Ru ALLOY-OXIDE BUFFER LAYER FOR INTERGRANULAR EXCHANGE DECOUPLING FOR CoPt-B_2O_3 GRANULAR MEDIA

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I. INTRODUCTION

CoPt-oxide granular media have been widely used for perpendicular magnetic recording. To further increase recording density of the media, reduction of media noise through the promotion of intergranular exchange decoupling is essential[1)]. Generally, to exchange decouple magnetic grains of the media, oxides with amorphous phase which do not dissolve into CoPt alloy have been employed as the grain boundary materials. The oxide is expected to segregate into the trench of Ru underlayer so that CoPt grains can grow heteroepitaxially on the bump of Ru underlayer. Previously, we had found that a granular medium with high magnetocrystalline anisotropy (K_u) was successfully realized when B_2O_3 was applied for the grain boundary material[2)]. However, the separation between magnetic grains at the initial growth region in the Ru trench by low melting point oxide such as B_2O_3 is not sufficient[3)]. Therefore, we have carried out an investigation on the deposition of a buffer layer (BL) with non-ferromagnetic metal and oxide on the Ru underlayer to grow the non-ferromagnetic metal and oxide on the Ru bump and trench, respectively, aiming to intergranular decouple the magnetic grains. In this paper, we will discuss about the effect of utilizing BL on the intergranular exchange decoupling in relation with magnetic properties.

II. RESULTS AND DISCUSSION

Samples structure used in this study: Sub./ Ta (5 nm)/ $Ni_{90}W_{10}$ (6 nm)/ Ru (0.6 Pa, 10 nm)/ Ru (8.0 Pa, 10 nm)/ BL/ $Co_{80}Pt_{20}$-30vol%B_2O_3 (4-16 nm)/ C (7 nm). $Ru_{50}Co_{25}Cr_{25}$-30vol%TiO_2 (0-3 nm) was used for the BL. Here for the BL, a non-ferromagnetic Ru alloy which consists of the metal element of underlayer (Ru) and granular media (Co) was adopted for the metal material to maintain hetero-epitaxial growth of CoPt alloy on Ru. While TiO_2 was chosen as a typical material used for the grain boundaries in the granular media.

Fig. 1 shows *m-H* loops for CoPt-B_2O_3 granular media (a) without and (b) with RuCoCr-TiO_2 BL (1 nm) at various media thicknesses. When a BL is introduced, larger coercivity (H_c) and smaller slope (α) at around H_c for each media thickness can be observed.

Fig. 2 shows dependence of H_c on the BL thickness (d_{BL}). When d_{BL} is increased from 0 to 1.5 nm, a large increase of H_c around 20%, from 7.5 to 9.0 kOe can be observed. Further increase of d_{BL} to 3.0 nm will decrease H_c from 9.0 to 8.7 kOe. This indicates that the employment of the BL is quite effective to increase H_c of the medium.

To find out the origin of H_c variation according to various BL thickness, anisotropy field (H_k), thermal stability and degree of intergranular exchange coupling were investigated. Here, thermal stability and degree of intergranular exchange coupling are determined from $v_{act}K_u^{grain}/kT$ and α, where v_{act} is the activation volume measured from time dependence of remanence coercivity[4)] and K_u^{grain} is evaluated from K_u of the granular media when 30vol% B_2O_3 is excluded. Fig. 3 shows dependence of (a) H_k and K_u, (b) $v_{act}K_u^{grain}/kT$ and (c) α on d_{BL}. When d_{BL} is varied from 0 to 1.5 nm, H_k remains constant at around 19 kOe, $v_{act}K_u^{grain}/kT$ decreases from 160 to 140, and α decreases from 1.7 to 1.2, which reveals that the granular medium is thermally stable and the intergranular exchange decoupling is promoted. Further increase of d_{BL} to 3.0 nm will decrease H_k from 19 to 17 kOe. This result suggests that the decrease of degree of intergranular exchange coupling when d_{BL} is increased from 0 to 1.5 nm induces larger H_c. Furthermore, the reduction of H_c for d_{BL} thicker than 1.5 nm is caused by the reduction of H_k which is originated from K_u reduction.

From these results, the introduction of RuCoCr-TiO_2 BL underneath the high K_u CoPt-B_2O_3 granular media is quite effective to increase H_c through reduction of intergranular exchange coupling.

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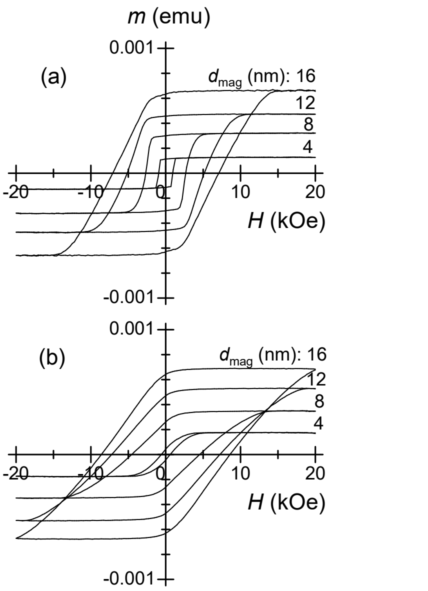
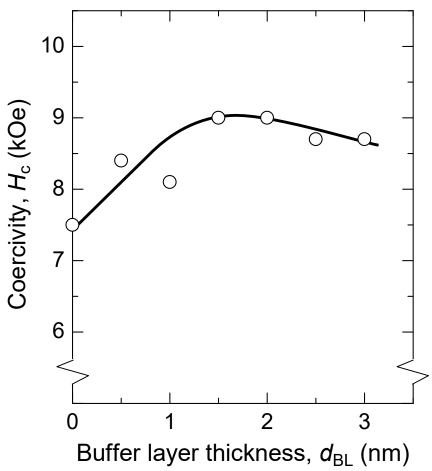


Fig. 1 *m-H* loops for CoPt-B_2O_3 granular media (a) without and (b) with RuCoCr-TiO_2 buffer layer (1 nm) at various granular layer thicknesses.

Fig. 2 Dependence of coercivity (H_c) on the buffer layer thickness (d_{BL}).



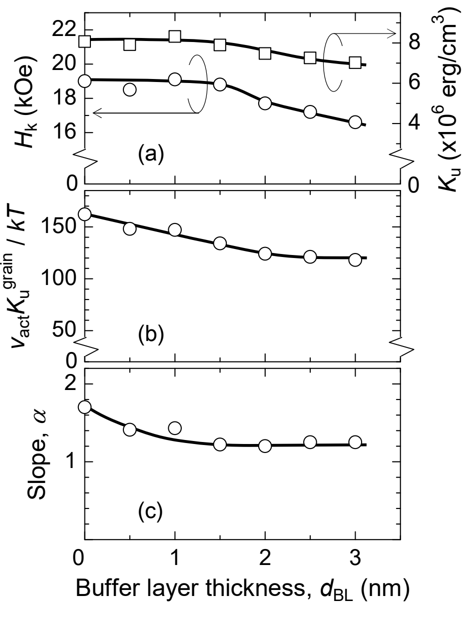


Fig. 3 Dependence of (a) H_k and K_u, (b) $v_{act}K_u^{grain}/kT$ and (c) Slope (α) on buffer layer thickness (d_{BL}).