CONTROL OF EPITAXIAL STRAIN AND MAGNETIC ANISOTROPY IN COBALT-FERRITE THIN FILMS BY VARIOUS BUFFER LAYERS

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I. Introduction

Large PMA can be introduced via the magnetoelastic effects in a uniaxial distortion by a substrate-induced epitaxial strain[2], for example. In fact, cobalt-ferrite (CFO) thin films grown on MgO(001) substrate suffering 0.6% in-plane tensile strain, results in introducing a large perpendicular magnetic anisotropy (PMA) K_u^{eff} of 14.7 Merg/cm^3 [1]. Likewise, CFO films grown on Mg_2AlO_4(001) substrate suffering 3.6 % in-plane compressive strain, exhibits as large as negative K_u of – 60 Merg/cm^3. In addition, even though such a large lattice strain, those induced PMA of CFO(001) epitaxial films can be quantitatively explained within a framework of magneto-elastic theory[3]. In other words, the induced magnetic anisotropy can be quantitatively explained by the phenomenological magneto-elastic effect in this lattice distortion range, at least. Therefore, even larger PMA by inducing 3~4 % tensile strain can be expected. In this study, we report various buffer layers to introduce the larger lattice constant than MgO(001) and the magnetic anisotropy, especially induced K_u of CFO(001).

II. Experimental

We selected Mg_2SnO_4 (MSO) as buffer layers and grew it by using a reactive rf-magnetron co-sputtering of Mg and Sn metal targets. The reactive gas was pure oxygen. We grew CFO films by using a reactive rf-magnetron sputtering of a CoFe alloy target. We evaluated surface and crystal structure for the CFO films by a reflection high energy electron diffraction (RHEED) and X-ray diffraction techniques. Magnetization and magnetic anisotropy constants were measured by using a SQUID magnetometer and a magnetic torque measurement.

III. Results

RHHED images of both MSO and CFO films show the streak patterns, suggesting a single crystal and sufficiently flat surfaces. Figure 1 shows in-plane and out-of-plane MH-loops of 10-nm-thick CFO film on an 80-nm-thick MSO buffer layer. The value of the saturation magnetization was 460 emu/cm^3, which is larger than 425 emu/cm^3 for bulk CFO. Surprisingly, in-plane magnetization was not saturated at all even when 70 kOe was applied. Apparently, a strong PMA presents in the film. From a magnetic torque measurement, the intrinsic K_u^{eff} was estimated to be over 20 Merg/cm^3.

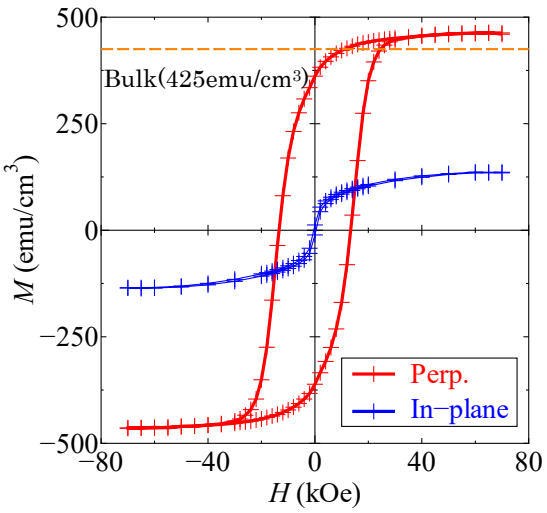

Figure 1: MH loops of the thin film (CFO thickness: 10 nm)

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