AB03

Effects of Substrate Temperature and Cu Underlayer Thickness on the Formation of $SmCo_5$ Epitaxial Thin Films on Al_2O_3(0001) Single-Crystal Substrates

Mitsuru Ohtake[1]*, Yuri Nukaga[1], Fumiyoshi Kirino[2], and Masaaki Futamoto[1]
[1]Faculty of Science and Engineering, Chuo University, Bunkyo-ku, Tokyo 112-8551, Japan
[2]Tokyo National University of Fine Arts and Music, Taito-ku, Tokyo 110-8714, Japan
*Corresponding author: E-mail: ohtake@futamoto.elect.chuo-u.ac.jp

$SmCo_5$ is a high Ku material of 1.1×10^8 erg/cm^3 and has been investigated recently for applications as thin film magnets, thin film recording media, etc. $SmCo_5$ polycrystalline films with (0001) preferred texture have been prepared by employing Cu underlayers on glass or SiO_x substrates [1-3]. For such applications, high-quality epitaxial thin films grown on single-crystal substrates are the strong candidates since the magnetic anisotropy and the uniformity are well controlled and can be fabricated into nano-patterns. In our previous study, $SmCo_5$(0001) epitaxial films were prepared on Cu(111) single-crystal underlayers [4]. The aim of this paper is to investigate the effects of substrate temperature and Cu underlayer thickness on the formation of $SmCo_5$(0001) epitaxial thin films and to illustrate the growth structure of $SmCo_5$ crystal on Cu(111) underlayer.

Figure 1 shows the substrate temperature dependence of RHEED pattern observed for $SmCo_5$ films grown on 10-nm-thick Cu underlayers. *In-situ* RHEED observation has shown that $SmCo_5$(0001) epitaxial films are successfully formed. A high-quality $SmCo_5$(0001) epitaxial film was obtained at a substrate temperature of 500 °C. However, for $SmCo_5$ films formed at lower temperatures, amorphous RHEED patterns are overlapped with the ordered RHEED pattern with increasing $SmCo_5$ layer thickness, as shown in Figs. 1(a) and 1(b). The $SmCo_5$ layer has two types of domains whose orientations are rotated around the film normal by 30 degrees each other. Figure 2 shows the XRD spectrum of the $SmCo_5$ film deposited at 500 °C. The $SmCo_5$(0001) superlattice peak is clearly observed in addition to the $SmCo_5$(0002) fundamental peak. Parts of Cu atoms diffuse into the $SmCo_5$ layer from the underlayer and an $Sm(Co,Cu)_5$ alloy layer is presumably formed. The formation of $SmCo_5$ ordered phase is also delicately influenced by the Cu underlayer thickness. The Cu atom diffusion into the $SmCo_5$ layer is considered to play an important role in assisting the formation of $SmCo_5$ epitaxial thin film.

This work was supported in part by NEDO, Japan.

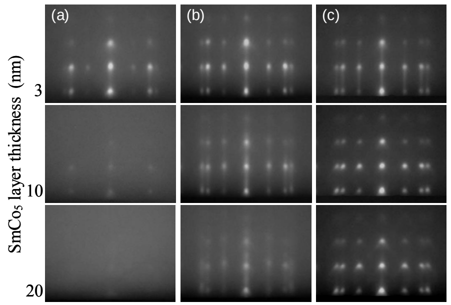

Fig. 1. RHEED patterns obtained from SmCo5 layers grown on 10-nm-thick Cu underlayers at (a) 400 °C, (b) 450 °C, and (c) 500 °C, respectively.

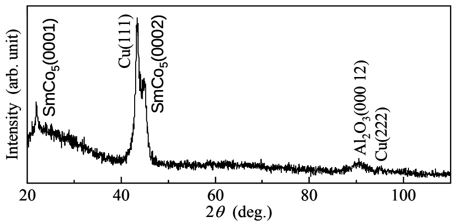

Fig. 2. XRD spectrum of $SmCo_5$ film grown on 10-nm-thick Cu underlayer at 500 °C.

REFERENCES
[1] J. Sayama *et al*.: *J. Phys. D: Appl. Phys*., **37**, L1 (2004).
[2] S. Takei *et al*.: *J. Magn. Magn. Mater*., **272-276**, 1703 (2004).
[3] Y.K. Takahashi *et al*.: *J. Appl. Phys*., **100**, 053913 (2006).
[4] Y. Nukaga *et al*.: *IEEE Trans. Magn*., **44** (2008).

AB04

Different Magnetization Processes Caused by Two Vortex Helicities of Onion States in Permalloy Rings

Mei-Feng Lai*
Institute of NanoEngineering and MicroSystems, National Tsing Hua University, Hsinchu 300, TAIWAN.
*Corresponding author: E-mail: mflai@mx.nthu.edu.tw

Ring-structured magnetic thin film has attracted much attention and become a promising candidate for the data storage application [1]. It is also a good system for the study of dynamics of domain walls [2,3]. Most previous works [2,3] indicate that in a magnetization reversal process the onion state transforms to flux closure state and finally to the reverse onion state. So the hysteresis loop exhibits two obvious sharp steps, which correspond to the transitions from the onion state to flux closure state and from the flux closure state to the reverse onion state. In this study, two different remanent magnetization configurations in permalloy rings are verified experimentally and numerically to lead to different magnetization reversal processes, which are caused by the helicities of the two small vortex domain walls in the two sides of the onion state. When the two vortex domain walls are in the same helicity, the onion state will transform to flux closure state/vortex state with increasing of the field, and then transform from the flux closure state/vortex state to the reverse onion state with further increasing of the field. When the two vortex domain walls are in opposite helicities, however, with increasing of the field the onion state will transform directly to the reverse onion state skipping the flux closure state/vortex state. Magnetoresistance corresponding to the above two magnetization reversal processes is obtained by experimental and numerical approaches, which are in good agreement.

REFERENCES
[1] J.-G. Zhu and Y. Zheng, J. Appl. Phys. 87, 6668 (2000).
[2] M.-F. Lai, Z.-H. Wei, C.-R. Chang, J. C. Wu, J. H. Kuo, and J.-Y. Lai, Phys. Rev. B 67, 104419 (2003).
[3] M. Klaui, CAF Vaz, L. Lopez-Diaz, and JAC Bland, J. Phys. Condensed Matter 15, 985 (2003).