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Magnetic Compton profile of amorphous $Gd_{50}Ni_{50}$ alloy

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Introduction

Some guiding rules and pictures have emerged for understanding the magnetic properties of Rare-earth (RE) and transition metal (TM) compounds and alloys. Charge transfer model [1] describes well the experimental results that TM magnetic moments decrease gradually with an increase of RE content. According to this model in Gd-Ni alloy system, Ni magnetic moment should decrease and vanish at the RE concentration of $GdNi_2$. However we have found that the Ni retains a magnetic moment in $GdNi_2$ compound by the XMCD measurements [2] and the Magnetic Compton profile (MCP) measurements [3]. In this paper we measure MCPs of $Gd_{50}Ni_{50}$ amorphous alloy and answer the question whether the Ni loses its magnetic moment or not.

Experimental

Amorphous $Gd_{50}Ni_{50}$ alloy ribbons were prepared by melt span method. The alloy ribbons were stacked to increase scattering volume.

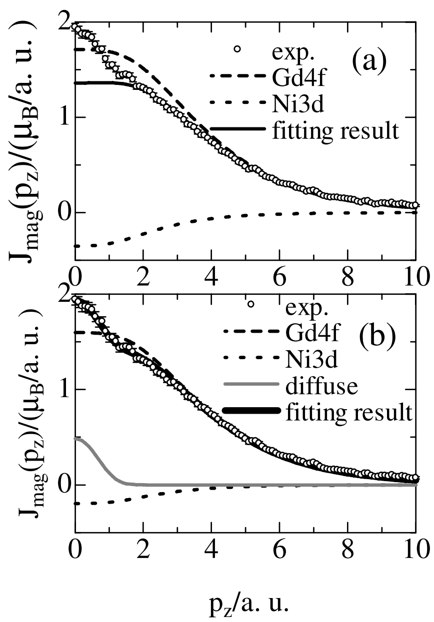
The energy of the incident x-ray was tuned to 135keV. A sample was set in a superconducting magnet with a magnetic field of 1T. The incident X-ray was tilted by 10 degree against the applied field. Surface plane of the ribbon sample was set to be 10 degree from the incident X-ray direction. The measurements were carried out at 10K.

Results and Discussion

The magnetic Compton profile of the stacked amorphous $Gd_{50}Ni_{50}$ alloy ribbon sample is shown in Figure 1. In order to distinguish the contributions between Ni_3d magnetic moment and that of Gd_4f, the MCP is decomposed into Ni_3d contribution and that of Gd_4f employing a least square fitting analysis. The fitting function of Ni_3d and Gd_4f are theoretical momentum distributions of atomic states calculated by Hartree-Fock method [4].

Figure 1(a) shows the decomposed profiles by two components of Gd_4f and Ni_3d. The fitting range is from 2 a. u. to 10 a. u. The region of p_z less than 2 a. u. is excluded because the chemical bonding effects affect the MCPs in this region. From an assumption that the Gd_4f magnetic moment is 7 μ_B, the Ni_3d magnetic moment becomes -0.91 μ_B. However, this value of the Ni_3d magnetic moment is inconsistent with our magnetization measurements (-0.6 μ_B). Furthermore, it has been found that value of Ni_3d magnetic moment depends on the fitting range.

Figure 1(b) shows the decomposed profiles by three components of Gd_4f, Ni_3d and s, p-like 'diffuse' elements. The diffuse contributions come from Ni (4s) and Gd (5d, 6s) electrons. The fitting range is fixed to be from 0 a. u. to 10 a. u. From an assumption that Gd_4f magnetic moment is 7μ_B, Ni_3d magnetic moment becomes -0.55 μ_B. This value of the Ni_3d magnetic moment is almost the same as our magnetization measurements (-0.6 μ_B). The diffuse contribution is 0.37 μ_B. This value is similar to our previous MCP measurements of the $GdNi_2$ compound [3] and GdCu amorphous alloy[5].



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