Fabrication of $L2_1$-ordered Co_2TiSi Heusler Alloy Epitaxial Films

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Recently, Co_2TiSi full-Heusler alloy is theoretically predicted to be the Weyl semimetal that the Weyl points exist in wave number space. [1] Because of the existence of the Weyl points, a large anomalous Hall effect can be observed in the Co_2TiSi full-Heusler alloy. In addition, Co_2TiSi has a large spin polarization due to its half-metallic property. [2] Therefore, Co_2TiSi has attracted much attention as a potential candidate for spintronics applications. [3] In this research, we fabricated Co_2TiSi thin films epitaxially grown on MgO substrates and investigated their anomalous Hall effect.

The ultra-high vacuum magnetron sputtering method was used for the preparation of the thin films. The structure of the sample was MgO (001) sub. / Co_2TiSi (50 nm) / Ta (5 nm). For the deposition of Co_2TiSi films, the Ar gas pressure was 0.07 to 0.15 Pa, and the substrate heating temperature (T_s) and the post annealing temperature (T_a) were varied in the range of 300 to 700℃. The sputtering power (W_T) was also changed from 40 W to 100 W. We characterized the crystal structure by XRD, the magnetic property by SQUID, and the anomalous Hall effect by PPMS.

Fig. 1 shows the Ar gas pressure p dependence of $L2_1$ order parameters for Co_2TiSi thin films annealed at 700°C. In the condition of p = 0.11 and 0.15 Pa, a high $L2_1$ order parameters > 80% was successfully obtained. Fig. 2 shows the measurement temperature dependence of the saturation magnetization in the samples with p = 0.07, 0.11, and 0.15 Pa (T_a = 700°C). The magnitude of saturation magnetization was close to the bulk value (213 emu/cc) at low temperature regardless of the Ar gas pressure. [4] However, the anomalous Hall conductivity of sample was 20 - 30 S/cm at low temperature and it was much smaller than the expected value. We infer that the Fermi level for the prepared Co_2TiSi is not cross the Weyl points and further control of the film composition is needed to observe the large anomalous Hall effect.

Reference

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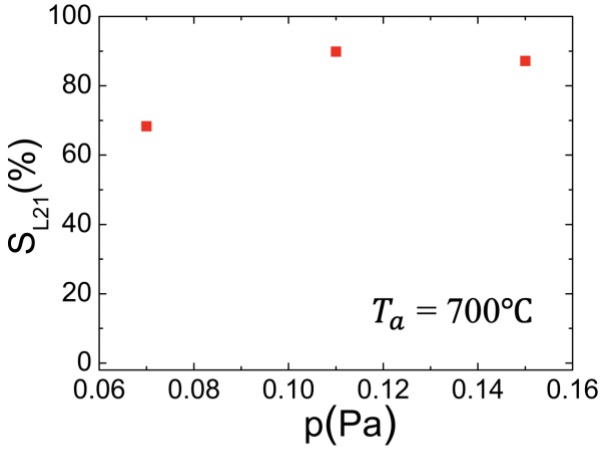

Fig. 1 Deposition pressure dependence of $L2_1$ order parameter

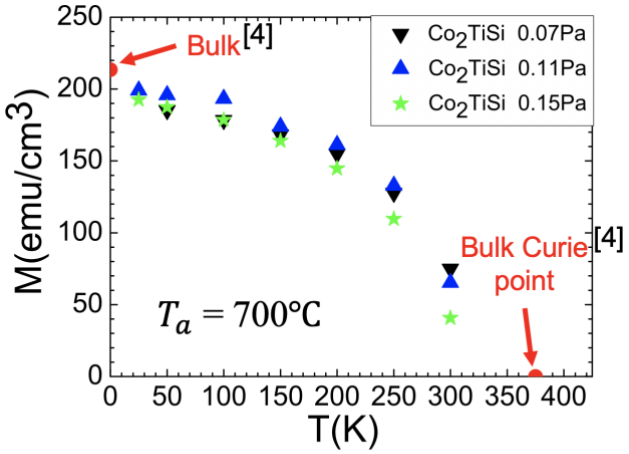

Fig. 2 Measurement temperature dependence of the saturation magnetization