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反応性マグネトロンスパッタリング法により作製した Fe リッチ Co フェライトエピタキシャル薄膜における垂直磁気異方性の評価

Evaluation of Perpendicular Magnetic Anisotropy in Fe-rich Cobalt Ferrite Epitaxial Thin Film Grown by a Reactive Magnetron Sputtering Technique

筑波大学 [1]，高エネ研 [2]　○新関 智彦 [1]，内海 優二 [1]，井浦 真 [1]，柳原 英人 [1]，喜多 英治 [1]，中尾 裕則 [2]，雨宮 健太 [2]，酒巻 真粧子 [2]

Univ. of Tsukuba[1], KEK-PF[2] ○Tomohiko Niizeki[1], Yuji Utsumi[1], Makoto Iura[1], Hideto Yanagihara[1], Eiji Kita[1], Hironori Nakao[2], Kenta Amemiya[2], Masako Sakamaki[2]

E-mail: niizeki.tomohiko.gm@u.tsukuba.ac.jp

Recently, there is a great need for highly functional, but ubiquitous materials that enable us to hedge against potential market risk of precious materials. In the field of magnetic recording, for example, most of the magnetic thin films exhibiting large perpendicular magnetic anisotropy (PMA) depend on noble metals or rare earth elements to possess large spin-orbit coupling. On the other hand, some spinel ferrites composed of 3*d* transition elements and oxygen such as cobalt-ferrite ($CoFe_2O_4$) are known to show strong PMA without help of precious elements but with lateral strain by pseudomorphic epitaxial growth [1]. In this study, we have investigated strain-induced PMA of Fe-rich cobalt-ferrite epitaxial thin film to evaluate that of stoichiometric $CoFe_2O_4$, circumventing the direct evaluation of the ultra hard magnetic properties.

Epitaxial Fe-rich Co ferrite ($Co_{1-0.25}Fe_{2+0.25}O_4$) thin films were epitaxially grown on cleaved MgO(001) substrates by reactively sputtering an alloy target of $Co_{25}Fe_{75}$ (Co:Fe=1:3) in the mixture of Ar and O_2 gasses. The total pressure during the process is 0.5-0.6 Pa, where O_2 gas flow rate was varied from 1.2 to 2.1 sccm (~ 0.005 Pa). The *M-H* loops and the magnetic torque curves of the films were measured at 300 K by using SQUID-VSM and on-chip strain-gauge method with a horizontal rotator, respectively.

The magnetization of our $Co_{1-0.25}Fe_{2+0.25}O_4$ films is successfully saturated at 70 kOe in perpendicular geometry and the saturation magnetization reaches as high as 430 emu/cc for the sample prepared with O_2 flow rate of 1.8 sccm. The uniaxial anisotropy constant estimated from torque curves measured at 90 kOe also shows the maximum of 5.7 Merg/cc at the same condition, that is twice as large as the crystalline anisotropy constant of stoichiometric bulk $CoFe_2O_4$ (~ 3 Merg/cc) [2]. The result of anomalous X-ray diffraction measurement revealed little anti-site defect (swap between Co and Fe cations) exists in our film. The spectra of X-ray magnetic circular dichroism suggest considerable amount of orbital angular momentum of Co cation left in our film which is consistent with relatively large saturation magnetization obtained for our films compared with that estimated on the assumption that orbital momentum of Co cation is quenched.

[1] A. Lisfi *et al.*, Phys. Rev. B **76**, 054405 (2007).

[2] R. M. Bozorth *et al.*, Phys. Rev. **99**, 1788 (1955).