Significant modification of magneto-transport properties of Mn_4N thin films by Ni substitution

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[Introduction]

Mn_4N thin film is a possible candidate for the future DW motion devices due to its small saturation magnetization (M_S) of 80 emu/cm^3 and perpendicular magnetic anisotropy (PMA) of ~1 Merg/cm^3.[1)] We had successfully grown $Mn_{4-x}Ni_xN$ thin films on MgO(001) substrates by MBE and investigated their magnetic properties, finding out that Ms drastically decreased by a small amount of Ni substitution. PMA was observed when $x \leq 0.25$.[2)] We therefore speculate that $Mn_{4-x}Ni_xN$ is more suitable for faster DW motion than Mn_4N with smaller current. In this work, we grew $Mn_{4-x}Ni_xN$ thin films on $SrTiO_3$ (STO)(001) substrates, which matches the Mn_4N lattice better than MgO(001), and investigated their transport and magnetic properties.

[Experiment]

10-nm-thick Mn_4N film and 30-nm-thick $Mn_{4-x}Ni_xN$ (x = 0.1, 0.25, 0.5) films were grown on STO(001) and MgO(001) substrates by MBE. The magnetic properties were measured by vibrating sample magnetometer (VSM). Anomalous Hall Effect (AHE) was measured by physical properties measurement system (PPMS). Both measurements were performed at room temperature.

[Results and discussion]

PMA was observed in $Mn_{4-x}Ni_xN$ on STO when $x \leq 0.5$ and M_S decreased with the increase of x; M_S of $Mn_{3.9}Ni_{0.1}N$ was 47.4 emu/cm^3. Figures 1 and 2 show the anomalous Hall resistivity (ρ_{AH}) of $Mn_{4-x}Ni_xN$ thin films on STO(001) and MgO(001) with the magnetic field perpendicular to plane. Although the ρ_{AH} of Mn_4N thin film was negative[3)], this value became positive when x = 0.25 and 0.5. We consider that Ni substitution drastically modified the spin-dependent conduction properties of Mn_4N. We plan to measure AMR to investigate magneto-transport properties.

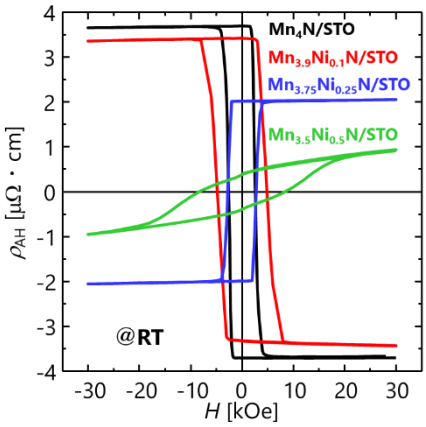

Fig.1 ρ_{AH} of $Mn_{4-x}Ni_xN$ on STO

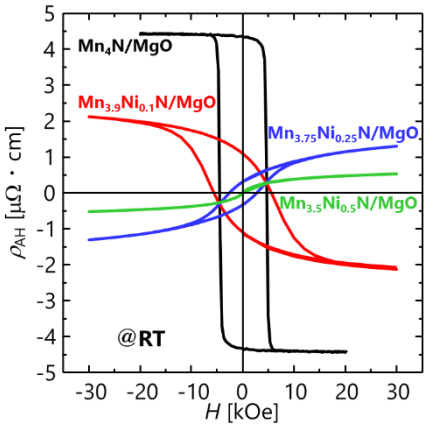

Fig.2 ρ_{AH} of $Mn_{4-x}Ni_xN$ on MgO

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1) K. Ito, Y. Yasutomi *et al.*, Appl. AIP Advances **6**, 056201 (2015).
2) T. Komori *et al.*, the 65th JASP spring meeting, 19p-D104-20 (2018).