

Anomalous Hall Effect in Epitaxial Thin Films of Mn₂VAI Full-Heusler Alloy

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Mn-based full-Heusler ferrimagnet, Mn₂VAI is a promising source for spin injection because of its high spin polarization and low magnetization, however, the magneto-transport properties of the thin films have scarcely been reported. Mn₂VAI may exhibit specific behavior in anomalous Hall effect (AHE) as compared to well-studied Co-based Heusler alloys because the DOS in spin-down electrons for Mn₂VAI consists of the *d* orbital band at the Fermi level [1]. In this study, AHE in epitaxial thin films of Mn₂VAI was investigated.

50-nm-thick Mn₂VAI films were epitaxially grown on MgO (001) single-crystal substrates using a magnetron sputtering technique with various substrate temperatures (*T_s*). AHE was measured in the 10-300 K temperature range using DC four-probe method of a Quantum Design physical properties measurement system. The Hall resistivity (ρ_{xy}) and the longitudinal resistivity (ρ_{xx}) were simultaneously measured. An external magnetic field (*H*) of up to 50 kOe was applied perpendicular to (001) film plane, and electric current was applied to Mn₂VAI[100] direction. The anomalous Hall resistivity (ρ_{AH}) was obtained from a ρ_{xy} vs. *H* curve by extrapolating the linear part of ρ_{xy} to *H* = 0.

Fig. 1 shows (a) dependence of ρ_{xy} and ρ_{xx} on *H* in the film with *T_s* = 600°C and (b) dependence of ρ_{AH} and ρ_{xx} at *H* = 50 kOe on *T_s*. At *T_s* = 300°C and 700°C, the magnitude of ρ_{AH} was quite low because the film with *T_s* = 300°C has no magnetization and the film with *T_s* = 700°C grew like island [2], which resulted in high ρ_{xx} . The ρ_{AH} took maximum at *T_s* = 600°C, and this trend was similar to the dependence of order parameter (or magnetization) on *T_s* [2]. The maximum ρ_{AH} of Mn₂VAI was about 15 times as high as that of 30-nm-thick epitaxial film of a Co-based Heusler alloy, Co₂Fe_{0.4}Mn_{0.6}Si (ρ_{AH} = 0.126 $\mu\Omega \cdot \text{cm}$, ρ_{xx} = 48.8 $\mu\Omega \cdot \text{cm}$ at *T_{meas.}* = 300 K). This relatively high ρ_{AH} of Mn₂VAI may be caused by *d* band at the Fermi level.

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[1] I. Galanakis *et al.*, Phys. Rev. B **75**, 092407 (2007).

[2] K. Fukuda *et al.*, IEEE Trans. Magn. **53**, 2600304 (2017).

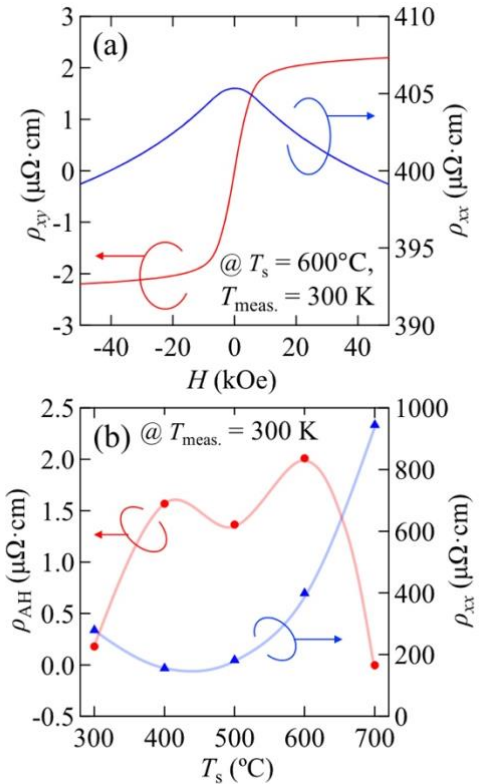


Fig. 1 (a) Dependence of ρ_{xy} and ρ_{xx} on *H* at *T_{meas.}* = 300 K in the film with *T_s* = 600°C and (b) *T_s* dependence of ρ_{AH} and ρ_{xx} (at *H* = 50 kOe) at *T_{meas.}* = 300 K.