Proposal of Novel Cobalt-Palladium Media Controlled with C or Si Underlayer for Ultra High Density Magnetic Recording

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I. Introduction

Co/Pd multilayer films have attracted our attention to be applied for perpendicular magnetic recording [1] because of its high perpendicular magnetic anisotropy, resulting in suppression of the erasure of recorded information due to thermal fluctuation. However, one of critical issues of the Co/Pd multilayer perpendicular magnetic recording media is that they show high noise in read-write (R/W) characteristics due to their strong exchange interaction.

In this study, we have applied amorphous C or Si film as an underlayer of Co/Pd multilayer media. The effect of C and Si underlayers thicknesses on magnetic properties, R/W characteristics, and microstructures are investigated.

II. Experimental

Thin film media composed of [Co (0.2 nm)/Pd (0.8 nm)]$_{20}$/X(X=C, Si, and Pd) were prepared on a 2.5 inch diameter glass substrate by DC magnetron sputtering. The background pressure in sputtering system was kept below 2.0×10^{-7} Torr. Thicknesses of underlayers were varied from 5 to 120 nm. Magnetic properties were evaluated with a vibrating sample magnetometer (VSM). The magnetic anisotropy constant, K_u, was obtained with a torque magnetometer. The magnetization state were observed using a magnetic force microscopy (MFM). The R/W characteristics were investigated by using a merged MR head for recording (gap length g_w=0.28 μm) and reproducing (shield-to-shield gap length $g_{s\text{-}s}$ =0.2 μm) both.

III. Results and discussion

Figures 1(a) and 1(b) show effects of underlayers thicknesses on coercivity Hc and the value of α, which is defined as the derivative of the M-H loop at the value of coercively (=4π(dM/dH) $_{H=Hc}$) [2]. They were obtained from M-H loops measured in the direction perpendicular to the film surface. It was clearly observed that the coercivity value increased with increasing the underlayers thicknesses and that they showed a constant value or a slight decrement over 60 nm in thicknesses of underlayers. However, the value of α, which has been reported to have a close relationship with the strength of exchange interaction and the size of magnetic cluster, showed a constant value of 12 for the Pd underlayer, while that was decreased to as small as 2 with increasing the C and Si underlayers thicknesses. These experimental results indicate that the mechanism of increasing coercivity of the media with the C and Si underlayers is quite different from that of the media with the Pd underlayer, even though the increase in underlayers thicknesses, in any case, results in the increment of Hc as shown in Fig.1(a).

Figures 2(a) and 2(b) show the MFM images of the media without underlayer (a) and with 60 nm of C underlayer (b), respectively [3]. The samples were ac-demagnetized by using an electromagnet of VSM before the MFM observation. For fig.2(a), maze patterns consisted of large magnetic clusters are shown. On the other hand, the size of magnetic clusters remarkably decreased by increasing the C underlayer thickness, and relatively higher signal-to-noise (S/N) ratio was obtained for the medium with thicker carbon underlayer. From plane-view TEM observation, it was revealed that the medium exhibiting high Hc and high S/N ratio possessed fine crystalline grains of ~14 nm in average diameter.

Detailed analysis of microstructure, such as TEM observation after chemical etching, will be presented at the conference.

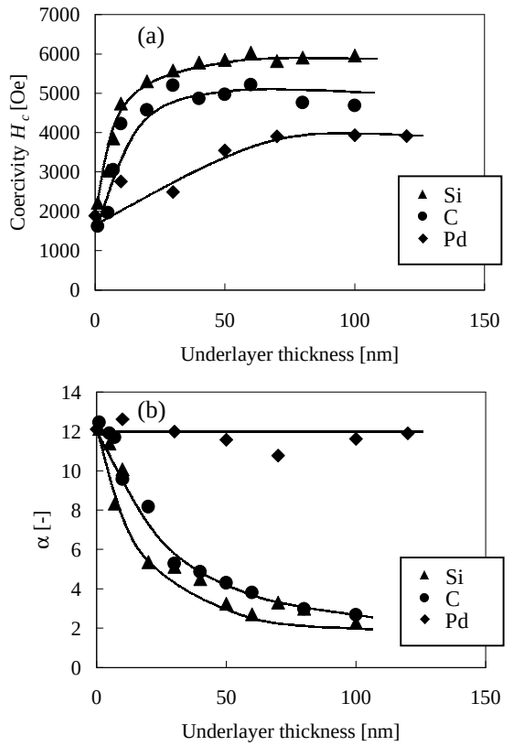

Fig.1 Dependence of (a) coercivity and (b) α on underlayer thickness.

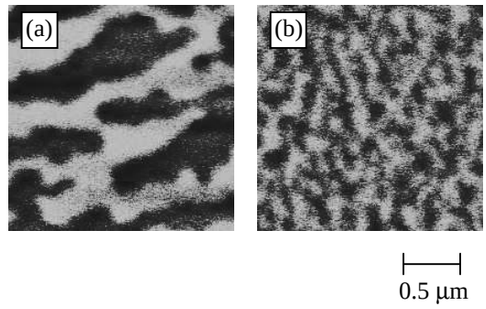

Fig.2 MFM images of the Co/Pd media (a) without and (b) with 60nm of carbon underlayer, respectively.

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References

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