Effect of amorphous Cr-Ti texture inducing layer on highly (002) textured large grain $Cr_{80}Mn_{20}$ seed layer for $L1_0$ ordered FePt-C granular film

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Introduction Heat-assisted magnetic recording media has attracted much attention for future hard disk drive owing to the high magnetocrystalline anisotropy of $L1_0$ ordered FePt ($K_u \sim 7\times10^7$ erg/cm^3) [1]. In order to improve signal to noise ratio, it is necessary to fabricate the medium in which the grains are magnetically isolated such as FePt-C based granular film. For large perpendicular anisotropy, controlling the *c*-axis (002) orientation of the FePt, corresponding to the magnetic easy axis, toward normal to the film is required. In general, the preferred crystal orientation of the FePt can be adjusted by means of hetero-epitaxial growth from (002) textured MgO underlayer. However, it is reported that the misalignment of the (002) grains normal to the film is caused by angular distribution of the MgO (002) orientation [2, 3]. Origin of the angular distribution is regarded due to the absence of the epitaxy growth of the MgO underlayer, which is directly deposited on an amorphous film. In this study, method to suppress the angular distribution is proposed by introducing a new concept of layered structure.

Concept of layered structure The proposed structure consists of the magnetic layer (ML)/under layer (UL)/seed layer (SL)/ texture-inducing layer with amorphous structure (*a*-TIL) as shown in Fig.1. Developing the SL with having the highly (002) texture-crystalline film, key idea of the concept, can be described when satisfying the high wettability of SL on *a*-TIL. The liquid phase of sputtered atoms of the SL tends to spread out on the *a*-TIL before solidification. Since the crystal terrace, evolved during solidification from liquid phase, possesses the largest surface area on the top surface compared to the other surfaces, the main contribution to the sheet texture evolution results from the top surface. And consequently, the large grain size with highly textured SL can be realized.

Typically, the condition of high wettability is defined as Young relation written below $\gamma_{SL} > \gamma_{in}+\gamma_{a\text{-TIL}}$ where γ_{SL} is surface energy of SL, γ_{in} is interfacial energy, and $\gamma_{a\text{-TIL}}$ is surface energy of *a*-TIL. Since there is still lack of information on γ_{in}, expectation for high wettability by using the interfacial energy is difficult. However, it can be rationalized by taking into account the quantitative value between γ_{SL} and $\gamma_{a\text{-TIL}}$. Accordingly, condition favorable for the high wettability can be a high value of $\gamma_{a\text{-TIL}}$ and a lower value γ_{SL}. Thus, we have investigated to enlarge the grain size of SL by changing the quantitative value of $\gamma_{a\text{-TIL}}$.

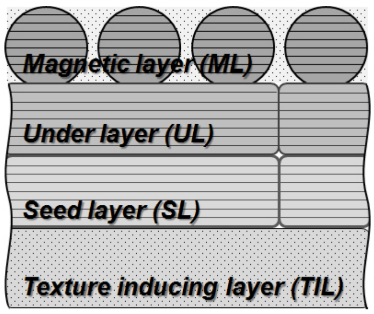

Fig. 1 Concept of layered structure for suppressing the (002) texture distribution of FePt-C medium.

Experimental results CrMn and Cr-Ti were introduced as the SL and *a*-TIL, respectively [5]. In order to enlarge the grain size of SL, two methods were presented. (1) High wettability; changing the compositions of Cr-Ti *a*-TIL owing to the higher γ_{Ti} (2.570 J/m^2) than γ_{Cr} (2.056 J/m^2) [5]. (2) Promoting the adatomic mobility of the SL; elevating the substrate temperature. The film structure used in this study consists of CrMn (30)/$Cr_{100-x}Ti_x$ (20)/$Ni_{60}Ta_{40}$(2)/glass substrate. Substrate temperature was elevated before CrMn deposition. The temperature varied from RT to 600 °C. Ti composition (x) in the $Cr_{100-x}Ti_x$ *a*-TIL varied from 0 to 100 at.%. Figure 2 shows the dependence of the full width of half maximum at CrMn (002) diffraction ($FWHM_{002}$) on the grain diameter (*GD*) of the CrMn SL with various fabrication conditions of Cr-Ti TIL. The $FWHM_{002}$, degree of the angular distribution, was evaluated by rocking curve profile (not shown in this abstract). The GD was estimated by Scherrer equation using CrMn (110) diffraction measured by in-plane XRD. As shown in the figure, the $FWHM_{002}$ decreases from 10.5 deg to 3.4 deg with increase of the *GD* from 11.4 nm to 15 nm. The result indicated that the remarkable progress in reducing the one-third value of the angular distribution was accomplished by increase of 3 nm of *GD*. It is expected that the epitaxy from CrMn, MgO to FePt-C can be improved by introducing Cr-Ti *a*-TIL.

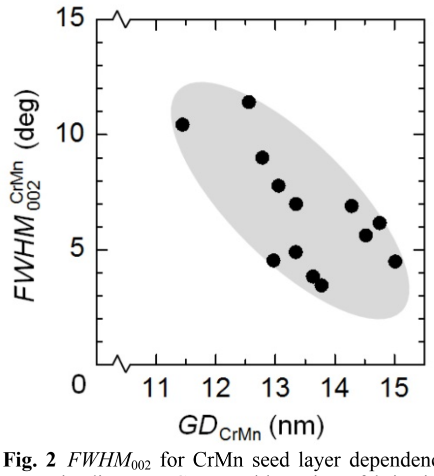

Fig. 2 $FWHM_{002}$ for CrMn seed layer dependence on grain diameter GD_{CrMn} with various fabrication conditions of Cr-Ti TIL.

Reference 1) M. H. Kryder *et al*., *Proceedings of the IEEE*, **96**, 1810 (2008). 2) S. Wicht *et al*., *J. Appl. Phys.*, **114**, 063906 (2013). 3) J. Wang *et al*., *Acta Mater*., **91**, 41 (2015). 4) S. J. Jeon *et al*., *J. Appl. Phys.*, **117**, 17A924 (2015). 5) L. Z. Mezzy *et al*., *Jpn. J. Appl. Phys*., **21**, 1596 (1982).