

Temperature-dependence of Nd magnetic moment in a NdFe₁₂N_x thin film by X-ray magnetic circular dichroism

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BACKGROUND

The saturation magnetization, M_s , of NdFe₁₂N compounds with ThMn₁₂ structure is expected to be a high M_s because of a high concentration of Fe¹⁾. Recently, we successfully prepared the NdFe₁₂N_x film with the M_s of 1.66 ± 0.08 T at 300 K.²⁾ Moreover, the Curie temperature of NdFe₁₂N_x was 150 °C higher than that of Nd₂Fe₁₄B. However, the M_s and the anisotropy field, H_A , decays more rapidly as the temperature increase for NdFe₁₂N_x compared with those of Nd₂Fe₁₄B and Sm₂Fe₁₇N₃.³⁾ These trends of the M_s and H_A against temperature strongly depend on the strength of the indirect exchange coupling of Nd(4f)-Fe(3d) according to the *ab initio*-based calculation⁴⁾. In order to investigate the origin of the trend of the M_s against temperature, we measured the temperature dependency of the Nd magnetic moment by measuring temperature dependency of amplitude of the magnetic circular dichroism (MCD) signal from the Nd- $M_{IV,V}$ edge.

EXPERIMENTAL

MgO(001)//W/NdFe₁₂N_x(50 nm)/W(2 nm) was prepared by co-sputtering system followed by ref.2. The XMCD measurement was performed at SPring-8 BL25SU by using electromagnet in the range between -1.9 and +1.9 T at 300, 200, 100 and 15 K.

RESULT

The MCD spectrum was successfully obtained through W cap layer of 2 nm for Nd- $M_{IV,V}$ edge although the probing depth for this XMCD measurement is several nm. Figure (a) shows the hysteresis curves for Nd magnetic moment at various temperatures. Here, the vertical axis was normalized at the value at 15 K and 1.9 T. The magnetic moment of Nd decreases almost linearly with increasing temperature and 30 % of the Nd moment was missing at 300 K as shown in Fig. (b). This trend is different from the total magnetization of NdFe₁₂N_x, which is dominated by the Fe magnetic moments, indicating that the indirect Nd(4f)-Fe(3d) coupling might be relatively weak⁴⁾.

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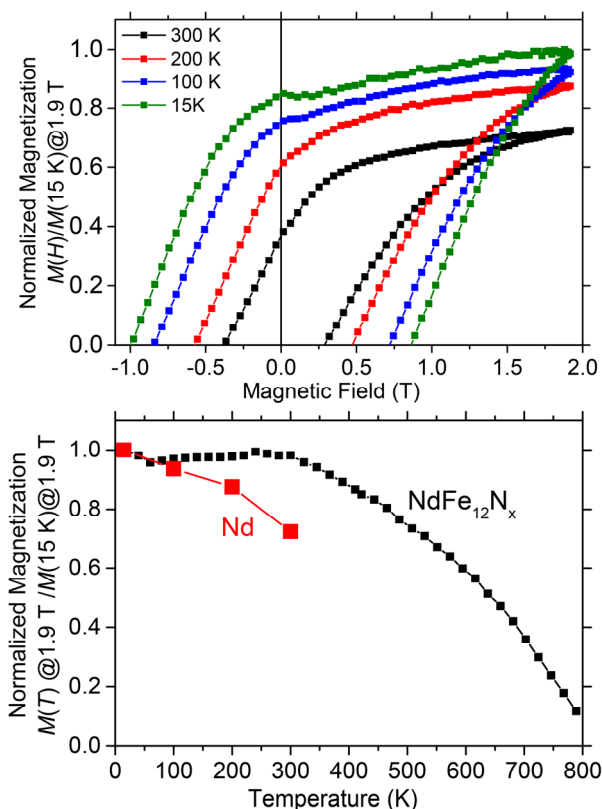


Fig (a) The magnetic hysteresis obtained from Nd- $M_{IV,V}$ edge at various temperature of 300, 200, 100 and 15 K. (b) The temperature dependence of the Nd magnetic moment together with the total magnetic moment of NdFe₁₂N_x.