Exploring magnetic compensation composition in Fe-doped Mn_4N epitaxial films at room temperature

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[Introduction] Current-induced domain wall motion (CIDWM) is a key phenomenon for spintronics applications. In order to achieve faster CIDWM, we have been investigating Mn_4N-based materials. We achieved the DW velocity of $v_{DW} \sim 900$ m/s at $j = 1.2 \times 10^{12}$ A/m^2 only using spin transfer torque at RT in Mn_4N[1]. Furthermore, we found that the magnetic compensation (MC) occurs at RT in Ni or Co-doped Mn_4N by x-ray magnetic circular dichroism (XMCD) measurements[2][3]. In these materials, Ni(Co) atoms preferentially occupy corner (I) sites with their magnetic moments aligned anti-parallel to those of Mn(I) atoms when its composition is small. This decreases the magnetization and thereby leads to MC (Fig.1). In Ni-doped Mn_4N close to MC, we achieved a much faster v_{DW} of 2000 m/s at RT only driven by STT[5]. Similar MC can be anticipated in Fe-doped Mn_4N films. In this work, we investigate magnetic structures and a MC composition in Fe-doped Mn_4N films.

[Experiment] 20–30 nm-thick Fe-doped Mn_4N films were epitaxially grown on $SrTiO_3$(001) substrates by molecular beam epitaxy. SiO_2 or Pt capping layers were sputtered *in-situ* on the surface to prevent oxidation. Saturation magnetization (M_S) was measured by a vibrating sample magnetometer at RT.

[Result and discussion] Figure 2 shows the M_S values of Fe-doped Mn_4N ($Mn_{4-x}Fe_xN$) films as a function of Fe composition x[4]. Note that the value of M_S does not vary very much around x = 0–1, while obvious increase was observed at x > 1. This tendency can be seen in Ni or Co-doped Mn_4N around its MC composition as well. This suggests that there might be a minimum point of M_S, which suggests the presence of MC point in Fe-doped Mn_4N. The trend in M_S under detailed composition ratio and the result of XMCD will be discussed in the talk.

Acknowledgment

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[Reference]

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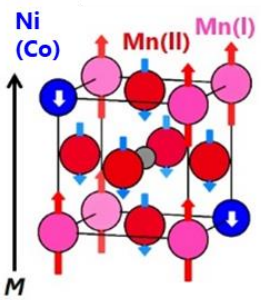

Fig.1 The expected magnetic structure of Ni or Co-doped Mn_4N based on the XMCD results.

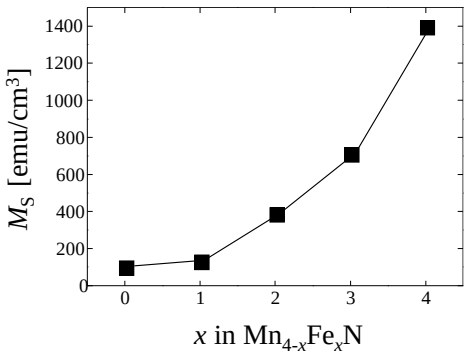

Fig.2 Saturation magnetizations of $Mn_{4-x}Fe_xN$ as a function of x value measured at RT[4].