Large grain size of Cr seed layer deposited on CrTi amorphous layer for future high K_u FePt-C granular medium

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Introduction　Hard disk drive industry has been evolved through the increase of the areal density before the emergence of the trilemma. Thermally assisted magnetic recording has been introduced as one of the prospective technologies for future recording media by using the $L1_0$ ordered FePt with high magnetocrystalline anisotropy (K_u) of 7×10^7 erg/cc[1)]. In order to use the $L1_0$ ordered FePt as the recording media, it is necessary to fabricate the granular type such as FePt-C medium whose magnetic grains are completely separated each other by the C boundaries. However, it is reported that the reduction of the signal to noise ratio (SNR) arise from the magnetic anisotropy field variation, which is caused by the angular distribution of the (002) sheet texture in the FePt medium[2)]. Generally, the sheet texture of the crystalline film is known to be attributed to the epitaxial growth on crystalline underlayers. In this report, we proposed a new concept of the layered structure for reducing the angular distribution of sheet texture in FePt-C medium.

Concept of the layered structure　The concept is to realize a highly oriented sheet texture in seed layer by promoting Frank-van der Merwe growth mode (layer by layer growth)[3)]. According to the initial state of the sputtering process when the sputtered atoms adhere to the surface of the crystalline film in liquid state, growth mechanism is determined by the wettability of the atoms. If the wettability is large enough, the atoms maximize the contact surface on the film that tremendously induces the epitaxial growth. Consequently, formation of the layer by layer fashion on the crystalline film namely, large grain, leads to the highly oriented sheet texture. Figure 1 shows a schematic of the new concept of the layered structure. The structure is consists of the magnetic layer (ML)/barrier layer (BL)/seed layer (SL)/texture inducing layer (TIL). Main function of each layer is as follows: TIL as determining the grain size, SL as contributing the highly oriented (002) sheet texture, BF as preventing the atomic diffusion between ML and SL by using MgO, and ML as FePt-C magnetic recording medium with the highly (002) sheet texture. The main issue in here, is to find out suitable materials for TIL and SL. M. Mikami reported that the grain size of the recording medium is controlled by Ni-based amorphous layers under the oxygen process[4)], suggesting that the grain size of seed layer would be changed depending on the amorphous material. Since the Cr alloy material has small lattice misft, the material can be used as seed layer. Accordingly, both amorphous and Cr-alloy can be applied as TIL and SL. To obtain (002) texture of SL, it is necessary to change its surface energy. In addition Cr alloy material is widely used in FePt medium because of the small lattice misft with the MgO. To obtain (002) texture of SL, it is necessary to change its surface energy. Here, we tried to investigate the various samples. We applied substrate heating process to fabricate the large grain seed layer by using above TIL and SL materials.

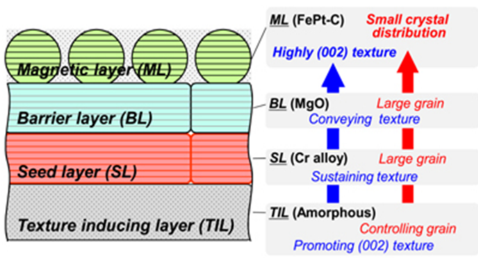

Fig. 1 Concept of the layered structure for reducing the (002) texture distribution of FePt-C medium.

Experimental results　In order to fabricate the large grain seed layer, one example structure, Cr (SL) and CrTi (TIL). Stacking structure is following Cr(10) / CrTi(50) / Sub. Figure 2 shows the grain diameter (GD) and integrated intensity of sheet texture for Cr seed layers (I_{002}) as a function of the substrate temperature (T_{sub}) represented as red circle and black square. Here, GD was evaluated from Scherrer equation with (110) diffraction appeared in-plane XRD. As shown in the graph GD increases from 8 to 12 nm as increasing T_{sub} from 200 to 475 °C, and then decreases 12 to 11.5 nm as further increasing T_{sub}. Similar tendency was observed in I_{002} graph. Increase of I_{002} from 10 to 80 cps as increasing T_{sub} from 200 to 520 °C, and then decreases 80 to 25 cps as further increasing T_{sub}. These results suggested that the I_{002} is affected by the grain size of seed layer. In summary, we demonstrated increase of the grain size of Cr seed layer deposited on CrTi amorphous layer under the heat treatment.

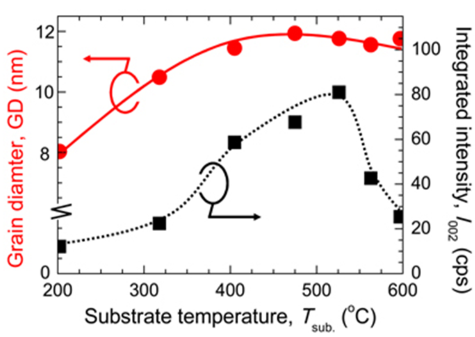

Fig. 2 Grain diameter (GD) and integrated intensity of sheet texture for Cr seed layers (I_{002}) with respect to the substrate temperature (T_{sub}).

Reference　1) Mark. H. Kryder *et al*., *Proceedings of the IEEE* **96**, 1810, (2008). 2) Hai Li *et al*., *J. Appl. Phys.* **115**, 17B744 (2014). 3) Seifert W *et al*., *Prog. Cryst. Growth Charact.* **33** 423 (1996). 4) M. Mikami et al., *IEEE Trans. Magn.* **39**, 2258 (2003).