Temperature dependence of magneto-transport properties of $Mn_{4-x}Ni_xN$ thin films

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[Introduction]

Ferrimagnetic Mn_4N thin film is a candidate of the future domain wall (DW) motion devices thanks to its small spontaneous magnetization (M_S) of ~ 100 emu/cm^3 and perpendicular magnetic anisotropy (PMA) of 1 Merg/cm^3 [1]. We successfully grew $Mn_{4-x}Ni_xN$ thin films on MgO(001) and STO(001) substrates by MBE, finding out that M_S drastically decreased by a small amount of Ni substitution and PMA was preserved meanwhile [2]. We note that the sign of anomalous Hall resistivity (ρ_{xy}) reversed between x = 0.1 and 0.25, suggesting magnetization compensation of Mn_4N by Ni substitution [2]. It was reported that maximum performance of DW motion was observed in ferrimagnetic materials at their compensation points [3]. In this work, we observed temperature dependence of magneto-transport properties in order to analyze its mechanism of compensation.

[Experiment]

25-nm-thick $Mn_{4-x}Ni_xN$ (x = 0.1 and 0.25) epitaxial films were grown on STO(001) substrates. Afterwards, the stripe, with a 50 μm width and 80 μm length, was formed along the Mn_4N[100] direction for each sample. Anomalous Hall effect measurement was performed for them in the temperature range 10 – 290 K. Magnetic field was applied perpendicularly to the planes.

[Results and discussion]

Figure 1 shows ρ_{xy} of $Mn_{4-x}Ni_xN$ thin films on STO(001) substrates for x = 0.1 (top) and x = 0.25 (bottom). ρ_{xy} of $Mn_{3.75}Ni_{0.25}N$ didn't change as much as that of $Mn_{3.9}Ni_{0.1}N$, which we attribute to weakened temperature dependence by alloying. Similar tendency was also found in $Fe_{4-x}Mn_xN$ thin films [4]. Instead, the coercivity (μ_0H_C) greatly increased over 1.2 T and AHE couldn't be measured below 150 K in our system. We expect that this divergence occurred because of decrease in M_S, which corresponds to our previous report on temperature dependence of magnetization [2]. We're going to perform X-ray magnetic circular dichroism to verify their compensation.

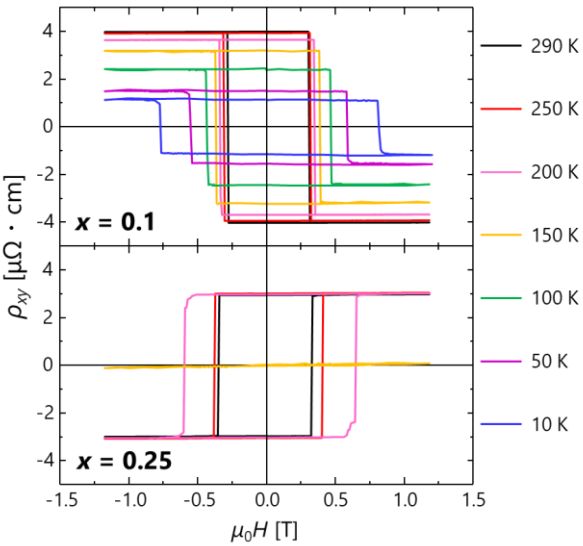

Fig. 1 Temperature dependence of ρ_{xy} of $Mn_{4-x}Ni_xN$ at x=0.1 and 0.25 on STO(001).

[Reference]

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