Magnetic structure of Co-rich $Mn_{4-x}Co_xN$ epitaxial films proved by X-ray magnetic circular dichroism

H. Mitarai[1], T. Yasuda[1], T. Komori[1], K. Toko[1], K. Amemiya[2], and T. Suemasu[1]

1. Inst. of Appl. Phys., Univ. of Tsukuba 2. IMSS, KEK

E-mail: Mitarai06Haruka@gmail.com

[Introduction]

Mn_4N film is an antiperovskite rare-earth free ferrimagnet advantageous in fast magnetization reversal thanks to its perpendicular magnetic anisotropy (K_u ~ 1.1×10^5 J/m^3) and a small saturation magnetization (M_S = 71 kA/m)[1]. On the other hand, Co_4N film is a ferromagnet with high spin polarization of conduction electrons (~ 0.88[2]). Recently, we investigated $Mn_{4-x}Co_xN$ in terms of its magnetic properties and the magnetic structure. So far, we found two magnetic compensation points at RT between x = 0.2 and 0.8 and 0.8 and 1.3. However, there is no information about the magnetic structures of $Mn_{4-x}Co_xN$ with x > 3.0. Clarifying the mechanism of changes in magnetic structure of $Mn_{4-x}Co_xN$ caused by changes in x is of interest. In this work, we performed X-ray magnetic circular dichroism (XMCD) measurements of $Mn_{4-x}Co_xN$ epitaxial films and investigated the change in the magnetic structures by composition ratio at RT.

[Experiment]

Around 15 nm-thick $Mn_{4-x}Co_xN$ films with x = 3.0, 3.6 and 3.9 were epitaxially grown on $SrTiO_3$(001) substrates by molecular beam epitaxy. X-ray absorption spectroscopy (XAS) and XMCD measurements were performed at BL-16A of Photon Factory. We applied magnetic field of ±5T perpendicular to the plane.

[Result and discussion]

Figures 1(a)-(d) show the XAS and XMCD spectra of $Mn_{4-x}Co_xN$ films at the Mn $L_{2,3}$ absorption edges. Both the sharp peak (α) and the broad peak (β) are observed for Mn_4N in Fig. 1(a). In contrast, the broad peak (β) is missing in Figs. 1(b)-1(d), and only the sharp peaks (α) caused by Mn atoms at corner sites [3] are present. The negative sign of these peaks indicates that the magnetic moment of Mn is parallel to that of Co and the external magnetic field. In these XMCD profiles, Mn atoms at face-centered sites are not observed. Thus, we can say that Mn atoms preferentially replace Co atoms at the corner site.

Acknowledgment

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[References]

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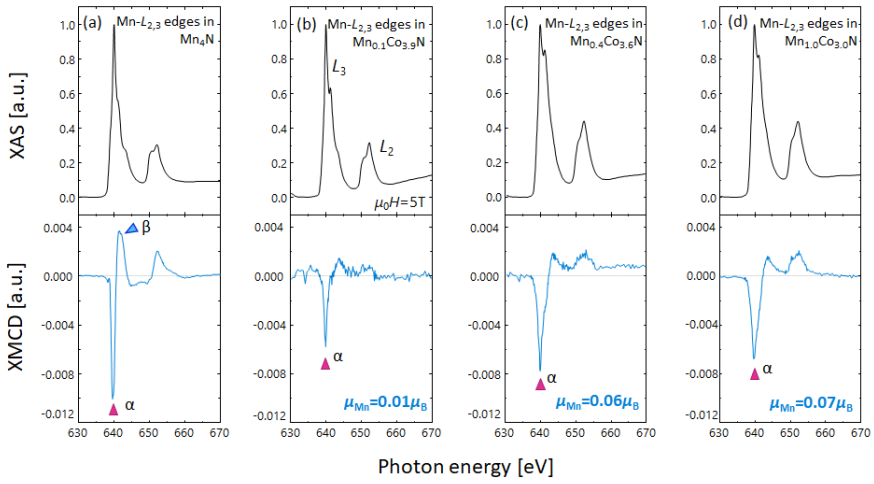

Fig. 1 XAS (black) and XMCD (blue) spectra in (a) Mn_4N, (b) $Mn_{0.1}Co_{3.9}N$, (c) $Mn_{0.4}Co_{3.6}N$, and (d) $Mn_{1.0}Co_{3.0}N$ films at the Mn $L_{2,3}$ absorption edges.