Large Anomalous Hall Effect in Antiferromagnetic Mn_3Sn Thin Films

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Anomalous Hall effect (AHE) has been considered to occur only in ferromagnetic materials. Recently, the origin of the effect is revealed, and the possibility of AHE effect in antiferromagnetic materials was pointed out. Experimentally, in bulk single crystal of antiferromagnetic Mn_3Sn, an AHE was observed which has a significant amplitude as same as ferromagnetic materials. This effect is called large AHE [1]. If we can apply this effect to practical devices such as magnetic random access memories, they can be densified, because antiferromagnetic materials do not leak the disturbing magnetic field around them. The purpose of this research is the fabrication of Mn_3Sn thin films and the observation of large AHE.

Thin films were deposited on SiO_2 substrate by Mn and Sn co-sputtering method at room temperature. The stacking structure of the films is Ta(5 nm)/$Mn_{100-x}Sn_x$(50 nm)/ substrate, where, x = 20, 25, 27, and 30 at%. After the deposition, the films were annealed to promote crystallization. X-ray diffraction (XRD) was conducted to analyze the crystal structure of the films.

In the XRD profiles, a diffraction peak originated from Mn_3Sn phase was observed for the samples annealed at 400ºC or higher. From magnetization curve which was measured by superconducting quantum interference device (SQUID), we found that the value of magnetization and coercivity were 10 times larger than those of the bulk Mn_3Sn and that the shape of the magnetization curve was similar to the bulk's one. From the measurement of the AHE in $Mn_{100-x}Sn_x$ thin films shown in Fig. 1, we found the magnitude is 10 times smaller than the bulk's one. When we normalize the AHE magnitude by the magnetization value, it is one or two order larger than those of usual ferromagnetic materials. We concluded that the large AHE was successfully observed in $Mn_{100-x}Sn_x$ thin films.

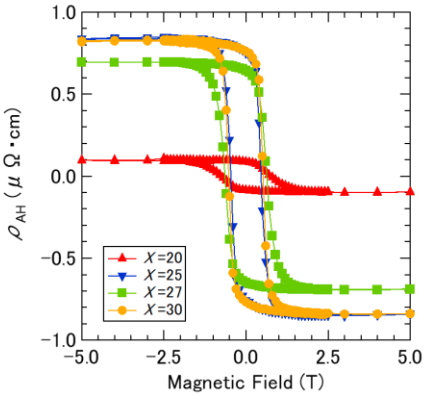

Fig.1. Results of measuring AHE

[1] . S. Nakatsuji *et al*., Nature **527**, 212–215 (2015).