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Electronic states of Cu-3d electrons in concentrated amorphous Gd-Cu alloys

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Introduction

The Cu metal seems to have played sometimes fascinating and important rolls in solid state physics. Over 30 years long-term's research of Rare Earth (RE)-Transition metal (TM) alloys, the Cu metal has lured the researchers to use it in order to isolate the magnetic exchange interaction of RE alone [1]. The magnetic isolation of RE can provide a clear clue to understanding the roll of magnetic electrons of RE (*4f*, *5s*, *5d* and *6s*). However, these attempts do not seem to have born fruitful information about the electric states of RE, since the sample in Cu-rich content did not saturate and showed spin-glass like behavior.

In 1994, Tanaka *et al*. have tried to elucidate the electronic states of Cu and Gd for $Gd_{60}Cu_{40}$ amorphous alloy [2, 3] by means of magnetic Compton profile (MCP) method [4] and have found that the magnetic moment of the sample was described dominantly by that of *4f* electrons of Gd and that the contribution of spin polarization of *s, p*-like electrons was more suppressed than that of pure Gd metal.

In this report, for the Gd-Cu samples in much richer content of Gd, we examine mainly the effects of strong molecular field from Gd upon Cu-*3d* electrons employing the MCP measurement.

Experimental

The amorphous alloys of Gd_xCu_{100-X} (X=67, 70 at%) were quenched from the melt employing a single roller system. The MCP measurements were carried out at the AR-NE1 beamline. Circularly polarized X-rays emitted from an elliptical multi-pole wiggler were monochromatized and focused on the sample by a single channel-cut bent Si crystal. The energy of incident X-rays were tuned to be 135 keV in order to avoid the effects of some kinds of fluorescence and to obtain a good quality of MCP signals. The sample was cooled by a closed- type refrigerator and the temperature of the sample was held to be 10K and 110K. The magnetic field applied on the sample was 1 Tesla and partly 2 Tesla for 110K, which are large enough to saturate the sample. The Curie temperature of the sample was about 145K.

Results and Discussion

Figure 1 shows the experimentally obtained MCP of amorphous $Gd_{67}Cu_{33}$ alloy at 10K under the magnetic field of 1 Tesla, together with the calculation result. The open circles are the experimental results and the solid line is the calculated MCP of atomic *4f* electrons of Gd employing the relativistic Hartree-Fock method [5]. The most parts of experimental results of MCP (P_z>2.5) can be described by the calculated *4f* electrons of Gd and this result shows that the *3d* electrons of Cu does not contribute to the magnetic moment of the sample and are magnetically inactive.

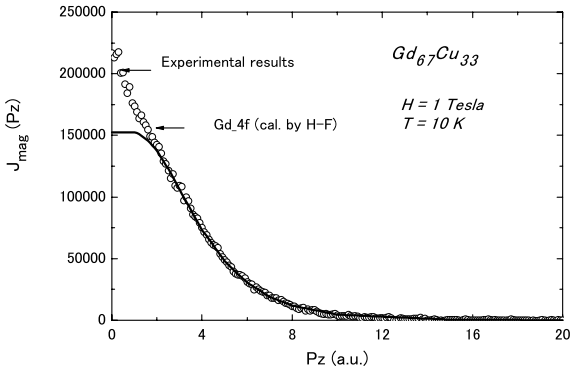

Fig. 1. Magnetic Compton Profile of $Gd_{67}Cu_{33}$ amorphous all The open circles are the experimental results and the solid li the calculated result for 4f electrons of Gd.

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