

AB03

Effects of Substrate Temperature and Cu Underlayer Thickness on the Formation of SmCo₅ Epitaxial Thin Films on Al₂O₃(0001) Single-Crystal Substrates

Mitsum Ohtake^{1*}, Yuri Nukaga¹, Fumiyoshi Kirino², and Masaaki Futamoto¹¹Faculty of Science and Engineering, Chuo University, Bunkyo-ku, Tokyo 112-8551, Japan²Tokyo National University of Fine Arts and Music, Taito-ku, Tokyo 110-8714, Japan

*Corresponding author: E-mail: ohtake@futamoto.elect.chuo-u.ac.jp

SmCo₅ is a high Ku material of 1.1×10^8 erg/cm³ and has been investigated recently for applications as thin film magnets, thin film recording media, etc. SmCo₅ 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, SmCo₅(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 SmCo₅(0001) epitaxial thin films and to illustrate the growth structure of SmCo₅ crystal on Cu(111) underlayer.

Figure 1 shows the substrate temperature dependence of RHEED pattern observed for SmCo₅ films grown on 10-nm-thick Cu underlayers. *In-situ* RHEED observation has shown that SmCo₅(0001) epitaxial films are successfully formed. A high-quality SmCo₅(0001) epitaxial film was obtained at a substrate temperature of 500 °C. However, for SmCo₅ films formed at lower temperatures, amorphous RHEED patterns are overlapped with the ordered RHEED pattern with increasing SmCo₅ layer thickness, as shown in Figs. 1(a) and 1(b). The SmCo₅ 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 SmCo₅ film deposited at 500 °C. The SmCo₅(0001) superlattice peak is clearly observed in addition to the SmCo₅(0002) fundamental peak. Parts of Cu atoms diffuse into the SmCo₅ layer from the underlayer and an Sm(Co,Cu)₅ alloy layer is presumably formed. The formation of SmCo₅ ordered phase is also delicately influenced by the Cu underlayer thickness. The Cu atom diffusion into the SmCo₅ layer is considered to play an important role in assisting the formation of SmCo₅ epitaxial thin film.

This work was supported in part by NEDO, Japan.

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).

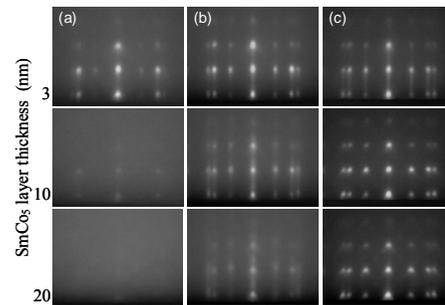


Fig. 1. RHEED patterns obtained from SmCo₅ layers grown on 10-nm-thick Cu underlayers at (a) 400 °C, (b) 450 °C, and (c) 500 °C, respectively.

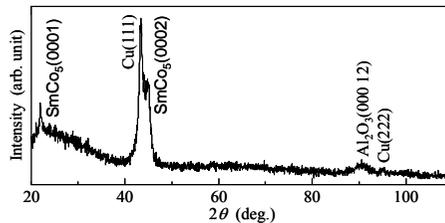


Fig. 2. XRD spectrum of SmCo₅ film grown on 10-nm-thick Cu underlayer at 500 °C.

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).