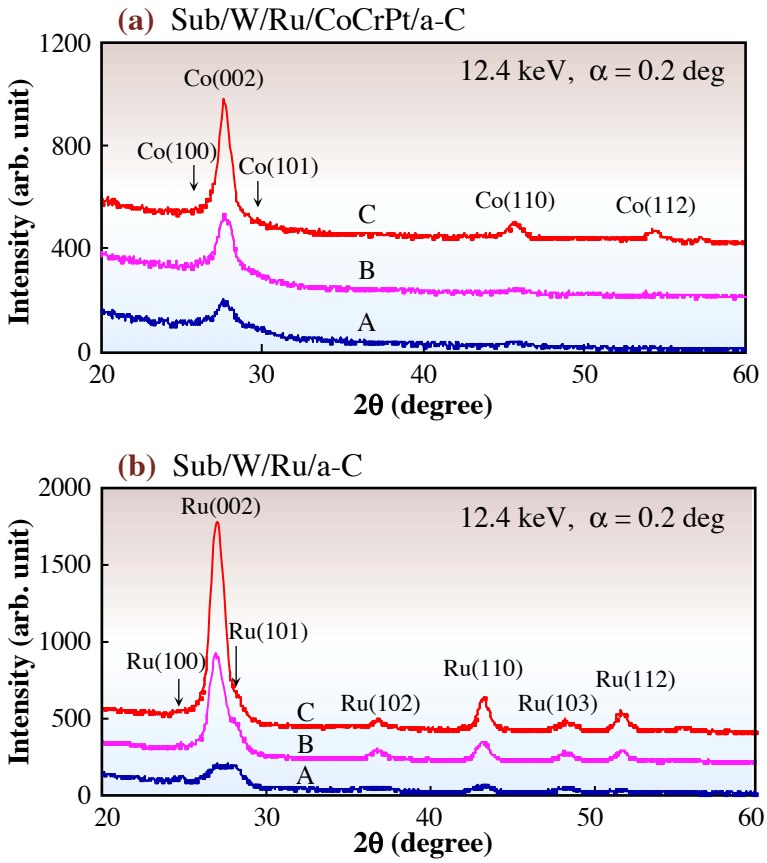


*Fig. 2. In-plane diffraction profiles of* ***(a)*** *CoCrPt magnetic layers and* ***(b)*** *Ru intermediate layers for the Ru deposition conditions, A, B, C, of magnetic media prepared with the non-heating process. Magnetic coercivity Hc are A: 2452Oe, B: 3671Oe, C: 3909Oe.*

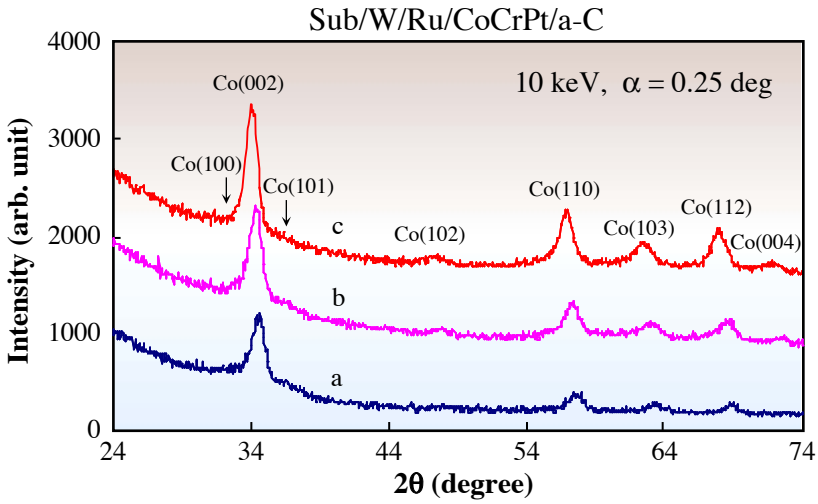


*Fig. 3. In-plane diffraction profiles of three CoCrPt magnetic films of magnetic media for Pt content. Pt content is **a**: low, **b**: middle, **c**: high. Magnetic coercivity increases with increasing Pt content. Magnetic coercivity Hc are A: 3567Oe, B: 4685Oe, C: 7052Oe.*

yield mode at beamline **BL16B2**.

XANES spectra of CoCrPt thin films are shown in Fig. 4. The intensity of the Co-Kα fluorescent X-ray decreases with increasing Pt content. The absorption at the *K*-edge is probably influenced by Pt. XANES spectral shapes of the three CoCrPt films are almost the same, suggesting that the electronic environments of Co atoms are almost the same.

We revealed that, in the new-type magnetic recording media with an Ru intermediate layer, the Ru intermediate layer plays an important role in controlling the preferred c-axis orientation of the CoPt alloy magnetic layer. Experimental results suggest that the increase in coercivity with increasing Pt content is caused, partly at least, by the decrease in the lattice misfit between the CoPt alloy and Ru.

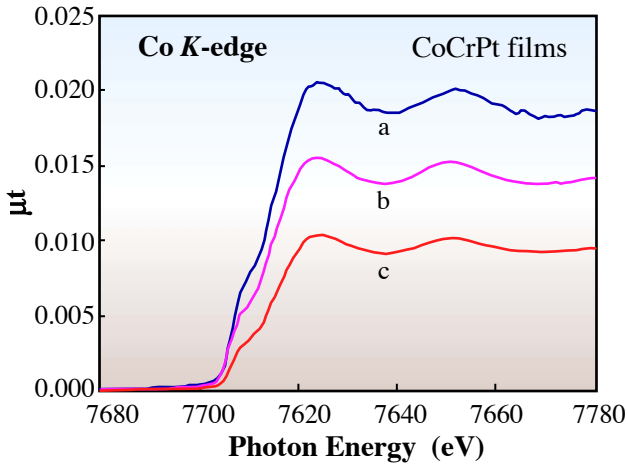


*Fig. 4. XANES spectra of three CoCrPt magnetic films of magnetic media for Pt content. Pt content is **a**: low, **b**: middle, **c**: high.*

Michio Ohsawa

Fuji Electric Corporate Research & Development Ltd.

E-mail: ohsawa-michio@fujielectric.co.jp

**References**

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