$Mn_{2-\delta}CoGa_{1+\delta}$ 薄膜における正方晶歪と垂直磁気異方性

Tetragonal strain and perpendicular magnetic anisotropy in $Mn_{2-\delta}CoGa_{1+\delta}$ thin films

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Mn_2CoGa is an ordered alloy that has inverse Heusler or $L2_{1b}$ structure. In either case, half metallic density of states was predicted, in which a semiconducting band gap appears in one spin channel at the Fermi level [1]. Our group reported that the lattice strain, i.e., the *c*/*a* ratio where *c* and *a* are lattice constants of a unit cell, of $Mn_{2-\delta}CoGa_{1+\delta}$ ($\delta = 0.3$) thin films depends on the metallic buffer layer material and the film thickness. As a result, we found a positive correlation between the *c*/*a* ratio and the uniaxial magnetic anisotropy constant, K_u [2]. In terms of spintronics application, half-metallic materials showing the uniaxial magnetocrystalline anisotropy are interesting, and it is important to study their spin-dependent transport properties. However, the previous sample structure utilizing the metallic buffer layers causes current shunting which leads to the complication in transport. Therefore, in this study, we have aimed to control the lattice strain and the K_u using the film samples directly deposited onto insulating oxide substrates.

In experiments, a $Mn_{2-\delta}CoGa_{1+\delta}$ ($\delta = 0.1$) layer was deposited on substrates with different lattice constants (MgO, $SrTiO_3$) by using ultrahigh vacuum-compatible magnetron sputtering system. The layer thicknesses, *t*, were 5, 10, 20, and 30 nm. The substrate temperature was 500 °C. A 3-nm-thick Ta was subsequently deposited at room temperature as a protection layer. Compared to the lattice of Mn_2CoGa, the lattice constants of MgO and $SrTiO_3$ are about 2% larger and 6% smaller, respectively. The values of *c/a* ratio were determined using x-ray diffraction (XRD) patterns, and the K_u was determined from the in-plane and out-of-plane magnetization curves measured by a vibrating sample magnetometer.

From the XRD results, the maximum *c*/*a* ratio was 1.02 for a 5-nm-thick sample onto the $SrTiO_3$ substrate. The *c*/*a* ratio decreases with *t* and it was almost 1 for *t*=30 nm. A positive correlation between *c*/*a* and K_u was confirmed in the sample onto the $SrTiO_3$ substrates, which is similar with the previous results for metallic buffer layers. Details including the results for the samples onto MgO substrates will be reported in the presentation.

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